

**EMC® Symmetrix®
DMX-3**

Product Guide

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Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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.

This equipment has been tested and found to comply with the requirements of European Community Council Directives 89/336/EEC, 73/23/EEC, and 98/68/EEC relating to electromagnetic compatibility and product safety respectively.

This product complies with EN55022, CISPR22 and AS/NZS CISPR22 Class A.

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.

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Korean Ministry of Information and Communication statement

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Systems standards certification and compliance

Stand-alone system enclosures have been tested and certified for compliance with the international environmental and safety specifications listed below. Each enclosure is marked to indicate such compliance and certification as required.

The Symmetrix DMX-3 system is a Stationary Pluggable Type B system.

Safety standards

Standard	Description
CAN/CSA-C22.2 NO. 60950-1-07	Safety of Information Technology Equipment
EN 60950-1	Safety of Information Technology Equipment, including electrical business equipment
IEC 60950-1	Safety of Information Technology Equipment, including electrical business equipment
UL 60950-1	Safety of Information Technology Equipment
GOST IEC 60950-1	Safety of Information Technology Equipment
CNS14336	Safety of Information Technology Equipment
CE Marking	Low Voltage Directive Requirements

EMI/EMS standards

Standard	Description
FCC Part 15	Class A, Radio Frequency Device Requirements
ICES-003	Class A, Interference-Causing Equipments Standard Digital Apparatus
CE Marking	European EMC Directive
VCCI	Class A, Voluntary Control Council for Interference
AS/NZS CISPR22	Class A, Electromagnetic Interference -Limits & Methods of Measurement of ITE
CNS13438	BSMI EMC Requirements
MIC	RRL EMC

HS/TS substances according to Chinese standards

In accordance with China's Administrative Measures on the Control of Pollution Caused by Electronic Information Products (EIP) # 39, also known as China RoHS, the following information is provided regarding the names and concentration levels of Toxic Substances (TS) or Hazardous Substances (HS) which may be contained in EMC products relative to the EIP standards set by China's Ministry of Information Industry.

Name of the Component	Hazardous/Toxic Substance/Elements					
	Lead (PB)	Mercury (Hg)	Cadmium (CD)	Hexavalent Chromium (CR6+)	Polybrominated Biphenyl (PBB)	Polybrominated Diphenyl Ether (PBDE)
Printed Circuit Boards	X	O	O	O	O	O
Power/Buss Backplanes	X	O	O	O	O	O
ac-dc-Power Supplies	X	O	X	O	O	O
dc-dc-Power Supplies	X	O	X	O	O	O
Standard Power Supply (SPS)	X	O	X	O	O	O
Power Distribution Units (PDU)	X	O	X	O	O	O
Power Line Interface Module (PLIM)	X	O	O	O	O	O
ac Power Cords	X	O	O	O	O	O
Fiber Optic Cables /	O	O	O	O	O	O
SFPs (optical cable connectors)	X	O	O	O	O	O
Copper Cables	X	O	O	O	O	O
Batteries (all types)	X	O	O	O	O	O
Relays	X	O	X	O	O	O
Enterprise Director	X	O	O	O	O	O
Fiber Channel Switch	X	O	O	O	O	O
Keyboard Video Monitor (KVM)	X	O	O	O	O	O
Laptop	O	X	O	O	O	O
SCSI Disk drives	O	O	O	O	O	O
ATA Disk drives	O	O	O	O	O	O
Disk Assembly Enclosures	X	O	O	O	O	O
DIMMs	O	O	O	O	O	O
Fan assemblies	X	O	O	O	O	O
Mechanical brackets, slides	O	O	O	O	O	O
Upgrade Mountng Kits	O	O	O	O	O	O
Front Panels / Replacement Doors	O	O	O	O	O	O
Chassis Assembly (sheet metal, etc)	O	O	O	O	O	O
Cabinets Assembly (w/PDUs, etc)	X	O	O	O	O	O
Software / Documentation CDs	O	O	O	O	O	O

X represents that the concentration of such hazardous/toxic substance in all the units of homogeneous material of such component is higher than the SJ/Txxx-2006 Requirements for Concentration Limits.

O represents that no such substances are used or that the concentration is within the aforementioned limits.

依照中国标准的有毒有害物质信息

根据中华人民共和国信息产业部 (MIIT) 制定的电子信息产品 (EIP) 标准 — 中华人民共和国《电子信息产品污染控制管理办法》（第 39 号），也称作中国 RoHS，下表列出了 EMC 产品所包含的有毒有害物质的名称及含量等级方面的信息：

部件名称	有毒、有害物质或元素					
	铅 (PB)	汞 (Hg)	镉 (CD)	六价铬 (CR6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板	X	O	O	O	O	O
电源/母线底板	X	O	O	O	O	O
交流转直流电源	X	O	X	O	O	O
直流转直流电源	X	O	X	O	O	O
备用电源 (SPS)	X	O	X	O	O	O
配电装置 (PDU)	X	O	X	O	O	O
电源线接口模块 (PLIM)	X	O	O	O	O	O
交流电源线	X	O	O	O	O	O
光缆/	O	O	O	O	O	O
SFP (光缆连接器)	X	O	O	O	O	O
铜质电缆	X	O	O	O	O	O
电池 (所有类型)	X	O	O	O	O	O
继电器	X	O	X	O	O	O
企业级导向器	X	O	O	O	O	O
光纤通道交换机	X	O	O	O	O	O
键盘视频显示器 (KVM)	X	O	O	O	O	O
笔记本电脑	O	X	O	O	O	O
SCSI 磁盘驱动器	O	O	O	O	O	O
ATA 磁盘驱动器	O	O	O	O	O	O
磁盘组合存储模块	X	O	O	O	O	O
DIMMs (双列直插式内存模块)	O	O	O	O	O	O
风扇部件	X	O	O	O	O	O
机械支架、滑轨	O	O	O	O	O	O
升级安装工具包	O	O	O	O	O	O
前挡板/备用门	O	O	O	O	O	O
底盘部件 (薄金属板等)	O	O	O	O	O	O
机柜部件 (包括 PDU 等)	X	O	O	O	O	O
软件/文档 CD	O	O	O	O	O	O

- X表示该部件的某一均质材料中的有毒有害物质的含量超出 SJ/Txxx-2006 标准规定的限量要求。
- O表示不含有此类物质或此类物质的含量在上述标准规定的限量要求以下。

California Perchlorate Materials Notice

Attention: This product may contain Perchlorate Material – special handling may apply. See: www.dtsc.ca.gov/hazardouswaste/perchlorate for more specifics.

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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 system or move the system.



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 nondisruptive replacement, never plug or unplug printed circuit boards with the power on. Severe component damage may result.

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. For the latest details and limitations, please refer to the Symmetrix Enginuity Release Notes in the Documentation/White Paper Library on the EMC Powerlink web site at:

<http://Powerlink.EMC.com>

If your Symmetrix DMX-3 does not function properly or does not function as described in this document, please contact your EMC representative.

Audience

This product guide is part of the Symmetrix DMX-3 documentation of the Symmetrix DMX systems (referenced as DMX-3 in this product guide).

This product guide describes the Symmetrix DMX-3 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.

Related documentation

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

<http://Powerlink.EMC.com>

Conventions used in this guide

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

Note: 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.

This product guide contains no DANGER messages.

Typographical conventions

EMC uses the following type style conventions in this document:

Normal

Used in running (nonprocedural) text for:

- Names of interface elements (such as names of windows, dialog boxes, buttons, fields, and menus)
- Names of resources, attributes, pools, Boolean expressions, buttons, DQL statements, keywords, clauses, environment variables, filenames, functions, utilities
- URLs, pathnames, filenames, directory names, computer names, links, groups, service keys, file systems, notifications

Bold:

Used in running (nonprocedural) text for:

- Names of commands, daemons, options, programs, processes, services, applications, utilities, kernels, notifications, system call, man pages

Used in procedures for:

- Names of interface elements (such as names of windows, dialog boxes, buttons, fields, and menus)
- What user specifically selects, clicks, presses, or types

<i>Italic:</i>	Used in all text (including procedures) for: • Full titles of publications referenced in text • Emphasis (for example a new term) • Variables
Courier:	Used for: • System output, such as an error message or script • URLs, complete paths, filenames, prompts, and syntax when shown outside of running text
Courier bold:	Used for: • Specific user input (such as commands)
<i>Courier italic:</i>	Used in procedures for: • Variables on command line • User input variables
< >	Angle brackets enclose parameter or variable values supplied by the user
[]	Square brackets enclose optional values
	Vertical bar indicates alternate selections - the bar means “or”
{ }	Braces indicate content that you must specify (that is, x or y or z)
...	Ellipses indicate nonessential information omitted from the example

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

Where to get help

EMC support, product, and licensing information can be obtained as follows.

Product information — For documentation, release notes, software updates, or for information about EMC products, licensing, and service, go to the EMC Powerlink website (registration required) at:

<http://Powerlink.EMC.com>

Technical support — For technical support, go to EMC Customer Service on Powerlink. To open a service request through Powerlink, you must have a valid support agreement. Please contact your EMC sales representative for details about obtaining a valid support agreement or to answer any questions about your account.

Your comments

Your suggestions will help us continue to improve the accuracy, organization, and overall quality of the user publications. Please send your opinion of this document to:

`techpubscomments@eng.EMC.com`

Introducing the Symmetrix DMX-3

This chapter provides an overview of the Symmetrix DMX-3 and highlights the performance, availability and serviceability features, and hardware and software options.

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Symmetrix DMX-3

The Symmetrix DMX™ systems are EMC’s family of high-end storage solutions. The DMX-3 model establishes a new performance and capacity trajectory for the highest of the high-end enterprise systems. The DMX-3 fully leverages the EMC industry-leading storage management functionality and introduces the economic benefits of scalable packaging to the high-end storage market.

The Symmetrix® DMX-3 is incrementally scalable, supporting from 96 to 1,920 2 Gb/s high-performance Fibre Channel disk drives, providing a maximum raw capacity of approximately 1 PB. To support the massive scalability of DMX-3 configurations, the DMX architecture has been expanded and improved to deliver higher throughput (1 GB/s links) and increased I/O performance (four dual 1.3 GHz PPC processor complexes per director). [Table 1 on page 30](#) describes some of the Symmetrix DMX-3 performance features.

Table 1 Symmetrix DMX-3 performance features

DMX data paths	32 – 128	8 per I/O director, 16 per global memory director
DMX data bandwidth	32 – 128 GB/s	
DMX message bandwidth	4.0 – 6.4 GB/s	
PowerPC processors	84 – 130	Four dual 1.3 GHz processor complexes per director
Global memory	16 – 512 GB ^a	Available in 8, 16, 32, and 64 GB global memory directors
Concurrent Memory transfers	8 – 32	4 per global memory director

a. 256 GB effective

The field-proven Direct Matrix Architecture® (“[Symmetrix DMX-3 architecture](#)” on page 57) provides dedicated, nonblocking interconnects between I/O directors and global memory regions. 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-3 configurations

The DMX-3 consists of a single system bay and from one to eight storage bays. The system bay contains the 24-slot card cage, service processor, power modules, and battery backup unit (BBU) assemblies. The storage bays contain disk drives and associated BBU modules. In a highly scalable component and cabinet configuration, the DMX-3 has the capacity, connectivity, and throughput to handle a wide range of high-end storage applications.

[Figure 1 on page 31](#) provides a front view of the exterior of a Symmetrix DMX-3 configured with one system bay and eight storage bays. [Figure 2 on page 32](#) provides a front view of the exterior of a Symmetrix DMX-3 configured with one system bay and four storage bays. [Figure 3 on page 32](#) provides a front view of the exterior of a Symmetrix DMX-3 configured with one system bay and one storage bay.

[Chapter 2, "Symmetrix DMX-3 Hardware,"](#) provides more complete descriptions of the Symmetrix DMX-3.



Figure 1 Symmetrix DMX-3 nine-bay configuration



Figure 2 Symmetrix DMX-3 five-bay configuration



Figure 3 Symmetrix DMX-3 two-bay configuration

Symmetrix platform and Enginuity operating environment

The Symmetrix DMX hardware architecture ([“Symmetrix DMX-3 architecture” on page 57](#)) and the Enginuity operating environment are the foundation for the Symmetrix DMX system storage platform, which consists of the following:

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

[Figure 4 on page 33](#) illustrates the relationships among these software layers (and Symmetrix hardware).

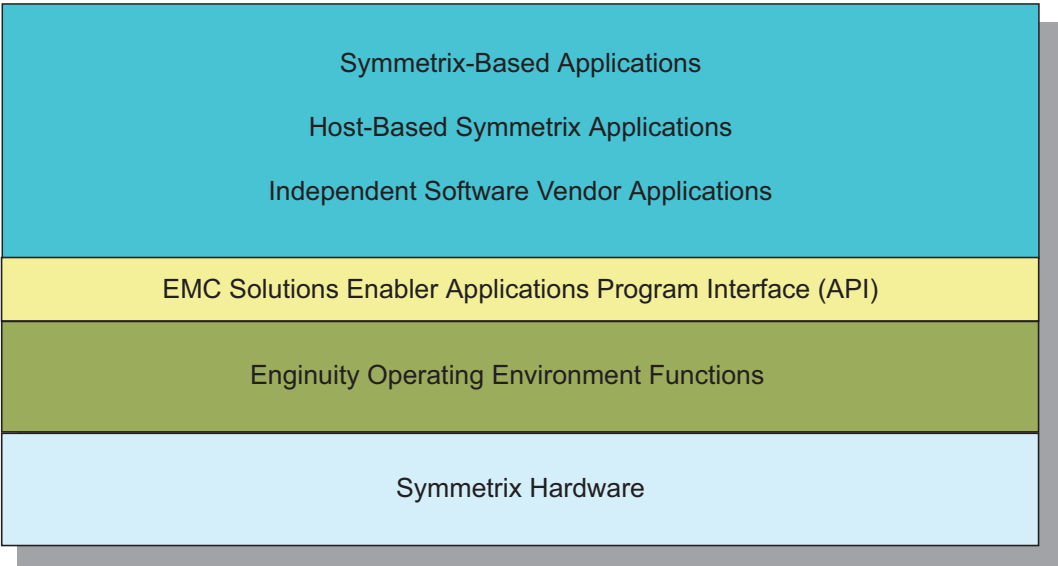


Figure 4 Enginuity and the storage platform relationships

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:

- ◆ Independently 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 Solutions Enabler APIs

EMC 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.

Note: For more information on EMC storage management APIs, contact your local 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-3 offers 73 GB, 146 GB, 300 GB, and 500 GB disk drives and can be configured with from 96 to 1,920 disk drives.

The capacities are based on storage capacity of each disk drive type and the following storage protection options:

- ◆ Mirrored (RAID 1)
- ◆ RAID 10, RAID 1/0
- ◆ SRDF
- ◆ RAID 5 (3+1) or RAID 5 (7+1)
- ◆ RAID 6 (6+2) or RAID 6 (14+2)

Note: Refer to Appendix A for more information on drive and system capacities.

Factors affecting storage capacity

The following factors affect disk storage capacity:

- ◆ Drive capacity size
- ◆ Type of data protection options used
- ◆ Internal Symmetrix File System (SFS) usage — A Symmetrix DMX-3 reserves two SFS logical volumes consisting of 6,140 cylinders each (slightly less than 6 GB). These volumes are protected using mirroring, consuming slightly less than 24 GB total physical space.
- ◆ The size of the blocks — 512 or 520 bytes per block
- ◆ Vault devices — Symmetrix DMX-3 uses vault devices for vaulting data from global memory during a power-down operation. Vault devices require 5 GB of space. For each pair of disk directors in a DMX-3, 160 GB of total capacity is reserved for vaulting data from memory during system powerdown.

Note: Refer to [“Configuration rules for vault devices” on page 70](#) and [“Vaulting” on page 162](#), for more information on Vaulting.

Global memory requirements

The Symmetrix DMX-3 is available with global memory capacity ranging from 16 GB to 512 GB (256 GB effective). The total global memory requirement for a Symmetrix DMX-3 is based upon specific system configurations and customer requirements. Besides the customer's applications, other variables that affect the amount of global memory a Symmetrix DMX-3 requires include the following:

- ◆ Number of global memory directors
- ◆ Variable back-end disk director and front-end channel director board configurations
- ◆ Various loop configurations for disk drives
- ◆ Number of disk drives
- ◆ Disk capacity, including speed and protection type
- ◆ Number of logical volumes

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

Note: [“Global memory directors” on page 82](#) provides additional information on memory configurations can be found in.

Performance features

Symmetrix DMX-3 offers improved performance over conventional Storage Control Unit (SCU) and Direct Access Storage Device (DASD) designs. [Table 2 on page 37](#) identifies many of the Symmetrix DMX-3 and Enginuity supported features that enhance performance and increase throughput.

Table 2 Performance features roadmap (1 of 2)

Feature	Document Sources
Direct Matrix (DMX) Architecture with up to 128 direct nonblocking data paths and up to 128 GB/s aggregate internal bandwidth in the DMX-3	• “Symmetrix DMX-3” on page 30 and “Symmetrix DMX-3 architecture” on page 57 • “Symmetrix DMX-3 and component scaling attributes” on page 54 • “DMX-3 point-to-point message matrix” on page 59
Symmetrix DMX-3 global memory directors for optimized performance	• “Global memory performance features” on page 115 • “Memory striping” on page 116 • “Global memory directors” on page 82 • “Global memory director configuration” on page 84
One hundred percent global memory fast write capabilities	• “Write operations” on page 108 • “Disk mirroring (RAID 1) concepts” on page 178
PermaCache option	• “PermaCache option” on page 119
2 Gb/s Fibre Channel Drive Infrastructure	• “Fibre Channel disk subsystem” on page 66
• Multiple scalable channel directors, disk directors, and global memory directors ^a • ESCON channel speeds up to 17 MB/s • FICON channel speeds up to 4 Gb/s • Fibre Channel speeds up to 4 Gb/s • iSCSI channel speeds up to 1 Gb/s • Gigabit Ethernet (GigE) remote director speeds up to 1 Gb/s • FICON Cascading and Open Systems Intermix Configurations	• “Channel, disk, and global memory directors” on page 75 • “ESCON channel directors” on page 78 • “FICON channel director” on page 80 • “Fibre Channel directors (front-end)” on page 77 • “iSCSI channel directors” on page 81 • “Gigabit Ethernet (GigE) remote directors” on page 81 • “Symmetrix FICON configurations” on page 93
Logical volume capacities	• “Symmetrix DMX-3 logical volume capacities” on page 68
Hypervolume Extension option	• “Open systems hypervolumes” on page 124 • “Mainframe systems hypervolumes” on page 129
Tiered storage optimization	• “Symmetrix Priority Controls” on page 133 • “Dynamic Cache Partitioning” on page 134
Virtual LUNs	• “Virtual LUN technology” on page 136
ControlCenter	• “EMC ControlCenter family of products” on page 143
TimeFinder	• “TimeFinder family of products” on page 147
Dynamic host addressing	• “Dynamic Host Addressing” on page 141

Table 2 Performance features roadmap (2 of 2)

Feature	Document Sources
Tab based Caching (TBC)	• "Tag Based Caching (TBC)" on page 117
3380 and 3390 mixed-track geometry	• "IBM CKD DASD disk emulation" on page 72
Compatible Parallel Access Volumes (COM-PAVs)	• "Compatible Parallel Access Volumes (COM-PAV)" on page 216
Dynamic Parallel Access Volumes	• "Dynamic Parallel Access Volumes" on page 216
PPRC Command Support	• "IBM MetroMirror (PPRC)" on page 219

- a. Contact your local EMC Sales Representative for currently supported host channel connectivity.

Availability and integrity features

The Symmetrix DMX-3 includes key enhancements that improve the reliability, availability, and serviceability. [Table 3 on page 39](#) highlights many of the Symmetrix DMX-3 availability and integrity features.

Table 3 **Availability and integrity features roadmap (1 of 2)**

Feature	Document Sources
Proactive Error Detection and Remote Support	• “Maintaining data integrity” on page 167 • “Error Checking and Correction, and data integrity protection” on page 168 • “Disk error correction and error verification” on page 169 • “Global memory director data integrity logic” on page 170
Support for online Enginuity upgrades and updates	• “Nondisruptive Enginuity upgrades” on page 165
Fully fault-tolerant design with redundant critical components and concurrent maintenance support	• “Reliability and availability features” on page 155
Channel director redundancy with end-to-end automatic channel failover and load balancing	• “Channel director redundancy” on page 156
Internal Control Data Path redundancy	• “Internal control data path redundancy” on page 157
Fibre Channel back-end functionality featuring redundant disk directors, disk channels, and disk ports	• “Fibre Channel back-end redundancy” on page 157 • “Fibre Channel arbitrated loop design” on page 158
Dual-initiator disk directors	• “Dual-initiator feature” on page 160
2N power supply redundancy	• “Redundant power subsystem” on page 161
Vaulting	• “Configuration rules for vault devices” on page 70 • “Vaulting” on page 162
Redundant Global Memory	• “Redundant global memory” on page 155
Advanced Communications and Environmental Control Modules	• “DMX-3 communications and environmental control” on page 88
DMX-3 security features	• “Symmetrix Service Credential, Secured by RSA” on page 173 • “Symmetrix Audit Log” on page 174 • “EMC Certified Data Erasure for Symmetrix Disks” on page 174
Symmetrix Mirroring option	• “Disk mirroring (RAID 1) concepts” on page 178
RAID 5 (3+1), RAID 5 (7+1) RAID 6 (6+2), RAID 6 (14+2) RAID 10 data protection options	• “Symmetrix DMX RAID 5” on page 185 • “Symmetrix DMX RAID 6” on page 193 • “Symmetrix RAID 10 for mainframe systems” on page 183

Table 3 Availability and integrity features roadmap (2 of 2)

Feature	Document Sources
Sparing option	• "Dynamic sparing" on page 204 • "Permanent sparing" on page 201
SRDF	• "Base SRDF family products" on page 208 • "SRDF family options" on page 209
• Nondisruptive component replacement • Nondisruptive change or remove drives	• "Nondisruptive component replacement" on page 164 • "Nondisruptively change or remove FBA devices" on page 166

Serviceability features

Each Symmetrix DMX-3 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-3 control e-net matrix is the Communications and Environmental Control Module, known as the XCM. The XCM provide the low-level system-wide communications for running application software, monitoring, and system diagnostics from the service processor.

Symmetrix DMX systems feature an incrementally scalable 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, which can be replaced while the Symmetrix system is powered on, including:

- ◆ Channel directors
- ◆ Disk directors
- ◆ Global memory directors
- ◆ Disk adapters
- ◆ Channel adapters
- ◆ Disk devices
- ◆ Power supplies
- ◆ Power Distribution Units (PDU)
- ◆ Power Distribution Panels (PDP)
- ◆ Power supply / cooling module for drive enclosure
- ◆ Battery backup modules
- ◆ Cooling fan modules
- ◆ Communications and Environmental Control (XCM) modules
- ◆ Service processor components:
 - Keyboard
 - Video Display and Mouse

Note: [Chapter 2, "Symmetrix DMX-3 Hardware"](#) and ["Nondisruptive component replacement" on page 164](#) provide more information on these components.

Supported software applications

Engenuity is what enables simultaneous connection to virtually all mainframe, UNIX, Windows, AS/400, and Linux platforms — and all validated in EMC's interoperability labs. The result: you can do whatever you want with your information. Centralize it. Re-purpose it. Consolidate it. Replicate it. Share it. Distribute and manage it. Put it to work where it's relevant, anytime without compromise.

Engenuity is the solid foundation of EMC's storage software offering—and the driving force behind the operational consistency and nondisruptive features across Symmetrix.

The software offerings are divided into these categories:

- ◆ [“Tiered Storage Optimization” on page 42](#)
- ◆ [“Storage management” on page 43](#)
- ◆ [“Information management” on page 43](#)
- ◆ [“Symmetrix local and remote replication software solutions” on page 43](#)
- ◆ [“Information mobility” on page 44](#)

Note: Product information on these software options are available on the EMC Powerlink website at:
<http://Powerlink.EMC.com>.

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

Tiered Storage Optimization

EMC delivers two software products with the latest version of Engenuity (V5772) that optimize performance with multi-tiered Symmetrix systems. Dynamic Cache Partitioning provides dedicated memory resource allocation. Symmetrix Priority Controls help manage multiple application workloads by setting priority levels for device groups, allowing higher-priority applications to have faster response times than lower priority applications.

Note: See [“Tiered storage optimization” on page 133](#) for related information.

Storage management

Storage Management Console is an intuitive, browser-based GUI for Symmetrix device management for open systems as well as z/OS-attached systems. Symmetrix Management Console features management and monitoring of local and remote replication, as well as the tiered storage optimization tools Symmetrix Priority Controls and Dynamic Cache Partitioning.

The EMC ControlCenter family of storage management software, provides automated management of your multi-vendor networked storage environment through a single, consistent, information-centric approach.

EMC z/OS Storage Manager (EzSM) is a mainframe software product providing discovery and viewing of your Symmetrix environment. EzSM provides facilities to handle volumes, data sets, catalogs, and detailed Symmetrix functionality information.

Note: See [“EMC ControlCenter family of products” on page 143](#) for related information.

Information management

The Symmetrix Remote Data Facility (SRDF) and TimeFinder families of products deliver the most comprehensive and time-proven replication solutions available in the market.

Note: See [“TimeFinder family of products” on page 147](#) for related information. See [“Base SRDF family products” on page 208](#) and [“SRDF family options” on page 209](#) for related information.

Symmetrix local and remote replication software solutions

The EMC TimeFinder and SRDF families of software are the most powerful suites of local and remote storage replication solutions available in the industry; enabling business continuance volumes for parallel processing activities like backup, testing and development, and local restore, as well as remotely replicated copies to guard against primary site disasters and outages.

Note: See [“TimeFinder family of products” on page 147](#) for related information. See [“Base SRDF family products” on page 208](#) and [“SRDF family options” on page 209](#) for related information.

Information mobility

Copy and move data to where it provides the most value. Symmetrix DMX enables online data mobility and migration while minimizing complexity and disruption. Move data between storage tiers, platforms, and sites quickly, efficiently, and without disruption.

- ◆ EMC Open Migrator/LM — provides host-based, nondisruptive data migration/data mobility at the volume level for Microsoft Windows and UNIX servers.
- ◆ EMC Open Replicator for Symmetrix — Enables remote point-in-time copies to be used for high-speed data mobility, remote vaulting, migrations, and distribution between EMC Symmetrix DMX and qualified storage systems with full or incremental copy capabilities.
- ◆ SRDF/Data Mobility (DM) — Enables rapid transfer of data from source volumes to remote volumes anywhere in the world.

Note: Product information on these software options are available on the EMC Powerlink website at:

<http://Powerlink.EMC.com>.

Note: See “Base SRDF family products” on page 208 and “SRDF family options” on page 209 for related information.

Hardware options

The following hardware options are offered with the DMX-3 systems:

- ◆ DMX-3 Silencer
- ◆ DMX-3 Systems Securing Kits

DMX-3 Silencer

The Symmetrix DMX-3 Silencer as shown in [Figure 5 on page 45](#) is a fan noise reduction option for the Symmetrix DMX-3 system bay and storage bay systems. The Symmetrix DMX-3 Silencer is designed with leading edge sound reducing materials that attenuate high-frequency noise components and reduce overall sound levels. It is designed not to affect airflow or thermal performance.



SYM-001247

Figure 5 DMX-3 Silencer

Table 4 on page 46 provides the DMX-3 Silencer kits model information.

Table 4 DMX-3 Silencer kits model information

Model Number	Description	Comments
TB24-Silencer	System bay silencer kit	1 kit per bay
SB-Silencer	Storage bay silencer kit	1 kit per bay

The DMX-3 Silencer kit contains the following components:

- ◆ DMX-3 Silencer for top of system bay and or storage bay
- ◆ Full length foam piece for the storage bay
- ◆ An 11-in. by 20-in. foam piece for the system bay

Note: Contact your EMC Sales Representative for Silencer kit information and current availability.

DMX-3 Silencer specifications

Table 5 on page 46 lists the dimensions and weight for the DMX-3 Silencer for the system bay and storage bay.

Table 5 DMX-3 Silencer physical specifications

DMX-3 silencer for system bay	Dimensions:	Inches	Centimeters
	Height	8.25	20.96
	Width	23	58.42
	Depth	36.5	92.71
	Weight	Pounds	Kilograms
		10	4.54
DMX-3 silencer for storage bay	Dimensions:	Inches	Centimeters
	Height	6.5	16.51
	Width	29	73.66
	Depth	36.5	92.71
	Weight	Pounds	Kilograms
		9.4	4.26

Table 6 on page 47 lists the sound power and sound pressure levels.

Table 6 Sound power and sound pressure levels-A weighted

Bay	Sound power ^a w/o silencer (B)	Sound power ^a w/silencer (B)	Sound pressure ^b w/o silencer (dB)	Sound pressure ^b w/silencer (dB)
DMX-3 system bay	8.5	8.0	66	62
DMX-3 storage bay	7.8	7.6	62	60
DMX-3 system bay and storage bay	8.5	8.2	68.4	63

- a. Includes 3dB correction factor per Statskontroet.
b. Average of the four sides of the machine per ISO 7779.

DMX-3 Systems Securing Kits

Some customers require that their EMC equipment be installed to withstand significant shock and vibration. Installation of EMC Symmetrix DMX-3 systems securing kits in combination with adequate substrate construction, will mitigate collateral damage during such events.

The kits contain heavy brackets plus hardware used to attach the brackets to the frames of the system and storage bays. The brackets are attached to the floor using bolts that engage the flooring substructure provided by the user.

Symmetrix DMX-3 systems securing kits can be installed to system and storage bays without lifting the bays.

Note: Please refer to the *Symmetrix DMX-3 Physical Planning Guide* for information regarding the EMC securing kits, or contact your EMC Sales Representative for specific information.

Symmetrix DMX-3 Hardware

This chapter describes the main hardware components of the Symmetrix DMX-3 including:

◆ Major components	50
◆ Symmetrix DMX-3 architecture	57
◆ Symmetrix channel connectivity and host integration.....	63
◆ Fibre Channel disk subsystem	66
◆ Channel, disk, and global memory directors.....	75
◆ Symmetrix DMX-3 power subsystems	85
◆ DMX-3 communications and environmental control	88
◆ Channel attachments	91

Major components

The Symmetrix DMX-3 is a disk array subsystem that is composed of a system bay and from one to eight storage bays. This section describes the Symmetrix DMX-3 components.

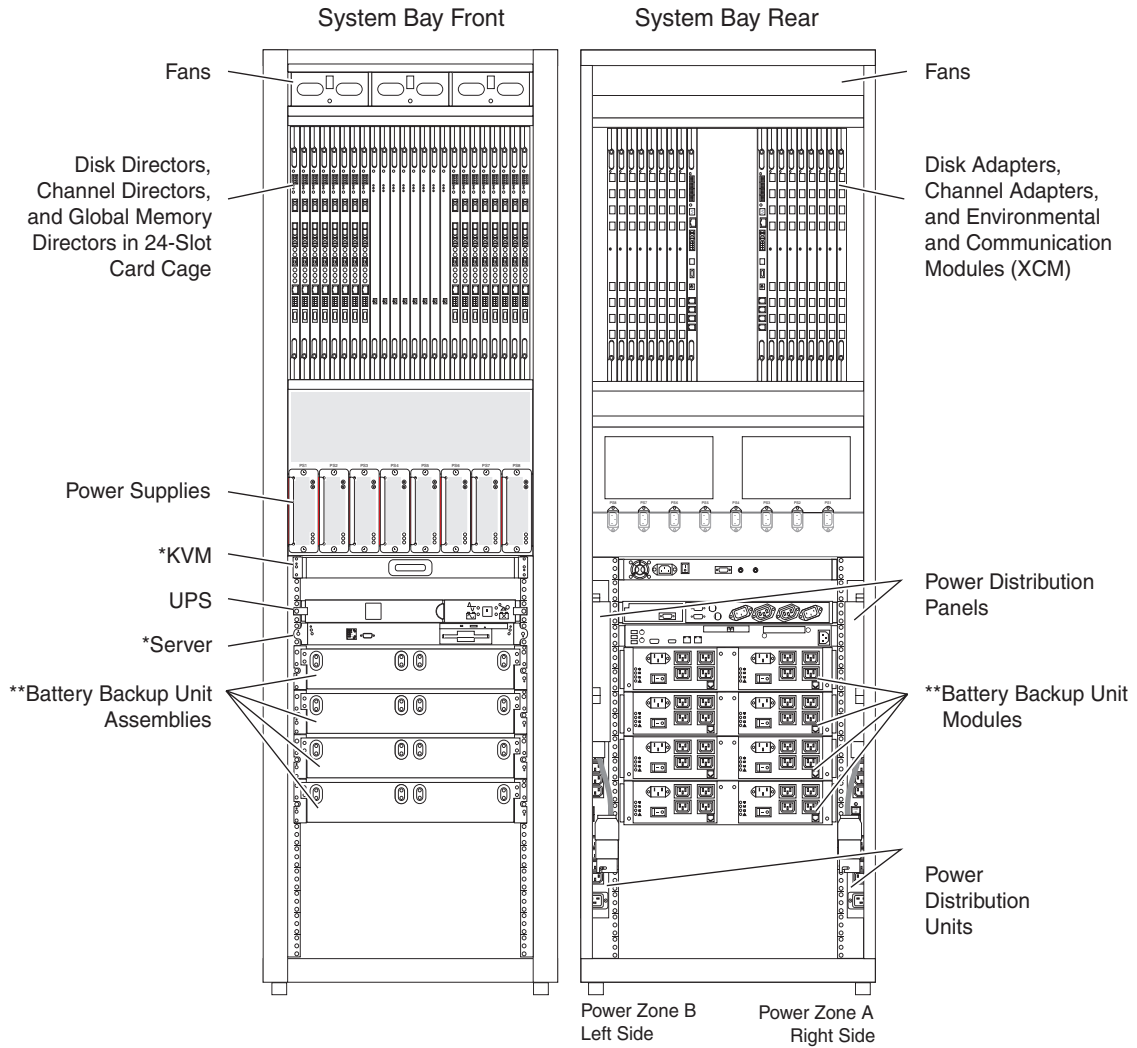
Table 7 Symmetrix DMX-3 model component overview

Symmetrix DMX-3 Components	Component Information Location
Main component locations of the system bay, front and rear views	Figure 6 on page 51
Main component descriptions of the system bay	Table 8 on page 52
Main component locations of the storage bay, front and rear views	Figure 7 on page 53
Main component descriptions of the storage bay	Table 9 on page 54



WARNING

To reduce the risk of personal injury, do not open the doors or move the Symmetrix DMX-3 unless you are qualified and familiar with safety procedures for electrical equipment and the Symmetrix DMX-3. The Symmetrix DMX-3 contains no user-serviceable parts. Neither the system bay nor the storage bays should not be moved or opened for any reason by untrained persons. If the Symmetrix DMX-3 is in need of relocation or repair, only qualified personnel should access components inside the bays or move them.



* The Service Processor consists of the KVM and the server.

** The Battery Backup Unit Assembly consists of two Battery Backup Unit Modules.

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Figure 6 Symmetrix DMX-3 system bay (interior view, front and rear)

Table 8 Symmetrix DMX-3 system bay component overview

Component	Description
Cooling Fan Modules	Three 3-fan modules maintain air circulation and cool the unit internally.
Card Cage and Midplane	The front 24 slots contain global memory directors, disk directors, and channel directors (front-end Fibre Channel, ESCON, FICON, and iSCSI channel directors ^a , and/or GigE Remote directors). The rear slots contain the channel host adapters, GigE Remote adapters, disk adapters, and the Communications and Environmental Control Modules (XCMs).
Channel Directors/Adapters and Remote Director Adapters (Front-End) ^a	Up to 12 channel directors connect to the front side of the midplane and the adapters to the rear side of the midplane in the system cabinet. Each channel director's adapter provides the interface to the host or network.
Fibre Channel Disk Directors/Adapters (Back-End)	Two, four, six or eight disk directors connect to the midplane in the front of the cabinet. Each disk director's adapter provides the interface to the Fibre Channel disk drives. The adapter connects to the opposite side of the midplane in the rear of the cabinet.
Global Memory Directors	Two, four, six, or eight global memory directors provide up to 512 GB (256 GB effective) total global memory, available in 8 GB, 16 GB, 32 GB, and 64 GB global memory director capacities.
Communications and Environmental Control Module (XCM)	Two communications and environmental control modules (XCMs) connect to the midplane in the rear card cage. The XCM contains the Ethernet interface between the directors (channel, disk, and memory) and the service processor. It monitors and logs environmental events for all Symmetrix DMX-3 FRUs (field replaceable units) and reports any operational problems such as thermal excursion, voltage drop, etc. It also has connectors for paths between the XCM and the BBU modules (in the system bay and the storage bays) for sending commands and receiving status.
Power Supplies	Up to eight 1,800 watt power supplies support the system bay and are split between two (A and B) three-phase power zones. Each zone supports up to four power supplies. One zone can maintain power for the entire system bay independent of the power supplies in the other zone. The DMX-3 is available in three-phase Delta or three-phase WYE configurations.
Power Distribution Panel (PDP), Power Distribution Unit (PDU), and AC connectors	Two PDPs, one for each zone, provide a centralized cabinet interface and distribution control of the AC power input lines when connected to the system bay PDUs. The PDPs contain the manual On/Off power switches, which are accessible through the rear door. The PDUs, one for each power zone, provide the main interface between the input AC from the PDPs and the various components contained within the system bay.
Battery Backup Unit (BBU) Assembly consisting of two BBU modules	Up to eight 2.2 kW BBU modules provide backup for each of the power supplies. If AC power fails, the BBU modules can maintain power for two 5-minute periods of AC loss while the Symmetrix system shuts down.
Service Processor (Keyboard, Video Display, and Mouse - KVM), server, and Uninterruptible Power Supply (UPS)	The service processor consists of a KVM and a server that connects to the Symmetrix subsystem through an Ethernet 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 provides diagnostic and maintenance utilities for the Symmetrix system. The server battery backup is provided by a UPS.

a. Contact your local EMC Sales Representative for current channel director availability.

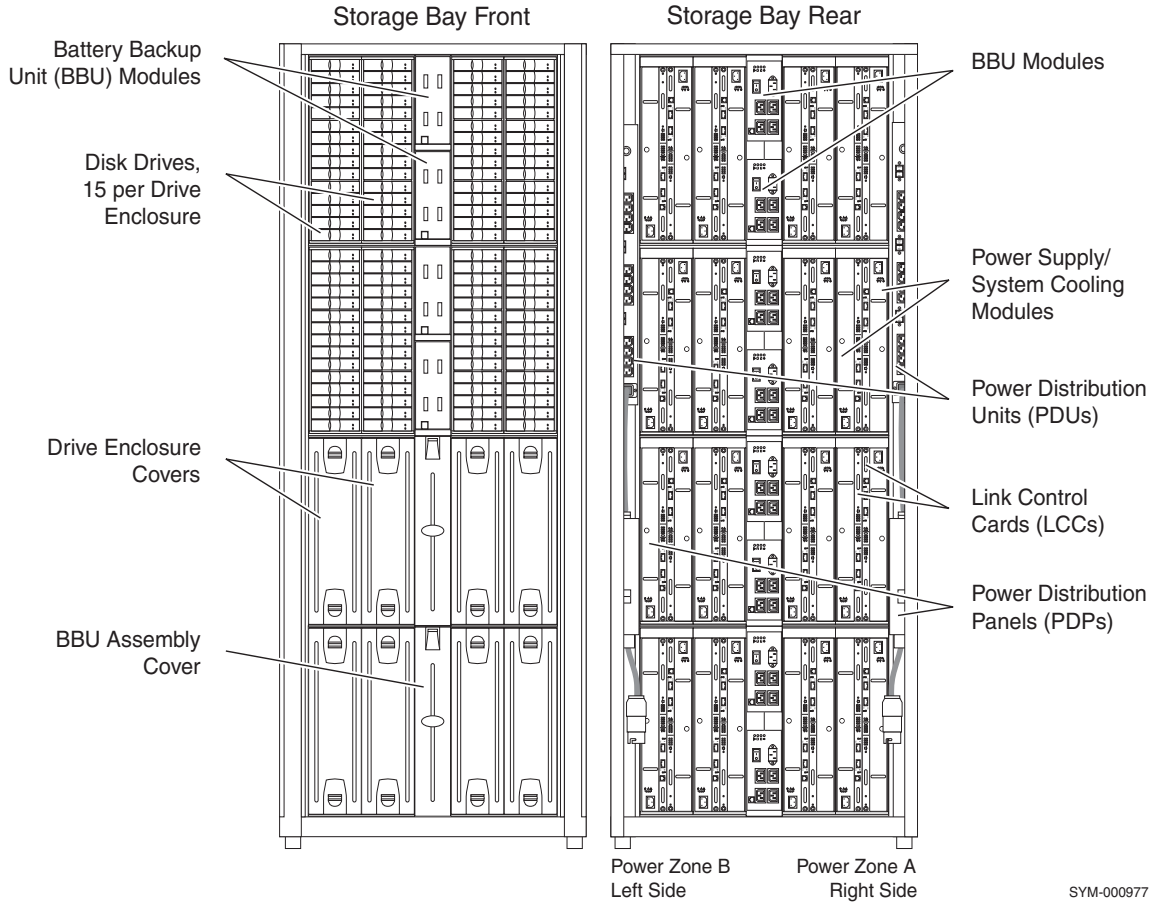


Figure 7 Symmetrix DMX-3 storage bay (interior view, front and rear)

Table 9 Symmetrix DMX-3 storage bay component overview

Component	Description
Drive Enclosures	The Symmetrix DMX-3 storage bay is configured with capacities of 120 or 240 disk drives. Each drive enclosure includes the following components: • Redundant power and cooling modules for disk drives • Two Link Control Cards (LCC) • From 4 to 15 Fibre Channel disk drives per drive enclosure The storage bays can be populated with any combination of DMX disk drives (73 GB, 146 GB, and 300 GB 10,000 rpm drives; 73 GB and 146 GB 15,000 rpm drives; and 500 GB 7,200 rpm drives) Some configuration restrictions may apply.
Battery Backup Unit (BBU) modules	Two BBU modules are required for four drive enclosures (up to eight BBU modules support up to 16 drive enclosures in one storage bay. The 2.2 kW BBU modules provide backup power to the drive enclosures.
Power Distribution Panel (PDP), Power Distribution Unit (PDU), and AC connectors	Two PDPs, one for each zone, provide a centralized cabinet interface and distribution control of the AC power input lines when connected to the storage bay PDUs. The PDPs contain the manual On/Off power switches, which are accessible through the rear door. The PDUs, one for each power zone, provide the main interface between the input AC from the PDPs and the BBU modules to the drive enclosures contained within the storage bay.

Symmetrix DMX-3 and component scaling attributes

The Symmetrix DMX-3 base configurations are composed of a system bay and independent storage bays, that have common configuration guidelines. Any DMX-3 base configuration accommodates the later addition (upgrade) of capacity through the on-line addition of drives, drive enclosures, if required, and additional storage bays that support up to 1,920 2 Gb/s disk drives. The Direct Matrix™ infrastructure accommodates nondisruptive addition of disk directors (increasing from two to eight disk directors) enabling increased capacity when needed.

The DMX-3 consists of a system bay and from one to eight storage bays. The DMX-3 system bay has from two to eight disk directors, up to 12 channel directors (combined director total 16), and two, four, six, or eight global memory directors. The system bay also contains up to eight power supplies, each of which has a dedicated 2.2 kW BBU.

[Table 10 on page 55](#) describes the available DMX-3 configurations.

Table 10 DMX-3 configurations

Number of disk directors	2 disk directors	4 disk directors	6 disk directors	8 disk directors
Drive channels	8	16	24	32
Minimum and maximum number of disk drives	96 - 240	192 - 960	360 - 1,440	480 - 1,920
Minimum and maximum TB capacity (raw) ^a	7.04 - 119.90	14.08 - 479.62	26.40 - 719.43	35.21 - 959.54
Maximum TB capacity (protected) ^b	102	301	435	525.1 ^c
Maximum global memory (usable)	64 GB	144 GB	216 GB	256 GB
Usable connectivity ^d	48 x 4 Gb/s Fibre Channel	64 x 4 Gb/s Fibre Channel	64 x 4 Gb/s Fibre Channel	64x 4 Gb/s Fibre Channel
	24 x 4 Gb/s FICON	48 x 4 Gb/s FICON	40 x 4 Gb/s FICON	32 x 4 Gb/s FICON
	48 ESCON	64 ESCON	64 ESCON	64 ESCON
	8 x 1 Gb/s Ethernet remote replication	8 x 1 Gb/s Ethernet remote replication	8 x 1 Gb/s Ethernet remote replication	8 x 1 Gb/s Ethernet remote replication
	24 x 1 Gb/s Gigabit Ethernet iSCSI	48 x 1 Gb/s Gigabit Ethernet iSCSI	40 x 1 Gb/s Gigabit Ethernet iSCSI	32 x 1 Gb/s Gigabit Ethernet iSCSI

a. Minimum raw capacity for a DMX-3 is based on 73 GB disk drives and maximum capacity is based on 500 GB disk drives.

b. Maximum protected capacity for a DMX-3 is based on RAID 5 (7+1) data protection configurations, allowance for vault devices, and Symmetrix file system (SFS) requirements.

c. Based 1,920 500 GB drives.

d. Combinations may be limited or restricted.

DMX-3 configuration rules and guidelines

The following are some of the system configuration rules and guidelines to consider when planning your new and/or upgrading your DMX-3.

- ◆ All bays must be configured in an inline installation. Each bay is bolted to the adjacent bay(s) during installation.
- ◆ Storage bays can be populated with any combination of 73 GB, 146 GB and 300 GB 10,000 rpm drives, 73 GB and 146 GB 15,000 rpm drives, and 500 GB 7,200 rpm drives. Some restrictions may apply.
- ◆ A minimum of four (4) disk drives must be configured in each drive enclosure.

- ◆ While all drives (different capacities and/or different speeds) can be intermixed in Symmetrix DMX-3 systems, locations on disk director pairs and drive loops may affect application performance. Consult your Symmetrix representative for guidelines on optimal configuration of mixed drive sizes and speeds.
- ◆ 5 GB on the first 4 drives of every drive loop (160 GB per disk director pair) is reserved for memory vaulting.
- ◆ The first four disk drives on each drive loop in the direct-attached storage bay support the memory vault devices.
- ◆ 24 GB of total capacity is reserved for internal Symmetrix File System (SFS) use.
- ◆ Symmetrix systems support various data protection methods:
 - RAID 1 — Mirrored pairs of two hypervolumes
 - RAID 1/0 — Mirroring and striping for open system environments
 - RAID 10 — Data striped across four mirrored pairs of hypervolumes for mainframe environments
 - RAID 5 (3+1) or RAID 5 (7+1) — Data striped on four or eight hypervolumes with rotating parity
 - RAID 6 (6+2) or RAID 6 (14+2) — Data striped on eight or sixteen hypervolumes with rotating parity
 - SRDF — Data mirrored to another Symmetrix
 - Dynamic sparing — Increases data availability by copying the data on a failing volume to a spare volume until the original device is replaced
 - Permanent sparing — Replaces a faulty drive automatically from a list of available spares residing in the Symmetrix system without CE involvement on site

Note: [Chapter 5, “Data Integrity, Availability, and Protection,”](#) provides more information and configuration rules regarding the above data protection options.

- ◆ Consider details of space, power and installation requirements as well as planning for future system expansion. [Appendix C, “Planning and Installation,”](#) and the *Symmetrix DMX-3 Physical Planning Guide* provide details on these topics.

Symmetrix DMX-3 architecture

The Symmetrix DMX-3 features a high-performance, Direct Matrix Architecture (DMX) supporting up to 128 point-to-point serial connections within the DMX system.

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 includes the following topics:

- ◆ [“DMX-3 block diagram” on page 57](#)
- ◆ [“DMX-3 configuration rules and guidelines” on page 55](#)
- ◆ [“DMX-3 point-to-point message matrix” on page 59](#)
- ◆ [“DMX-3 slot configuration” on page 61](#)

DMX-3 block diagram

In a fully configured Symmetrix DMX-3, each of the eight director ports on the sixteen directors connects to one of the 16 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 8 on page 58](#) illustrates the point-to-point architecture and the interconnection of the major components of the Symmetrix DMX-3 systems.

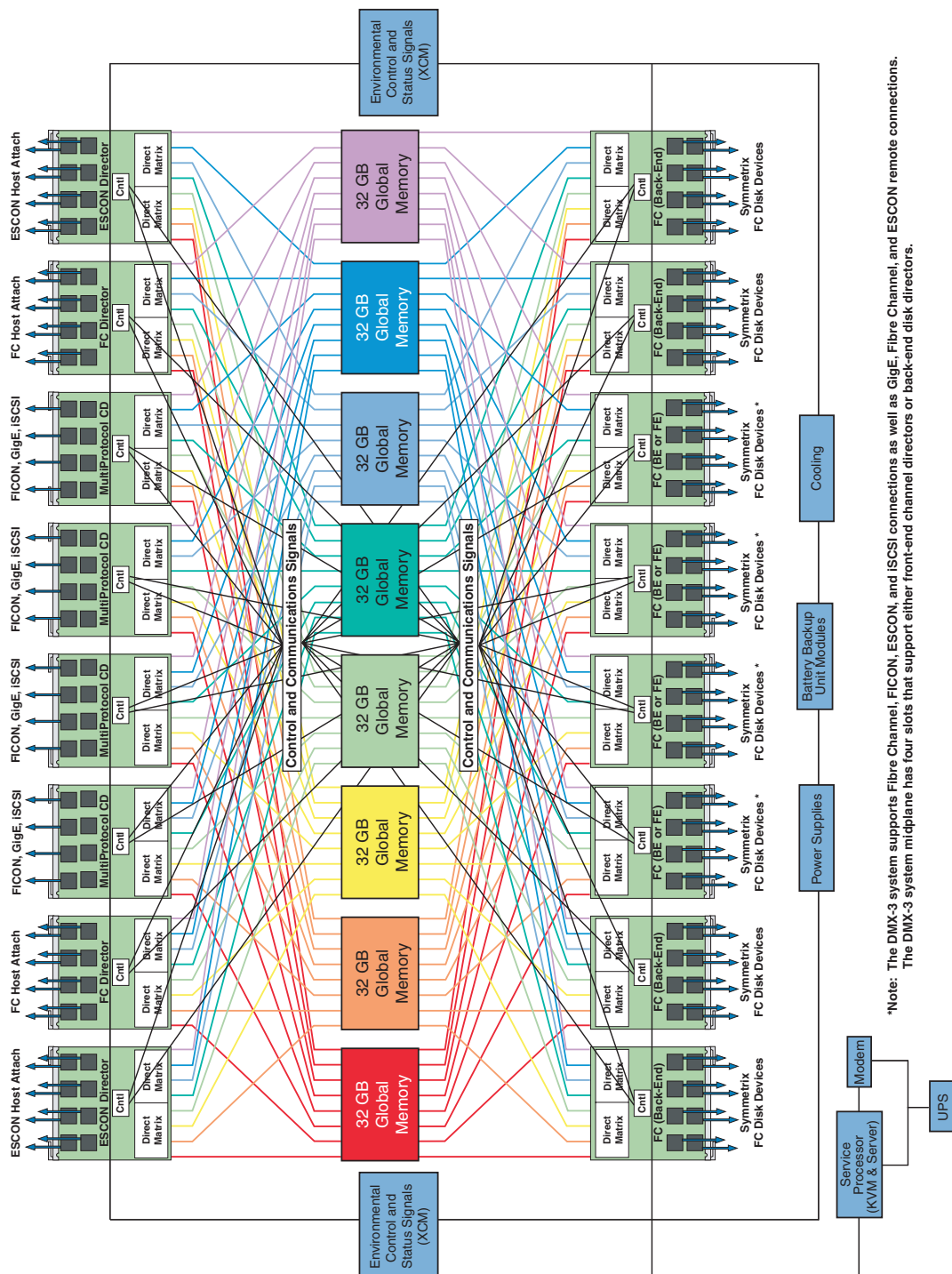


Figure 8 **Symmetrix DMX-3 block diagram**

Note: The DMX-3 system supports Fibre Channel, FICON, ESCON, and iSCSI connections as well as Gige, Fibre Channel, and ESCON remote connections. The DMX-3 system midplane has four slots that support either front-end channel directors or back-end disk directors.

DMX-3 point-to-point message matrix

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 9 on page 60](#) 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.

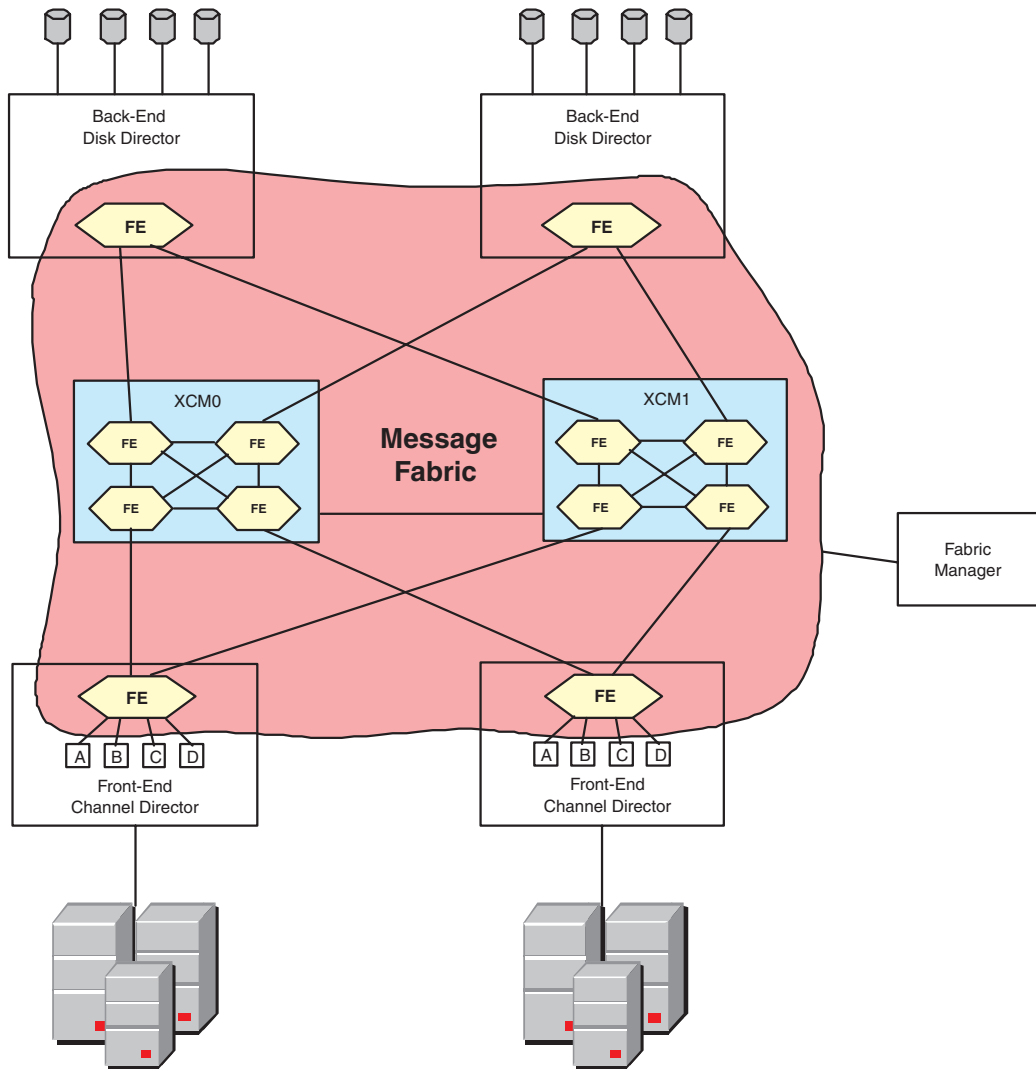


Figure 9 Symmetrix DMX-3 message fabric

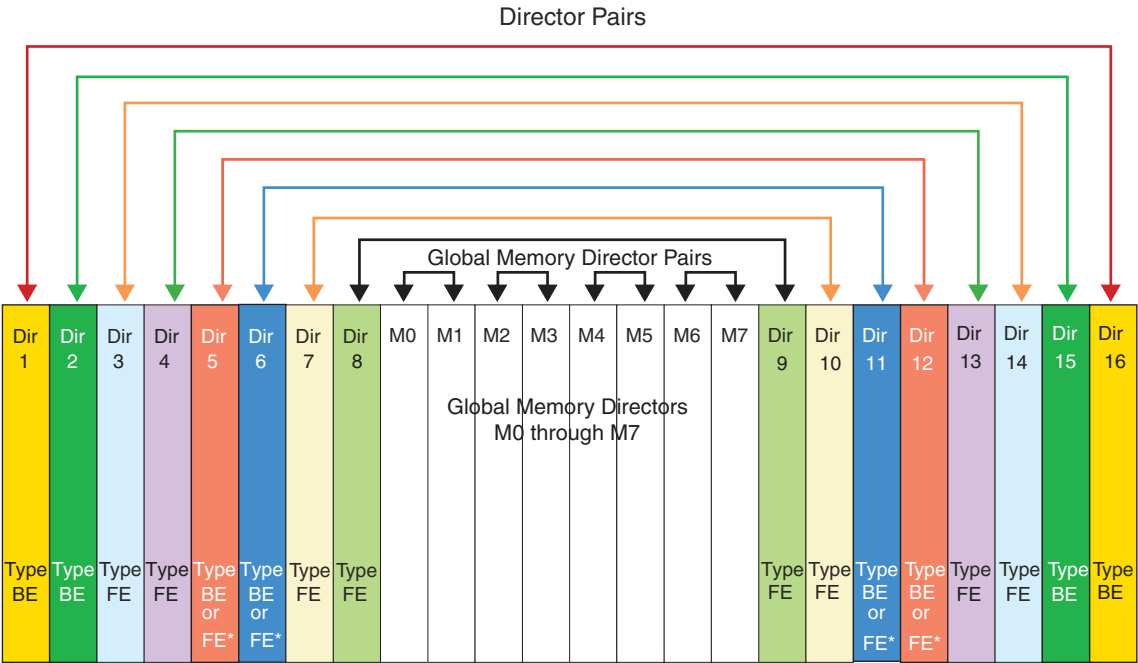
DMX-3 midplane slot configuration

The front of the Symmetrix DMX-3 card cage midplane contains the channel directors, disk directors, and global memory directors. The rear card cage midplane contains the adapters, and the Communications and Environmental Control Module (XCM) pair.

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 and GTLP signals occurs at the adapters in the end slot locations.

DMX-3 slot configuration

The Symmetrix DMX-3 midplane provides eight slots in the center of the midplane 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 10 on page 61](#) 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.

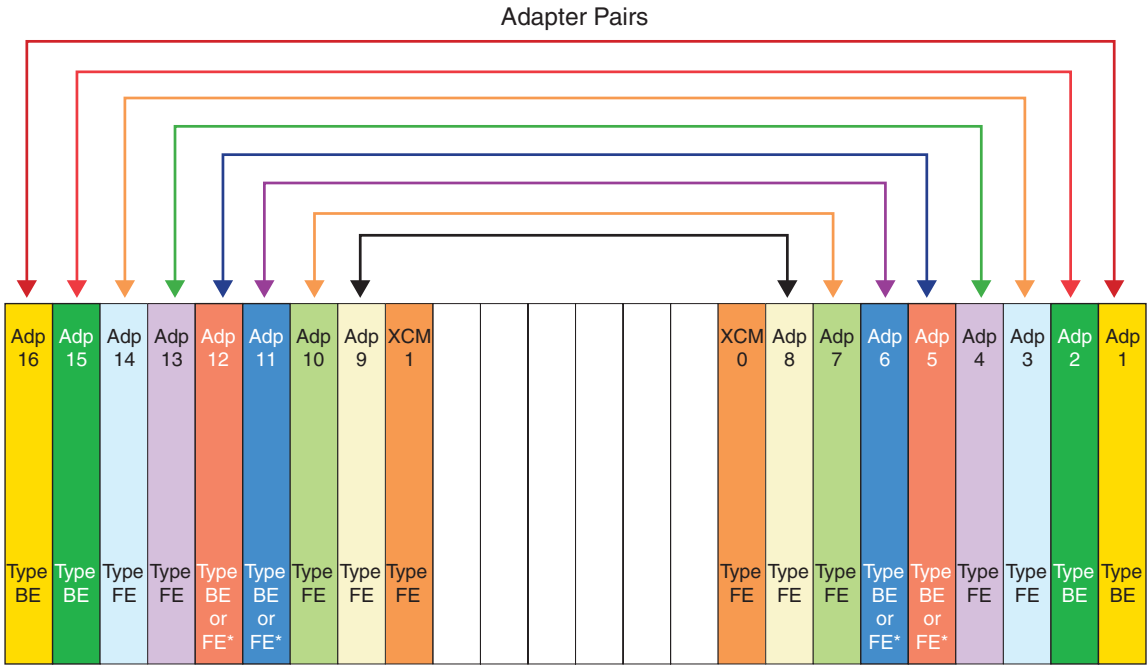


*Note: These slots (Directors 5, 6, 11, and 12) in the midplane can be configured with either front-end or back-end directors.

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Figure 10 Symmetrix DMX-3 card cage configurations (front)

On the rear side of the midplane (Figure 11 on page 62), the adapters reside behind their respective directors, and two slots behind the memory are reserved for the XCM pair.



*Note: These slots (Adapters 12, 11, 6, and 5) in the midplane can be configured with either front-end or back-end adapters.

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Figure 11 Symmetrix DMX-3 card cage configurations (rear)

Symmetrix channel connectivity and host integration

The Symmetrix DMX-3 can be integrated with all major enterprise hosts and servers. This section outlines the emulations and hosts Symmetrix systems support through Fibre Channel, iSCSI, ESCON, FICON, or GigE (SRDF) interfaces.

Note: For the most current information on Symmetrix systems and specific host integration, contact your local EMC Sales Representative, or refer to the EMC Powerlink website.

Channel connectivity

The Symmetrix DMX-3 supports connectivity to mainframe and open systems hosts.

Note: 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, contact your local EMC Sales Representative.

Open systems connectivity

The Symmetrix DMX-3 connects to Fibre Channel and iSCSI open system host interfaces such as UNIX, Windows, Linux, and iSeries systems.

Note: Contact your local EMC Sales Representative for availability of iSeries host connectivity.

Mainframe systems connectivity

The Symmetrix DMX-3 supports ESCON and FICON host connectivity to mainframe systems.

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.

The DMX-3 systems support Fibre Channel connectivity to iSeries systems. Fibre Channel is currently capable of running up to 2 Gbs/s full duplex with iSeries systems.

Note: For information on disk devices supported for iSeries systems, contact your EMC Sales Representative.

Symmetrix channel configurations

EMC offers the following Symmetrix DMX-3 channel directors:

- ◆ Eight-port ESCON directors
- ◆ Eight-port Fibre Channel directors
- ◆ Multiprotocol Channel Director (MPCD) that supports:
 - FICON host connections
 - iSCSI host connections
 - GigE SRDF connections
 - Fibre Channel connections

Note: [Table 18 on page 77](#) describes DMX-3 channel director configurations.

Supported Fibre Channel interfaces

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

Note: Consult your local 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.

Supported cluster hosts

For the most recent information on supported cluster hosts, refer to the EMC Powerlink website.

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.

Note: For a more detailed discussion of channel attachment options, refer to [“Channel attachments” on page 91](#).

[Table 11 on page 65](#) shows the IBM DASD models and controllers that Symmetrix systems emulate.

Table 11 IBM controller/DASD compatibility

IBM DASD	IBM Controller		
	3990-6	2105	2107
3380 ^a	X	X	X
3390-1	X	X	X
3390-2	X	X	X
3390-3	X	X	X
3390-9	X	X	X
3390-27		X	X
3390-54 ^b		X	X

- a. Contact your local EMC Sales Representative for information on 3380 support.
- b. Contact your local EMC Sales Representative for currently supported IBM controller/DASD emulation modes.

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 z/OS operating system can be supported, including:

TPF	AIX/ESA	MVS/ESA	MVS/SP	MVS/XA
MVT/VSE	VM/ESA	VM/HPO	VM/SP	VM/XA
VSE/ESA	VSE/SP	z/OS	z/OS.e	z/VM

Symmetrix DMX systems also support the following mainframe operating systems:

GC0S7	GCOS8	LINUX for z/Series	MSP	OS/1100
PICK	TPF ^a	UTS		

- a. Contact your local EMC Sales Representative for availability of TPF support.

Fibre Channel disk subsystem

The Symmetrix DMX-3 disk subsystem are contained in the storage bay(s). They are fully redundant components and can be replaced nondisruptively. The disk subsystems consist of the following components:

- ◆ Disk drives — One-inch low-profile 2 Gb/s Fibre Channel disk drives available in 73 GB, 146 GB, 300 GB, and 500 GB sizes. A fully populated drive enclosure holds 15 disk drives. 16 drive enclosures per storage bay.
- ◆ Two link control cards (Fibre Channel interface cards)
- ◆ Two power supply/cooling modules

The drive enclosure supports 2 Gb/s back-end fibre interface (FC-AL). The dual-loop configuration provides redundancy, port bypass capability, and disk access up to 2 Gb/s per loop.

Disk devices

The Symmetrix DMX-3 uses industry-standard 2 Gb/s Fibre Channel disk drives for physical disk devices. The disk drives are installed in the front of storage bays and connect to a midplane. Each disk drive is integrated with a dual-port Fibre Channel Arbitrated Loop (FC-AL) controller with Fibre Channel interface that transports SCSI protocol. The Symmetrix DMX-3 supports Fibre Channel loops ranging from 15 drives to 60 drives per loop. [Table 12 on page 66](#) lists the features for each type of Symmetrix DMX-3 disk drive assembly.

Table 12 Symmetrix DMX-3 disk drive features ^a

Disk capacity and rotational speed	73 GB 10 K rpm	73 GB 15 K rpm	146 GB 10 K rpm	146 GB 15 K rpm	300 GB 10 K rpm	500 GB 7.2 K rpm
Interface maximum data transfers per port	2 Gb/s FC	2 Gb/s FC	2 Gb/s FC	2 Gb/s FC	2 Gb/s FC	2 Gb/s FC
Internal data rate megabits per second ^b	470 - 944	685 - 1,142	470 - 944	685 - 1,142	470 - 944	470 - 944
Average access time (read/write) ms ^a	4.7/5.4	3.5/4.0	4.7/5.4	3.5/4.0	4.7/5.4	8.5/9.5
Device-level data buffer	16 MB	16 MB	32 MB	32 MB	32 MB	32 MB

a. Contact your EMC Sales Representative for the latest drive specifications.

b. These specifications are subject to change.

Link control cards (LCC)

The link control card's main function is to provide services to the drive enclosure, which includes the capability to control functionality and monitor environmental status. Each drive enclosure has two LCCs. The LCC performs the following functions:

- ◆ Individual Fibre Channel disk poweron and poweroff functions
- ◆ Loop configuration control
- ◆ Failover control
- ◆ Marker LED control
- ◆ Individual disk port control
- ◆ Drive presence detection
- ◆ Reporting of temperature and voltage status information
- ◆ RS-232 monitoring of the BBU modules that support the components in the storage bay

Power supply/cooling module

Two 12 V, 400 W power supply/cooling modules provide all necessary power and cooling to the 15 disk drives in the disk enclosure in an N+1 configuration.

Symmetrix DMX disk device capacities

Precise storage capacity values depend on:

- ◆ Whether the user configures the disk to emulate an open systems device or a mainframe 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, RAID 5 (3+1), RAID 5 (7+1), RAID 6 (6+2), RAID 6 (14+2), RAID 10, SRDF).

Note: [Table 13 on page 68](#) shows the available Symmetrix cylinders and storage capacities for 73 GB, 146 GB, 300 GB, and 500 GB disk devices based on the open systems, mainframe, and iSeries emulations. When calculating total system capacity, the following must also be included: 24 GB of total capacity is reserved for internal Symmetrix File System use. From 160 to 640 GB of total capacity is reserved for vaulting data from memory during system power down. Each DMX-3 system requires a minimum of two global spare drives and one additional global spare drive for every 100 disk drives or a portion thereof. For example, a DMX-3 with 547 disk drives requires 2 + 6 = 8 global spare drives.

Note: The GB values shown in [Table 13 on page 68](#) 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 13 Symmetrix DMX-3 disk drive capacities ^a

Disk Size and Speed (rpm)	73 GB 10 K or 15 K	146 GB 10 K or 15 K	300 GB 10 K	500 GB 7.2K
Raw Capacity	73.41 GB	146.82 GB	300 GB	500 GB
Formatted Capacity (open systems in GB ₁₀)	73.34 GB ₁₀	146.69 GB ₁₀	299.76 GB ₁₀	499.6 GB ₁₀
Formatted Capacity (open systems in GB ₂)	68.30 GB ₂	136.62 GB ₂	279.17 GB ₂	465.29 GB ₂
Cylinders (open systems)	74,611	149,227	304,932	508,626
Formatted Capacity (mainframe systems, 3380 emulation) ^a	69.88 GB ₁₀	139.77 GB ₁₀	285.60 GB ₁₀	476.00 GB ₁₀
Cylinders (mainframe systems, 3380 emulation) ^a	98,134	196,269	401,052	668,420
Formatted Capacity (mainframe systems, 3390 emulation)	72.40 GB ₁₀	144.81 GB ₁₀	295.91 GB ₁₀	493.19 GB ₁₀
Cylinders (mainframe systems, 3390 emulation)	85,189	170,379	348,150	580,251
Formatted Capacity (iSeries emulation)	72.82 GB ₁₀	145.66 GB ₁₀	292.46 GB ₁₀	N/A

a. Contact your local EMC Sales Representative for information on 3380 emulations, disk devices, and data protection methods.

Symmetrix DMX-3 logical volume capacities

The maximum number of logical volumes supported on Symmetrix DMX-3 physical disk devices depends on the data protection used. [Table 14 on page 68](#) describes the logical volumes supported on Symmetrix DMX disk devices.

Table 14 Logical volumes supported on Symmetrix DMX-3 disk devices

Symmetrix DMX-3 Disk Devices and Data Protection ^a	Maximum Logical Volumes
Logical Volumes per Disk Device with SRDF Protection (without local data protection)	160
Logical Volumes per Disk Device with RAID 1 Protection	173
Logical Volumes per Disk Device with RAID 5 (3+1) Protection	255
Logical Volumes per Disk Device with RAID 5 (7+1) Protection	255
Logical Volumes per Disk Device with RAID 6 (6+2) Protection	255
Logical Volumes per Disk Device with RAID 6 (14+2) Protection	255
Logical Volumes per Disk Device with RAID 10 Protection (mainframe data volumes only)	255

a. For information on Symmetrix DMX-3 data protection options, refer to [Table 29 on page 176](#).

Note: For more information on logical volumes, refer to [“Open systems hypervolumes” on page 124](#) or [“Mainframe systems hypervolumes” on page 129](#). Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your local EMC Sales Representative.

The Symmetrix DMX-3 can support up to 64,000 logical volumes, depending on the number of disk directors, the type of data protection, and hardware configuration. [Table 15 on page 69](#) describes the maximum logical volumes supported on DMX-3 systems by the number of drives, DA boards, and type of data protection employed.

Note: [“Logical volumes supported for DMX-3 systems” on page 69](#) shows the maximum logical volumes available for the Symmetrix DMX-3 with the number of disk drives stated and a homogeneous protection scheme on those disk drives. The logical volume limit is a function of the number of disk directors, disk drives, Enginuity level, and data protection type. Consult your local EMC Sales Representative for currently supported logical volumes for DMX-3 systems.

Table 15 Logical volumes supported for DMX-3 systems (1 of 2)

Maximum Number of Disk Drives	Number of DA Boards	Data Protection	Maximum Logical Volumes per System
1,920	8	SRDF	64,000
1,920	8	RAID 1	64,000
1,920	8	RAID 5 (3+1)	64,000
1,920	8	RAID 5 (7+1)	32,768
1,920	8	RAID 6 (6+2)	30,720
1,920	8	RAID 6 (14+2)	15,360
1,920	8	RAID 10	16,000
1,440	6	SRDF	64,000
1,440	6	RAID 1	64,000
1,440	6	RAID 5 (3+1)	49,152
1,440	6	RAID 5 (7+1)	24,576
1,440	6	RAID 6 (6+2)	23,040
1,440	6	RAID 6 (14+2)	11,520
1,440	6	RAID 10	16,000
960	4	SRDF	64,000
960	4	RAID 1	64,000
960	4	RAID 5 (3+1)	32,768
960	4	RAID 5 (7+1)	16,384

Table 15 Logical volumes supported for DMX-3 systems (2 of 2)

Maximum Number of Disk Drives	Number of DA Boards	Data Protection	Maximum Logical Volumes per System
960	4	RAID 6 (6+2)	15,360
960	4	RAID 6 (14+2)	7,680
960	4	RAID 10	16,000
240	2	SRDF	20,760
240	2	RAID 1	20,760
240	2	RAID 5 (3+1)	15,300
240	2	RAID 5 (7+1)	7,650
240	2	RAID 6 (6+2)	3,840
240	2	RAID 6 (14+2)	1,920
240	2	RAID 10	7,650

Configuration rules for vault devices

Vault devices are volumes on designated physical disk drives that reserve a dedicated 5 GB space for vaulting data including metadata. The following configuration rules apply to the vaulting drives and disk directors:

- ◆ Each disk director pair requires 32 such dedicated devices for a total of 160 GB of vault space per disk director pair.
- ◆ The vault devices can only use single-mirror data protection and cannot be configured with TimeFinder/Snap, virtual, or dynamic spare devices.
- ◆ The drive pool, virtual devices, or drive devices cannot reside in the 5 GB of vault space. However, they can reside on the same physical disk drive as the vault devices but not within the vault devices.
- ◆ The distribution of the vault devices across the disk directors, the back-end interfaces, and the physical disks should be such that a full vault will be possible within the time frame dictated by the capacity of the battery (up to five minutes).
- ◆ The total capacity of all of the vault hypervolumes in the system will be at least sufficient to keep two logical copies of the persistent part of global memory.

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.

Note: 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

Enginuity 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.
- ◆ Convert between mirrored and RAID protected volumes.
- ◆ The optimal order is to delete devices and then add. If done in the reverse order, unnecessary global memory will be allocated for the deleted devices.
- ◆ When attempting to add or delete devices, or change protection type of devices, a new minimum cache value will be calculated. In rare cases this new value could prohibit the changes until additional memory is added to the system.

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.

Logical volume structure (open systems)

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

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 128 blocks of 512 bytes

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

$$n * 15 * 128$$

n for each volume is defined during Symmetrix configuration.

To calculate the size of the logical volume:

$$\text{Number of cylinders} * \text{heads} * \text{blocks} * 512 \\ (n * 15 * 128 * 512)$$

Note: [“Open systems hypervolumes” on page 124](#) provides information on configuring open systems logical volumes.

IBM CKD DASD disk emulation

The Symmetrix DMX system appears to mainframe operating systems as a 3990-6, 2105, or 2107 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 16 on page 73](#) 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.

Note: Contact your EMC Sales Representative for 3380 support.

Note: For more IBM DASD emulation characteristics, refer to [Appendix A, “Symmetrix DMX-3 Specifications.”](#)

Table 16 IBM DASD emulation characteristics

IBM DASD Model	MB/Volume	Bytes/Track	Bytes/Cylinder	Cylinders/Volume
3390-54 ^a	55,688	56,664	849,960	65,520
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 ^a	1,891	47,476	712,140	2,655

a. Contact your local EMC Sales Representative for currently supported IBM Controller/DASD emulation modes and 3380 support.

Mixed track geometries

You can configure a Symmetrix DMX system with both 3380 and 3390 track geometries on the same disk device (3380 and 3390 devices cannot be defined in the same SSID or LCU). A single disk device can contain up to 255 logical volumes, depending on the data protection used.

Note: For information on configuring mainframe logical volumes, refer to [“Mainframe systems hypervolumes” on page 129.](#)

IBM/PCM data and command formats

All Symmetrix systems 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 3390 Storage Control Reference*. [Figure 12 on page 73](#) shows the CKD track format emulated for 3390 and 3380 DASD.

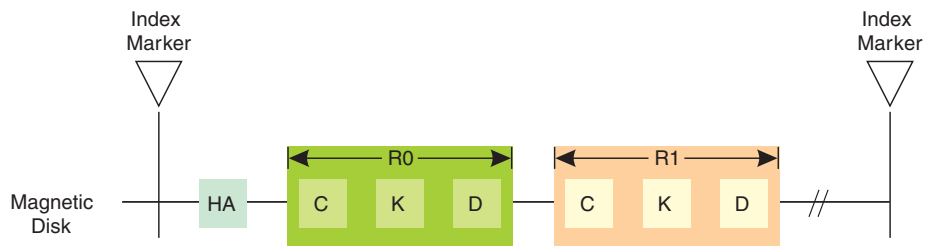


Figure 12 Track format for 3390 DASD

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 12 on page 73](#). 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 marker — An index marker indicates the physical beginning and end of each track for each disk device ([Figure 12 on page 73](#)).

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-3 directors. The channel directors and global memory directors manage the storage control functions. The disk directors handle the data storage functions.

Channel director connectivity

The Symmetrix DMX-3 provides 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 connection combinations:
 - Fibre Channel
 - FICON
 - iSCSI
 - GigE (Gigabit Ethernet) remote directors used for SRDF

Note: The Symmetrix DMX-3 supports mixed ESCON, FICON, Fibre Channel, and iSCSI interfaces when the required Symmetrix ESP software is installed on the Symmetrix system. Contact your local EMC Sales Representative for currently supported host connectivity.

The Symmetrix DMX-3 supports 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-3 supports mainframe connectivity through ESCON and FICON directors. The Symmetrix DMX-3 connects directly to host processors through physical channel attachments. [Table 17 on page 76](#) describes the protocols that are supported by the Symmetrix DMX-3 channel directors.

Table 17 Supported protocols and Symmetrix DMX-3 channel directors

Protocol ^a	Usable System Ports ^b	Ports per Channel Director
4 Gb/s Fibre Channel host/SAN ports	2-64	1-8 per Fibre Channel Director
2 Gb/s Fibre Channel remote replication ports	2-8	1-4 per Fibre Channel Director
1 Gb/s iSCSI ports	2-32	1-4 per Multiprotocol Channel Director
1 Gb/s GigE remote replication ports	2-8	1-4 per Multiprotocol Channel Director
4 Gb/s FICON host ports	2-32	1-4 per Multiprotocol Channel Director
ESCON host ports	2-80	1-8 per ESCON Channel Director
ESCON remote replication ports	2-8	1-4 per ESCON Channel Director

a. Contact your local EMC Sales Representative for ESCON channel director and GigE Remote support availability.

b. Usable ports are per qualified channel directors.

Channel director descriptions

Symmetrix DMX-3 channel directors are single boards 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 DMX-3 supports up to 10 channel directors.

Note: [Appendix C, “Planning and Installation,”](#) provides information on mainframe and open systems channel director configurations. Contact your local EMC Sales Representative for specific supported configurations.

All channel directors contain four high performance processor complexes. The channel directors process data from the host and manage access to global memory over a direct matrix (DMX) technology ([Figure 8 on page 58](#)). Each channel director on the Symmetrix DMX-3 supports eight internal links to global memory. DMX technology is used across the Symmetrix system, as it is also designed into each global memory director. In addition to DMX technology, each director includes support for a separate message matrix for the transfer of control information.

Note: [“DMX-3 point-to-point message matrix” on page 59](#) and [“DMX-3 communications and environmental control” on page 88](#) provide information on the Symmetrix DMX message matrix.

[Table 18 on page 77](#) describes the DMX-3 channel director models.

Table 18 Symmetrix DMX-3 channel director models and descriptions

Model Number	Description ^a	Fibre Channel ^b		GigE	FICON	
		MM	SM	MM	MM	SM
DMX3-80000B	8-Port Fibre Channel (FC) Director (8 multimode ports)	8	0	0	0	0
DMX3-71000B	8-Port Fibre Channel Director (7 multi/1 single-mode port)	7	1	0	0	0
DMX3-62000B	8-Port Fibre Channel Director (6 multi/2 single-mode port)	6	2	0	0	0
DMX3-00004B	4-Port FICON Channel Director (4 single-mode ports)	0	0	0	0	4
DMX3-00040B	4-Port FICON Channel Director (4 multimode ports)	0	0	0	4	0
DMX3-00103B	4-Port Multiprotocol Director (1 GigE or iSCSI mm port/3 FICON sm)	0	0	1	0	3
DMX3-00400B	4-Port GigE or iSCSI Channel Director (4 multimode ports)	0	0	4	0	0
DMX3-ESCD8	8-Port ESCON DIR (8 multimode ports)	N/A	N/A	N/A	N/A	N/A
DMX3-40002B	6-Port Multiprotocol Director (4 FC mm port/2 FICON sm)	4	0	0	0	2
DMX3-40200B	6-PORT Multiprotocol Director (4 FC mm ports/2 GigE or iSCSI mm)	4	0	2	0	0
DMX3-60100B	7-PORT Multiprotocol Director (6 FC mm ports/1 GigE or iSCSI mm)	6	0	1	0	0

a. Contact your local EMC Sales Representative for currently supported host channel directors and GigE remote directors.

b. MM = Multimode. SM = Single-mode.

Fibre Channel directors (front-end)

The Fibre Channel front-end director has eight FC ANSI compliant, 4 Gb/s (also configurable to 2 Gb/s, and 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 single-mode and multimode configurations ([Table 18 on page 77](#)). 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 19 on page 77](#) lists the Fibre Channel front-end support capabilities for directors, their Symmetrix devices, and their addressing.

Table 19 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 Complex ^a
Symmetrix Devices per Processor Complex	4,096
Symmetrix Devices per Fibre Channel Director	16,384
Addresses Range per Port	0- 4,095 (0x000 - 0xFFFF)

a. Each Fibre Channel front-end director has four processor complexes.

Note: The numerical values for Symmetrix devices stated in [Table 19 on page 77](#) 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, go to the EMC Powerlink website.

The Symmetrix DMX-3 can support up to 8 qualified Fibre Channel directors. Contact your local EMC Sales Representative for specific supported configurations.

Fibre Channel adapters (front-end)

The Symmetrix DMX-3 Fibre Channel adapters provide the connectivity between the host channels and the Fibre Channel front-end director through optical transceiver connections.

Note: Symmetrix Fibre Channel directors currently support connections to a number of hosts supporting Fibre Channel connectivity. For a current list of supported hosts, go to the EMC Powerlink website.

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-3 ESCON director has eight ESCON channel interfaces for connection to host systems and eight high-speed paths to global memory. The ESCON channel director interfaces to the host channels through an eight-port ESCON channel interface adapter and supports data transfer rates up to 17 MB/s per port.

The Symmetrix ESCON director can support up to 1,024 logical paths per port when only the A port of the A and B ports of the processor is configured and up to 512 logical paths per port when both the A and B ports are configured.

Note: Contact your local EMC Sales Representative for ESCON channel director availability.

The Symmetrix DMX-3 may support 2 to 10 ESCON channel directors. [Table 20 on page 79](#) describes the ESCON channel configurations supported in the DMX-3.

Table 20 **ESCON director configurations**

	A and B Port Enabled	A Port Enabled
Maximum LCU (Logical Control Units) per port	16 (00 to FF)	16 (00 to FF)
Maximum LCUs per Symmetrix system	250	250
Maximum devices per LCU	256	256
Maximum logical paths per port	512	1,024
Maximum logical paths per LCU per port	32	64
Maximum DMX channel addresses per one or two ports	2,048 + 2,048	2,048
Maximum DMX channel addresses per Symmetrix system consisting of up to 64,000 base devices (physical devices) with up to 255 aliases (logical devices)	64,000	64,000
Maximum concurrent I/O host connections per Symmetrix DMX system ^a	80	40

a. The maximum concurrent I/O connections is based on 10 ESCON directors. Contact your local 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.

Multiprotocol Channel Directors

The Symmetrix DMX-3 Multiprotocol Channel Director (MPCD), through mezzanine card technology, supports Fibre Channel, GigE, iSCSI, and FICON protocols on Symmetrix DMX systems.

The MPCD implements a flexible mezzanine card that delivers highly configurable support for FICON channels to mainframe systems, Fibre Channel connections to open systems configurations, and/or Gigabit Ethernet support for iSCSI, and/or SRDF over IP connections.

Note: Contact your local EMC Sales Representative for currently supported protocols. [Table 18 on page 77](#) describes the supported Multiprotocol models.

FICON channel director

FICON channel directors support *native mode point-to-point* connections and FICON *native mode switched point-to-point* connections to IBM 9672, G5/G6, z/900, and z/990 systems running z/OS, z/VM, 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 bidirectional (full duplex) connections. Symmetrix FICON channels transfer data at speeds up to 4 Gb/s.

Note: For information on additional configuration options, refer to [“Symmetrix FICON configurations” on page 93](#).

The Symmetrix DMX FICON design auto-detects 4 Gb/s, 2 Gb/s or 1 GB/s at switch or channel port login time.

The Symmetrix DMX-3 system may support up to eight FICON channel directors. [Table 21 on page 80](#) describes the FICON channel director configurations supported in the DMX-3.

Table 21 FICON director configurations

Maximum LCUs (Logical Control Units) per port	64 (00 to FF)
Maximum LCUs per Symmetrix system	250
Maximum devices per LCU	256
Maximum logical paths per port	8,192
Maximum logical paths per LCU per port	128
Maximum DMX channel addresses per port	8,192
Maximum DMX channel addresses per Symmetrix system composed of up to 8,000 base devices (physical devices) with up to 255 aliases (logical devices)	64,000
Maximum I/O host connections per Symmetrix DMX system ^a	32

a. The maximum I/O connections are based on 8 FICON directors for the DMX-3. Contact your local 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.
- ◆ Allows the Symmetrix system to connect to your existing Ethernet infrastructure and directly access high-speed data transmission conduits via Internet Protocol (IP).
- ◆ Supports SRDF traffic to one or more remote Symmetrix systems that also have GigE remote directors installed.
- ◆ Supports TCP/IP protocols and function layers.
- ◆ Is fully compatible with the SRDF protocols and other Symmetrix DMX directors, drives, software, and protection schemes.

Symmetrix DMX GigE remote channels for SRDF transfer data at speeds up to 1 Gb/s. The GigE director provides up to four 1 Gb/s Ethernet ports and connects via LC connectors. It is compatible with Symmetrix DMX-2 and Symmetrix 8000 systems.

iSCSI channel directors

The Symmetrix DMX-3 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 1Gb/s Ethernet ports and connects via LC connectors.

The iSCSI directors support the iSNS protocol, a mechanism that provides Naming and Discovery services for iSCSI initiators. The iSNS server information is configured in the Symmetrix IMPL file for each iSCSI director. Each iSCSI director must register itself with the iSNS server, which provides:

- ◆ A mechanism to query iSNS server to find other hosts/targets
- ◆ Support for State Change Notification and Status Inquiry

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.

Fibre Channel disk directors (back-end)

The Symmetrix DMX-3 Fibre Channel back-end disk directors manage the interface to the disk drives, and are responsible for data movement between the disk drives and global memory. Each disk director on a Symmetrix DMX system supports eight internal links to global memory.

The Symmetrix DMX-3 features a 2 Gb/s Fibre Channel back-end infrastructure. The Fibre Channel disk director has eight multiplex processors that support one port each on its back adapter.

The Symmetrix DMX-3 is available with two, four, six, or eight disk directors, supporting Fibre Channel loops ranging from 15 drives to 60 drives per loop.

Note: 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-3 logical volume capacities” on page 68.](#)

Global memory directors

The Symmetrix DMX-3 global memory director technology is one of the most crucial components of a Symmetrix system. The DMX-3 uses global memory directors that use industry-standard Double Data Rate Synchronous Dynamic Random-Access Memory (DDR SDRAM), the latest generation of DDR SDRAM chip technology.

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. The DMX-3 global memory directors work in pairs. The hardware writes to the primary global memory director first, and then automatically writes data to the secondary global memory director. All reads are from the primary memory director. Upon a primary or secondary global memory director failure, all directors drop the failed global memory director and switch to a non-dual write mode. Striping between global memory directors is default.

Each Symmetrix DMX-3 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 has 16 ports with point-to-point serial connections between the global memory director and channel or disk directors (16 directors) through the direct matrix. Each memory director port consists of a pair of full-duplex serial links—two serial links out (TX) and two serial links in (RX).

Each of the eight director ports on the 16 directors connect to one of the 16 memory ports on each of the eight global memory directors ([Figure 13 on page 83](#)). These 128 individual point-to-point connections facilitate up to 128 concurrent cache operations in the system.

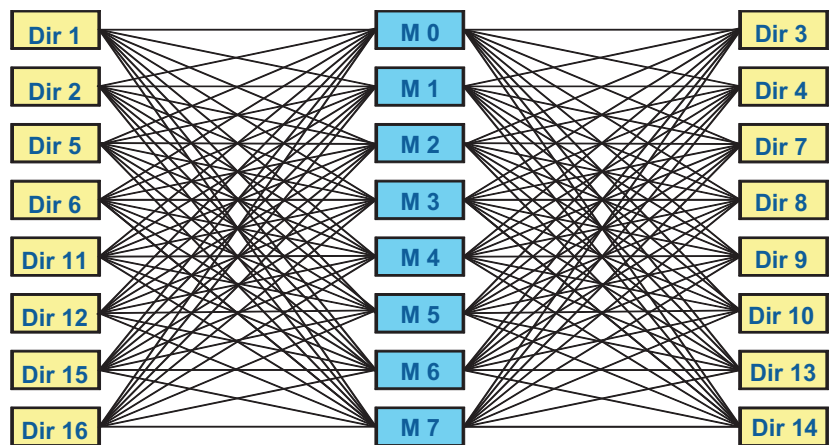


Figure 13 Global memory director to channel and disk director matrix

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 DMX system can support up to eight slots in the midplane dedicated to global memory and 512 GB of global memory (256 GB effective) global memory. Individual global memory directors are available in 8 GB, 16 GB, 32 GB, and 64 GB sizes.

When configuring global memory for the Symmetrix DMX systems follow these guidelines:

- ◆ Very large 8 disk director configurations may be limited or restricted by currently available Symmetrix DMX-3 maximum memory.
- ◆ Global memory directors can be added to the DMX-3 not to exceed the maximum designed for the system's configuration.
- ◆ Global memory directors must be configured in pairs of the same capacity.

Symmetrix DMX-3 power subsystems

The Symmetrix DMX-3 power subsystem uses a 2N power architecture. The Symmetrix DMX-3 power subsystem includes the following features in the system bay and storage bay:

- ◆ 2N power zones
- ◆ Dual-line cords, one for each zone per bay, providing on/off function
- ◆ BBU modules with internal chargers and electronic status reporting

The DMX-3 power subsystem architecture provides two completely separate power zones (Power Zone A and Power Zone B), each of which can maintain power for an entire system bay or storage bay independent of the operation of the second zone. There is no redundancy within each zone, rather the redundancy is accomplished through the two-zone design.

System bay power subsystem components

The system bay contains up to eight 1,800 Watt power supplies that are split into two power zones—Power Zone A and Power Zone B, consisting of up to four power supplies each. The system bay also contains up to eight 2.2 kW Battery Backup Unit (BBU) modules providing battery backup in the event an AC failure occurs. One BBU provides the AC line power, and high voltage DC backup to one 1,800 W power supply. The A side BBU modules receive their power from the A side Power Distribution Unit (PDU) and the B side BBU modules receive their power from the B side PDU ([Figure 14 on page 87](#)). Two Power Distribution Panels (PDPs), one for each zone, provide a centralized cabinet interface and distribution control of the AC power input lines when connected to the system bay PDUs. The PDPs contain the manual On/Off power switches, which are accessible through the rear door. The DMX-3 system bay PDPs are available in three-phase Delta and three-phase WYE configurations.

Through an RS-232 interface, the XCM modules communicate with the system bay BBU modules to determine the BBU status and run battery tests.

Storage bay power subsystem components

The storage bay power subsystem consists of the drive enclosure power supply/ cooling modules and the BBU modules that provide the battery backup for the drive enclosures. The A side BBU modules receive their power from the A side PDU and support both the A and B side drive enclosures. The B side BBU modules receive their power from the B side PDU ([Figure 14 on page 87](#)) and support both the A and B side drive enclosures. Two PDPs, one for each zone, provide a centralized cabinet interface and distribution control of the AC power input lines when connected to the storage bay PDUs. The storage bay PDPs contain the manual On/Off power switches, which are accessible through the rear door. The DMX-3 storage bay PDPs are available in three-phase Delta and three-phase WYE configurations.

Symmetrix DMX-3 power configurations

The Symmetrix DMX-3 power subsystem supports three-phase Delta or three-phase WYE configurations. Each bay requires two separate PDUs—one for Zone A and one for Zone B power for the Symmetrix DMX-3 system bay and each storage bay ([Figure 14 on page 87](#)).

Note: For more detailed information on the Symmetrix DMX-3 power requirements, refer to [“Power and cooling data” on page 253](#), [“Electrical specifications and power requirements” on page 254](#), and [“Symmetrix DMX-3 power requirements” on page 270](#). The *Symmetrix DMX-3 Physical Planning Guide* available on the EMC Powerlink website provides additional information.

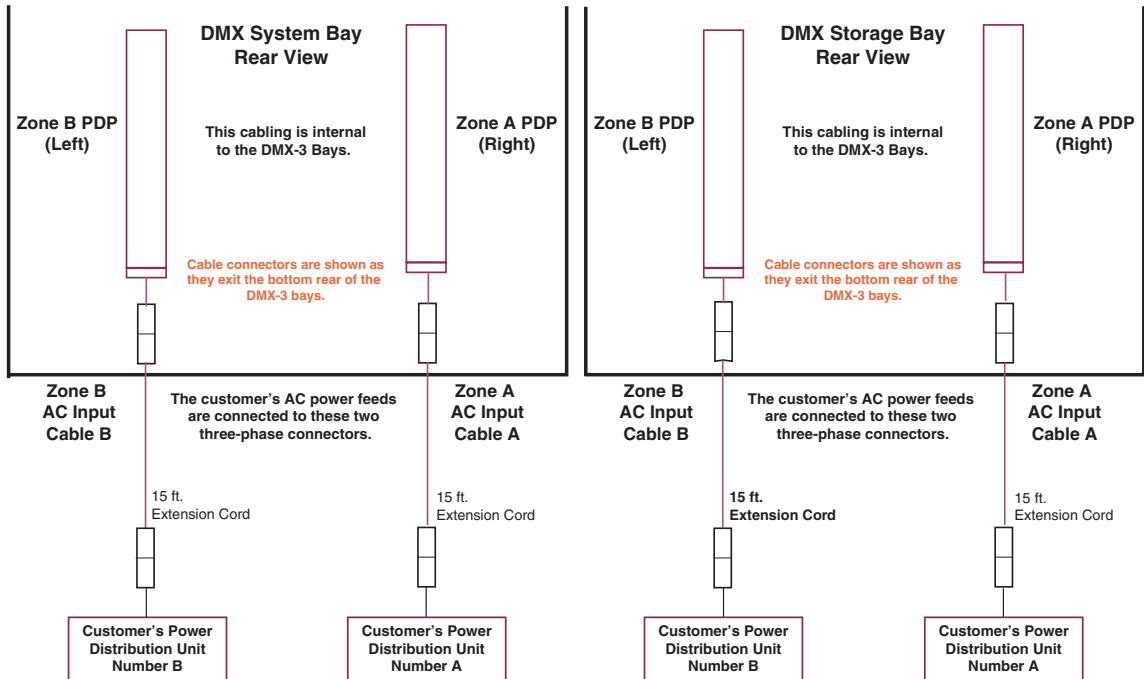


Figure 14 Symmetrix DMX-3 system bay and storage bay to customer PDU power cabling

DMX-3 communications and environmental control

Within the Symmetrix DMX-3 message matrix is the paired with the environmental control together in the Communications and Environmental Control Module (XCM). The XCM modules, XCM0 and XCM1, provide the low-level system-wide communications and environmental control for running application software, monitoring, and system diagnostics from the service processor.

Communications control functions

The XCM's primary function is to act as a communications agent between the service processor (KVM and server) and the embedded processing nodes within the system. [Figure 15 on page 89](#) 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 an XCM become temporarily unavailable. As a backup to the Ethernet fabric, the XCM also contains RS-232 multiplexing logic to allow for an alternate means of serial communication to embedded processing nodes within the DMX-3. The XCM also has the ability to issue remote commands to the director boards, global memory directors, and itself. These commands can be issued from the service processor or remotely, by the EMC Customer Support Center, providing a rich set of intelligent serviceability functions. Also within the XCM is the top-level fabric for the message matrix communications system. This is a high-speed communications fabric within the DMX-3 that allows for fast, reliable messaging between compute nodes.

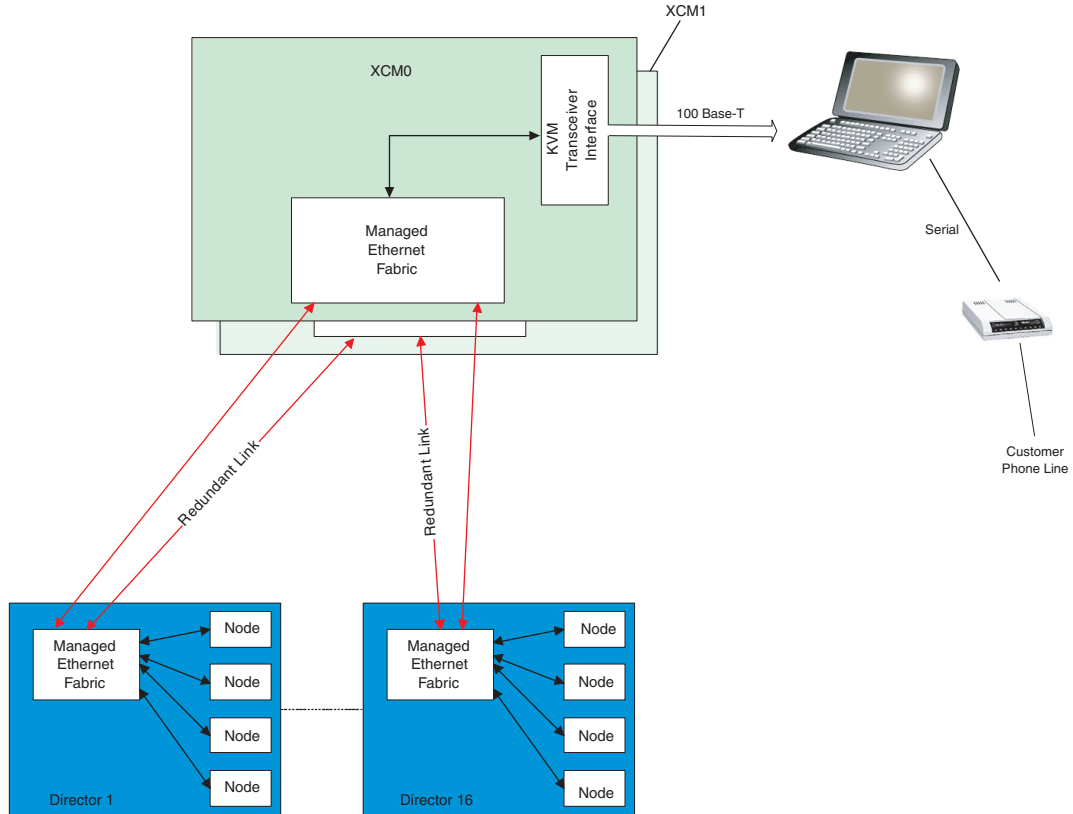


Figure 15 **Communication to directors**

Environmental control functions

The XCM monitors and logs environmental events across all critical components ([Figure 16 on page 90](#)) and reports any operational problems. Critical components include channel and disk directors, global memory directors, power supplies, power line input modules, fans, and various on/off switches. The XCM environmental control is capable of monitoring each component's local voltages ensuring optimum power delivery. Temperature of directors and memory are also continuously monitored. 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

- ◆ Current from each DC supply
- ◆ Voltage drops across major connectors

Ailing components can be detected and replaced before a failure occurs.

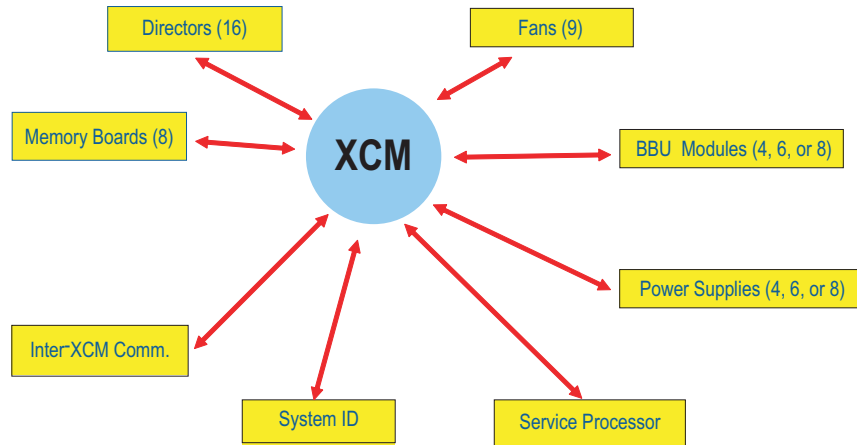


Figure 16 XCM environmental control functionality

Channel attachments

The Symmetrix DMX-3 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.

Note: 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 local 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.

FICON channel interface connections

The Symmetrix DMX-3 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.

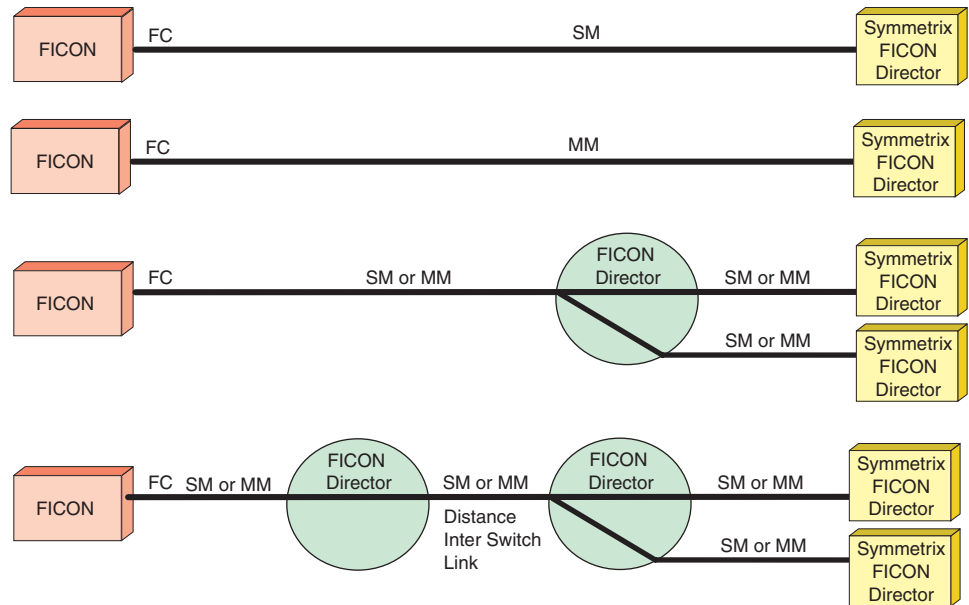
Note: For more information on the FICON director, refer to [“FICON channel director” on page 80](#).

FICON channels use fiber optic cables. The current FICON implementation supports data transfer rates up to 4 Gb/s. There are two types of fiber-optic cables: multimode and single-mode.

Note: Symmetrix systems directly connect to FICON single-mode or multimode cables. For information on additional configuration options, refer to [“Symmetrix FICON configurations” on page 93](#).

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 17 on page 92](#) illustrates several types of FICON channel attachments.

[Table 22 on page 92](#) describes the maximum distances supported by FICON cables.



SYM-000347

Figure 17 FICON channel attachments

Table 22 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
	9 micron, 4 Gb/s	10 km (6.2 miles) for each link
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
	50 micron, 4 Gb/s	150 m (492 ft) for each link
	62.5 micron, 1 Gb/s	300 m (984 ft) for each link
	62.5 micron, 2 Gb/s	150 m (492 ft) for each link
	62.5 micron, 2 Gb/s	70 m (230 ft) for each link

a. Distances are point-to-point.

Symmetrix FICON configurations

In addition to the standard direct-connect configuration, Symmetrix DMX-3 FICON models 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.

Note: For specific Cascading and Open System Intermix configuration requirements, contact your local 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 (InterSwitch 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-3 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.

Note: For more information on the ESCON director, refer to [“ESCON channel directors” on page 78](#).

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).

Note: 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 18 on page 95](#) illustrates several types of ESCON channel attachments. [Table 23 on page 96](#) describes cable types and supported distances.

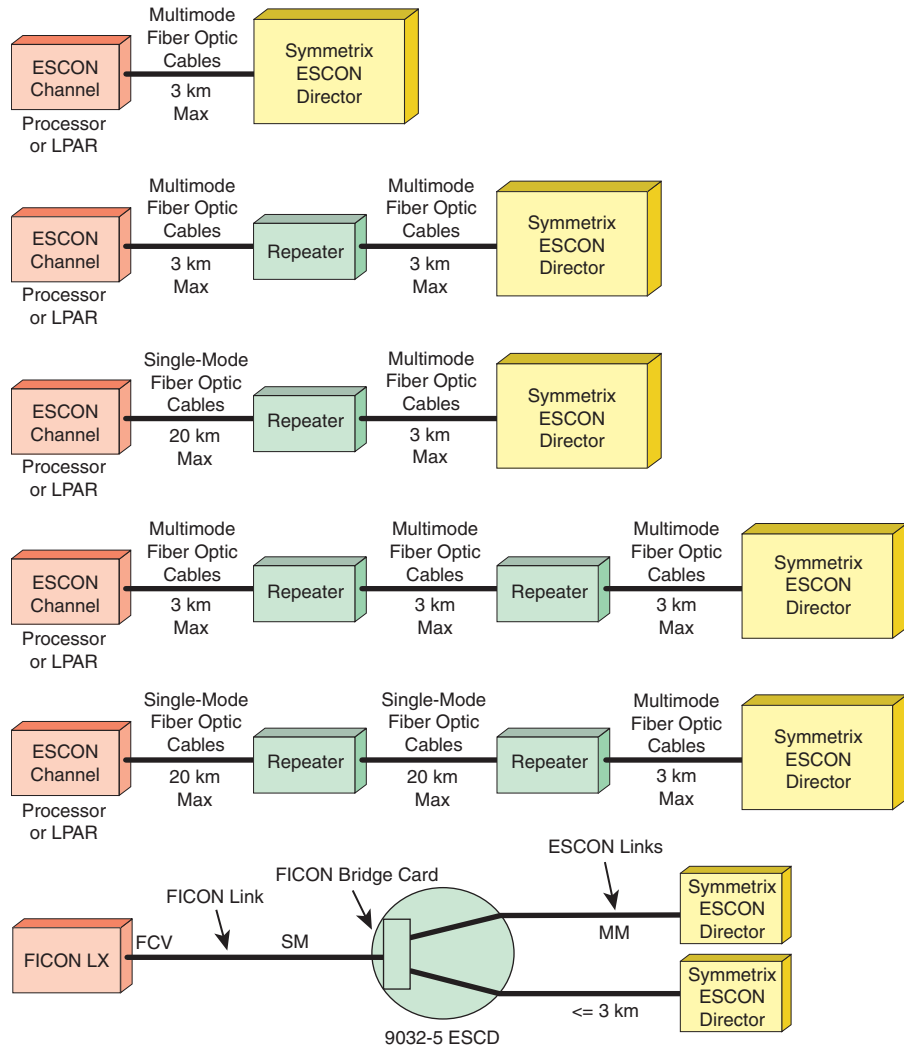


Figure 18 **ESCON channel attachments**

Table 23 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 three 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.

Note: 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).

Note: 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 Fibre Channel director provides the capability for eight concurrent operations through its eight physical interfaces for communicating with the host systems.

Note: For more information on the Fibre Channel director, refer to [“Fibre Channel directors \(front-end\)” on page 77](#).

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 4 Gb/s ([Table 24 on page 97](#)).

Table 24 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
	9 micron, 4 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	300 m (984 ft) per cable segment
	50 micron, 4 Gb/s	150 m (492 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
	62.5 micron, 4 Gb/s	70 m (230 ft) per cable segment

a. Distances are point-to-point.

Note: For more information on Fibre Channel attachments and cables, refer to the EMC Powerlink website.

Symmetrix DMX-3 Input/Output Operations

This chapter describes input and output operations between the Symmetrix DMX-3 system and a host system.

- ◆ Symmetrix DMX-3 operation 100
- ◆ Elements of a Symmetrix I/O operation 103
- ◆ I/O performance enhancements..... 111

Symmetrix DMX-3 operation

Intelligent global memory configurations allow Symmetrix DMX-3 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 19 on page 100](#) 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.

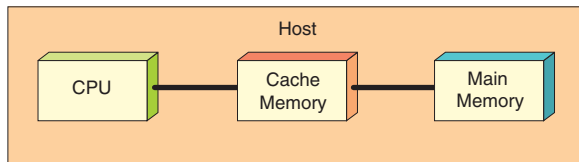


Figure 19 Host cache use

Symmetrix global memory management

The Symmetrix DMX-3 uses the same memory principle as host systems, but with enhanced caching techniques in global memory. [Figure 20 on page 101](#) illustrates global memory use in Symmetrix systems.

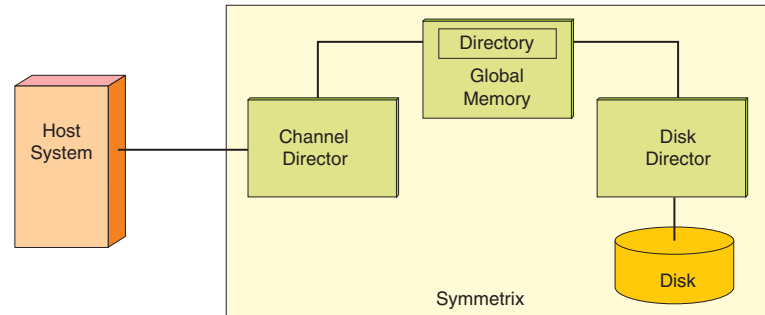


Figure 20 Symmetrix global memory management and data flow

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 20 on page 101](#)) to determine if the request can be satisfied within global memory. The directory contains information on each memory page and blocks within each page.
- ◆ Tag Based Caching (TBC), a Symmetrix Engineuity Least Recently Used (LRU) algorithm divides global memory into groups of several hundred slots called TBC groups. In the TBC data structure, four bytes represent each slot. The four bytes contain information about the last time the system most recently accessed this slot, whether the slot is write pending, and other slot attributes. The bytes that represent the slots of a TBC group are contiguous in global memory.

The TBC LRU algorithm determines which data residing in global memory has the *lowest* probability that the system will access it soon, and discards this data to make room for new data the system is about to access.

- ◆ 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 prefetch algorithm is designed to minimize seek and latency on the disks, and to provide good response times.
- ◆ 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.

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 intelligent, adaptive 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.

Enginuity uses an intelligent algorithm attuned to “real-life” workloads and dynamic usage patterns which will detect sequences quickly, but prefetch only when the probability of increasing global memory hits is high. It will place data in memory on time and without interfering with other system activities. The prefetch to memory resulting in global memory hits dramatically improves response to a host request by as much as a factor of 10. It also optimizes back-end utilization by transferring large portions of data in each instance, minimizing seek and latency delays associated with I/O operations directly from disk.

By incorporating intelligent prefetch algorithms, Enginuity prefetches all the data that is needed—and only the needed data—and does it on time, without affecting the response time of other I/O events. Enginuity’s algorithms are the most sophisticated and advanced in the industry and are optimized for what you need next. They can adjust for real-world situations and intelligently choose the method that works best for a given situation.

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” on page 103
- ◆ “I/O response time: Open systems environment” on page 104
- ◆ “Symmetrix I/O operations” on page 104
- ◆ “Read operations” on page 106
- ◆ “Write operations” on page 108
- ◆ “Write destaging operation” on page 110

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 21 on page 103](#).



Figure 21 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 22 on page 104](#).

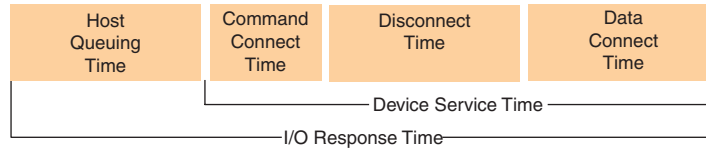


Figure 22 I/O response time (open systems environment)

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.

Note: 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 23 on page 105](#)):

- ◆ 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.

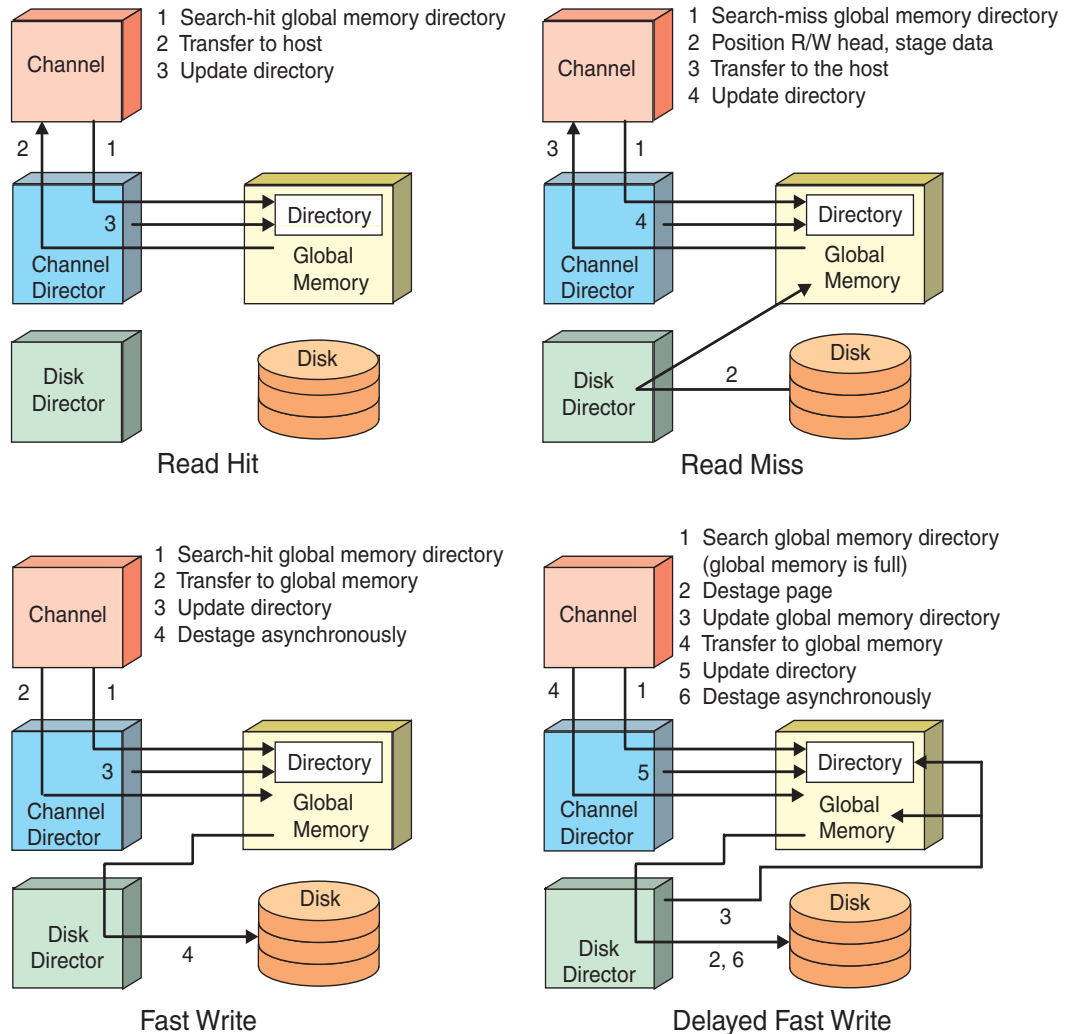


Figure 23 Symmetrix I/O operations

Read operations

There are two types of read operations: read hit and read miss. [Figure 24 on page 106](#) illustrates the data flow for read operations.

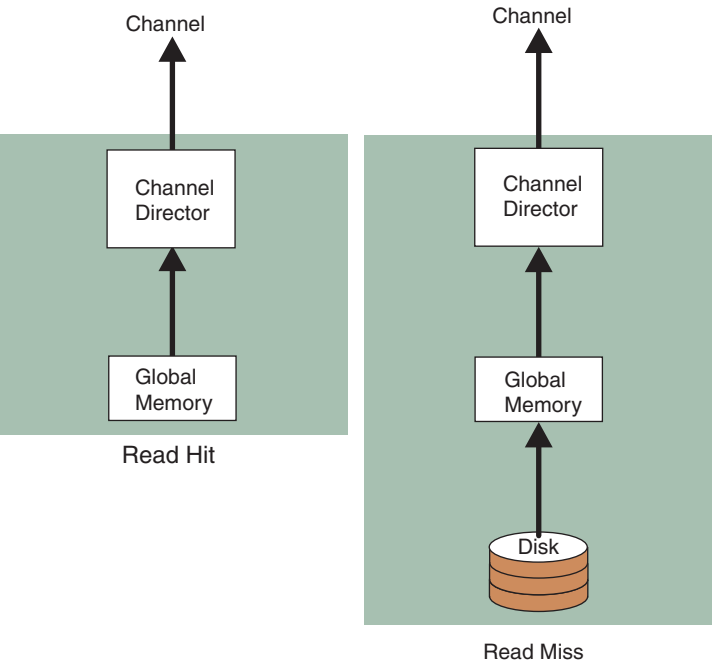


Figure 24 Read operations

Read hit In a read hit operation ([Figure 24 on page 106](#)), 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 and latency ([Figure 25 on page 106](#)).

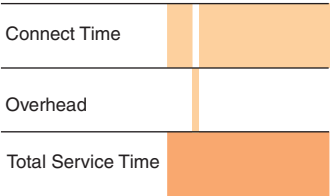


Figure 25 Read hit

Read miss In a read miss operation ([Figure 24 on page 106](#)), 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 26 on page 107](#)). During the disconnect time, other commands can be executed on other devices on the bus, or commands can queue to the same device.

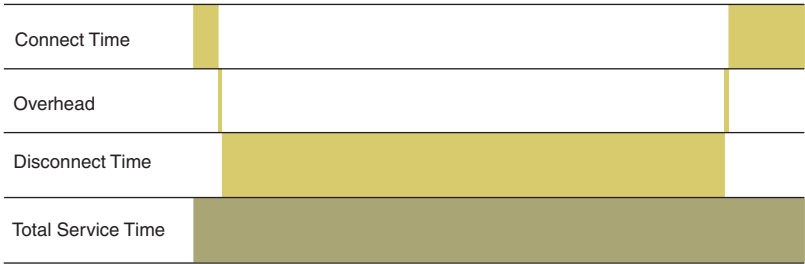


Figure 26 Read miss

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 23 on page 105](#)).

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 27 on page 108](#)), 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.

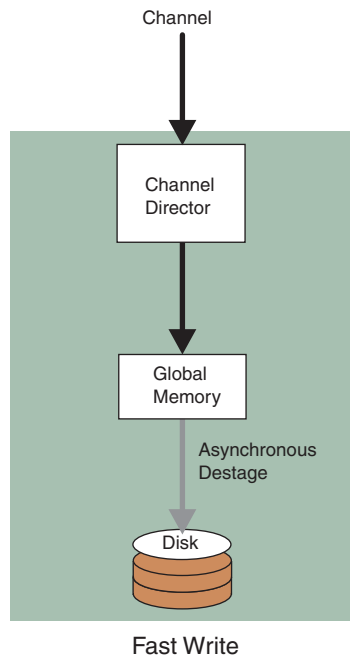


Figure 27 Write operations

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 28 on page 109](#)).

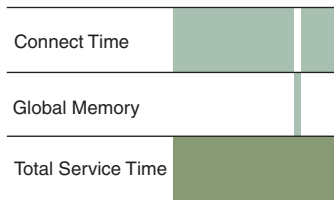


Figure 28 Fast write

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 29 on page 109](#)). 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.

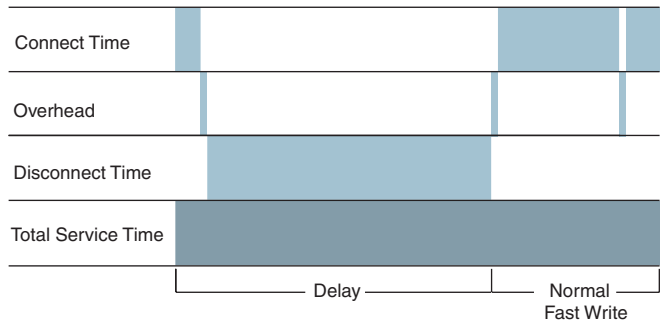


Figure 29 Delayed fast write

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 30 on page 110](#) illustrates this destaging operation.

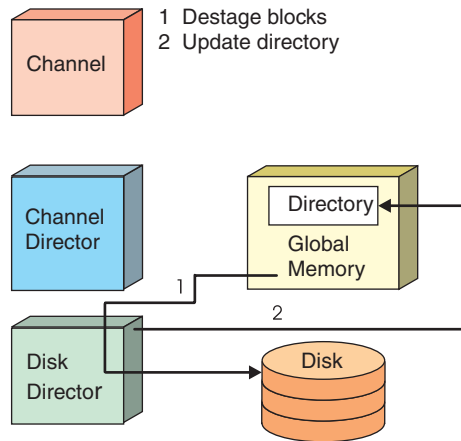


Figure 30 Destaging operation

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 (WPIs) 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 Fibre Channel drive loops ranging from 15 drives to 45 drives per loop. For more information on director and disk combinations, refer to [“Fibre Channel disk subsystem” on page 66](#) and [“Fibre Channel disk directors \(back-end\)” on page 82](#).
- ◆ 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.
- ◆ 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-3 and explains how to optimize the following features.

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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-3 offers 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-3 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-3 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 512 GB (256 GB effective) of global memory in the DMX-3.
- ◆ 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" on page 116](#)
- ◆ ["Tag Based Caching \(TBC\)" on page 117](#)
- ◆ ["Fast write capabilities" on page 118](#)
- ◆ ["Dynamic Mirror Service Policy \(DMSP\) algorithm" on page 118](#)
- ◆ ["Disk Rotational Position Ordering \(RPO\)" on page 118](#)
- ◆ ["Disk Multiple Priority Queues \(DMPQ\)" on page 118](#)
- ◆ ["PermaCache option" on page 119](#)

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 acts as intelligent offload engines to perform repetitive system critical functions. Global memory ASICs consist of the following components:

- ◆ ["Parallel global memory regions" on page 116](#)
- ◆ ["Buffering" on page 116](#)
- ◆ ["Access arbitration" on page 116](#)
- ◆ ["Memory striping" on page 116](#)

Parallel global memory regions

Symmetrix DMX-3 global memory architecture drastically reduces memory contention by partitioning the global memory into four separately addressable, simultaneously accessible regions. In a Symmetrix DMX-3 with eight global memory directors, there are 32 separately addressable and accessible global memory regions. The DMX-3 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.

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

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.

Tag Based Caching (TBC)

Enginuity uses Tag Based Caching (TBC) Least Recently Used (LRU) algorithm for cache management. Enginuity divides global memory into groups of several hundred slots. In the TBC data structure, four bytes represent each slot. The four bytes contain information about the last time the system most recently accessed this slot, whether the slot is write pending, and other attributes. Each memory slot is represented by one *tag*. Tags are clustered into groups called *extents*.

The TBC LRU algorithm determines which slot in an extent was least recently used. This TBC LRU slot then loses its association with the track/data that is stored. Getting a new slot means reading all the presenting bytes of a TBC extent and choosing the oldest one to be replaced. Changing one bit removes it from the LRU pool of available slots. [Figure 31 on page 117](#) illustrates the TBC LRU process.

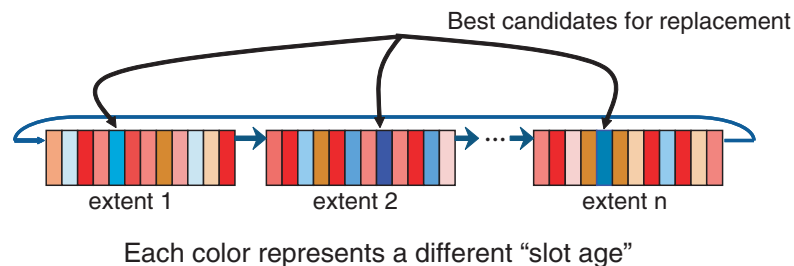


Figure 31 **TBC LRU function**

All the CPUs in a Symmetrix system access all the TBC extents. Enginuity manipulates the TBC extent under lock. To avoid contention over one TBC extent, each CPU in the Symmetrix system accesses the TBC extents in a different order, which guarantees even loads on the different TBC extents at any given time. TBC simplifies LRU implementation.

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.

Note: DMSP also works with the Symmetrix file system as described in [“Enhancement of dynamic mirror service policy” on page 120](#).

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 Enginuity 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 (DMPQ)

Disk Multiple Priority Queues enable 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 RAID 6 options (in (6+2) or (14+2) 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 RAID 6 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 local 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 or greater 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.

Symmetrix file system performance features

Enginuity automatically reserves 24 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. SFS reserves two SFS logical volumes consisting of 6,140 cylinders each (slightly less than 6 GB). These volumes are protected using mirroring, consuming slightly less than 24 GB total physical space.

The SFS generates several benefits for Symmetrix users, namely:

- ◆ [“Dynamically adjusting performance algorithms” on page 120](#)
- ◆ [“Enhancement of dynamic mirror service policy” on page 120](#)
- ◆ [“Enhancement of Symmetrix Optimizer” on page 120](#)
- ◆ [“Enhanced system audit and investigation” on page 121](#)

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 to recommend swaps.

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-3 channel directors process data from the host and manage access to global memory over a direct matrix technology ([Figure 8 on page 58](#)). Each channel director on the Symmetrix DMX-3 supports eight internal links to global memory. The Symmetrix DMX-3 may support up to ten qualified channel directors that support connectivity to either mainframe systems or open systems hosts.

Note: For detailed information on each Symmetrix channel director, refer to [“Channel director descriptions” on page 76](#). Contact your local EMC Sales Representative for specific supported channel director configurations.

Note: A Symmetrix DMX-3 can 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-3 supports these channel directors:

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

Note: Contact your local EMC Sales Representative for GigE remote support availability.

- 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 4 Gb/s. Symmetrix systems support multimode cable lengths from 10 feet (three meters) to 1,640 feet (500 meters).

Note: [Table 23 on page 96](#) provides more detailed supported cable distance information. [Table 58 on page 287](#) 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 18 on page 95](#) and [Table 23 on page 96](#)).

Note: [Table 61 on page 295](#) provides part numbers for ESCON channel cables.

FICON channels Symmetrix FICON channels transfer data at speeds up to 4 Gb/s. The DMX-3 FICON design auto-detects 4 Gb/s, or 2 Gb/s, 1 Gb/s at switch or channel port login time.

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

Note: [Table 22 on page 92](#) provides more detailed supported cable distance information. [Table 62 on page 298](#) provides part numbers for FICON channel cables. For information on FICON multimode configuration support, contact your local EMC Sales Representative.

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

Note: Contact your local EMC Sales Representative for GigE remote support availability.

Host connectivity

Symmetrix DMX-3 supports connectivity to open systems hosts such as UNIX, Linux, and Windows systems through iSCSI, GigE (SRDF), and Fibre Channels. The Symmetrix DMX-3 supports mainframe systems host connectivity through ESCON and FICON channels.

Note: Symmetrix DMX-3 only supports Fibre Channel connectivity for iSeries hosts. The Symmetrix DMX-3 can support *simultaneous* connections to mainframe systems hosts and open systems hosts when the required Symmetrix ESP software is installed on the Symmetrix system.

Open systems hypervolumes

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

- ◆ [“Hypervolume extension feature” on page 124](#)
- ◆ [“Disk device cylinders” on page 124](#)
- ◆ [“Logical volume mapping” on page 125](#)
- ◆ [“Metavolumes” on page 125](#)

Note: [“Mainframe systems hypervolumes” on page 129](#) provides information on using the hypervolume extension feature in Symmetrix units connected to mainframe hosts.

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-3 allows up to 160 logical volumes on each Symmetrix DMX-3 open systems physical disk device and up to 64,000 logical volumes (address range 0x000 - 0xF9FF) per Symmetrix DMX-3 system, depending on the hardware configuration and the data protection options.

Note: Contact your local EMC Sales Representative for the number of logical volumes currently supported per DMX-3 system.

Note: For more information on logical volumes supported on Symmetrix DMX-3 disk devices and systems, refer to [“Symmetrix DMX-3 logical volume capacities” on page 68](#). Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your local EMC Sales Representative.

Disk device cylinders

The Symmetrix DMX-3 uses 3.5-inch, low-profile disk devices that are available in the following storage capacities and maximum usable Symmetrix cylinders ([Table 25 on page 125](#)).

Table 25 Symmetrix open systems disk capacities and cylinders

Drive Type	Maximum Usable Symmetrix Cylinders ^a
73 GB	74,611
146 GB	149,227
300 GB	304,932
500 GB	508,626

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 128 blocks of 512 bytes.

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 32](#).

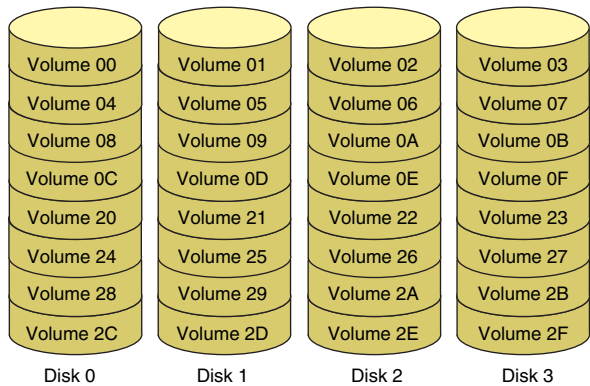


Figure 32 Logical volume mapping (8:1)

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 64 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 approximately 16TB in size. Metavolumes can be composed of nonsequential and nonadjacent volumes.

Note: 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 33 on page 127](#)). 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.

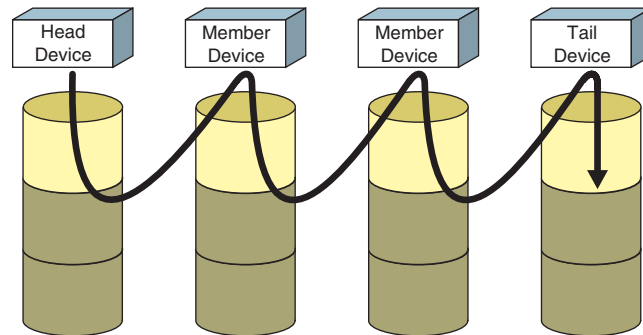


Figure 33 Concatenated volumes

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 34 on page 127). In data striping, equal size stripes of data from each participating drive are written alternately to each member of the set.

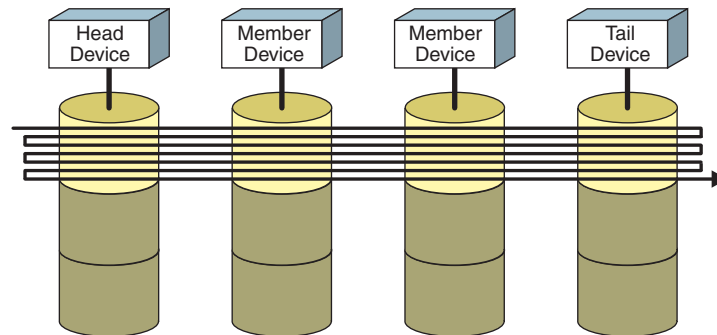


Figure 34 Striped data

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

Note: [“Open systems hypervolumes” on page 124](#) provides information on this feature in Symmetrix systems connected to open systems hosts.

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

- ◆ [“Hypervolume extension options” on page 129](#)
- ◆ [“Split-volume capability” on page 129](#)
- ◆ [“Extended cylinder addressing option” on page 130](#)
- ◆ [“Determining cylinders for hypervolume user data” on page 131](#)

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 255 logical volumes on each Symmetrix DMX-3 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-3 supports up to 255 logical volumes per physical disk device and up to 64,000 logical volumes (address range 0x000 - 0xF9FF) per system, depending on the Symmetrix DMX-3 hardware configuration and the data protection options.

Note: [“Symmetrix DMX-3 logical volume capacities” on page 68](#) provides more information on logical volumes supported on Symmetrix DMX-3 disk devices and systems. Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your local 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.

Note: 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 following:

- ◆ 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 26 on page 131 lists the disk device capacities for 3380 and 3390 emulations.

Table 26 Symmetrix mainframe disk capacities and cylinders

Drive Size 3.5-inch, Low-Profile	Available Symmetrix Cylinders	
	3380 Emulation	3390 Emulation
73 GB	98,134	85,189
146 GB	196,269	170,379
300 GB	401,052	348,150
500 GB	668,420	580,251

Table 27 on page 132 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 27 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
3390-54 ^a	65,520	0	2	2

a. Contact your local EMC Sales Representative for currently supported IBM controller/DASD emulation modes.

Note: Symmetrix DMX-3 systems can support 64 K cylinder CKD devices for operating systems (Siemens) that can exploit it.

Tiered storage optimization

Enginuity 5772 provides two new SW offerings that improve the ability of organizations to store multiple tiers of data in a single Symmetrix, isolating cache resources and prioritizing I/O to ensure more predictable performance levels for different applications:

- ◆ Symmetrix Priority Controls
- ◆ Dynamic Cache Partitioning

Symmetrix Priority Controls

Symmetrix Priority Controls is an offering of v5772 that allows customers to modify the read I/O performance of devices configured in the Symmetrix. Enginuity v5772 provides a set of tools which will enable priority control features within the microcode. These features include:

- ◆ Prioritization — Ability to prioritize I/O by the Symmetrix number.
- ◆ Priority queues — Globally set and executed prioritization of resource for a queue by cache, director, and in RDF I/O queue management. There will be a set of 16 different priority service levels (0 lowest to 15 highest). Service levels are set per group of LUNs. The priority is set at the device level. Each level can be assigned a *time to become urgent* value. The higher the priority level, the faster the processing for higher-tier applications
- ◆ Mainframe integration — Supports full integration with IBM's Workload Manager for z/OS.
- ◆ Performance and statistics reporting — The CE is able to control and query the behavior of the DMX-3 using internal functions. This enables verification that Symmetrix Priority Controls is working properly via a range of new counters and statistics that are reported. These statistics are grouped into three categories:
 - Statistics (general/global system statistics)
 - Priority statistics
 - Device statistics

Dynamic Cache Partitioning

This offering (a separate feature from Symmetrix Priority Controls) allows customers to modify cache performance of devices configured in the Symmetrix. Cache partitioning is a *logical partitioning* of cache. Using Tagged Base Caching (TBC), cache partitioning provides the ability to divide cache into eight *cache partitioning groups* (CPGs). Partitions can be static or dynamic. Unused cache can be temporarily donated to other partitions. The user is able to add (create), change (modify), or move CP groups.

Dynamic Cache Partitioning provides logical partitioning of cache that allows the definition of up to eight cache partitioning groups (CPGs) (seven new ones in addition to the default one). With Dynamic Cache Partitioning enabled, the user can create groups of devices and allocate a certain portion of Symmetrix cache to each group. The cache subsystem is aware of the user defined allocations and ensures that CPGs do not consume more cache than they are allotted. Each partition will have a target cache percentage as well as high and low watermarks. Dynamic Cache Partitioning is “dynamic” in that it will also allow donation of unused cache slots to other partitions after a specified donation time.

Dynamic Cache Partitioning can be managed through the Solutions Enabler (SE) command line interface. The SE interface allows the user to enable and disable cache partitioning, create, remove, and modify cache partitions, add devices to and remove devices from cache partitions, as well as view and list partitions and their related statistics.

Power vault devices can't be assigned to partitions. Special devices (RDF, meta devices, striped CKD) have their own rules.

In *read operations*, slots will be allocated subject to the cache partition size and current slot count.

In *write operations*, each partition will have its own write pending (WP) limits and counters. A WP fairness mechanism will assign a delay to any write request. The type of delay will be one of the following three: device, group (partition), or system.

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).
- ◆ Determine data storage capacity required for each host connected to the Symmetrix system.
- ◆ Determine the number of channels available from each host.
- ◆ Analyze the nature of the applications executed on the host connected to the Symmetrix system.
- ◆ Determine the availability of a Logical Volume Manager (LVM) on the host and the use of data striping.
- ◆ Determine and record the use of hypervolumes on the Symmetrix system, hypervolume size, and the allocation of hypervolumes between different hosts, different channels, and different applications.
- ◆ Determine the maximum drive and file system sizes supported by each host connected to the Symmetrix system.
- ◆ Analyze the requirements for device sharing.
- ◆ Define the number of Fibre Channel directors used and the number of ports used on each director.
- ◆ Define any special considerations for host-level mirroring for device distribution in the Symmetrix system.
- ◆ Plan for the possibility of upgrading the Symmetrix system with additional drives in the future and its effect on the configuration if the system installed is not at maximum capacity.

Virtual LUN technology

Virtual LUN technology, introduced with 5772, is an enhancement of Symmetrix Optimizer that enables transparent, non-disruptive data mobility between storage tiers. Virtual LUN technology offers two types of data movement; migration and relocation. Migration provides users the ability to move data between high-performance disks and high-capacity disks, or to populate newly added disk drives. This delivers tiered storage capabilities within a single Symmetrix array. Relocation is used when data needs to be moved to specific locations within the Symmetrix, to balance disk usage or to reclaim space left by deleted volumes.

Virtual LUN technology in 5772 will only migrate data between drives with the same RAID protection schemes.

Migration features

Migration contains the following features:

- ◆ Moves one or more devices to one or more target disks
- ◆ All mirrors of the devices are moved
- ◆ Migrated volumes are distributed across specified recipient drives by a sophisticated layout algorithm. Final placement of the volumes is not known in advance.
- ◆ After completion of the migration, the original volumes are deleted from their original locations

Relocation features

Relocation contains the following features:

- ◆ Moves data volumes to a specific physical disk
- ◆ All mirrors of the volume are moved
- ◆ Final placement is known in advance and must be specified by the user
- ◆ After completion of the move, the original volumes are deleted from their starting locations

Virtual LUN management

Symmetrix Optimizer and its Virtual LUN component can be managed with the following tools that support 5772 features:

- ◆ Symmetrix Management Console (SMC)
- ◆ Solutions Enabler Command Line Interface (CLI) (Using the *symoptmz* command and sub parameters)

Note: Contact your local EMC Sales Representative for specifics on support and implementation of these tools.

Migration and relocation features are based on Optimizer swap technology and share the same requirements as the traditional swap environment. Dynamic Relocation Devices (DRV's) must be available to provide additional protection during the data movement process. Only devices with a matching sized DRV are eligible for Optimizer, Virtual LUN control.

Data migration and relocation consume array resources and user definable limits can be placed on such resource expenditure. The maximum number of volumes that can be moved each day and the maximum simultaneous volumes to be moved, work together to determine resources that are used for the process. A priority value can also be assigned to the copy process of each participant volume. Together, these parameters affect how long a migration or relocation will take. The Symmetrix configuration lock will remain in place while the Virtual LUN data movement is in progress. If other configuration management functions are routinely scheduled, the Virtual LUN process will be limited by the maximum simultaneous volumes and maximum number of volumes to ensure completion within a timeframe that would allow the configuration lock to be released for other activities.

Optimizer Virtual LUN functionality moves the logical volume as a complete entity. Subsets of data that reside on the logical volumes remain unknown to the process. Consequently, users are advised to understand data placement and assign related data to grouped logical volumes.

At present, all management tools require the following manual exclusions when constructing Virtual LUN migration or relocations lists.

- ◆ Source: Meta volume members.
- ◆ Target: Migration drives containing the source volumes. Sometimes drives containing the migration source volumes are included in the list of available targets. Be careful to exclude the drives containing the source volumes from the migration target list to ensure successful Virtual LUN processes.

The following sequence shows an example of the Symmetrix Management Console (SMC) three-step process to prepare a migration. The entry dialog is available under the Optimizer > Swap/Move > Manual Move drop down sequence.

Figure 35 on page 138 shows step 1 of the SMC migration dialog, selecting the devices. Only devices with an appropriately sized DRV will be displayed in the list of available devices. Devices are highlighted and moved to the Selected Devices list on the right hand side of the dialog box.

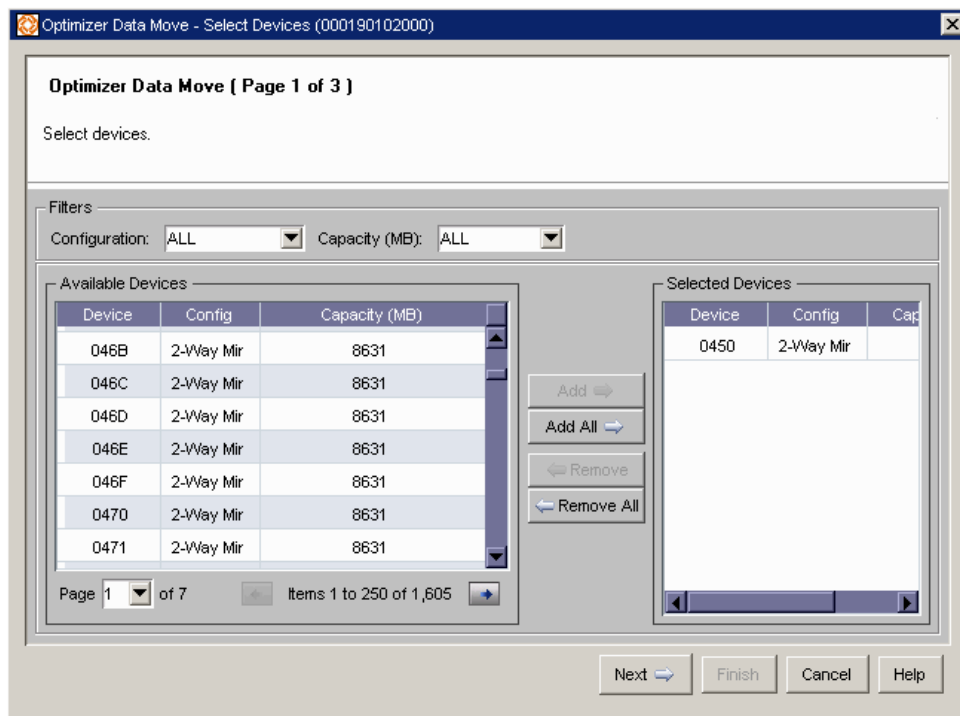


Figure 35 SMC migration dialog step 1

Figure 36 on page 139 shows step 2 of the SMC migration dialog, selecting the target disks. It is important to note that disks containing the source devices are excluded from the migration target disks.

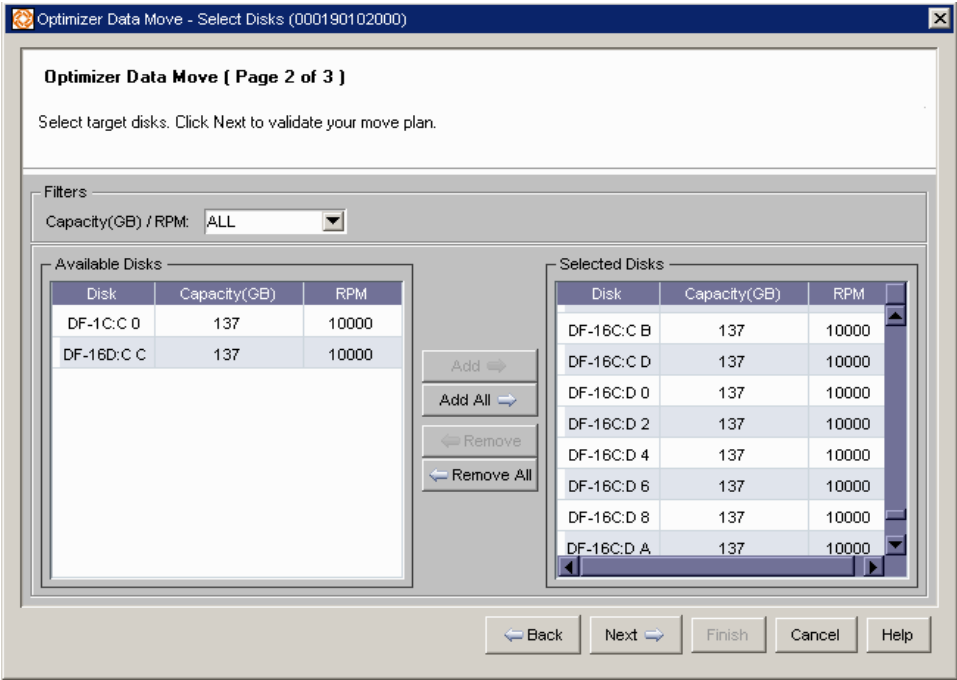


Figure 36 SMC migration dialog step 2

Figure 37 on page 140 shows step 3 of the SMC migration dialog: scheduling the data move. The start of the Virtual LUN process can be scheduled in this SMC window, or it can start according to policies defined in the Optimizer program. Other Optimizer parameters, such as maximum simultaneous volumes, maximum number of volumes and priority, will affect the runtime of the Virtual LUN migration.

Note: See “Symmetrix Optimizer” on page 146 for additional information.

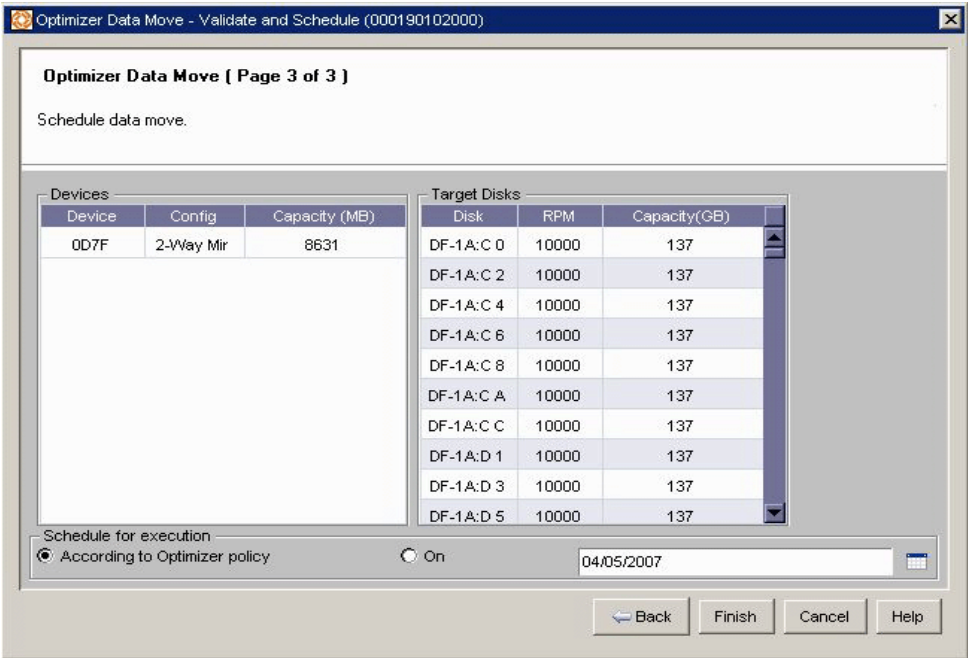


Figure 37 SMC migration dialog step 3

Dynamic Host Addressing

Dynamic Host Addressing allows any device seen by any HBA to have any LUN number, by avoiding fixed LUN offsets. Dynamic Host Addressing is an enhancement to the VolumeLogix functionality to provide more flexibility of device addressing on Symmetrix ports.

VolumeLogix allows users to control which devices on a Symmetrix port are visible to which HBAs (using the HBA WWN). A previous feature of Volume Logix, LUN Offset, allowed the user to specify a single 'offset' for each HBA (for each Symmetrix port) that would be used to allow HBA's to have their own set of devices visible, starting at LUN address zero. This was particularly useful for HBA's that required the use of LUN addresses 0x00-0xFF. LUN Offset was limited in that it allowed only a single offset to be specified. Since the LUN address used by the host was directly associated with the address configured on the FA port, the flexibility of this feature was limited.

Dynamic Host Addressing provides maximum flexibility when configuring devices addresses, by removing any association between the host LUN address and the address given to the device on the FA port. The only requirement is that the device be mapped to the FA port. This feature allows any device to be configured for any LUN address on any originator (HBA) on any port. When configuring new storage and/or assigning devices to a port and originator, the user can either specify the LUN address that the HBA will use to access the device (for maximum control), or let the system find the next LUN address available for that HBA (if the user does not require control over specific LUN addresses).

Dynamic Host Addressing requires a new format of the records in the VolumeLogix database in the system. Moving to the new format will be done nondisruptively to the user and transparent overall. On the first provisioning action that specifies Dynamic Host Addressing should be used, the record containing the configuration information for the HBA/Symm port in question will be translated nondisruptively to the new format. Impact is transparent to the user. Records in both the old format and the Dynamic Addressing format can coexist in the system; translation is done only on those records that are being updated.

Dynamic Host Addressing is supported with SYMCLI version 6.4.

Multiport volume access for open systems environments

Unlike most disk arrays, the Symmetrix system can present any logical volume through any number of Fibre Channel channels to the hosts connected to the system. 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).

Note: For more information on multiport volume access, and the most current information on Symmetrix systems and specific host integration, contact your local EMC Sales Representative, or refer to the EMC Powerlink website.

Software options overview

The following software options are described in these sections:

- ◆ “EMC ControlCenter family of products” on page 143
- ◆ “Symmetrix Optimizer” on page 146
- ◆ “TimeFinder family of products” on page 147
- ◆ “Solutions Enabler” on page 148

EMC ControlCenter family of products

EMC ControlCenter is a family of products that provides you with an integrated approach to managing your multivendor storage environment, and automating many of your common storage management tasks. The ControlCenter base product is comprised of Open Integration Components (OIC). Several other ControlCenter plug-in products are available. The ControlCenter products you choose depend on the Storage Resource Management (SRM) solutions you want to implement.

Note: This EMC ControlCenter section contains many references to supporting publications, which can be accessed from any of the following:

Documentation/Help CD provided with your EMC ControlCenter installation kit

EMC Powerlink at <http://Powerlink.EMC.com>

ControlCenter Documentation Library, which is available from the ControlCenter Console’s help menu after installation.

Open integration components

At the heart of ControlCenter is a common foundation and infrastructure, which provides scalability, usability, and information sharing across all ControlCenter applications. An embedded database stores and shares information about each object being managed. Common services, part of OIC, discover, correlate, and map relationships between objects.

This design enables ControlCenter applications, such as Symmetrix Manager and Performance Manager, to span storage array, storage network, and host management functions.

OIC components include:

- ◆ User interfaces
 - E Web Console

- ◆ Infrastructure
 - ECC Server
 - Repository
 - Store
- ◆ Agents
 - Host agents for Solaris, HP-UX, AIX, Linux, and Windows
 - Common Mapping Agent
 - Database Agent for Oracle
 - Database Agent for DB2
 - Integration Gateway Agent
 - Physical agent for z/OS
 - Storage Agent for SMI
- ◆ Common services

Common services span across all ControlCenter applications providing you with simple access to various tasks and to the various views of your SAN and the objects in it. These common services allow you to discover and monitor objects in your SAN.

For example; you can map the relationship of storage structures from databases and file systems through to their logical and physical location within the storage array. Common services also provides you with information such as the status of your environment, high-level perspective on performance, capacity, and health.

Common services include:

- ◆ Administration services
 - Security management
 - Agent configuration
- ◆ Console views include:
 - Topology view
 - Relationship view
 - Properties view
 - Performance view
 - Alerts view
 - Command History

Storage resource management solutions

In addition to the base functionality provided by OIC, several other ControlCenter products are available. ControlCenter product packaging is based on the storage resource management (SRM) solutions that follow.

SRM planning and provisioning

The planning and provisioning solution allows you to design, plan, and provision a multivendor storage infrastructure for the benefit of improving the utilization, performance, and cost effectiveness of your storage assets. It also allows you to quickly recognize, isolate, and respond to storage issues from a single console.

This solution is achieved using the following ControlCenter applications:

- ◆ SAN Manager™
- ◆ SAN Advisor™
- ◆ Automated Resource Manage™

SRM monitoring and reporting

The monitoring and reporting solution allows you to effectively utilize your storage assets, manage inventory, and assess how your storage is performing.

This solution is achieved using the following ControlCenter applications:

- ◆ Performance Manager
- ◆ StorageScope™
- ◆ StorageScope File Level Reporter

SRM storage device management

The storage device management solution allows you to actively configure and optimize storage arrays.

This solution is achieved using the following ControlCenter applications:

- ◆ Symmetrix Manager
- ◆ Symmetrix Optimizer

Symmetrix Optimizer

Symmetrix Optimizer helps you increase the performance of a Symmetrix system by spreading I/O activity evenly across the physical disks. When a particular drive is in high demand, there is excessive head movement on that drive. This movement slows down read and write activity. By balancing highly active and less active logical devices across drives, seek activity is balanced, and contention among drives is reduced. Throughput within the overall Symmetrix system is improved, and you experience optimal response times.

Optimizer performs self-tuning of Symmetrix data configurations from the Symmetrix service processor by:

- ◆ Analyzing statistics about Symmetrix logical device activity.
- ◆ Determining which logical devices should have their physical locations swapped to enhance Symmetrix performance.
- ◆ Swapping logical devices and their data using internal Dynamic Reallocation Volumes (DRVs) to hold customer data while reconfiguring the system (on a device-to-device basis).

How Symmetrix Optimizer works

Symmetrix Optimizer:

- ◆ Automatically collects logical device activity data, based upon the devices and time window you define.
- ◆ Identifies “hot” and “cold” logical devices, and determines on which physical drives they reside.
- ◆ Compares physical drive performance characteristics, such as spindle speed, head actuator speed, and drive geometry.
- ◆ Determines which logical device swaps would reduce physical drive contention and minimize average disk service times.
- ◆ Using the Optimizer Swap Wizard, swaps logical devices to balance activity across the back end of the Symmetrix array.

Optimizer is designed to run automatically in the background, analyzing performance in the performance time windows you specify and performing swaps in the swap time windows you specify.

TimeFinder family of products

The TimeFinder family of software is the most powerful suite of local storage replication solutions available, delivering a wide range of in-the-system data copying capabilities to meet mixed service level requirements without operational impact.

Use the TimeFinder family to:

- ◆ Create instantly accessible business continuance volumes (BCVs): mirrors, clones, and snapshots
- ◆ Perform backups quickly, frequently, and without disruption
- ◆ Reduce time limitations through workload compression
- ◆ Eliminate job-step copies to improve batch processing time
- ◆ Seamlessly load or update data warehouses as needed
- ◆ Provide production data for application development testing without scheduling downtime.

The TimeFinder family includes the following products:

- ◆ TimeFinder family base products:
 - TimeFinder/Clone
Highly functional, high performance full volume, point-in-time BCVs for backups, online restores, and volume migrations
 - TimeFinder/Snap
Pointer-based, economical, space-saving snapshots of BCVs for reduced recovery points and fast local data restore
- ◆ TimeFinder family add-on options:
 - TimeFinder/Mirror
Highly available, ultra-performance mirror BCV option for the most demanding environments
 - TimeFinder/Consistency Groups
Maintain data coherency across TimeFinder-protected application volumes to ensure data consistency and restartability
 - TimeFinder/Exchange Integration Module and TimeFinder SQL integration Module
Tight integration of the TimeFinder family with Microsoft Exchange and SQL applications for automated backup and restore

Solutions Enabler

In order to retrieve data from a Symmetrix system and information about databases and file systems that are to be monitored by certain ControlCenter agents, such as Common Mapping Agent, you must install the EMC Solutions Enabler on the host managing the Symmetrix system (either the host running the Storage Agent for Symmetrix or a proxy host).

Solutions Enabler provides low-level SCSI commands that communicate with Symmetrix systems to retrieve configuration, status, and performance information.

When you install Solutions Enabler, you are installing these components:

- ◆ **SYMMAPI** — The Symmetrix Application Programming Interface and runtime libraries
- ◆ **SYMCLI** — An open systems application, written using the SYMAPI, that manages Symmetrix systems
- ◆ **SYMAPI Server** — A process that retrieves status and performance information by polling the Symmetrix systems and processing client commands.

This chapter discusses the Symmetrix DMX-3 features and options that affect data availability and reliability.

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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
- ◆ Redundant global memory
- ◆ Channel director redundancy
- ◆ Redundant internal data paths
- ◆ Internal control data path redundancy
- ◆ Fibre Channel back-end redundancy
- ◆ Dual-Initiator feature
- ◆ Redundant power subsystem
- ◆ Vaulting
- ◆ 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 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.

Working with your local EMC Sales Representative, you can choose from the following Symmetrix data protection options to match your critical data requirements:

- ◆ [“Mirroring \(RAID 1\)” on page 151](#)
- ◆ [“RAID 1/0” on page 152](#)
- ◆ [“RAID 10” on page 152](#)
- ◆ [“RAID 5” on page 152](#)
- ◆ [“RAID 6” on page 152](#)
- ◆ [“Symmetrix Remote Data Facility \(SRDF\)” on page 153](#)
- ◆ [“Permanent sparing” on page 201](#)
- ◆ [“Dynamic sparing” on page 204](#)

Mirroring (RAID 1)

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.

Note: [“Disk mirroring \(RAID 1\) concepts” on page 178](#) provides more information on the Symmetrix Mirroring option.

RAID 1/0 RAID 1/0 is a combination of RAID 1 and RAID 0 for *open systems environments*. Data is striped across mirrored pairs.

Note: [“Symmetrix RAID 1/0 for open systems” on page 182](#) provides additional information.

RAID 10 RAID 10 is a combination of RAID 1 and RAID 0 for the *mainframe environment*. Data is striped across mirrored pairs.

Note: [“Symmetrix RAID 10 for mainframe systems” on page 183](#) provides additional information.

RAID 5 The Symmetrix DMX-3 supports RAID 5 data protection. This is an implementation of the industry-standard RAID 5 data-protection technique with rotating parity across all members of the RAID 5 set. RAID 5 provides cost-effective data protection against drive failure. While the most demanding environments continue to opt for mirrored storage for maximum performance, RAID 5 offers an extremely attractive alternative for information storage where price is more important than performance.

For Symmetrix DMX, RAID 5 is available in one of two configurations per array, RAID 5 (3+1) or RAID 5 (7+1), in which data and parity are striped across four or eight physical disks, respectively.

RAID 5 offers Symmetrix DMX-3 customers the benefits of:

- ◆ Symmetrix Optimizer supports RAID 5 devices.
- ◆ RAID 5 devices can be used with Dynamic SRDF and PPRC.
- ◆ RAID 5 devices require only one spare drive.

Note: [“Symmetrix DMX RAID 5” on page 185](#) provides additional information.

RAID 6 RAID 6 is defined as any configuration that supports more than a single disk drive failure. Similar to RAID 5 devices, the data blocks are striped / interleaved across all members of the RAID group. RAID 6 uses permanent sparing. If no spare is found in a *good* location, then dynamic sparing is invoked.

For Symmetrix DMX, RAID 6 is available in one of two configurations per array, RAID 6 (6+2) or RAID 6 (14+2), in which data and parity are striped across eight or sixteen physical disks, respectively.

Symmetrix Remote Data Facility (SRDF)

Note: The [“SRDF family of products” on page 208](#) contains additional information on SRDF applications.

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.

Note: Each of the SRDF product offerings is sold under a separate license by EMC. For more in-depth information about SRDF, refer to the *EMC Symmetrix Remote Data Facility (SRDF) Product Guide*. Contact your local EMC Sales Representative for specific information on availability of each of the SRDF products.

Permanent sparing

Permanent sparing is an automatic data protection option for all Symmetrix DMX-3 systems. It is used in conjunction with mirroring, RAID 5, RAID 6, or SRDF. The permanent sparing process identifies a drive in a *good* location and begins to move the data to the new drive. If there is no drive available in a *good* location, the dynamic sparing process is followed.

After the permanent sparing process completes, all system features are available, and the Symmetrix returns to normal operation without waiting for a CE to replace the failed drive. The failed drive is left as a not ready drive. When the failed drive is replaced, the CE issues commands for the Symmetrix system to place the drive in the spare pool, making it available should another volume fail in the future.

Note: [“Permanent sparing” on page 201](#) provides more information on the permanent sparing option.

Dynamic sparing

Dynamic sparing is a data protection option for all Symmetrix DMX-3 systems. It is used in conjunction with mirroring, RAID 5, RAID 6, or SRDF. If permanent sparing cannot be used, then dynamic sparing is invoked. Dynamic sparing limits the exposure after drive failure and before drive replacement. With dynamic sparing, the Symmetrix system maintains a pool of spare drives that are used only when the system detects a potentially failing device. The dynamic sparing process moves the data and uses the spare until the original device can be replaced.

Note: Contact your local EMC Sales Representative for specific Dynamic sparing configuration rules. Also refer to [“Dynamic sparing” on page 204](#).

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.

Note: [“Maintaining data integrity” on page 167](#) provides more information on global memory director data integrity protection.

Redundant global memory

Symmetrix DMX-3 global memory director operations are redundant by way of a primary and secondary global memory director working as a pair. If an error is detected in one of the memory directors, no writes are allowed to the board containing the error. The writes will be made to the nonfailing memory director until the failed global memory director is replaced. The remaining good memory director remains unprotected until a memory director replacement is performed on the failed memory director. When the new memory director is installed, Global Services personnel perform a copy back from the good remaining director to the newly installed director. This ensures that both memory directors are completely synchronized in the Symmetrix DMX-3 system.

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-3 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. [Table 28 on page 156](#) defines the number of host/SAN connections available for the Symmetrix DMX-3 system.

Table 28 Symmetrix DMX-3 channel director connectivity

Protocol ^a	Usable System Ports ^b	Ports per Channel Director
4 Gb/s Fibre Channel Host/SAN ports	2-64	1-8 per Fibre Channel Director
2 Gb/s Fibre Channel remote replication ports	2-8	1-4 per Fibre Channel Director
1 Gb/s iSCSI ports	2-32	1-4 per Multiprotocol Channel Director
1 Gb/s GigE remote replication ports	2-8	1-4 per Multiprotocol Channel Director
4 Gb/s FICON host ports	2-32	1-4 per Multiprotocol Channel Director
ESCON host ports	2-80	1-8 per ESCON Director
ESCON remote replication ports	2-8	1-8 per ESCON Director

- a. Contact your local EMC Sales Representative for ESCON channel director and GigE Remote support availability.
- b. Usable ports are per qualified channel directors.

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, (host-to-switch and 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 Communications and Environmental Control Module (XCM). 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 XCM domain for replacement. The connection is made through the plug-in XCM.

There are two XCMs per system. If we look at a fully configured Symmetrix DMX, for example, 16 directors are configured with 32 point-to-point serial connections. This means 16 connections are routed to the first XCM and the other 16 redundant connections are routed to the second XCM. The message engine (ME) component of the message matrix provides protection against rogue or runaway 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 nonstop 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 link control card (LCC), which in turn is connected through separate cables to two different disk directors. These two pathways are completely independent of one another.

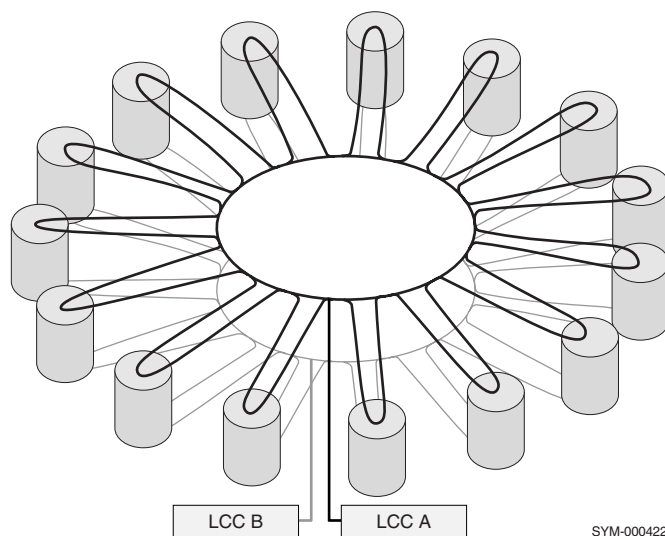
Fibre Channel arbitrated loop design

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 link control 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 LCC through the control bus and reconfigure the loop into a working state.

Link control cards (LCCs)

The LCC is the heart of the Symmetrix DMX-3 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 contains up to 15 individual disk drives, contains a pair of LCCs.

Each LCC connects one of the ports of the 15 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 LCC 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 LCC 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 LCC (A or B), so access to the data is maintained even during service operations. [Figure 38 on page 159](#) is an illustration of the back-end redundancy of the Symmetrix DMX-3 system.



SYM-000422

Figure 38 Fibre Channel back-end redundancy

Data integrity for Fibre Channel arbitrated loops

In order to ensure 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 ensure 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 10-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—ensuring 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 LCC of Disk Director 1 is paired with a LCC and a processor of Disk Director 16 ([Figure 39 on page 161](#)). 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.

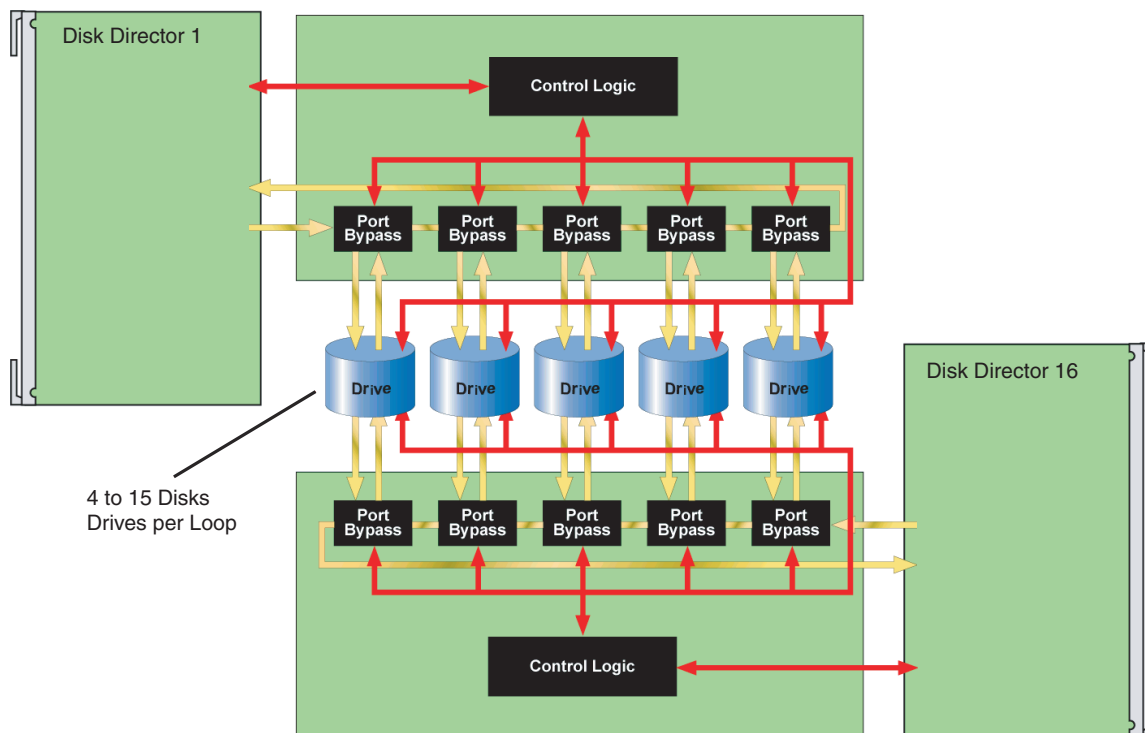


Figure 39 Symmetrix DMX dual-initiator example

Redundant power subsystem

The Symmetrix DMX-3 has a modular power subsystem featuring a redundant architecture that facilitates field replacement of any of its components without any interruption in processing.

The Symmetrix DMX system power subsystem has two power zones for redundancy and drive expansion. The DMX 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.

If any Symmetrix DMX-3 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.

Vaulting

As cache size, disk size, and power requirements have grown, the time required to destage data has also increased. Vaulting is designed to limit the time needed to power off the system if it needs to switch to a battery supply. The vault image is fully redundant, with the specified contents of global memory being saved twice to independent disks.

Powerdown operation

When a DMX-3 is powered down, transitioned to offline, or when environmental conditions trigger a vault situation, a vaulting procedure is initiated. During powerdown or power loss, the part of global memory being saved first reaches a consistent image (no more writes). The disk directors then write the appropriate sections of global memory to disk, saving two copies of the logical data. The BBU modules maintain power to the system during the powerdown process for up to 5 minutes.

Powerup operation

During power up, the data is written back to global memory to restore the system. When the Symmetrix system is powered on, the startup program does the following:

- ◆ Initializes the hardware and the environmental system
- ◆ Restores the global memory from the saved data while checking the integrity of the data
- ◆ Performs clean-up, data structure integrity, and re-initialization of needed global memory data structures

At the end of startup program, the system resumes normal operation when the BBU are recharged enough to support another vault. If any condition is not safe, the system will not resume operation and will call Customer Support for diagnosis and repair. In this state, Customer Support will be able to communicate with the Symmetrix system and find out the reason for not resuming normal operation.

Power loss to one power zone

The Symmetrix DMX-3 power subsystem two-zone design ensures that if there is an AC power loss to one of the zones, power from the second power source will maintain power to the affected bay or bays, provided that each system bay or storage bay's two PDPs are connected to two separate source PDUs at the customer's site.

Upon an AC power loss, the system will maintain operation. When the system goes into single power zone operation a 20-hour timer is invoked.

Before the 20-hour period ends, the EMC Customer Engineer can choose one of the following options:

- ◆ Repair the cause of the power fault.
- ◆ Reset the 20-hour timer to continue the single-power zone operation.
- ◆ Allow the system to vault, shutting down the system in an orderly manner.

Battery backup units (BBU) modules

The BBU modules ensure data integrity during power outages. The BBU modules provides the means for vaulting 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 modules are 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 modules allow the Symmetrix system to remain online to the host system in the event of an AC power loss. The BBU modules automatically turn on when the Symmetrix system detects loss of AC power. The BBU modules will maintain power to the Symmetrix system for up to five minutes while the global memory is vaulted to the vault disk drives.

The BBU modules also prevent disk device failures due to the sharp power drops that occur during unexpected power interrupts. The BBU modules have sufficient capacity to ride out multiple AC outages, however it requires up to eight hours of uninterrupted recharge time to fully recharge the BBU modules. The BBU modules also contain a self-diagnostic controller to ensure availability and correct operation by monitoring the battery condition, charger states, and by providing status updates to the Communications and Environmental Control Module (XCM).

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.

Symmetrix power failure on open systems channels

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.

When a power failure occurs, power switches immediately to the BBU modules 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:

- ◆ Channel directors
- ◆ Disk directors
- ◆ Global memory directors
- ◆ Disk adapters
- ◆ Channel adapters
- ◆ Disk devices
- ◆ Cooling fan modules
- ◆ Communications and Environmental Control (XCM) modules
- ◆ Power supplies
- ◆ Power Distribution Units (PDU)
- ◆ Power Distribution Panels (PDP)
- ◆ Service processor:
 - Keyboard
 - Video Display and Mouse (KVM)

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 global memory directors, channel directors, disk directors, disk adapters, and XCMs are mechanically keyed to prevent insertion to invalid slots. A *Disable Interface* feature ensures that at powerup 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 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

Note: 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 devices

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

Deleting (and then adding) devices online

Enginuity 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.
- ◆ Convert between mirrored and RAID protected volumes.
- ◆ The optimal order is to delete devices and then add. If done in the reverse order, unnecessary global memory will be allocated for the deleted devices.
- ◆ When attempting to add or delete devices, or change protection type of devices, a new minimum cache value will be calculated. In rare cases this new value could prohibit the changes until additional memory is added to the system.

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” on page 167
- ◆ “Error Checking and Correction, and data integrity protection” on page 168
- ◆ “Disk error correction and error verification” on page 169
- ◆ “Global memory director data integrity logic” on page 170
- ◆ “Global memory error correction and error verification” on page 170
- ◆ “Global memory chip-level redundancy” on page 171
- ◆ “Redundant global memory” on page 171
- ◆ “Longitude redundancy code (LRC)” on page 171
- ◆ “Byte-level parity checking” on page 171
- ◆ “Global memory access path protection” on page 171

Remote support

Remote support is an important and integral part of EMC Customer 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 40 on page 168](#). 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.

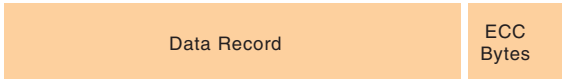


Figure 40 Data record format for conventional DASD

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 41 on page 169](#). 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 41 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 sparing. This feature maximizes data availability by diagnosing marginal media errors before data becomes unreadable.

Note: [“Sparing in Symmetrix systems” on page 199](#) provides information on sparing functionality.

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” on page 170](#)
- ◆ [“Global memory chip-level redundancy” on page 171](#)
- ◆ [“Longitude redundancy code \(LRC\)” on page 171](#)
- ◆ [“Byte-level parity checking” on page 171](#)
- ◆ [“Global memory access path protection” on page 171](#)

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 plus 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.

Redundant global memory

Symmetrix DMX-3 global memory director operations are redundant by way of a primary and secondary global memory director working as a pair. If an error is detected in one of the memory directors, no writes are allowed to the board containing the error. The writes will be made to the nonfailing memory director until the failed global memory director is replaced.

Longitude redundancy code (LRC)

Symmetrix global memory directors also incorporate sector-level Longitudinal Redundancy Checks (LRCs), 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.

DMX-3 security features

Enginuity v5772 provides a number of new and revised security features for the DMX-3. Major security features include:

- ◆ [“Symmetrix Service Credential, Secured by RSA” on page 173](#) — The Symmetrix Service Credential, Secured by RSA, prevents unauthorized service actions by authenticating valid identities on the service processor. This is enabled through strong authentication with industry-leading RSA technology, including a user password and encrypted credential that varies by user, action, system, and time.
- ◆ [“Symmetrix Audit Log” on page 174](#) — The Audit Log records major activities on the Symmetrix, including host-initiated actions, physical component changes, actions on the service processor, and attempts blocked by security controls such as Symmetrix Access Control. The Audit Log is secure and tamper-proof: event contents cannot be altered and can only be accessed by users with the “Auditor” role in Solutions Enabler v6.4.
- ◆ [“EMC Certified Data Erasure for Symmetrix Disks” on page 174](#) — EMC Certified Data Erasure for Symmetrix disks is a service processor-based offering for failed disks within DMX-3 systems. The erasure function overwrites data multiple times in adherence with the Department of Defense specification 5220.22-M. It complements EMC data erasure service for Symmetrix and CLARiiON frames, as well as a new EMC data erasure service for Fibre Channel and ATA disks removed from Symmetrix, CLARiiON®, and Celerra systems. Customers also can use ResourcePak, working with EMC certified data erasure service, to erase volumes on mainframe-attached Symmetrix systems.

Security overview

The security features and enhancements provide industry leading security to enterprise storage by:

- ◆ Assessing risk — By providing professional security services from EMC and selected partners including Security Classification Service and Security Assessment Service.
- ◆ Securing people — By providing integrated IAM solutions from EMC and selected partners including LUN masking Symmetrix access control and secure service credentials (v5772).
- ◆ Securing infrastructure — By providing information infrastructure from EMC including Secure Remote Support Gateway.
- ◆ Securing data — By providing data protection solutions from EMC and selected partners, including Encryption Design and Implementation Service, Data Erasure Service for Symmetrix, and disk erasure (v5772).
- ◆ Assuring policy compliance — Integrated SIEM solutions from EMC and selected partners including Symmetrix Audit Log and auditing enhancements (v5772).

Symmetrix Service Credential, Secured by RSA

The Service Credential technology applies exclusively to service processor activities and not host-initiated actions on Symmetrix devices. These service credentials describe who is logging in, what capabilities they have, a time frame that this credential is good for, and auditing of what actions the service personnel performed. If these credentials are not validated by Symmetrix, the user will not be able to log into the service processor and other internal CE functions. SSC covers both on site and remote login to Symmetrix.

Some of the security features are transparent to the customer such as service access authentication and authorization by the EMC CE and Service Credential (SC) (user ID information) restricted access (service processor and CE internal functions). Access is definable at a user level, not just at a host level. All Symmetrix user ID information will be encrypted for secure storage within the Symmetrix.

Service processor-based functions will honor Solutions Enabler Access Control settings per authenticated user in order to limit view/control of non-owned devices in shared environments such as Symmetrix or SRDF-connected systems.

Symmetrix Audit Log

The Symmetrix Audit Log logs EMC maintenance activities taking place on the Symmetrix service processor, as well as with host-initiated actions and physical component changes. Host commands may then be used to retrieve information from the Symmetrix Audit Log file, using the new Auditor role specified within Solutions Enabler that accompanies Enginuity v5772. Another critical security feature is that logged entry contents cannot be altered.

The audit log resides on the Symmetrix file system (SFS) within the array. Once the 40 MB capacity limit is reached, rotating log files begin to overwrite themselves. There is no need for organizations to maintain this file, unless they want to capture records before the circular 40 MB space recycles. It is important to note that organizations will need to regularly monitor and capture Audit Log contents should they need to retain history beyond the 40 MB capacity.

Note: Access to the Audit Log can be restricted in an open systems environment by utilizing Symmetrix Access Control or the new user authentication features of Solutions Enabler. Utilizing these methods, hosts and/or users that have been explicitly granted access will have the ability to view audit log entries.

EMC Certified Data Erasure for Symmetrix Disks

Data Erasure erases data on a physical medium where the granularity is an entire physical drive. The erasure can vary between a single pass write of data to the drive, all the way to multi pass erasure using complex algorithms as used in DoD 5220.22-M. The intent of secure disk erase is to remove all recoverable user data from a given physical drive, or report that the attempt to remove the data was unsuccessful.

Running Data Erasure

Upon purchase of the EMC Certified Data Erasure for Symmetrix Disks licence, a configuration change will be executed by the CE at time of installation, or at a later time, to enable this feature. The EMC Certified Data Erasure for Symmetrix Disks licence will enable the following functions to be performed. Data Erasure will commence on the “Not Ready” spare automatically, as long as sufficient numbers of permanent spares exist.

Provided the secure disk erase completes successfully, this process will allow a single CE visit to replace a failed drive with a new drive and return the failed drive EMC. The customer may then reference the audit log for evidence and proof of successful Data Erasure.

Note: The EMC certified Data Erasure for Symmetrix Disks license does not allow the customer to retain drives that cannot be erased.

If the customer has purchased the EMC Certified Data Erasure for Symmetrix Disks Service, the following services will be provided by the EMC CE:

- ◆ A certificate of completion for all disks successfully erased.
- ◆ Those non-erasable drives will be left with the customer for disposition at no additional charge.

EMC Certified Data Erasure will have the ability to restart (continuing where it left off on the physical disk) without script intervention after DA failover, IML, or power down. Enginuity will log an event indicating that disk erasure has completed. This status should be of high enough severity to cause the Symmetrix to call home. Enginuity will also provide data detailing the results of the completed Disk Erasure process so that a log file of the process can be created.

Data Erasure guidelines

The following guidelines must be adhered to during the Data Erasure process:

- ◆ Data Erasure requires permanent sparing. Disk Erasure is invoked only upon successful completion of permanent sparing.
- ◆ Data Erasure will only be able to run on an uninvoked “Not Ready” spare. This prevents a drive that is visible to the host from being exposed to Data Erasure.

Note: See [“Permanent sparing” on page 201](#) for additional information.

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 29 on page 176](#) 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 29 on page 176](#).

Table 29 Data protection options (1 of 2)

Data Protection Option	Description
Mirroring (RAID 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. “Disk mirroring (RAID 1) concepts” on page 178 contains more information.
Symmetrix RAID 1/0	Provides a combination of RAID 1 and RAID 0 for <i>open systems environments</i> . Data is striped across mirrored pairs. “Symmetrix RAID 1/0 for open systems” on page 182 contains additional information.
Symmetrix RAID 10	Provides a combination of RAID 1 and RAID 0 used for mainframe environments. “Symmetrix RAID 10 for mainframe systems” on page 183 contains more information.
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 “Symmetrix DMX RAID 5” on page 185 contains more information.
RAID 6	RAID 6 supports more than a single disk drive failure. RAID 6 is configured in (6+2) and (14+2) groups. RAID 6 uses both horizontal parity and diagonal parity. “Symmetrix DMX RAID 6” on page 193 contains more information.

Table 29 Data protection options (2 of 2)

Data Protection Option	Description
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>EMC Symmetrix Remote Data Facility (SRDF) Product Guide</i> . See “SRDF family of products” on page 208 for related information.
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 a required data protection method for all DMX-3 systems. “Dynamic sparing” on page 204 contains more information. “RAID 5 attributes” on page 185 contains information on RAID 5 sparing.
Permanent sparing	Replaces a faulty drive automatically from a list of available spares residing in the Symmetrix system without CE involvement on site. “Permanent sparing” on page 201 contains more information.

Disk mirroring (RAID 1) concepts

Symmetrix Mirroring (RAID 1) 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-3c*, 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 Enginuity 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 disk devices in an alternating method, a number of tracks from M1, and a number of tracks from M2. Interleave is designed to achieve maximum throughput.
- ◆ Split Service Policy — Differs from Interleave because read operations are assigned to either the M1 or the M2 logical volume, but not 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 Enginuity operating system.

Error recovery with mirroring

In the unlikely event that one volume in the mirrored pair fails, the Symmetrix system automatically uses the other volume without interruption of data availability. The Symmetrix system notifies the host operating system of the error and EMC Customer Support Center through the call-home feature. The EMC Product Support Engineer (PSE) then begins the diagnostic process and, if necessary, dispatches a Customer Engineer (CE) to the customer site. Once the suspect disk device is nondisruptively replaced, the Symmetrix system reestablishes the mirrored pair and 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 (DMSP)

The Symmetrix 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 continuous volumes), physical volumes, and disk directors (FEBE board back-end function). Then, 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 (BCV)

A Business Continuity Volume (BCV) is a standard *virtual* 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 (*virtual*) device can be RAID 1, RAID 5, or SRDF 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.

Virtual devices

Virtual devices are space-efficient copies which, as targets, do not directly consume physical storage. Each virtual device consists of tables and pointers to the data stored on the source device or on a pool of save devices. However, virtual devices do consume Symmetrix device numbers and host addresses. Virtual devices need to be configured at the initial set-up of a Symmetrix storage subsystem.

A virtual device is a host-accessible device containing track-level location information (pointers) that indicates where the copy session data is located in the physical storage. Virtual devices consume minimal disk storage, as they store only the address pointers to the data stored on the source device or a pool of save devices.

You can associate virtual devices (VDEV) paired with standard and BCV devices with any device group. In addition, TimeFinder/Snap control operations can be performed on any virtual device in a device group.

Virtual devices serve as a target in virtual snap device copies from either CKD or FBA source devices. Virtual devices cannot be SRDF devices.

Note: For additional information, refer to the *TimeFinder/Clone Mainframe SNAP Facility Version 5.6.0 Product Guide*.

For more information about virtual devices and TimeFinder/Snap operations, refer to the *EMC Solutions Enabler Symmetrix TimeFinder Family CLI Version 6.4 Product Guide*.

Symmetrix RAID 1/0 for open systems

RAID 1/0 is a stripe of mirrored pairs that is used in open systems environments. Drives are first mirrored. In the process, DMSP is employed to ensure the optimal mirrored performance. Next, the data is striped across the disks. This combines the advantage of full redundancy with the additional performance offered by the striping. For open systems, this involves using metavolumes to stripe data across mirrored pairs of disks. The stripe size for this is two cylinders.

For some applications, such as Microsoft Exchange, best practices dictate that RAID 1/0 should be used over basic RAID 1 to enhance I/O capability. Microsoft Exchange's workload is random and bursty with periods of high peaks, making this a difficult storage environment where I/O capacity per GB becomes important. Sequential reads or writes for simple concatenated volumes can only be serviced by a single M1/M2 pair until the end of the hyper is reached. Sequential read/write operations for a striped meta volume can be serviced by more spindles. For more details, please see *EMC Symmetrix Storage Solutions Microsoft Exchange 2000 and 2003 Best Practices*, available on the EMC Powerlink website at:
<http://Powerlink.EMC.com>

Symmetrix RAID 10 for mainframe systems

For Symmetrix, RAID 10 is used to designate the mainframe version of RAID 1/0. For a mainframe environment, the implementation is similar, except with a stripe size of one cylinder, and is implemented in groups of eight drives.

In the past, this has also been referred to as “CKD Meta Volumes.” 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 the following figure. Each member of the stripe group is also mirrored, thereby protecting the entire set. 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 in [Figure 42 on page 183](#), enables greatly improved performance in mainframe systems. RAID 10 uses four pairs of disks in its Symmetrix DMX implementation.

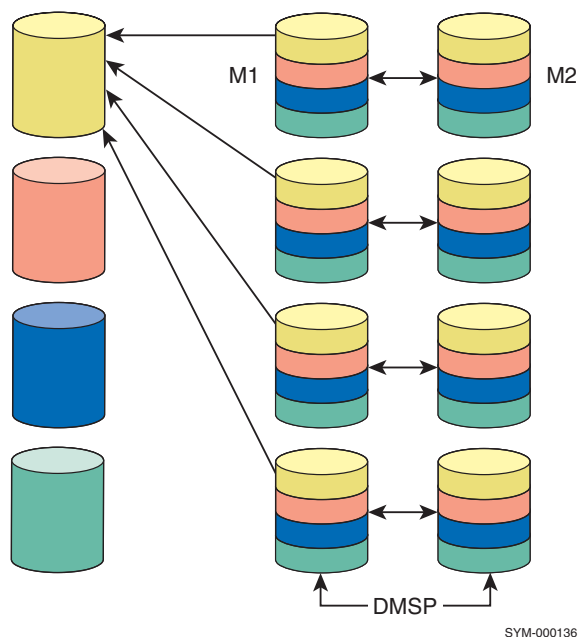


Figure 42 RAID 10 with Dynamic Mirror Service Policy

EMC has observed up to four times improvement in system performance while using a RAID 10 configuration with four pairs of disks as compared to an alternative configuration using a single pair of disks. EMC has also observed 20 percent to 30 percent improvement in back-end disk performance when DMSP is used, compared with a situation in which each of the mirrored pair serves 50 percent of the read I/Os. As users move to larger host volume sizes (3390-27s and eventually 3390-54s), the requirement for PAV/MA will accelerate. This allows for simultaneous access to different tracks (even the same track if all accesses are reads) on the same logical volume at the same time (even within the same stripe).

Symmetrix DMX RAID 5

RAID 5 overview

The Symmetrix DMX-3 supports RAID 5 data protection. RAID 5 is architected around block-based multip spindle parity protection. RAID 5 implements data striping and rotating parity across all hypervolumes of a RAID 5 device. The hypervolumes must reside on different physical disks.

The following sections describe how RAID 5 functions in Symmetrix systems:

- ◆ [“RAID 5 attributes” on page 185](#)
- ◆ [“RAID 5 device \(volume\)” on page 185](#)
- ◆ [“RAID 5 \(3+1\)” on page 186](#)
- ◆ [“RAID 5 \(7+1\)” on page 186](#)
- ◆ [“RAID 5 modes of operation” on page 186](#)
- ◆ [“RAID 5 performance optimization” on page 191](#)
- ◆ [“RAID 5 configuration rules” on page 192](#)

RAID 5 attributes

A RAID 5 device has the following attributes:

- ◆ RAID 5 track size is 64 KB.
- ◆ 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.
- ◆ RAID 5 groups can be:
 - Four members per logical device, RAID 5 (3+1)
 - Eight members per logical device, RAID 5 (7+1)

RAID 5 device (volume)

A RAID 5 device (logical volume) is made of four or eight hypervolumes each with tracks of data and a parity that rotate. RAID 5 stripes both data and parity across all hypervolumes of the RAID 5 device. The entire set of RAID 5 hypervolumes is presented to the host as a single RAID 5 device. [Figure 43 on page 186](#) shows a RAID 5 device consisting of four Symmetrix hypervolumes on four separate physical drives with one RAID 5 (3+1) device defined.

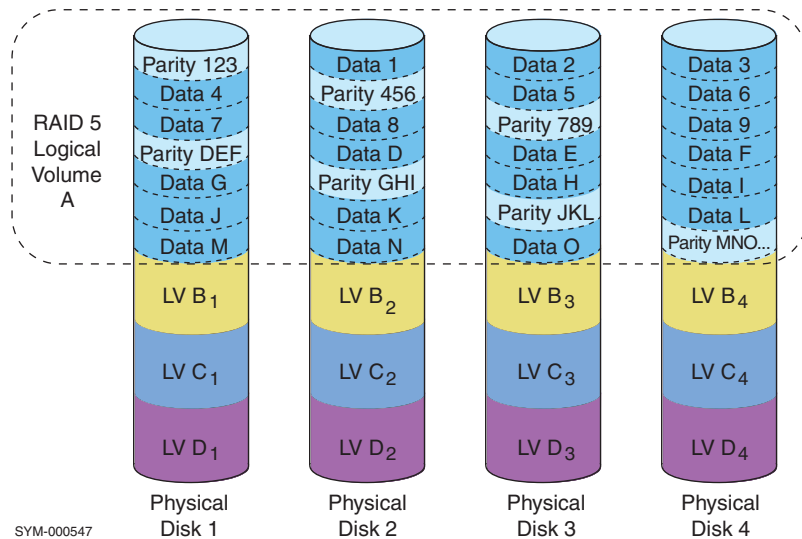


Figure 43 RAID 5 data/parity (3+1)

RAID 5 (3+1)

A RAID 5 (3+1) configuration consists of four Symmetrix devices with parity and data striped across each device. With this option, effectively 75 percent of the total storage capacity of a RAID 5 device is available for storing data.

RAID 5 (7+1)

A RAID 5 (7+1) configuration consists of eight Symmetrix devices with data and parity striped across each device. With this option, effectively 87.5 percent of total storage capacity of each RAID 5 device is available for storing data.

RAID 5 modes of operation

RAID 5 has the following modes of operation:

- ◆ [“Normal mode” on page 186](#)
- ◆ [“Regeneration” on page 187](#)
- ◆ [“Fast Copy Back” on page 187](#)

Normal mode

When a RAID 5 device operates with all hypervolumes functioning, it is operating in normal mode. In normal mode, the Symmetrix DMX system accomplishes data redundancy by using the standard EXCLUSIVE OR (XOR) logic to generate and store parity that can

then be used to reconstruct the information stored on a failed/failing member.

Regeneration In the event that a RAID 5 hypervolume fails, the RAID 5 device operates with the surviving members. It is then running in reduced mode. The data on the failing/failed member is reconstructed by XOR'ing the information from the surviving members in the rank.

Fast Copy Back After the failed disk is replaced, data is rapidly copied back from the spare drive to the newly installed drive.

Normal mode

RAID 5 normal mode has the following functions:

- ◆ [“Writing data in RAID 5 normal mode” on page 187](#)
- ◆ [“Reading data in RAID 5 normal mode” on page 188](#)

Writing data in RAID 5 normal mode

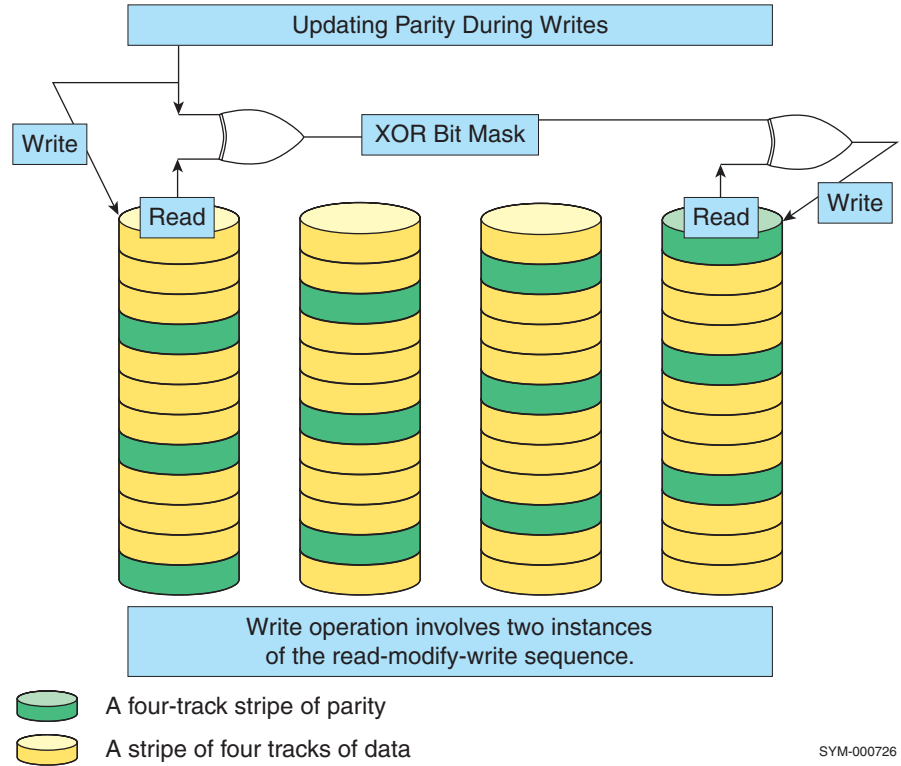
RAID 5 requires that the controller execute two read-modify-write sequences executed concurrently ([Table 30](#) and [Figure 44 on page 188](#)).

Table 30 RAID 5 write operation sequence in normal mode

Drive Containing Data	Drive Containing Parity
1. Read old information 2. Compute XOR bit mask 3. Write new information	1. Read old information 2. Receive XOR bit mask 3. Write new information

The Symmetrix DMX implementation of RAID 5 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.

Symmetrix DMX RAID 5 optimizes performance for large sequential write workloads as there is no need to read the parity from disks. Since many sequential tracks are written, they are all in Symmetrix global memory. The parity is calculated in global memory and information is written to the disks in one stroke without requiring the use of an expensive disk-level read-XOR-write operation.



SYM-000726

Figure 44 Writing data in RAID 5 normal mode

Reading data in RAID 5 normal mode

Read hit operations in a Symmetrix RAID 5 ([Figure 45 on page 189](#)) normal mode are processed through Symmetrix global memory as in normal Symmetrix system processing.

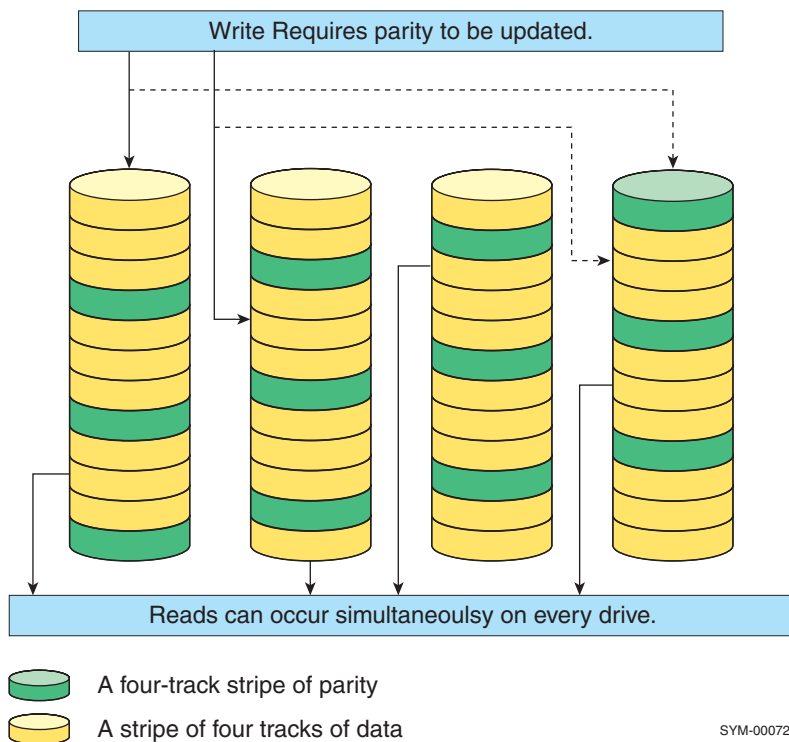


Figure 45 Reading data in RAID 5 normal mode

Regeneration

RAID 5 regeneration contains the following principles:

- ◆ “Data recovery with RAID 5” on page 189
- ◆ “RAID 5 recovery with a dynamic spare or permanent spare” on page 190
- ◆ “Write requests during regeneration” on page 190
- ◆ “Read requests during regeneration” on page 190
- ◆ “Fast Copy Back after replacing a disk using dynamic sparing” on page 190

Data recovery with RAID 5

Symmetrix RAID 5 provides continuous availability for all data if any single physical disk in the RAID 5 device fails or becomes unavailable. If a media error occurs, the affected tracks are regenerated. When a device fails or becomes unavailable, the Symmetrix RAID 5 device is put in regeneration mode. All data is still available to the host, but is unprotected against additional failures unless protected by dynamic sparing or permanent sparing.

If a physical device reports too many errors (even recoverable errors), or fails completely, that device is taken offline by the Symmetrix system. This condition causes the Symmetrix DMX system to place a remote service call to the Customer Support Center.

The Product Support Engineer (PSE) at the support center can determine if a disk drive should be identified for replacement and dispatches a Customer Engineer (CE) who starts the Symmetrix nondisruptive interactive drive replacement process. The logical devices on the disk being replaced are placed in a not-ready state and the associated ranks will begin operating in regeneration mode. After the new drive is in place, the regeneration process begins.

RAID 5 recovery with a dynamic spare or permanent spare

If the Symmetrix DMX system has an available dynamic spare or permanent spare, it copies the data from the failing device to the spare before the device fails, and reconstructs the data if necessary from the other surviving members of the RAID 5 device. After a spare is activated, it behaves as if it is a full fledged member of the RAID 5 device.

Note: Refer to [“Dynamic sparing with RAID 5 volumes” on page 207](#) for information on RAID 5 regeneration with dynamic sparing and [“Permanent sparing” on page 201](#) for RAID 5 regeneration with permanent sparing.

Write requests during regeneration

As write requests are made during regeneration, the new data is written to the RAID 5 device consisting of the surviving members and the dynamic spare or permanent spare if one is available.

Read requests during regeneration

Read requests for data in global memory (read hits) are serviced immediately from global memory. During regeneration, when read requests not found in global memory (read misses) occur, the required data is automatically regenerated by reading surviving members and using an XOR calculation, and is delivered to the spares pool.

Fast Copy Back after replacing a disk using dynamic sparing

After the failed disk is replaced, data is rapidly copied back from the the dynamic spare to the newly installed drive. This is a fast process of simply copying track by track. After copy back is completed, the original spare drive is returned to the dynamic spare pool.

Note: Symmetrix systems can be configured with dynamic sparing to restore data protection from a second drive failure. [“Dynamic sparing with RAID 5 volumes” on page 207](#) provides more information on dynamic sparing used with Symmetrix RAID 5.

RAID 5 performance optimization

The Engenuity operating environment deploys advanced I/O optimization techniques to enhance RAID 5 performance on Symmetrix DMX systems. On sequential writes to a RAID 5 device, there is no need to read the parity from disk. Since many sequential tracks are written, they are all in Symmetrix DMX global memory and hence parity is calculated in memory and is written to disk without the expensive read-modify-write operation.

Symmetrix Optimizer deployed with RAID 5 on Symmetrix DMX systems collects statistics on I/O access on individual RAID 5 hypervolumes as well as on RAID 5 devices over extended periods of time (typically a week). Symm Optimizer provides a comprehensive analysis of the statistical data collected to identify over- and under-utilized system resources. For example, Symm Optimizer can determine if hot spots (places of high I/O activity) or cold spots (places of low I/O activity) exist. (It is typically observed that 20 percent of physical disks are doing 80 percent of the I/O activity—Pareto principle.) Symm Optimizer observes and analyzes this unbalanced workload and makes recommendations for swapping the hot spindles with the cold spindles. If policy-based automation is chosen by the customer, Symm Optimizer implements the recommendations automatically and transparently. This results in a uniformly distributed workload across all physical spindles which in turn results in enhanced performance and improved resource utilization across the entire Symmetrix DMX system.

Note: Symmetrix systems can be configured with dynamic sparing to restore data protection from a second drive failure. [“Dynamic sparing with RAID 5 volumes” on page 207](#) provides more information on dynamic sparing used with Symmetrix RAID 5.

RAID 5 configuration guidelines

The following are some guidelines to consider when configuring RAID 5 devices:

- ◆ BCVs can be RAID 5 devices.
- ◆ SymmOptimizer Swap supports RAID 5 devices.
- ◆ SRDF devices can be RAID 5 devices.
- ◆ eSNAP source and destination devices can be RAID 5 devices.
- ◆ A log device can be a RAID 5 device.
- ◆ Concurrent Copy is supported with RAID 5.

RAID 5 configuration rules

The following configuration rules apply to RAID 5:

- ◆ Only one member of a RAID 5 group is permitted per drive loop. This configuration requires a minimum of eight drive enclosures for RAID 5 (7+1) and four drive enclosures for RAID 5 (3+1).
- ◆ RAID 5 (3+1) and (7+1) can co-exist in the same system.
- ◆ An $n + 1$ RAID 5 group requires one spare.
- ◆ Customers can configure more than one spare on RAID 5 systems (not in the same RAID 5 group), which can protect them from multiple drive failures.
- ◆ A single RAID 5 protection scheme can be configured within a system with any combination of SRDF, BCV, and mirroring protection.
- ◆ When a spare is invoked against a RAID 5 member, the same track can be valid on either the member or the spare, not both at the same time.

Symmetrix DMX RAID 6

RAID 6 overview

RAID 6 is defined as any configuration that supports more than a single disk drive failure. Similar to RAID 5 devices, the data blocks are striped/interleaved across all members of the RAID group.

The following sections describe how RAID 6 functions in Symmetrix systems:

- ◆ [“RAID 6 attributes” on page 193](#)
- ◆ [“RAID 6 device \(volume\)” on page 193](#)
- ◆ [“Even-Odd Algorithm” on page 194](#)
- ◆ [“RAID 6 \(6+2\)” on page 195](#)
- ◆ [“RAID 6 \(14+2\)” on page 195](#)
- ◆ [“Rebuilding data and parity members” on page 196](#)
- ◆ [“RAID 6 configuration guidelines” on page 197](#)
- ◆ [“Comparing RAID 5 and RAID 6” on page 197](#)

RAID 6 attributes

A RAID 6 device has the following attributes:

- ◆ RAID 6 track size is 64K.
- ◆ Data blocks are striped/interleaved across all members of the RAID group.
- ◆ RAID 6 groups can be:
 - Eight members per logical device (6+2)
 - Sixteen members per logical device (14+2)

RAID 6 device (volume)

A RAID 6 device (logical volume) is made of eight or sixteen hypervolumes each with tracks of data and a parity that rotate. RAID 6 stripes both data and parity across all hypervolumes of the RAID 6 device. Logically, the RAID 6 device is represented as a single mirror device.

[Figure 46 on page 195](#) shows a RAID 6 device consisting of Symmetrix hypervolumes on eight separate physical drives. Six data drives (D1 - D6) and two parity drives (D7 horizontal parity and D8 diagonal parity).

[Figure 47 on page 196](#) shows a RAID 6 device consisting of Symmetrix hypervolumes on 16 separate physical drives. Fourteen data drives (D1 - D14) and two parity drives (D15 horizontal parity and D16 diagonal parity).

Even-Odd Algorithm

The algorithm used by Symmetrix for RAID 6 is an XOR based algorithm called Even-Odd.

This algorithm calculates two types of parity — Horizontal Parity (HP) and Diagonal Parity (DP), in order to provide protection against the loss of two members of the RAID group. The two parities are calculated using different sets of the user data, and are independent of one another. Horizontal Parity is the equivalent of RAID 5 parity, and is calculated from the data across all the data disks. Diagonal Parity (DP) is made up of segments; each DP segment is calculated on a selected group of data segments. Each DP segment skips a different data drive in its calculation, which is key to the ability of this algorithms to reconstruct data after a double drive failure.

Another important requirement of this algorithm is that the number of data drives used in the DP calculations be a *prime* number. Symmetrix offers RAID 6 (6+2) and RAID 6 (14+2) protection (6 data or 14 data, with 2 parities each), neither of which is 'prime'. The Symmetrix implementation of Even-Odd assumes there to be 17 data drives in the RAID group - named D1-D17. For each of the protection schemes, the 'real' data drives take up positions D1-D6 (for 6+2) or D1-D14 (for 14+2) in the DP calculations; the remaining drives (Dx up to D17) are 'NULL disks'. These NULL disks exist only for the sake of the DP calculations, and the 'data' on these NULL disks is assumed to be all zero when calculating parity. These NULL disks do not consume any system resources (memory, cache, or disks). [Figure 46 on page 195](#) and [Figure 47 on page 196](#) show the RAID 6 data/parity layouts for RAID 6 (6+2) and RAID 6 (14 +2), respectively.

RAID 6 (6+2)

A RAID 6 (6+2) configuration consists of eight Symmetrix devices with parity and data striped across each device. With this option, effectively 75 percent of the total storage capacity of a RAID 6 device is available for storing data.

Figure 46 on page 195 shows a RAID 6 (6+2) data/parity layout.

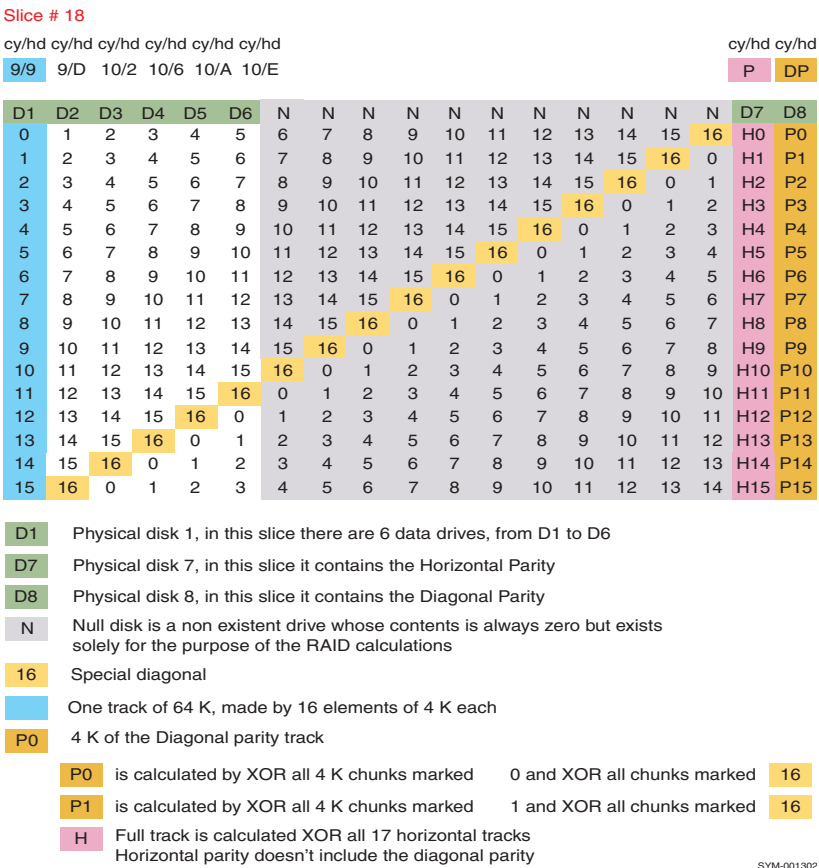


Figure 46 RAID 6 (6+2) data/parity layout

RAID 6 (14+2)

A RAID 6 (14+2) configuration consists of sixteen Symmetrix devices with parity and data striped across each device. With this option, effectively 87.5 percent of the total storage capacity of a RAID 6 device is available for storing data.

Figure 47 on page 196 shows a RAID 6 (14+2) data/parity layout.

D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	N	N	N	D15	D16
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	H0	P0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	0	H1	P1
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	0	1	H2	P2
3	4	5	6	7	8	9	10	11	12	13	14	15	16	0	1	2	H3	P3
4	5	6	7	8	9	10	11	12	13	14	15	16	0	1	2	3	H4	P4
5	6	7	8	9	10	11	12	13	14	15	16	0	1	2	3	4	H5	P5
6	7	8	9	10	11	12	13	14	15	16	0	1	2	3	4	5	H6	P6
7	8	9	10	11	12	13	14	15	16	0	1	2	3	4	5	6	H7	P7
8	9	10	11	12	13	14	15	16	0	1	2	3	4	5	6	7	H8	P8
9	10	11	12	13	14	15	16	0	1	2	3	4	5	6	7	8	H9	P9
10	11	12	13	14	15	16	0	1	2	3	4	5	6	7	8	9	H10	P10
11	12	13	14	15	16	0	1	2	3	4	5	6	7	8	9	10	H11	P11
12	13	14	15	16	0	1	2	3	4	5	6	7	8	9	10	11	H12	P12
13	14	15	16	0	1	2	3	4	5	6	7	8	9	10	11	12	H13	P13
14	15	16	0	1	2	3	4	5	6	7	8	9	10	11	12	13	H14	P14
15	16	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	H15	P15

D1 Physical disk 1, in this slice there are 14 data drives, from D1 to D14

D15 Physical disk 15, in this slice it contains the Horizontal Parity

D16 Physical disk 16, in this slice it contains the Diagonal Parity

N	Null disk is a non-existent drive whose contents are always zero but exists solely for the purpose of the RAID calculations
---	---

16 Special diagonal

One track of 64 K, made by 16 elements of 4 K each

P0 4 K of the Diagonal parity track

P0	is calculated by XOR all 4 K chunks marked 0 and XOR all chunks marked	16
----	--	----

P1	is calculated by XOR all 4 K chunks marked 1 and XOR all chunks marked 16
----	---

H Full track is calculated XOR all 17 horizontal tracks
Horizontal parity doesn't include the diagonal parity

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Figure 47 RAID 6 (14+2)

Rebuilding data and parity members

RAID 6 has two rebuilding processes: one member rebuild and two member rebuild.

Note: RAID 6 (6+2) and (14+2) uses permanent sparing functionality. [Table 31 on page 197](#) provides additional information.

One member rebuild In a *one member rebuild*, the data members rebuild like RAID 5, the horizontal parity rebuilds like RAID 5, and diagonal parity rebuilds using data from all data members.

Two member rebuild In a *two data member rebuild*, the rebuild is segment by segment recursively using *both* horizontal and diagonal parities.

In a *one data member and horizontal parity rebuild*, the data member is rebuilt using diagonal parity. The horizontal parity is rebuilt using all data members.

In a *one data member and diagonal parity rebuild*, the data member is rebuilt using horizontal parity. The diagonal parity is rebuilt using all data members.

In a *horizontal parity and diagonal parity rebuild*, both horizontal and diagonal parity is rebuilt using all data member data.

RAID 6 configuration guidelines

- The following are some guidelines to consider when configuring RAID 6 devices:
- ◆ BCVs can be RAID 6 devices.
 - ◆ SymmOptimizer Swap supports RAID 6 devices.
 - ◆ SRDF devices can be RAID 6 devices.
 - ◆ eSNAP source and destination devices can be RAID 6 devices.
 - ◆ A log device can be a RAID 6 device.
 - ◆ Concurrent Copy is supported with RAID 6.

Comparing RAID 5 and RAID 6

[Table 31 on page 197](#) describes the comparisons between RAID 5 and RAID 6.

Table 31 RAID 5 and RAID 6 comparison

RAID 5	RAID 6
Uses two mirrors to represent the device: data mirror and parity mirror.	Uses a single mirror to represent the overall state of the device.

Table 31 RAID 5 and RAID 6 comparison

RAID 5	RAID 6
Uses mirror invalid to indicate both logical and physical invalids.	Uses mirror invalid to indicate logical invalid; uses the Physical Consistency table to indicate physical inconsistent.
Supports both permanent sparing and dynamic sparing.	Supports permanent sparing. If permanent sparing is not successful on the first failure, no additional action is taken. If permanent sparing is also unsuccessful after a second failure (double-degraded mode), then RAID 6 dynamic sparing will be attempted.
Uses special disk commands to perform XOR operations.	Uses Symmetrix hardware functionality to perform XOR calculations.

Sparing in Symmetrix systems

Symmetrix DMX-3 systems support both permanent sparing and dynamic (temporary) sparing functionality. Sparing increases data availability without impacting performance. It is used in combination with all protection types, for example, mirroring, RAID 5, RAID 6, or SRDF.

Note: When a failing drive occurs, permanent sparing is automatically invoked by the Symmetrix system. If there is not a spare located in a *good* location (No spare suitable for a permanent swap, or unprotected volumes on the bad drive that will need to be copied to a dynamic spare before the swap is performed.), then dynamic sparing is automatically invoked.

Sparing configuration rules and guidelines

Note: The amount of recommended spares in a Symmetrix system is calculated by the EMC ordering system.

Spare drives are required for every Symmetrix DMX-3 configuration and must follow these rules and guide lines:

1. Two drives of each speed/capacity in the frame must be configured.
2. The minimum number of drives in the frame must be a base of two, plus one additional spare for each 100 drives, rounded up to the next full drive. If the total number of drives calculated in step 1 is less than this, additional drives equal to the largest capacity and slowest speed present in the system must be added to reach the system minimum.

Example: A system is configured with the following:

- 300 73 GB 15k drives
- 100 146 GB 15k drives
- 250 300 GB 10k drives

Spares will be calculated as follows:

Rule 1 requires 6 spares:

2 73 GB 15k drives

2 146 GB 15k drives

2 300 GB 10k drives

6 total spare drives

Since there is a total of 650 drives in the frame, rule 2 requires a minimum of 9 spares, (2 base plus 7 for the 650 drives) Thus an additional 3 drives, of the 300 GB 10k type must be added to reach a total of 9.

This results in the following:

2 73 GB 15k drives

2 146 GB 15k drives

5 300 GB 10k drives

9 total spare drives

Note: These calculations are for the minimum number of spare drives. It is usually a good idea to configure more than the minimum of two drives per type to increase the likelihood that a permanent spare drive is always available in a good location.

Note: The EMC Customer Engineer can use Enginuity's tools that define and enforce the many complex sparing rules. One of these tools is a disk map that shows each disk and the spares that cover it.

- ◆ When planning for spare drives, each of the system's drive capacity type, drive speed, and block sizes (512 and/or 520) must be considered. A valid pool of spares for each type of failing drive must be available.
- ◆ A failing drive cannot be spared with a different speed, block size, or capacity; even 10 K and 15 K are not compatible (permanent sparing).
- ◆ The spare cannot be on the same port, disk director, or loop as any of the mirrors or RAID members of the failed disk (permanent sparing).
- ◆ For permanent sparing purposes, Enginuity attempts to avoid invoking a dynamic spare on the same disk director as the failing drive. Enginuity uses this rule so that an uninvoked dynamic spare on the same disk director can be used for the permanent spare swap.

Sparing benefits

In summary, sparing offers the following benefits:

- ◆ Significantly decreases the amount of time required to rebuild and copyback the data from the failed drive
- ◆ Permanent sparing has a lower total affected time than dynamic sparing
- ◆ Increases protection of all volumes from loss of data
- ◆ Automatically activates the spare volume without interruption prior to loss of access to a potentially failing volume
- ◆ Ensures that the spare copy is identical to the original copy
- ◆ Increases data availability of all volumes in use without loss of any data capacity
- ◆ Is transparent to the host and requires no user intervention
- ◆ Resynchronizes a new disk device with the dynamic spare after repair of the defective device is complete

Permanent sparing

Symmetrix systems have a permanent sparing functionality that reserves volumes as standby spares. These volumes are not user-addressable. Enginuity determines when a physical volume is about to fail and initiates a rebuild and copyback (in parallel) of the contents of the disk device on which that volume resides to an available spare without any interruption in processing.

The Symmetrix system notifies the EMC Customer Support Center of this event with an Environmental-Data Present error. The permanent sparing option increases data availability without impacting performance. It is used in combination with mirroring, RAID 5, or SRDF.

Permanent sparing has the added benefit of allowing an EMC Customer Engineer operating on site or from the EMC Customer Support Center to force the Symmetrix system to rebuild/copyback the contents of a device to a permanent spare. This forced copy allows the EMC Customer Engineer to test or service a disk device nondisruptively while access to data continues.

Permanent sparing process

The permanent sparing process follows these steps: ([Figure 48 on page 203](#)):

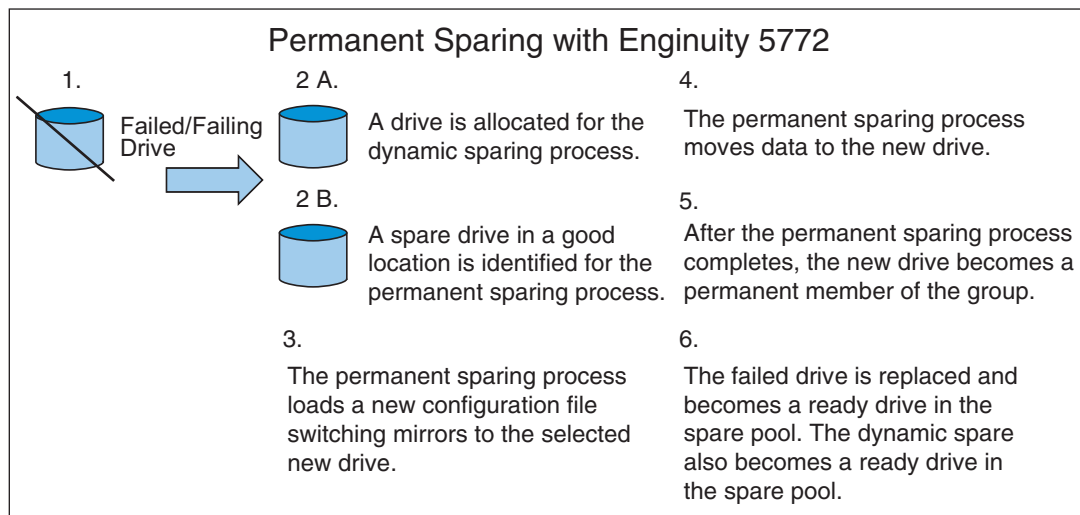
1. Engenuity determines when a physical volume is about to fail. The Symmetrix system makes its copying decision based on error statistics maintained by its directors, the intelligent disk microprocessor self-testing information, and its active error checking system.
2. If the Symmetrix sparing algorithms determine that the number of errors occurring on a volume is excessive and that a hard failure is probable, the sparing process starts one or two of the following processes:
 - a. Looks for an available spare in its pool of spares, dynamically invokes it, and initiates the *rebuild*.
 - b. Looks for and identifies a spare drive of the same capacity and speed in a *good* location to permanently replace the failing drive.

The process identifies a *good* location using the following rules:

- Not on the same disk director as any other member of the RAID group
- Not on the same loop or drive enclosure as any other member of the RAID group
- Not on the same power branch as any other member of the RAID group

Note: If a suitable permanent spare cannot be identified, dynamic sparing will continue. “[Dynamic sparing](#)” on [page 204](#) provides more information on the dynamic sparing process.

Note: Vault drives are not eligible for permanent sparing.



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Figure 48 Permanent sparing process

3. The permanent sparing process then loads a new configuration file in which all the mirrors initially configured on the failing drive are now configured on the selected (new) drive.
4. The permanent sparing process begins moving data to the new drive in parallel with the dynamic sparing process:
 - The permanent sparing starts as soon as possible before the dynamic sparing process is complete.
 - While the two processes continue, the Symmetrix system processes host I/O requests at the highest priority to minimize any effects on performance.
5. When the permanent sparing process is complete:
 - The drive used in the permanent sparing process becomes part of the group of the previously failing drive and the system returns to normal operation.
 - The drive used in the dynamic sparing process (if it was used) is returned to the spare pool.
 - The failed drive is set to not ready.
 - After the permanent sparing process completes, all system features are available.

6. When the failed drive is replaced, the CE issues commands for the Symmetrix system to place this drive in the spare pool, making them available should another volume fail in the future.

Note: EMC Customer Service is usually able to replace a failed drive within four hours. The time it takes to replace and resynchronize a failed drive within a RAID 5 group depends on the I/O activity to the logical volumes, the disk device, and the disk capacity. This time can be significantly reduced by implementing permanent sparing.

Note: See [“EMC Certified Data Erasure for Symmetrix Disks” on page 174](#) for information on how this feature works with permanent sparing.

Dynamic sparing

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. 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 49 on page 205](#)). 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.

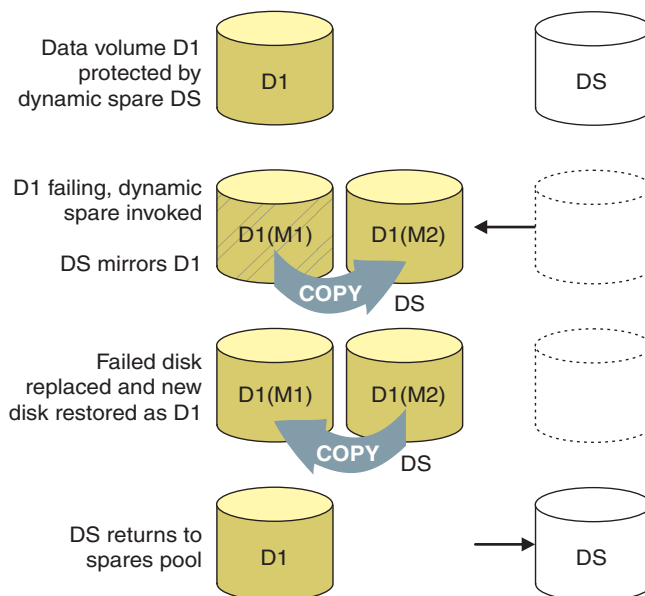


Figure 49 Dynamic sparing process

The dynamic sparing process selects a spare drive with the same block size (512 or 520 bytes) as the failing drive. The process also chooses an available spare drive of equal or larger capacity. There is no restriction preventing a 7.2K/10K/15K spare from being invoked against any other speed failing drive. For example, it is possible that a 7.2K spare will be invoked against a 15K failing drive, which may affect performance.

Dynamic sparing process

With dynamic sparing, 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 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.

Dynamic sparing with locally mirrored pairs

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.

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 50 on page 206](#)). 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.

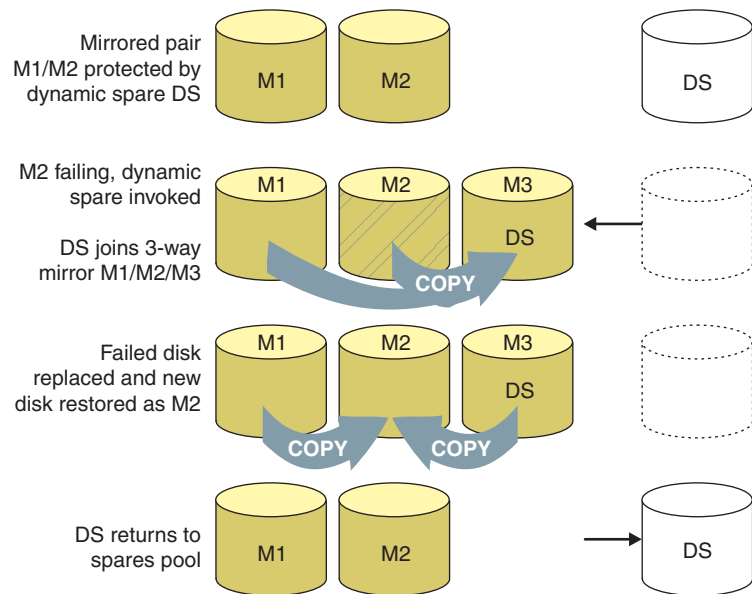


Figure 50 Dynamic sparing with locally mirrored pairs

**Dynamic sparing with
RAID 5 volumes**

RAID 5 is architected around block-based multispindle parity protection. RAID 5 implements data striping and rotating parity across all hypervolumes of a RAID 5 device. RAID 5 uses a single dynamic spare to temporarily replace a failing drive.

The RAID 5 dynamic 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. Enginuity supports a *direct copy* mode between the spare and the failing member.

For example, once the failing drive is replaced, Enginuity 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.

**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 unit containing the failing device and copies data from the failing device to the spare. The Symmetrix system continues processing I/Os (with the spare functioning as one of a mirrored pair with the failing device), and its remote mirror continues with no interruption in operation. If the Symmetrix system cannot copy all data from the failing device to the spare, it retrieve the unavailable data from the *good* member of the remote pair.

SRDF family of products

The EMC Symmetrix Remote Data Facility (SRDF) family of replication software offers various levels of Symmetrix based business continuance and disaster recovery solutions. The SRDF products offer the capability to maintain multiple, host-independent, mirrored copies of data. The Symmetrix systems can be in the same room, in different buildings within the same campus, or hundreds to thousands of kilometers apart.

By maintaining copies of data in different physical locations, SRDF enables you to perform the following operations with minimal impact on normal business processing:

- ◆ Disaster restart
- ◆ Disaster restart testing
- ◆ Recovery from planned outages
- ◆ Remote backup
- ◆ Data center migration
- ◆ Data replication and mobility

Note: The *EMC Symmetrix Remote Data Facility (SRDF) Product Guide* contains specific information on the SRDF family of products.

Base SRDF family products

The SRDF family consists of three base solutions:

- ◆ SRDF/Synchronous (SRDF/S, formerly SRDF) — High-performance, host-independent, real-time synchronous remote replication from one Symmetrix to one or more Symmetrix systems.
- ◆ SRDF/Asynchronous (SRDF/A) — High-performance extended distance asynchronous replication using a Delta Set architecture for optimal bandwidth utilization and minimal host performance impact. Additional SRDF/A features include:
 - SRDF/A Reserve Capacity enhances SRDF/A's ability to maintain operational state when encountering network resource shortfalls that would have previously suspended SRDF/A operations. With SRDF/A Reserve Capacity functions enabled, additional resource allocation can be applied to address temporary workload peaks, periods of network congestion, or even temporary network outages.

The two functions that implement SRDF/A Reserve Capacity are Transmit Idle and Delta Set Extension (DSE), which work together to maximize availability of continuous remote replication operations while minimizing operational overhead.

- ◆ SRDF/Data Mobility (SRDF/DM) — Rapid transfer of data from source volumes to remote volumes anywhere in the world, permitting information to be shared and content to be distributed, or information consolidated for parallel processing activities.

SRDF family options

There are a number of additional options and features that can be added to the base solutions to solve specific service level requirements. These options include:

- ◆ SRDF/Automated Replication (SRDF/AR) solutions for meeting very specific, remote replication service-level requirements
- ◆ SRDF/Star for advanced multisite failover with continuous protection
- ◆ SRDF/Consistency Groups (SRDF/CG) for data consistency
- ◆ SRDF/Cluster Enabler (SRDF/CE) for integration with host-based clustering products such as Microsoft Cluster Server (MSCS) and VERITAS Cluster Server (VCS).

Note: For simplicity, this document uses the term *SRDF* to represent all EMC SRDF related products, including: SRDF/A, SRDF/AR (multi-hop and single-hop), SRDF/DM, and SRDF/CG.

Note: The SRDF family of products can also be used with the EMC TimeFinder family of products, which includes TimeFinder/Mirror, TimeFinder/Clone, and TimeFinder/Snap. For simplicity, this document uses the term *TimeFinder* to represent all EMC TimeFinder related products. See [“TimeFinder family of products” on page 147](#) for additional information.

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	212
◆ Supported mainframe features	213
◆ Error reporting and recovery	224
◆ Sense byte information	235

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:

- ◆ “EMC z/OS Storage Manager” on page 213
- ◆ “Dynamic Channel Management” on page 214
- ◆ “Dynamic Path Reconnection” on page 214
- ◆ “Concurrent Copy” on page 214
- ◆ “Multi-Path Lock Facility/Concurrent Access” on page 215
- ◆ “MultiSubsystem Imaging” on page 215
- ◆ “Sequential Data Striping” on page 215
- ◆ “Partitioned Data Set (PDS) Assist” on page 216
- ◆ “Multiple Allegiance (MA)” on page 216
- ◆ “Compatible Parallel Access Volumes (COM-PAV)” on page 216
- ◆ “Dynamic Parallel Access Volumes” on page 216
- ◆ “RAID 10 striping” on page 217
- ◆ “Supported ESCON devices and logical paths” on page 218
- ◆ “Supported FICON devices and logical paths” on page 218
- ◆ “IBM MetroMirror (PPRC)” on page 219
- ◆ “XRC Support” on page 220
- ◆ “Configuring CKD volumes” on page 221
- ◆ “Deleting (and then adding) devices online” on page 222
- ◆ “Support for 64 K cylinders” on page 222
- ◆ “FICON Cascading and Open Systems intermix configurations” on page 222

EMC z/OS Storage Manager

EMC z/OS Storage Manager helps mainframe customers get full value from EMC product faster and more efficiently. It is the first storage management product by a storage provider designed specifically for the mainframe. Customers can discover and monitor the volumes in a Symmetrix system, set alerts for volumes, summarize Symmetrix configuration information, and much more from a mainframe ISPF screen. Some of the features include:

- ◆ EMC z/OS Storage Manager uses standard z/OS messaging and security packages.
- ◆ It leverages SMP/E for installation, logs user activity, and records changes in SMP. In seconds, z/OS Storage Manager accomplishes tasks that previously took hours or even days.
- ◆ It consists of a base package and optional plug-in modules. The base package provides an infrastructure framework and Symmetrix management.

- ◆ The optional family of plug-in functionality for z/OS Storage Manager also includes z/OS Storage Manager for SMS, which manages SMS and HSM.

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.

Note: 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, 2105, or 2107 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 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.

Note: Contact your local EMC Sales Representative for availability of TPF support.

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, 2105, or 2107 storage control and running Enginuity supporting the MPLF/CA feature.

MultiSubsystem Imaging

The Symmetrix DMX systems support multiple z/OS environments by providing maximum connectivity through the use of its 3990-6, 2105, or 2107 emulation modes and the Hypervolume Extension feature. The Symmetrix systems support up to 250 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 3990-6, 2105, or 2107 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 z/OS with DFSMS environments. The Symmetrix system must be emulating 3990-6, 2105, or 2107 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 3990-6, 2105, 2107, 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 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 or 2107 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 or 2107 control unit to support COM-PAV.

Dynamic Parallel Access Volumes

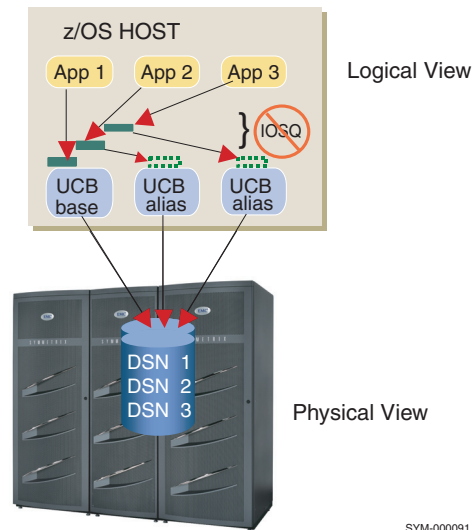
Parallel Access Volumes/Multiple Allegiance (PAV/MA) is a mainframe-exclusive feature that resolves the z/OS limitation allowing only one outstanding I/O operation to a device ([Figure 51 on page 217](#)). The PAV/MA feature was introduced with the IBM ESS 2105 storage subsystem. EMC's COM-PAV/MA feature 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 255 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.

Note: Contact your local EMC Sales Representative for the most current number of supported aliases.

Enginuity 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 z/OS.



SYM-000091

Figure 51

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.

Note: For more information on RAID 10, refer to [“Symmetrix RAID 10 for mainframe systems”](#) on page 183.

Supported ESCON devices and logical paths

Note: Contact your EMC Sales representative for current ESCON availability.

Enginuity 5771 supports up to 4,096 channel addresses distributed over two ports per processor and up to 2,048 channel addresses on one port. Symmetrix DMX-3 eight-port ESCON director supports up to 1,024 logical paths per processor. It supports up to 1,024 logical paths per port when the A port only is configured or up to 512 logical paths per port when both the A and B ports are configured. [Figure 52 on page 218](#) shows some sample configurations.

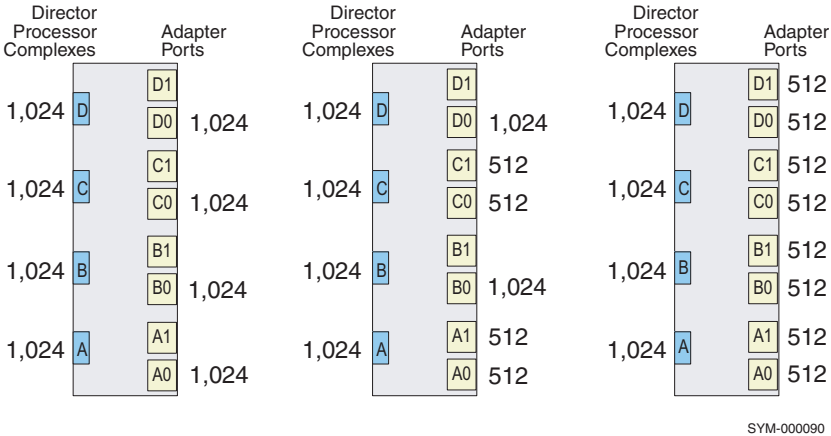
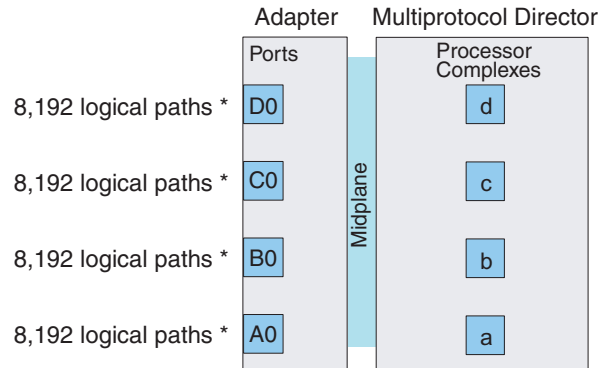


Figure 52 Supported ESCON logical paths per port

Note: For more ESCON director configuration information, refer to [“ESCON channel directors” on page 78](#).

Supported FICON devices and logical paths

Enginuity 5771 supports up to 8,192 channel addresses per FICON port. The four-port FICON adapter supports up to 8,192 logical paths per port per processor. [Figure 53 on page 219](#) shows a sample configuration.



* Up to 8,192 channel addresses can be configured accessible to a FICON adapter port at Enginuity code 5771.

SYM-000090A

Figure 53

Supported FICON logical paths per port

Note: For more FICON director configuration information, refer to [“FICON channel director” on page 80](#).

IBM MetroMirror (PPRC)

Enginuity level 5568 enables the Symmetrix system to support native IBM MetroMirror Peer-to-Peer Remote Copy (PPRC) commands through a Symmetrix feature called Compatible Peer. PPRC is the remote copying solution available with IBM storage systems ([Figure 54 on page 220](#)). Enginuity 5568 supports PPRC version 1, architecture level 2 (CGROUP FREEZE/RUN functionality). Enginuity level 5771 adds support for PPRC version 1, architectural levels 3 and 4 Hyper-Swap support, including failover/failback functionality. As a result, Symmetrix systems will support these capabilities in IBM's Geographically Dispersed Parallel Sysplex (GDPS) solution. Compatible Peer is available on Symmetrix systems with connections to ESCON and/or FICON hosts.

Note: Contact your local EMC representative for specific details regarding your Symmetrix system's support for Compatible Peer.

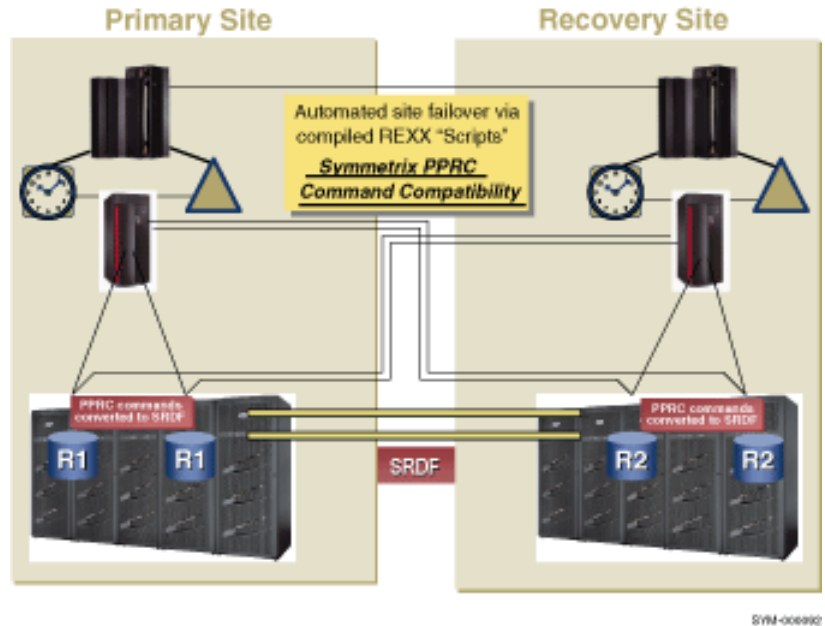


Figure 54 PPRC and GDPS support

XRC Support

Enginuity level 5772 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 zSeries data to a remote data center.

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 retrieves 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 that includes all I/Os received at that time or prior. This set of I/Os constitutes a *consistency group* that is written to the journal data sets, and then written to the volumes at the recovery site. This is shown in [Figure 55 on page 221](#).

Note: Only Engenuity level v5772 supports XRC functionality. Contact your EMC Sales Representative for specific details regarding your Symmetrix system's support for XRC.

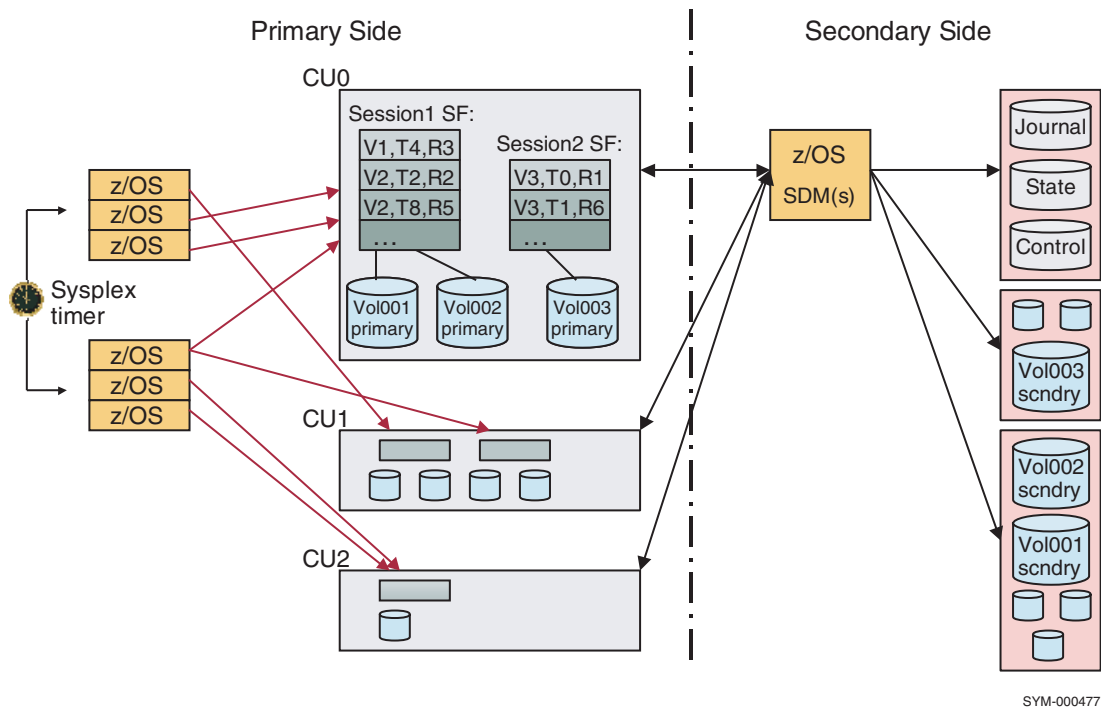


Figure 55 XRC overview

Configuring CKD volumes

Engenuity level 5771 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 level 5771 systems support 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.
- ◆ Convert between mirrored and RAID protected volumes.
- ◆ The optimal order is to delete devices and then add. If done in the reverse order, unnecessary global memory will be allocated for the deleted devices
- ◆ When attempting to add or delete devices, or change protection type of devices, a new minimum cache value will be calculated. In rare cases this new value could prohibit the changes until additional memory is added to the system.

Support for 64 K cylinders

Enginuity level 5771 supports 64 K 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 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.

Note: For specific Cascading and Open System Intermix configuration requirements, contact your local 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 (InterSwitch 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.

Note: Do *not* use ICKDSF to assign alternate tracks in the classic IBM manner since no alternate will be assigned.

Note: 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 32 on page 228](#). Event messages to the host as Service Alerts. In 2105, 2107, or 3990 controller emulations, the returned sense data is in SIM format. 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.

Symmetrix message reporting has been split into four levels of importance for customer convenience. Select the level that best suits your environment. This is done on the INIT screen of Symmwin by Customer Service.

Symmetrix DMX now supports SIM Severity Reporting. With severity reporting, you have control of which severities are reported to the MVS console and which ones are not reported. All SIM severities by default are reported to EREP so there's always a report of the error even if it's not reported to the MVS console. The default value in Symmwin is "Only Acute and Serious and Moderate (default)". This will report all SIM Acute, Serious, and Moderate Alerts to the MVS console with all the Service Alerts sent *only* to EREP.

The definitions are as follows:

- ◆ **Service Alert:** No system or application performance degradation is expected. No system or application outage has occurred.

Examples:

- 0462 M1 resynced to M2 device
- 0479 Environmental cable missing
- 047F PC successfully dialed home to report an error

- ◆ **Moderate alert:** Performance degradation is possible in a heavily loaded environment. No system or application outage has occurred.

Examples:

- 046D RDF group has lost links
- 0476 No connection between PC and system

- ◆ **Serious Alert:** A primary I/O subsystem resource is disabled. Significant performance degradation is possible. System or application outage may have occurred.

Examples:

- 0473 Mirror device not ready for periodic test
- 0472 Alarm signal set

- ◆ **Acute alert:** A major I/O subsystem resource is disabled, or damage to the product is possible. Performance may be severely degraded. System or application outage may have occurred

Examples:

- 0470 Temperature problems
- 047A AC line problem detected
- 0477 PC failed to call home due to communication problems
- 04E0 Communication problem

Table 32 Environmental errors reported as SIM messages (1 of 3)

Hex Code	Severity Alert	Description	SIM Ref Code
0453	Remote Service	Syscall EMC transfer poll from host. PC call home.	1453
0454	Service	Too many suspend/halt chains, switching to ADP-WP. Call home probably MVS PAGE DATA SET.	E454
0460	Serious	A dynamic spare was automatically invoked by a DA.	E460
0461	Service	M2 is resynced with M1 device (happens after M2 is brought back to ready).	E461

Table 32 Environmental errors reported as SIM messages (2 of 3)

Hex Code	Severity Alert	Description	SIM Ref Code
0462	Service	M1 is resynced with M2 device (happens after M2 is brought back to ready).	E462
0463	Serious	One of the disk adapters failed into IMPL Monitor.	2463
0464	Service	Migration has completed the migration for all migration devices.	E464
0465	Service	Device resync process has started.	E465
0466	Service	A dynamic spare was automatically invoked by a DA for an RDF R2 device on the other box.	E466
0467	Moderate	RDF ERROR reported across the link from the other box.	E467
0469	Service	Fibre Channel Optical Module problem (env_test8).	E469
046B	Service	Event trace running in excess of 30 days.	E46B
046D	Moderate	RDF GROUP is lost (no links).	E46D
046E	Service	RDF GROUP is up.	E46E
0470	Acute	Temperature problems (env_test0).	2470
0471	Serious	90% of log devices are in use.	2471
0472	Serious	Alarm signal set (env_test4).	2472
0473	Serious	Mirror device not ready at time of periodic test (env_test9).	E473
0474	Serious	Mirror device is write disable at time of periodic test (env_test9)	E474
0475	Serious	One of the mirror 2 devices not ready (env_test9).	E475
0476	Moderate	No connection between PC and system for extended period of time (env_test7).	2476
0477	Remote Failed	PC failed to call home due to communications problems.	1477
0478	Moderate	12 volt should be on during FLASH ERASE (env_test1).	2478
0479	Service	Environmental cable missing (env_test2).	2479
047A	Acute	AC line problems detected (env_test3).	247A
047C	Acute	Log device with user data is not ready.	247C
047D	Moderate	RA link lost for the group.	E47D
047E	Service	RDF link is operational after previous failure.	E47E

Table 32 Environmental errors reported as SIM messages (3 of 3)

Hex Code	Severity Alert	Description	SIM Ref Code
047F	Remote Service	PC successfully called home to report an error.	147F
04AF	Acute	Power Zone Missing.	24AF
04CA	Moderate	SRDF/A drops with reason codes 50, 60, or 62.	
04D1	Remote Service	Remote connection established. Remote control connected.	14D1
04D2	Remote Service	Remote connection closed. Remote control rejected.	14D2
04D3	Service	Flex filter problems.	24D3
04D4	Remote Service	Remote connection closed. Remote control disconnected.	14D4
04DA	Service	Problems with task/threads.	24DA
04DB	Service	SYMPL script generated error.	24DB
04DC	Service	PC related problems.	24DC
04E0	Remote Failed	Communications problems.	14E0
04E1	Service	Problems in error polling.	24E1
04F1	Moderate	Internal SPS fault.	24F1
04F2	Moderate	Internal SPS fault.	24F2
04F3	Moderate	No communication to disconnect SPS.	24F3

Operator messages

On z/OS, SIM messages will be displayed as IEA480E Service Alert Error messages. They have the format shown in [Figure 56 on page 230](#) and [Figure 57 on page 231](#).

```
*IEA480E 1903, SCU, ACUTE ALERT, MT=2105, SER=0507-00025,
REFCODE=247A-0000-0000
```

247A = AC Line Failure or Interruption

SYM-001083

Figure 56 z/OS IEA480E service alert error message format (AC power failure)

```
*IEA480E 1900,DASD,SERIOUS ALERT,MT=2105,SER=0507-00025,
REFCODE=E473-0000-7B01,VOLSER=LSJ13B,ID=01
```

Channel address = 7B

Number of errors = 01

Note: E473 = Mirror-1 volume in "Not Ready" state
Channel address of the "Not Ready" device

SYM-001084

Figure 57 z/OS IEA480E service alert error message format (mirror-1 volume in "not ready" state)

Note: All host channel paths to that device (target volume) will report this error message. Therefore, this 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 z/OS, these events are displayed as IEA480E Service Alert Error messages. They have the format shown in [Figure 58 on page 231](#) and [Figure 59 on page 232](#).

```
*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 58 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 59

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 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.

Note: 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.

Note: Refer to 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 33 on page 233](#) describes the error handling process you should follow for the Symmetrix system.

Table 33 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

Note: 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 compatibility mode or 32-byte mode for 3990 emulation.

Console error messages

Figure 60 on page 235 is an example of a typical z/OS console error message for 24-byte sense data.

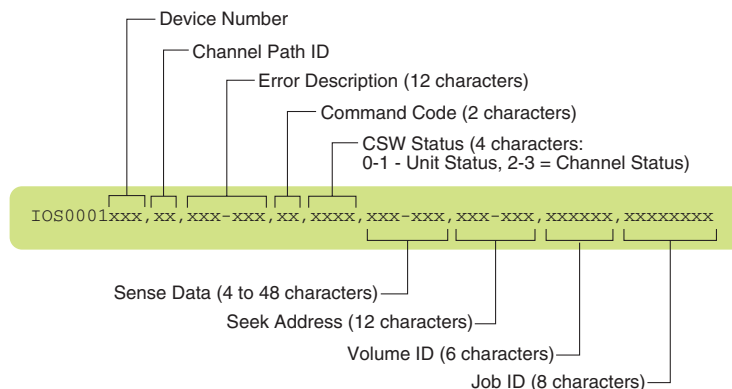


Figure 60 Typical console error message

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 34 on page 236](#) lists and describes the unit status bits.

Table 34 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 35 on page 236](#) lists and describes the channel status bits.

Table 35 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.

Note: 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-3
Specifications**

This appendix contains the specifications of the Symmetrix DMX-3 system.

◆ Storage control.....	240
◆ Physical data	249
◆ Environmental data	251
◆ Power and cooling data.....	253
◆ Electrical specifications and power requirements.....	254

Storage control

Emulation	3990-6, 2105, 2107, and FBA
Channel speeds	Up to 17 MB/s ESCON channel Up to 4 Gb/s FICON channel Up to 4 Gb/s Fibre Channel Up to 1 Gb/s iSCSI channel Up to 1 Gb/s GigE remote channel
Storage capacities	The following tables outline the minimum and maximum capacities for various DMX-3 systems. Table 36 outline capacities for the Symmetrix DMX-3 configured with two disk directors. Table 37 on page 242 outline capacities for the Symmetrix DMX-3 configured with four disk directors. Table 38 on page 244 outline capacities for the Symmetrix DMX-3 configured with six disk directors. Table 39 on page 246 outline capacities for the Symmetrix DMX-3 configured with eight disk directors. The capacities are presented based on the disk device capacities of 73 GB, 146 GB, 300 GB and 500 GB and these methods of data protection: ◆ SRDF (Symmetrix Remote Data Facility) ◆ Mirroring (RAID 1) ◆ RAID 5 (3+1) or (7+1) ◆ RAID 6 (6+2) or (14+2) ◆ Mirroring RAID 10 (mainframe disk devices, only) Note: The TB values shown in and are based on the following conventions: The TB₂ value is based on 1 TB = 1024 * 1024 * 1024 * 1024 bytes. The TB₁₀ value is based on 1 TB = 1000 * 1000 * 1000 * 1000 bytes. Although the open systems values are expressed differently, they are equivalent. A Symmetrix DMX-3 reserves two SFS logical volumes consisting of 6,140 cylinders each (slightly less than 6 GB). These volumes are protected using mirroring, consuming slightly less than 24 GB total physical space. For each pair of disk directors in a DMX-3 system, 160 GB of total capacity is reserved for vaulting data from memory during system powerdown. Actual usable capacity may vary depending on configuration and data protection types used.

Table 36 Capacities for Symmetrix DMX-3 systems with two disk directors^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity
Number of Drives	96	240	96	240	96	240	96	240
SRDF Capacity								
Open TB ₁₀	7.04	17.6	14.08	35.21	28.78	71.94	47.96	119.91
Open TB ₂	6.56	16.39	13.12	32.79	26.80	67.00	44.67	111.67
Mainframe TB ₁₀	6.95	17.38	13.90	34.76	28.41	71.02	47.35	118.37
iSeries	6.99	17.48	13.98	34.96	28.08	70.19	N/A	N/A
Mirrored Capacity								
Open TB ₁₀	3.52	8.80	7.04	17.60	14.39	35.97	23.98	59.95
Open TB ₂	3.28	8.20	6.56	16.39	13.40	33.50	22.33	55.84
Mainframe TB ₁₀	3.48	8.69	6.95	17.38	14.20	35.31	23.67	59.18
iSeries	3.50	8.75	6.99	17.48	14.04	35.10	N/A	N/A
RAID 5 (3+1) Capacity								
Open TB ₁₀	5.28	13.20	10.56	26.41	21.58	53.96	35.97	89.93
Open TB ₂	4.92	12.30	9.84	24.59	20.10	50.25	33.50	83.75
Mainframe TB ₁₀	5.21	13.03	10.43	26.07	21.31	53.26	35.51	88.77
iSeries	5.24	13.11	10.49	26.22	21.06	52.64	N/A	N/A
RAID 5 (7+1) Capacity								
Open TB ₁₀	6.16	15.40	12.32	30.81	25.18	62.95	41.97	104.92
Open TB ₂	5.74	14.34	11.48	28.69	23.45	58.63	39.08	97.71
Mainframe TB ₁₀	6.08	15.21	12.16	30.41	24.86	62.14	41.43	103.57
iSeries	6.12	15.29	12.24	30.59	24.57	61.42	N/A	N/A

Table 36 Capacities for Symmetrix DMX-3 systems with two disk directors^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity
RAID 6 (6+2) Capacity								
Open TB ₁₀	5.28	13.20	10.56	26.41	21.58	53.96	35.97	89.93
Open TB ₂	4.92	12.30	9.84	24.59	20.10	50.25	33.50	83.75
Mainframe TB ₁₀	5.21	13.03	10.43	26.07	21.31	53.26	35.51	88.77
iSeries	5.24	13.11	10.49	26.22	21.06	52.64	N/A	N/A
RAID 6 (14+2) Capacity								
Open TB ₁₀	6.16	15.40	12.32	30.81	25.18	62.95	41.97	104.92
Open TB ₂	5.74	14.34	11.48	28.69	23.45	58.63	39.08	97.71
Mainframe TB ₁₀	6.08	15.21	12.16	30.41	24.86	62.14	41.43	103.57
iSeries	6.12	15.29	12.24	30.59	24.57	61.42	N/A	N/A

a. Refer to storage capacity notes on [page 240](#) for configuration requirements.

Table 37 Capacities for Symmetrix DMX-3 systems with four disk directors^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity
Number of Drives	192	960	192	960	192	960	192	960
SRDF Capacity								
Open TB ₁₀	14.08	70.41	28.17	140.83	57.55	287.77	95.92	479.62
Open TB ₂	13.12	65.58	26.23	131.16	53.60	268.01	89.34	446.68
Mainframe TB ₁₀	13.90	69.51	27.80	139.02	56.82	284.08	94.69	473.46
iSeries	13.98	69.91	27.97	139.84	56.15	280.77	N/A	N/A

Table 37 Capacities for Symmetrix DMX-3 systems with four disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity
Mirrored Capacity								
Open TB ₁₀	7.04	35.21	14.08	70.41	28.78	143.88	47.96	239.81
Open TB ₂	6.56	32.79	13.12	65.58	26.80	134.00	44.67	223.34
Mainframe TB ₁₀	6.95	34.76	13.90	69.51	28.41	142.04	47.35	236.73
iSeries	6.99	34.96	13.98	69.92	28.08	140.38	N/A	N/A
RAID 5 (3+1) Capacity								
Open TB ₁₀	10.56	52.81	21.12	105.62	43.17	215.83	71.94	359.72
Open TB ₂	9.84	49.18	19.67	98.37	40.20	201.01	75.38	150.75
Mainframe TB ₁₀	10.43	52.13	20.85	104.27	42.61	213.06	71.02	355.10
iSeries	10.49	52.44	20.98	104.88	42.12	210.58	N/A	N/A
RAID 5 (7+1) Capacity								
Open TB ₁₀	12.32	61.61	24.64	123.22	50.36	251.80	83.93	419.67
Open TB ₂	11.48	57.38	22.95	114.76	46.90	234.51	78.17	390.85
Mainframe TB ₁₀	12.16	60.82	24.33	121.64	49.71	248.57	82.86	414.28
iSeries	12.24	61.18	24.47	122.36	49.13	245.67	N/A	N/A
RAID 6 (6+2) Capacity								
Open TB ₁₀	10.56	52.81	21.12	105.62	43.17	215.83	71.94	359.72
Open TB ₂	9.84	49.18	19.67	98.37	40.20	201.01	75.38	150.75
Mainframe TB ₁₀	10.43	52.13	20.85	104.27	42.61	213.06	71.02	355.10
iSeries	10.49	52.44	20.98	104.88	42.12	210.58	N/A	N/A

Table 37 Capacities for Symmetrix DMX-3 systems with four disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity
RAID 6 (14+2) Capacity								
Open TB ₁₀	12.32	61.61	24.64	123.22	50.36	251.80	83.93	419.67
Open TB ₂	11.48	57.38	22.95	114.76	46.90	234.51	78.17	390.85
Mainframe TB ₁₀	12.16	60.82	24.33	121.64	49.71	248.57	82.86	414.28
iSeries	12.24	61.18	24.47	122.36	49.13	245.67	N/A	N/A

a. Refer to storage capacity notes on [page 240](#) for configuration requirements.

Table 38 Capacities for Symmetrix DMX-3 systems with six disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity ^b
Number of Drives	360	1,440	360	1,440	360	1,440	360	1,440
SRDF Capacity								
Open TB ₁₀	26.40	105.62	52.81	211.24	107.91	431.65	179.86	526.93
Open TB ₂	24.59	98.36	49.18	196.73	100.50	402.01	167.51	526.93
Mainframe TB ₁₀	26.07	104.27	52.13	208.53	106.53	426.11	177.55	526.93
iSeries	26.22	104.87	52.44	209.75	105.29	421.15	N/A	N/A
Mirrored Capacity								
Open TB ₁₀	13.20	52.81	26.41	105.62	53.96	215.83	89.93	359.72
Open TB ₂	12.30	49.18	24.59	98.37	50.25	201.01	83.75	335.01
Mainframe TB ₁₀	13.03	52.13	26.07	104.27	53.26	213.06	88.77	355.10
iSeries	13.11	52.44	26.22	104.88	52.64	210.58	N/A	N/A

Table 38 Capacities for Symmetrix DMX-3 systems with six disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity ^b
RAID 5 (3+1) Capacity								
Open TB ₁₀	19.80	79.21	39.61	158.43	80.94	323.74	134.89	526.93
Open TB ₂	18.44	73.77	36.89	147.55	75.38	301.51	125.63	502.52
Mainframe TB ₁₀	19.55	78.20	39.10	156.40	79.90	319.59	133.16	526.93
iSeries	18.44	78.65	39.33	157.32	78.97	315.86	N/A	N/A
RAID 5 (7+1) Capacity								
Open TB ₁₀	23.10	92.42	46.21	184.84	94.42	377.70	157.38	525.10
Open TB ₂	21.52	86.07	43.04	172.14	87.94	351.76	146.57	525.10
Mainframe TB ₁₀	22.81	91.23	45.62	182.47	93.21	372.85	155.35	525.10
iSeries	22.94	91.76	45.88	183.54	92.13	368.51	N/A	N/A
RAID 6 (6+2) Capacity								
Open TB ₁₀	19.80	79.21	39.61	158.43	80.94	323.74	134.89	526.93
Open TB ₂	18.44	73.77	36.89	147.55	75.38	301.51	125.63	502.52
Mainframe TB ₁₀	19.55	78.20	39.10	156.40	79.90	319.59	133.16	526.93
iSeries	18.44	78.65	39.33	157.32	78.97	315.86	N/A	N/A
RAID 6 (14+2) Capacity								
Open TB ₁₀	23.10	92.42	46.21	184.84	94.42	377.70	157.38	525.10
Open TB ₂	21.52	86.07	43.04	172.14	87.94	351.76	146.57	525.10
Mainframe TB ₁₀	22.81	91.23	45.62	182.47	93.21	372.85	155.35	525.10
iSeries	22.94	91.76	45.88	183.54	92.13	368.51	N/A	N/A

a. Refer to storage capacity notes on [page 240](#) for configuration requirements.

b. Usable capacity with currently available memory.

Table 39 Capacities for Symmetrix DMX-3 systems with eight disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity ^b
Number of Drives	480	1,920	480	1,920	480	1,920	480	1,920
SRDF Capacity								
Open TB ₁₀	35.21	140.82	70.41	281.66	143.88	575.54	143.88	526.93
Open TB ₂	32.79	131.15	65.58	262.31	134.00	536.01	134.00	526.93
Mainframe TB ₁₀	34.76	139.02	69.51	278.04	142.04	568.15	142.04	526.93
iSeries	34.96	139.83	69.92	279.67	140.38	561.53	N/A	N/A
Mirrored Capacity								
Open TB ₁₀	17.60	70.41	35.21	140.83	71.94	287.77	71.94	468.38
Open TB ₂	16.39	65.58	32.79	131.16	67.00	268.01	67.00	468.38
Mainframe TB ₁₀	17.38	69.51	34.76	139.02	71.02	284.08	71.02	468.38
iSeries	17.48	69.91	34.96	139.84	70.19	280.77	N/A	N/A
RAID 5 (3+1) Capacity								
Open TB ₁₀	26.40	105.62	52.81	211.24	107.91	431.65	107.91	526.93
Open TB ₂	24.59	98.36	49.18	196.73	100.50	402.01	100.50	526.93
Mainframe TB ₁₀	26.07	104.27	52.13	208.53	106.53	426.11	106.53	526.93
iSeries	26.22	98.36	52.44	209.75	105.29	402.01	N/A	N/A
RAID 5 (7+1) Capacity								
Open TB ₁₀	30.81	123.22	61.61	246.45	125.90	503.60	125.90	525.10
Open TB ₂	28.69	114.76	57.38	229.52	117.25	469.01	117.25	525.10
Mainframe TB ₁₀	30.41	121.64	60.82	243.29	124.28	497.13	124.28	525.10
iSeries	30.59	122.35	57.38	244.71	122.84	491.34	N/A	N/A

Table 39 Capacities for Symmetrix DMX-3 systems with eight disk directors ^a

	73 GB Drives		146 GB Drives		300 GB Drives		500 GB Drives	
	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity	Minimum Capacity	Maximum Capacity ^b
RAID 6 (6+2) Capacity								
Open TB ₁₀	26.40	105.62	52.81	211.24	107.91	431.65	107.91	526.93
Open TB ₂	24.59	98.36	49.18	196.73	100.50	402.01	100.50	526.93
Mainframe TB ₁₀	26.07	104.27	52.13	208.53	106.53	426.11	106.53	526.93
iSeries	26.22	98.36	52.44	209.75	105.29	402.01	N/A	N/A
RAID 6 (14+2) Capacity								
Open TB ₁₀	30.81	123.22	61.61	246.45	125.90	503.60	125.90	525.10
Open TB ₂	28.69	114.76	57.38	229.52	117.25	469.01	117.25	525.10
Mainframe TB ₁₀	30.41	121.64	60.82	243.29	124.28	497.13	124.28	525.10
iSeries	30.59	122.35	57.38	244.71	122.84	491.34	N/A	N/A

a. Refer to storage capacity notes on [page 240](#) for configuration requirements.

b. Usable capacity with currently available memory.

MB/Volume by emulation type

3380D emulation ^a	630
3380E emulation ^a	1,260
3380K emulation ^a	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
3390-54 emulation ^a	55,688

a. Contact your local EMC Sales Representative for 3380 and 3390-54 emulation availability.

Bytes/Track

Note: Fixed Block Architecture (FBA) capacities are based on 512 bytes per block, 128 blocks per track, and 15 tracks per cylinder.

3380 emulations ^a	47,476
3390 emulations	56,664
FBA	65,536

a. Contact your EMC Sales Representative for 3380 support.

Bytes/Cylinder

Note: Fixed Block Architecture (FBA) capacities are based on 512 bytes per block, 128 blocks per track, and 15 tracks per cylinder.

3380 emulations ^a	712,140
3390 emulations	849,960
FBA	983,040

a. Contact your EMC Sales Representative for 3380 support.

Cylinders/Volume

3380D emulation ^a	885
3380E emulation ^a	1,770
3380K emulation ^a	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
3390-54 emulation	65,520
FBA (maximum)	65,472

a. Contact your local EMC Sales Representative for 3380 and 3390-54 emulation availability.

Disk device form factor

1-inch (2.54 cm)	Height (Low-Profile)
3.5-inch (8.75 cm)	Width

Physical data

The Symmetrix DMX-3 supports configurations of one system bay and from one to eight storage bays. [Table 40 on page 249](#) through [Table 42 on page 250](#) contain the physical data for the DMX-3 system.

Table 40 Physical specifications

Description	System Bay Measurements	Storage Bay Measurements
Dimensions		
Height	76.66 in (194.7 cm) ^a	76.66 in (194.7 cm) ^a
Width	24.02 in (61.0 cm)	30.20 in (76.3 cm)
Depth	41.16 in (104.5 cm)	41.88 in (106.4 cm)
Clearance for Service and Airflow		
Front	42 in (106.7 cm)	42 in (106.7 cm)
Rear	42 in (106.7 cm)	42 in (106.7 cm)
Top	18 in (45.7 cm)	18 in (45.7 cm)

a. This measurement includes the top trim piece. Without the trim piece, the system bay height is 74.90 in. (190.25 cm).

Table 41 Multibay width measurements ^a

System Bay and Storage Bay Configurations	System Bay and Storage Bay Widths
System bay and one storage bay	54.47 in (137.9 cm)
System bay and two storage bays	84.92 in (214.8 cm)
System bay and three storage bays	115.37 in (291.7 cm)
System bay and four storage bays	145.82 in (368.6 cm)
System bay and five storage bays	176.27 in (445.5 cm)
System bay and six storage bays	206.72 in (522.4 cm)
System bay and seven storage bays	237.17 in (599.3 cm)
System bay and eight storage bays	267.62 in (676.2 cm)

a. .25 in (.6 cm) added for gap between each bay.

Table 42 Multibay weights

Description	Weights lbs (kg)	Rolling Load Rates	Maximum Rate Per Castor ^a (Front)
System bay ^b	1,626 lbs (737.5 kg)	1,000 lbs per tile	600 lbs.
Storage bay ^c	2,422 lbs (1,098.6 kg)	1,000 lbs per tile	800 lbs.
System bay and one storage bay	4,048 lbs (1,836.1 kg)	-	-
System bay and two storage bays	6,470 lbs (2,934.7 kg)	-	-
System bay and three storage bays	8,892 lbs (4,033.3 kg)	-	-
System bay and four storage bays	11,314 lbs (5,131.9 kg)	-	-
System bay and five storage bays	13,736 lbs (6,230.5 kg)		
System bay and six storage bays	16,158 lbs (7,329.1 kg)		
System bay and seven storage bays	18,580 lbs (8,427.7 kg)		
System bay and eight storage bays	21,002 lbs (9,526.3 kg)		

a. Castor weights are measured on a level floor.

b. All system bay weights are calculated for a fully loaded configuration of channel directors, disk directors, global memory directors, and complete power subsystem.

c. All storage bay weights are calculated for a fully loaded configuration of 240 drives.

Environmental data

The Symmetrix DMX-3 requires a period of time to become acclimated to a computer room environment before and after you unpack it. Before unpacking the system, allow it to stabilize in the environment for 24 hours. After unpacking the system, do not apply AC power to it for at least the number of hours specified in [Table 43 on page 251](#) through [Table 47 on page 252](#) contain the environmental specifications for the DMX-3 system.

Table 43 Environmental acclimation

From transit/storage environment	Hours required	To nominal office/computer room environment
Hot: Above 75° F (24° C)	4 hours	68° F–72° F (20°–22° C)
Nominal: 68° F – 72° F (20° C – 22° C)	1 hour	
Cool: 40° F – 65° F (4° C – 18° C)	4 hours	
Cold: Below 40° F (4° C)	6 hours	
Damp, high humidity	4 hours	Air conditioned, low humidity

Table 44 Operating environment specifications

Condition	System bay
Operating temperature	50° - 90° F (10° to 32° C)
Operating altitude (at 32 °)	7,500 ft (2,286 m)
Operating altitude (maximum)	10,000 ft (3048 m) 1.1° derating per 1000 ft
Operating humidity	20% to 80% noncondensing
Raised floor environment	Recommended, but not required

Table 45 Shipping and storage environment specifications

Condition	System bay and storage bay
Ambient temperature	-40° to 149° F (-40° to 65° C)
Temperature gradient	43.2° F/hr (24° C/hr)
Relative humidity	10% to 90% noncondensing
Maximum altitude	25,000 ft (7,619.7 m)

Table 46 Air volume generated

System configuration description	English units	Metric (SI) units
System bay	1,747 cfm	49 cfm
Storage bay	1,280 cfm	36 cfm

Table 47 Sound power and sound pressure levels

System configuration description	Sound power levels (dB)	Sound pressure levels (dB)
Storage bay	78 dB	62 dB ^a
System bay	84 dB	66 dB ^a
System bay and one storage bay ^b	85 dB	67.4 dB
System bay and two storage bays ^b	86 dB	68.5 dB
System bay and three storage bays ^b	86.4 dB	69.4 dB
System bay and four storage bays ^b	87 dB	70 dB
System bay and five storage bays ^b	87.5 dB	70.8 dB
System bay and six storage bays ^b	88.0 dB	71.3 dB
System bay and seven storage bays ^b	88.4 dB	71.8 dB
System bay and eight storage bays ^b	88.8 dB	72.2 dB

a. Average sound pressure measurement of the four standby positions per STATSKONTORET.

b. Calculated value.

Power and cooling data

The Symmetrix DMX-3 currently supports configurations of one system bay and from one to eight storage bays as described in [Table 48 on page 253](#).

Table 48 DMX-3 power consumption and heat dissipation

System Configuration Description ^a	Total Power Consumption (kVA)	Heat Dissipation (Btu/Hr)
System bay	6.4	21,850
Storage bay	6.1	19,800
System bay with one storage bay	12.5	41,380
System bay with two storage bays	18.6	61,180
System bay with three storage bays	24.7	80,980
System bay with four storage bays	30.8	100,780
System bay with five storage bays	36.9	120,580
System bay with six storage bays	43.0	140,380
System bay with seven storage bays	49.1	160,180
System bay with eight storage bays	55.2	179,980

a. All system bay values are for a fully loaded configuration of channel directors, disk directors, global memory directors, and complete power subsystem. All storage bay values are for a fully loaded configuration of 16 drive enclosures and 240 15,000 rpm disk drives. Contact your local EMC Sales Representative for specific supported configurations.

Note: When planning power requirements for a data center, consider that the data listed in [Table 48 on page 253](#) are for steady-state operation. After the loss and return of AC power, the batteries in the BBU modules go into recharging mode for up to eight hours and consume 20 percent more power than the calculations shown.

Electrical specifications and power requirements

This section describes electrical specifications, power cables, connectors, and extension cords for the Symmetrix DMX-3 system bay and each storage bay for North American and International sites. Each DMX-3 system bay and storage bay has two power connectors affixed to each PDP (Figure 61 on page 254). The DMX-3 system uses three-phase power only. The type of input power is determined by the PDP (power distribution panel) required. There are two choices:

- ◆ 3-phase, Delta, line-to-line, 4-wire
- ◆ 3-phase, WYE, line-to-neutral, 5-wire

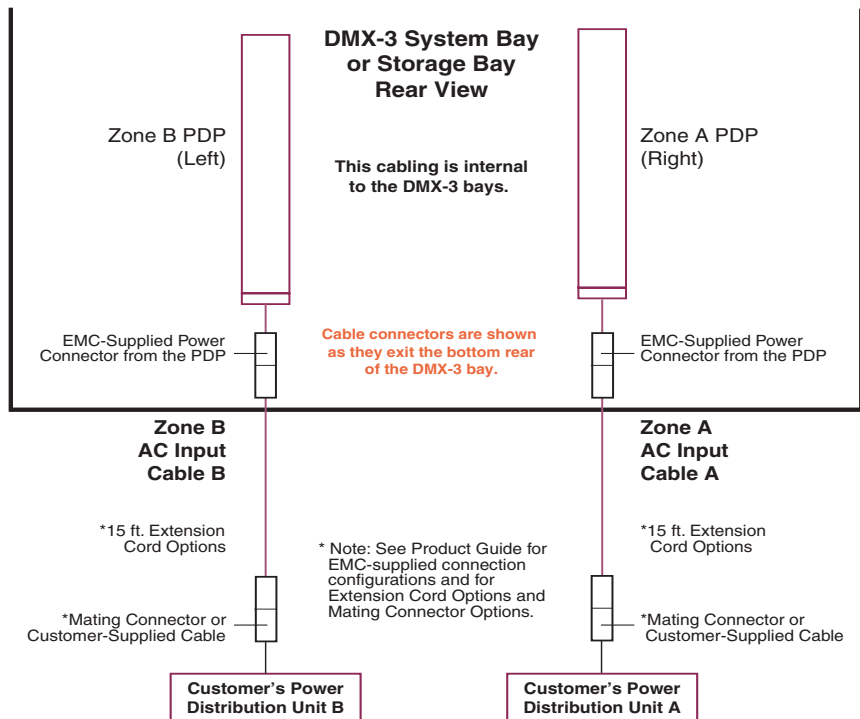


Figure 61 DMX-3 power connections

Note: "Symmetrix DMX-3 power requirements" on page 270 provide pre-installation power site requirements. The Symmetrix *DMX-3 Physical Planning Guide* also provides additional planning information for power requirements.

DMX-3 North American power specifications

[Table 49 on page 255](#) describes the electrical specifications for the Symmetrix DMX-3 system bay and storage bays for systems installed in North American, three-phase, Delta environments.

Table 49 Electrical specifications, North American, three-phase, four-wire (Delta)

Specification	North American Three-Phase, (Delta)
Input Voltage ^a	200 / 240 VAC L-L nom (240 VAC optimal)
Range	200–240 VAC ± 10%
Frequency	50/60 Hz
Circuit Breakers	50 A
Power Zones	Two
Power Requirements at Customer Site (minimum)	Two 50A three-phase drops per bay

a. An imbalance of AC input currents may exist on the three-phase power source feeding the Symmetrix system. For any configuration other than three power supplies per zone, a current imbalance will exist on the three-phase AC input. The customer's electrician must be alerted to this possible condition to balance the phase-by-phase loading within the customer's data center.

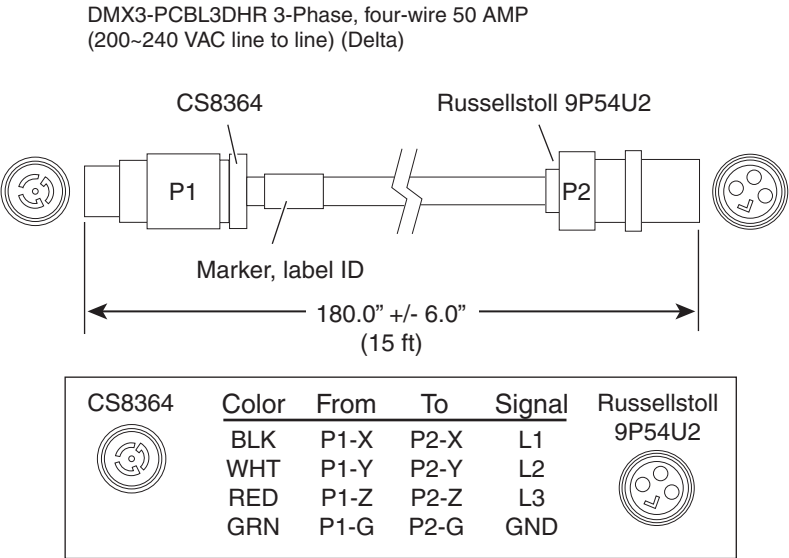
DMX-3 North American extension cords and mating connectors

For a North American, three-phase, four-wire, (Delta) configuration, attached to each PDP is a 50A Hubbell CS8365C or an equivalent 8365 type connector. [Table 50 on page 256](#) describes the optional EMC extension cords that connect to this Hubbell connector and mating connector options.

Table 50 Extension line cord, North American, three-phase, four-wire, (Delta)

Extension line cord description	Extension line cord EMC model number ^a	Mating connector EMC model number ^a , and vendor part number
Three-phase, 15 ft line cord with connectors on each end (Delta). - Connector CS8364C mates to the DMX-3 system bay or storage bay power connector Hubbell CS8365C or an equivalent 8365 type connector - Thomas and Betts/Russellstoll 9P54U2 connector can mate to the optional EMC Russellstoll mating connector or customer-supplied cables.	EMC Model Number: DMX3-PCBL3DHR (Figure 62 on page 256)	EMC Model Number: DMX-ACON3P-50 rated up to 50A. Vendor Part Number: Russellstoll 9C54U2T
Three-phase, 15 ft line cord with connectors on each end (Delta): - Connector CS8364C mates to the DMX-3 system bay or storage bay power connector Hubbell CS8365C or an equivalent 8365 type connector. - Connector CS8365C can mate to customer-supplied Hubbell CS8365C or an equivalent 8365 type connector or extension cord.	EMC Model Number: DMX3-PCBL3DHH (Figure 63 on page 257)	Customer-supplied Hubbell CS8364 or CS8364 equivalent. No EMC mating connector available.

a. Customers use the EMC model numbers for ordering purposes.



SYM-001095 PG

Figure 62 EMC model number DMX3-PCBL3DHR cable description

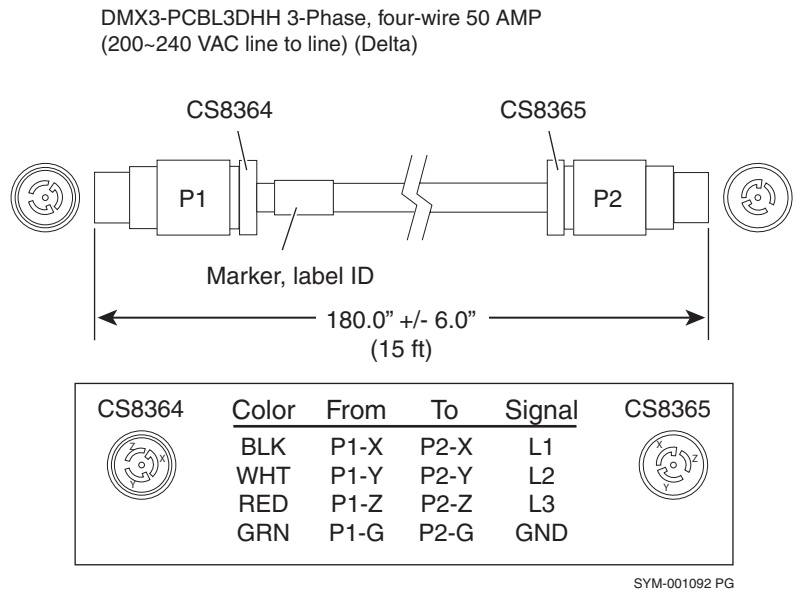


Figure 63 EMC model number DMX3-PCBL3DHH cable description

DMX-3 international power specifications

[Table 51 on page 258](#) describes the electrical specifications for the Symmetrix DMX-3 system bay and storage bays for systems installed in International, three-phase, five-wire (WYE) environments.

Table 51 Electrical specifications, international, three-phase, five-wire, (WYE)

Specification	International Three-Phase (WYE)
Input Voltage ^a	220 / 230 / 240 VAC L-N nom (240 VAC optimal)
Range	200–240 VAC $\pm$ 10%
Frequency	50/60 Hz
Circuit Breakers	32 A ^b
Power Zones	Two
Power Requirements at Customer Site	Two 32 A, three-phase drops per bay

- An imbalance of AC input currents may exist on the three-phase power source feeding the Symmetrix DMX-3 system. This occurs if an even number of power supplies is required to satisfy the power requirements for this Symmetrix DMX-3 configuration. The customer's electrician must be alerted to this possible condition to balance the phase-by-phase loading conditions within the customer's data center.
- For high voltage installations (380 - 415 VAC line-to-line), a 32 A rated circuit breaker is recommended. For International installations where a three-phase, four-wire Delta source is used, a 50 A circuit breaker is required.

DMX-3 international extension cords and mating connectors

Each DMX-3 system bay and storage bay has two power cables affixed to each PDP ([Figure 61 on page 254](#)). For an International, three-phase, WYE configuration, attached to each PDP is a 32A ABL Sursum S52.30 connector. [Table 52 on page 258](#) describes the optional extension cords that connect to the ABL Sursum S52.30 connectors.

Table 52 Extension line cord, international, three-phase, five-wire, (WYE)

Extension line cord description	Extension line cord	Mating connector EMC model number and vendor part number
Three-phase, 15 ft line cord set, International IEC309 (WYE): - Connector ABL Sursum K52.30 mates to the DMX-3 system bay or storage bay power connector ABL Sursum S52.30. - Flying leads on the other end of cable.	EMC Model Number: DMX3-PC3YAFLE (Figure 64 on page 259)	Flying leads. No mating connectors available.
Three-phase, 15 ft line cord set, International IEC309 (WYE): - Connector ABL Sursum K52.30 mates to the DMX-3 system bay or storage bay power connector ABL Sursum S52.30. - Connector, Garo P432-6 on the other end of cable connects to a customer-supplied Garo S-432-6 coupler.	EMC Model Number: DMX3-PCBL3YAG (Figure 65 on page 259)	Customer-Supplied Garo S-432-6 coupler. No EMC model available.

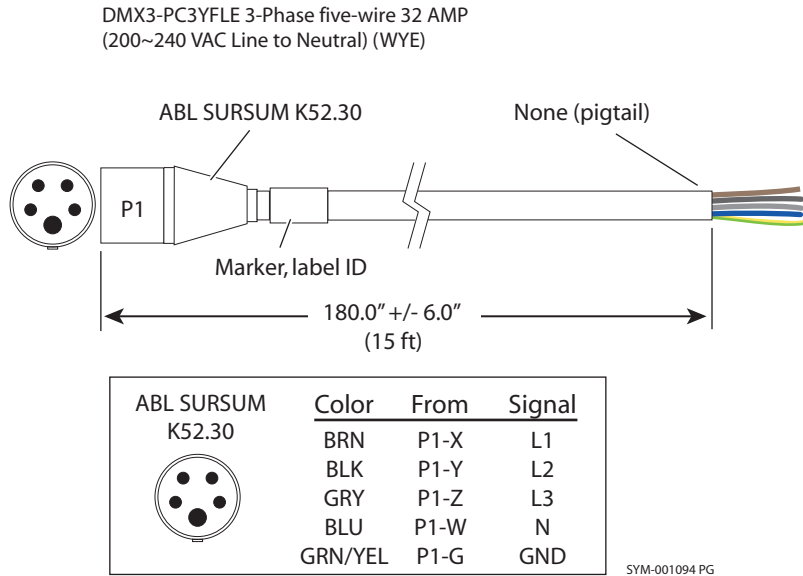


Figure 64 EMC model number DMX3-PC3YAFLE cable description

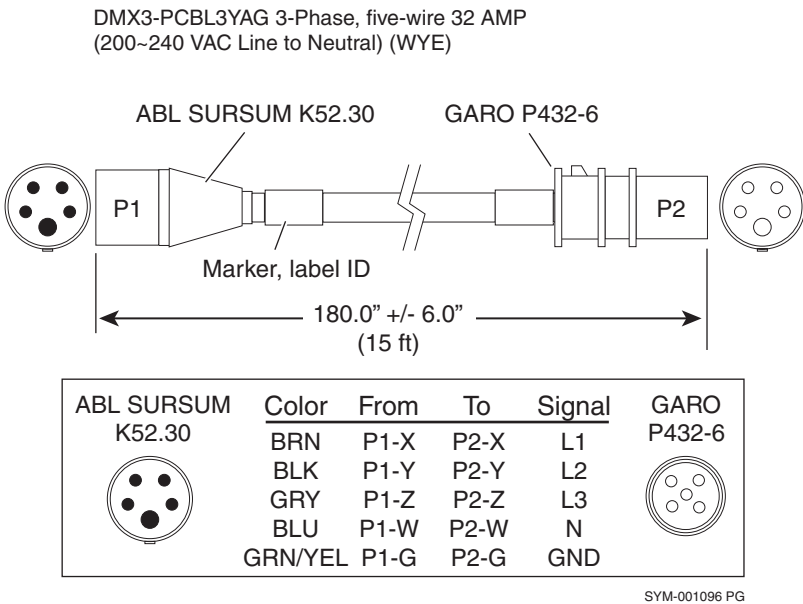


Figure 65 EMC model number DMX3-PCBL3YAG cable description

Power Sequences

This appendix provides instructions for powering the Symmetrix DMX-3 up and down.

- ◆ Routinely powering up the Symmetrix DMX-3 262
- ◆ Powering down the Symmetrix DMX-3 264

Routinely powering up the Symmetrix DMX-3



CAUTION

The Symmetrix DMX-3 contains no user-serviceable parts. Therefore, the system bay and storage bays should not be opened for any reason by untrained personnel. If the Symmetrix DMX-3 is in need of repair, only qualified personnel familiar with safety procedures for electrical equipment and the Symmetrix DMX-3 should access components inside the unit.

Note: For Symmetrix DMX-3 power connection and configuration requirements, refer to the *Symmetrix DMX-3 Physical Planning Guide* and the *Symmetrix DMX-3 Quick Start Power Connection Guide*. Do not use the following procedures for powering up the Symmetrix DMX-3 for the first time. If you have powered down the Symmetrix DMX-3 for an emergency condition, call the EMC Service Support Center for assistance before powering up the system.

Perform these steps to power up the Symmetrix DMX-3 after it has been routinely powered down by the PDP power switches:

1. On the rear door of each Symmetrix DMX-3 storage bay ([Figure 66 on page 263](#)), press the Zone A and Zone B power distribution panel (PDP) power switches to the up (|) ON position.
2. On the rear door of the Symmetrix DMX-3 system bay ([Figure 66 on page 263](#)), press the Zone A and Zone B PDP power switches to the up (|) ON position.

The Symmetrix system begins its initial microcode program load (IMPL) startup procedure.

3. Wait at least 30 minutes for the IMPL procedure to complete.

Note: The actual IMPL procedure time varies by system type and configuration.

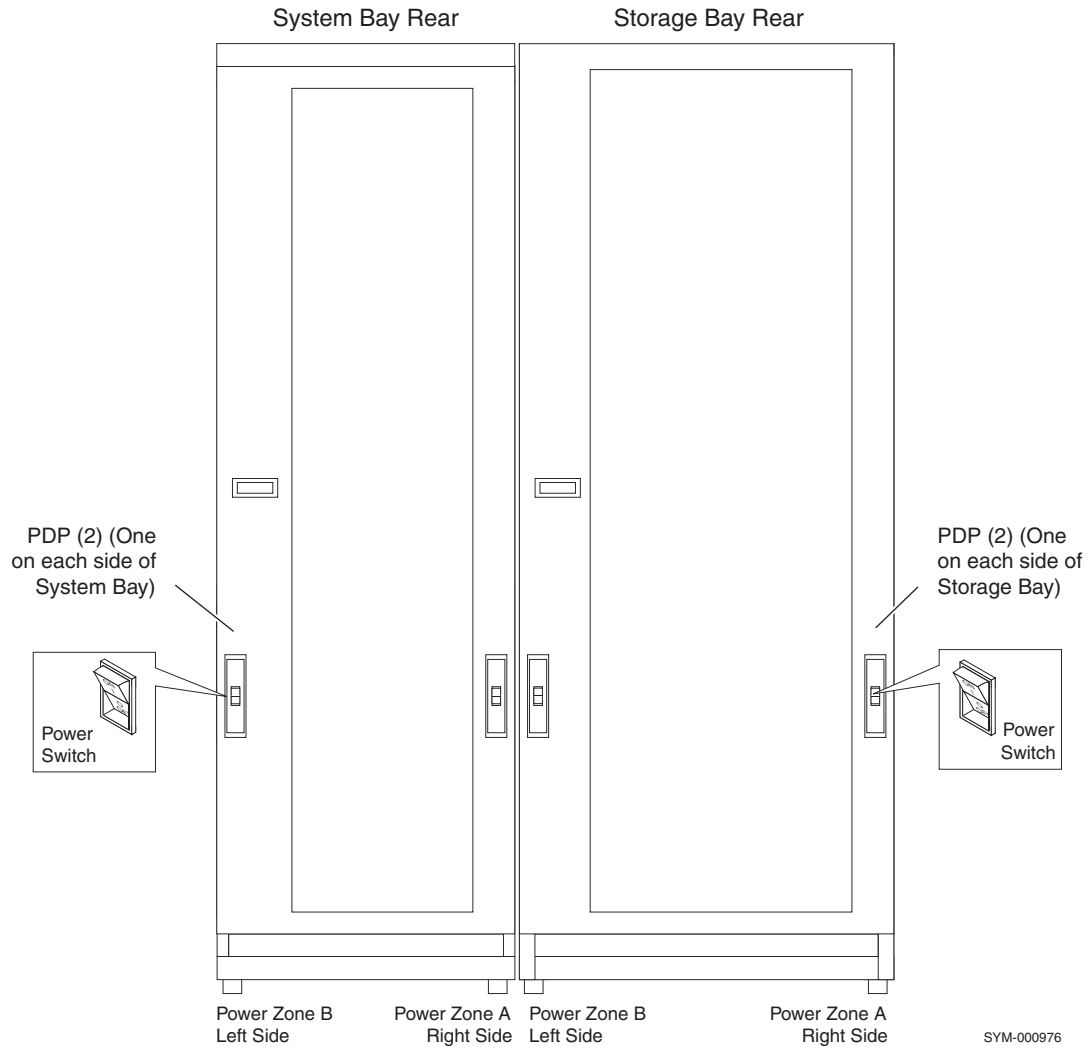


Figure 66 Symmetrix DMX-3 system bay and storage bay power switches

Powering down the Symmetrix DMX-3

Note: The Symmetrix DMX-3 is designed to stay powered up for most all situations. Unless there is an emergency situation, first call the EMC Service Support Center for assistance before powering down the Symmetrix DMX-3.

Perform these steps to power down the Symmetrix DMX-3, using the PDP power switches located on the rear door of the system bay and storage bays:

1. Stop all processes to the Symmetrix DMX-3.

Note: If you are powering down the Symmetrix DMX-3 for an emergency condition, stopping all processes to the system is not necessary.

2. On the rear door of the system bay ([Figure 66 on page 263](#)), press the Zone A and Zone B PDP power switches to the down (O) OFF position.
3. On the rear door of the storage bays ([Figure 66 on page 263](#)), press the Zone A and Zone B PDP power switches to the down (O) OFF position.

Note: The BBU modules automatically turn on when the Symmetrix system detects loss of AC power. The BBU modules will maintain power to the Symmetrix system for up to five minutes while the global memory is vaulted to the vault drives.

This appendix covers the tasks you need to complete when planning or verifying the physical configuration of the Symmetrix DMX-3 or creating I/O addressing schemes.

◆ Planning overview	266
◆ Symmetrix DMX-3 power requirements	270
◆ System placement options	275
◆ Planning host connectivity	280
◆ Disk director port assignments	282
◆ Open systems installations	283
◆ Mainframe systems installations	293

Planning overview

This section provides an overview of the physical details related to planning an installation of the Symmetrix DMX system. It reviews all the necessary installation details performed by EMC personnel and outlines customer responsibilities.

Note: Inform EMC of any labor union-based restrictions or security clearance requirements prior to delivery. For additional information on planning the installation for your Symmetrix DMX-3, refer to the *Symmetrix DMX-3 Physical Planning Guide*.

The Symmetrix DMX-3 is 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. Although a raised floor is not required, it is recommended. 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 53 on page 266](#) lists the responsibility summary at the first planning session.

Table 53 Pre-installation responsibility summary

EMC responsibility	Customer responsibility
Provide all details necessary for site planning and preparation.	Provide an environment that supports safe installation of the Symmetrix DMX-3 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 DMX-3 presite considerations

When planning the installation site for your Symmetrix DMX-3, you will need to meet with your EMC team to complete the presite plan.

The DMX-3 has one system bay and from one to eight storage bays. The system bay, when fully configured can weigh approximately 1,626 lbs (737.5 kg). A single storage bay with 240 disk drives can weigh approximately 2,422 lbs (1,098 kg).

The maximum weight per system bay caster is 600 lbs and the maximum weight per storage bay caster is 800 lbs. [Table 42 on page 250](#) describes weights for various DMX-3 configurations.

Listed below are some of the pre-installation items to consider before installing the DMX-3 at your site:

- ◆ Equipment ramp needed if the receiving floor is not level with computer room floor

Note: All portions of the DMX-3 bays, including optional doors, shall clear ramp and threshold slopes up to 1:10 (rise to run ratio), per Code of Federal Regulations – ADA Standards for Accessible Design, 28 CFR Part 36.

- ◆ Weight capacities for ([Table 42 on page 250](#)):
 - Service elevator if delivery is to another floor
 - Computer room floor
 - The loading dock
 - The loading dock tailgate
- ◆ Length of covering required for floor protection
- ◆ Direct dial-up phone line (for remote support) within six feet (two meters) of the unit ("[Remote support](#)" on page 269)
- ◆ System cabling and power cabling routing 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 DMX-3. From a physical planning perspective, review the routing path(s) from the host(s) to the Symmetrix DMX-3. Resolve any physical access issues *before* the installation date. Also consider if host cables and power cables require overhead routing. ("[Overhead host cable routing](#)" on page 276 and "[Overhead power cable routing](#)" on page 276)
- ◆ Power hardware requirements ("[Power and cooling data](#)" on page 253 and "[Electrical specifications and power requirements](#)" on page 254)
- ◆ Environmental requirements -- The Symmetrix DMX-3 requires the environmental specifications outlined in "[Environmental data](#)" on page 251.
- ◆ "[Physical data](#)" on page 249 provides overall system dimensions and weights for the Symmetrix DMX-3 configurations.



CAUTION

The customer must make sure the site meets or exceeds the specifications listed.

Layout and space recommendations

Layout and space considerations are found in [“System placement options” on page 275](#).



WARNING

“Floor load-bearing requirements” on page 277 defines important floor load-bearing requirements. Failure to comply with these requirements could result in severe damage to the Symmetrix DMX-3 system, the raised floor, the subfloor and the surrounding infrastructure, as well as serious bodily injury or death to persons in proximity to the system.



WARNING

Before the Symmetrix DMX-3 bays are rolled into position in the computer room, note how close the wheels are to the edge of the cutout. If the Symmetrix system needs to be relocated, contact the EMC Customer Support Center.



WARNING

When moving the storage bay down an incline, the rear of the cabinet must go first.

When moving the storage bay up an incline, the rear of the bay must go last.

Securing the system

If the system is to be secured to the floor for increased stability, use Symmetrix DMX-3 Secure bracket kits. Contact your EMC Sales Representative for more information.

Transportation and delivery guidelines

A Symmetrix DMX-3 delivered within the United States or Canada travels by air-ride truck or van. The Symmetrix DMX-3 system bay and storage bays are shrouded by custom-designed shipping material, crated, and palletted. Integrated shock absorbing casters on which the Symmetrix DMX-3 system bay and storage bay rest facilitate their movement during shipping and installation.

A Symmetrix DMX-3 delivered Internationally normally involves 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-3, 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.

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-3 occurs through the external serial modem connected to the Symmetrix service processor. This feature requires customers to provide a dedicated telephone line (for the modem). The modems do not require external power connections.

Planning for upgrades

When planning for upgrades, consider space, power, and environmental concerns as described in this product guide and the *Symmetrix DMX-3 Physical Planning Guide*.

Symmetrix DMX-3 power requirements

The DMX-3 requires three-phase AC power. Each DMX-3 system bay and storage bay has two power zones providing (2N) redundancy. A fully populated system supports eight power supply modules.

Note: “Symmetrix DMX-3 power subsystems” on page 85, “Electrical specifications and power requirements” on page 254, and “Power and cooling data” on page 253 provide more information on power requirements.

The customer is responsible for supplying and installing the required receptacles on two separate power distribution units (PDUs) for Zone A and Zone B power for the Symmetrix DMX-3 system bay and each storage bay in advance of delivery. [Figure 67](#) and [Figure 68](#) on [page 271](#) show the required power cabling for the Symmetrix DMX-3 system bay and each storage bay.

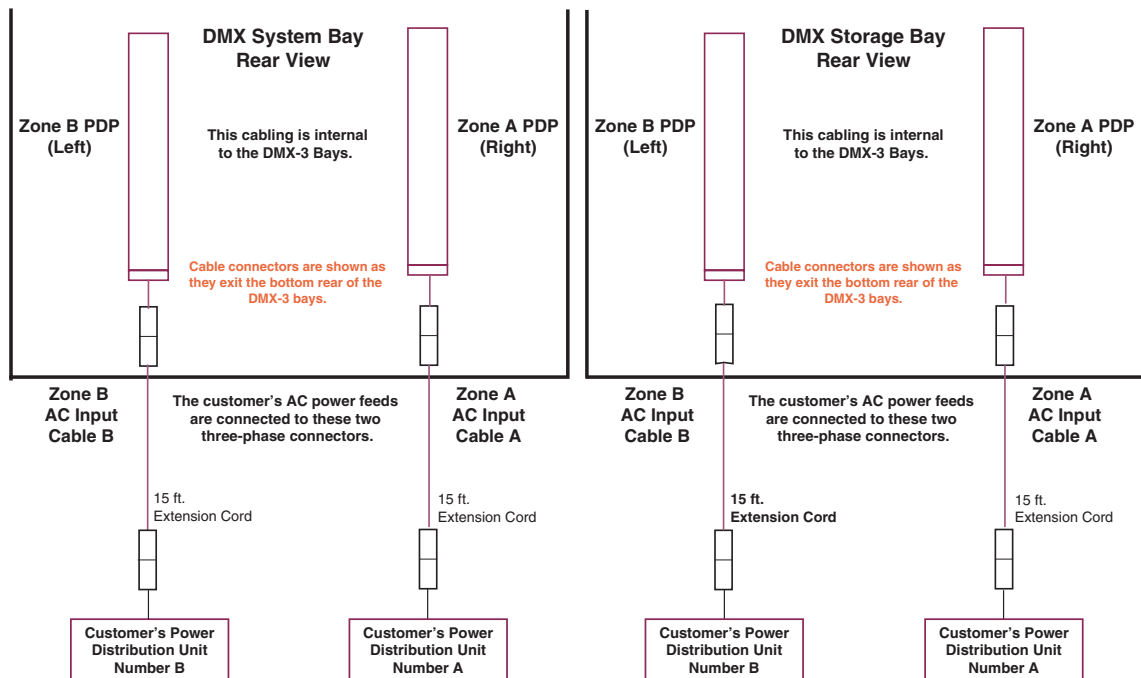
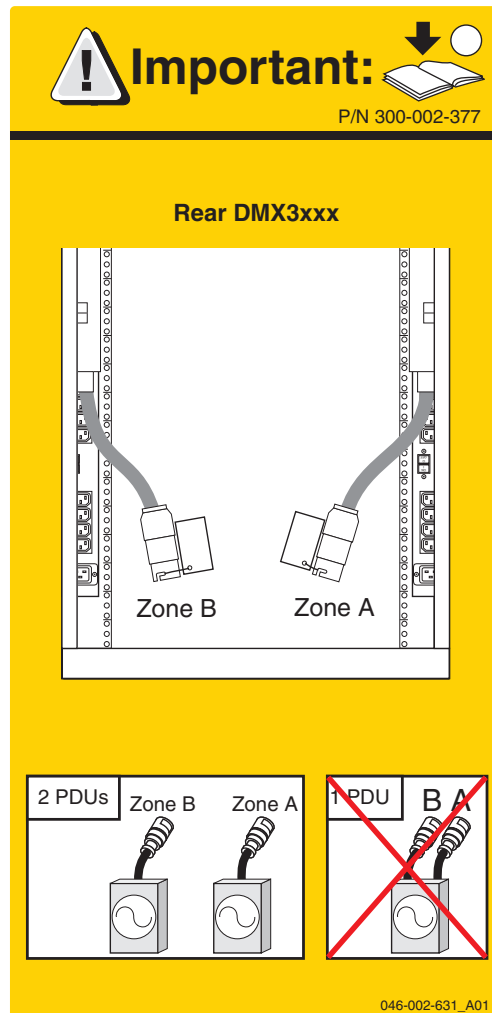


Figure 67 DMX-3 system bay and storage bay to customer PDU power cabling

Two Separate Customer Site PDUs are required.

For site preparation and power connection procedures, refer to the *EMC Symmetrix DMX-3 Quick Start Power Connection Guide*.



SYM-000921

Figure 68 DMX-3 power cabling requirement

Note: The label shown in [Figure 68](#), represents the label attached to each cable exiting the Symmetrix DMX-3 system bay and each storage bay. Symmetrix DMX-3 requires two dedicated and isolated AC power feeds that plug directly into the PDPs of the bays. The customer must supply separate PDU connections for proper power redundancy. DMX-3 power redundancy can only be assured at the customer PDU and after. **These labels are only to be removed from the cables by the customer's site electrician.** This same label is permanently adhered to the inside of the rear doors of the system bay and the storage bays.

Symmetrix touch current compliance



CAUTION

The Symmetrix DMX-3 system bay and the storage bay 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 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 254](#) 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 guide (refer to [“Power and cooling data” on page 253](#)) are intended for air conditioning and utility loading purposes only.

Because the Symmetrix 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 emi 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 bays are 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 systems meet regulatory requirements as referenced by the following UL/IEC/EN 60950 3d Edition:

5.1.7 Equipment with touch (leakage) current exceeding 3.5 mA

For Stationary Permanently Connected Equipment, or Stationary Pluggable Equipment Type B, having a main protective earthing terminal, if the Touch (Leakage) Current measurements exceed 3.5 mA 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-3 is a Stationary Pluggable Type B system, and has been extensively tested and certified to meet the above standard, including the application of the following warning labels in English and French:

- ◆ EMC warning label, part number 046-002-420 is located inside the rear of the Symmetrix DMX-3 system bay.
- ◆ EMC warning label, part number 046-002-593 is located inside the rear of the Symmetrix DMX-3 storage bay.

Choosing a UPS

The Symmetrix system is capable of supporting two consecutive five-minute power outages before its BBU modules are 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 Zone B and Zone A 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 2N fault tolerance specification of the Symmetrix power system.
- ◆ EMC provides kVA power consumption specifications for each system model as described in [“Power and cooling data” on page 253](#). Refer to these specifications when choosing a UPS.

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.

System placement options

The Symmetrix DMX-3 system configurations can be installed in several different flooring environments. The system can be installed on a nonraised floor or raised floor environment. Although it is not required, the raised floor environment is the preferred installation environment. “[Floor load-bearing requirements](#)” on [page 277](#) lists the floor loading requirements for the Symmetrix DMX-3 installation.

When planning the DMX-3 system placement, EMC recommends positioning the storage bay frame first so that the closed front door aligns with the floor tile edge. The system bay frame is then aligned with the storage bay frames and are bolted together later. When the system bay and all the storage bay doors are closed, the system bay is slightly recessed in relation to the storage bays because the depth of the system bay door is less than the depth of the storage bay doors.

[Figure 69 on page 275](#) shows the placement of a DMX-3 with a system bay and four storage bays on a level nonraised floor.

Note: In a nonraised floor environment, ensure that the room meets environmental specification requirements. Refer to “[Environmental data](#)” on [page 251](#).

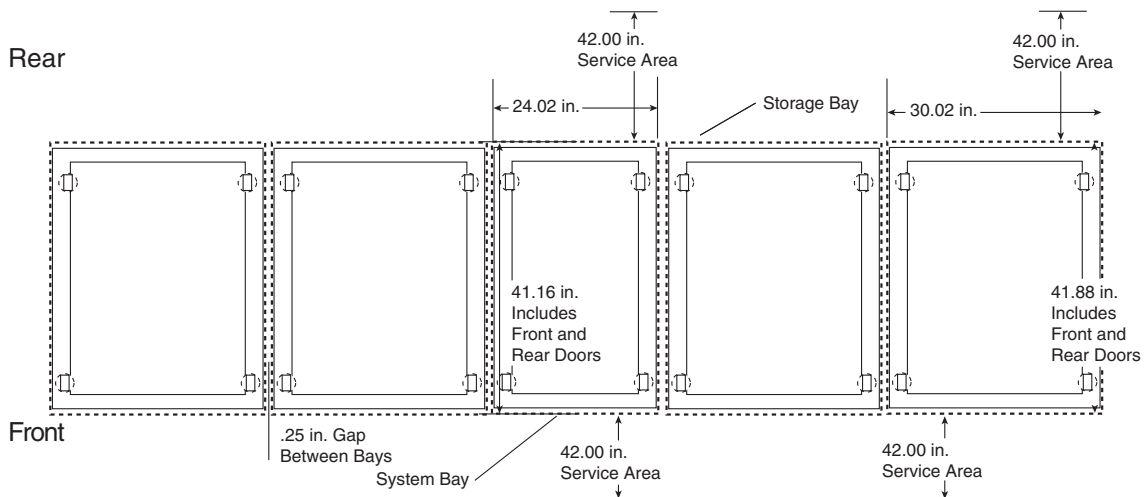


Figure 69 Nonraised floor installation



WARNING

Customer must be aware that the load-bearing capacity of the data center floor is not readily ascertainable through a visual inspection of the floor and that the only definitive way to ensure that the floor is capable of supporting the load associated with the Symmetrix DMX-3 storage system is to have a certified architect or the data center design consultant inspect the specifications of the floor to ensure that the floor is capable of supporting the loads specified in [Table 42 on page 250](#). Customer is responsible for insuring that the floor of the data center on which the Symmetric DMX-3 System is to be configured is capable of supporting these loads when the system is configured directly on the data center floor.



WARNING

Failure to comply with these requirements could result in severe damage to the Symmetrix DMX-3 system, the raised floor, the subfloor and the surrounding infrastructure, as well as serious bodily injury or death to persons in proximity to the system.

NOTWITHSTANDING ANYTHING TO THE CONTRARY IN ANY AGREEMENT BETWEEN EMC AND CUSTOMER, EMC FULLY DISCLAIMS ALL LIABILITY FOR DAMAGE RESULTING FROM CUSTOMER'S NON-COMPLIANCE WITH THE ABOVE FLOOR LOAD-BEARING REQUIREMENTS AND CUSTOMER ASSUMES ALL RISK ASSOCIATED WITH SUCH NON-COMPLIANCE.

Overhead host cable routing

When installing a Symmetrix DMX-3 system configuration, the cabling is handled from the overhead when installing on a nonraised floor or in some instances on a raised floor. To assist in the management of overhead host cable routing, a topside cable routing bracket (Model # DMX3-CBL BRKT), must be purchased and installed at the rear of the equipment bay.

Overhead power cable routing

If the customer requires power to be supplied from overhead then EMC recommends the power cables be *dropped* on the outside of the cabinet next to the hinge side of the doors and routed inside the machine.

The cable retainer bracket will be removed to allow the cables inside the machine and replaced after cable routing is complete. The cables should be dressed to allow all doors to open freely. The customer is responsible for meeting all of his/her local installation safety requirements.

Note: Although EMC does not require raised floors for routing power cables, it is recommended.

Floor load-bearing requirements

It is recommended but not required that the Symmetrix DMX-3 configuration be installed on a raised floor. To ensure proper physical support of the system, if the system is installed on a raised floor, the following requirements must be compiled with:

- ◆ Floor must be level.
- ◆ Floor tiles and stringers must be rated for a minimum static load of 1,600 lbs (725.7 kg) based on two casters of 800 lbs (362.9 kg) each per tile.
- ◆ Floor tiles must be rated for a minimum of 1,000 lbs (453.6 kg) rolling load.
- ◆ Floor tiles and stringers must be rated for a minimum static ultimate load of at least 3,000 lbs (1360.8 kg) per tile.
- ◆ Do not position the system bay or storage bays with more than two casters on a single floor tile.

Note: Cutting tiles per specifications as shown on [Figure 70 on page 279](#) will ensure the proper caster placement.

- ◆ Use 24 x 24 in. (61 x 61 cm) heavy duty steel filled with concrete floor tiles. If different size or type tiles are used, customer must insure that the tiles are load rated as specified above.
- ◆ Use or create no more than one floor tile cutout that is no more than 8 in. (20.3 cm) wide by 6 in. (15.3) deep in each 24 x 24 in. (61 x 61 cm) floor tile.
- ◆ Floor tile cutouts will weaken the tile. Therefore, at least one additional pedestal mount adjacent to the cutout of a tile is required. The number and placement of additional pedestal mounts relative to a cutout should be in accordance with the tile manufacturer's recommendations.
- ◆ Care should be taken when positioning the cabinets to make sure that a caster is not moved into a cutout.

- ◆ In order to ensure that extraneous weight does not compromise the integrity of the raised floor and/or the data center nonraised floor proximate the system, a minimum 4 foot buffer around the perimeter of the system which is clear of any equipment that is not associated with the system must be maintained at all times.



WARNING

Customer must be aware that the load-bearing capacity of the data center floor is not readily ascertainable through a visual inspection of the floor and that the only definitive way to ensure that the floor is capable of supporting the load associated with the Symmetrix DMX-3 storage system is to have a certified architect or the data center design consultant inspect the specifications of the floor to ensure that the floor is capable of supporting the loads specified in [Table 42 on page 250](#). Customer is responsible for insuring that the floor of the data center on which the Symmetrix DMX-3 system is to be configured is capable of supporting these loads, whether the system is configured directly on the data center floor, or the system is configured on a raised floor supported by the data center floor.



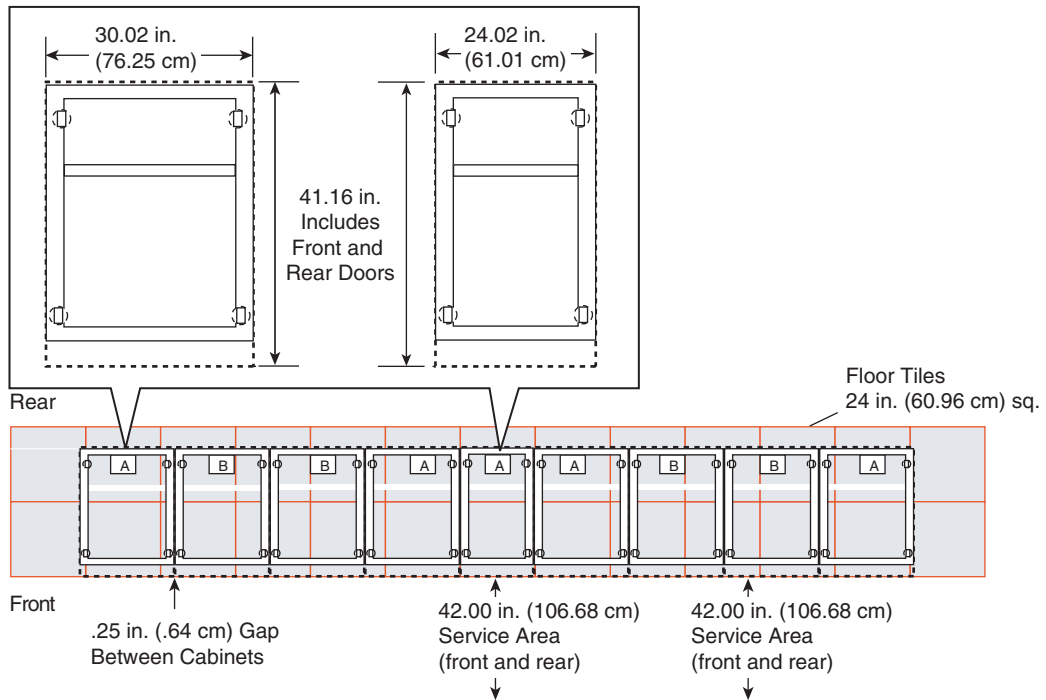
WARNING

Failure to comply with these requirements could result in severe damage to the Symmetrix DMX-3 system, the raised floor, the subfloor and the surrounding infrastructure, as well as serious bodily injury or death to persons in proximity to the system.

NOTWITHSTANDING ANYTHING TO THE CONTRARY IN ANY AGREEMENT BETWEEN EMC AND CUSTOMER, EMC FULLY DISCLAIMS ALL LIABILITY FOR DAMAGE RESULTING FROM CUSTOMER'S NON-COMPLIANCE WITH THE ABOVE FLOOR LOAD-BEARING REQUIREMENTS AND CUSTOMER ASSUMES ALL RISK ASSOCIATED WITH SUCH NON-COMPLIANCE.

Symmetrix DMX-3 configuration floor cutouts

Several DMX-3 configurations are available. [Figure 70 on page 279](#), which illustrates the configuration and the recommended floor tile cutouts for a system bay and eight storage bays. To build a smaller system, remove storage bays as necessary around the system bay. The illustrations assume that the floor tiles are 24 x 24 in. (61 x 61 cm). Also refer to Chapter 6 in the *Physical Planning Guide*, which contains tables and configuration illustrations that show bays needed for various DMX-3 configurations.



Note:

- All tiles are 24 in. (60.96 cm) by 24 in. (60.96 cm).
- All cutouts are 8 in. (20.32 cm) by 6 in. (15.24 cm).
- All cutouts are 9 in. (22.86 cm) from the front and rear of the tile.
- All A cutouts are centered on the tiles, 9 in. (22.86 cm) from the front and rear and 8 in. (20.32 cm) from sides.
- All B cutouts are centered from front and rear 9 in. (22.86 cm). One side is on the edge of the tile and the other is 16 in. (40.64 cm) from the side.

Figure 70 One system bay and eight storage bays

Planning host connectivity

The Symmetrix DMX-3 supports open systems connectivity through Fibre Channel and iSCSI channel directors. Mainframe connectivity is supported through ESCON and FICON channel directors. SRDF connections are supported through GigE connections between Symmetrix systems. [Table 54 on page 280](#) describes each type of host channel director and the DMX-3 model number

Table 54 Symmetrix DMX-3 channel director models

Host Type and Port Descriptions	DMX-3 Model Number
8 Fibre MM Ports	DMX3-80000B
7 Fibre MM +1 SM Fibre Ports ^a	DMX3-71000B
6 Fibre MM + 2 SM Fibre Ports	DMX3-62000B
4 FICON SM Ports	DMX3-00004B
4 FICON MM Ports	DMX3-00040B
4 iSCSI or GigE ^b MM Ports	DMX3-00400B
4 Fibre MM + 2 FICON SM Ports	DMX3-40002B
4 Fibre MM + 2 iSCSI or GigE ^b MM Ports	DMX3-40200B
6 Fibre MM + 1 iSCSI or GigE ^b MM Ports	DMX3-60100B
1 iSCSI or GigE ^b MM + 3 FICON SM Ports	DMX3-00103B
8 ESCON Ports ^b	DMX3-ESCD8

- a. MM = Multimode SM = Single mode.
- b. Contact your local EMC Sales Representative for availability.

Host channel director port assignment worksheet

You can use the following worksheet ([Table 55 on page 281](#)) to determine the total quantity of Symmetrix host channel adapter ports that are required for your Symmetrix DMX-3.

- Note:** The GigE-MM description in [Table 55 on page 281](#) refers to GigE or iSCSI configurations.
- Note:** “Open systems installations” on [page 283](#) provides specific open systems configuration information. “Mainframe systems installations” on [page 293](#) provides specific mainframe information.

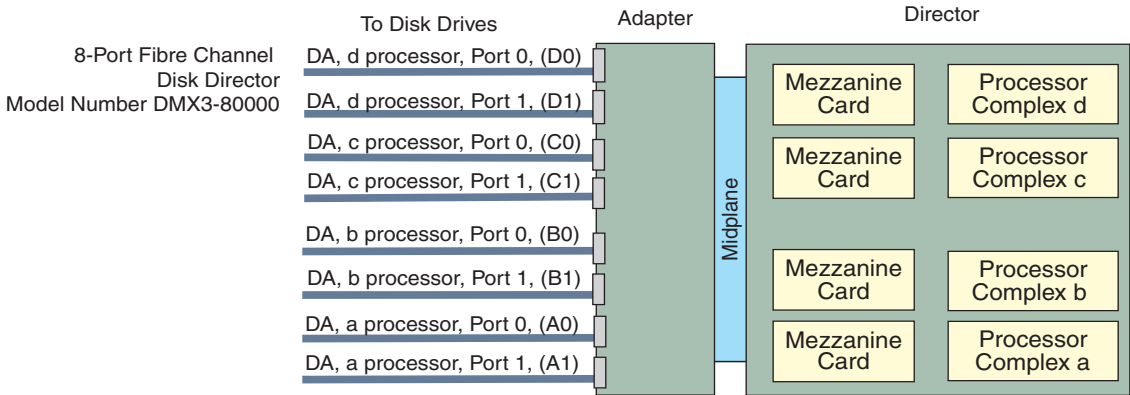
Table 55 Symmetrix DMX-3 channel adapter port worksheet

Director Model & Number of Ports	Quantity of Directors	Fibre-MM Ports	Fibre-SM Ports	FICON-SM Ports	FICON-MM Ports	ESCON Ports	Gig-E -MM Ports
DMX3-80000B							
Fibre-MM, 8 Ports							
DMX3-71000B							
Fibre-MM, 7 Ports							
Fibre-SM, 1 Port							
DMX3-62000B							
Fibre-MM, 6 Ports							
Fibre-SM, 2 Ports							
DMX3-00004B							
FICON-SM, 4 ports							
DMX3-00040B							
FICON-MM, 4 ports							
DMX3-00400B							
Gig-E-MM, 4 Ports							
DMX3-40002B							
Fibre-MM, 4 Ports							
FICON-SM, 2 Ports							
DMX3-40200B							
Fibre-MM, 4 Ports							
Gig-E-MM, 2 Ports							
DMX3-60100B							
Fibre-MM, 6 Ports							
Gig-E-MM, 1 Port							
DMX3-00103B							
FICON-SM, 3 Ports							
Gig-E-MM, 1 Port							
DMX3-ESCD8							
ESCON,8 Ports							
		Fibre-MM	Fibre-SM	FICON-SM	FICON-MM	ESCON	Gig-E -MM
Total All Ports							

Disk director port assignments

The Symmetrix DMX-3 Fibre Channel back-end disk directors manage the interface to the disk drives, and are responsible for data movement between the disk drives and global memory. The DMX-3 uses an eight-port Fibre Channel disk director. The DMX-3 uses one pair of terminating disk adapters and the remainder are nonterminating.

Figure 71 on page 282 shows the interface between the disk directors and the disk drives and the port designations.



Notes:
Examples of SymmWinn designations:
DA = Fibre Channel disk director in SymmWin.
DA 16d = Disk Director 16, processor d, which is located in slot F of the card cage.

Figure 71 Fibre Channel disk director port designations

Open systems installations

Note: For mainframe installation requirements, refer to [“Mainframe systems installations” on page 293](#).

Note: This section contains hardware and host checklists to be used when connecting a Symmetrix DMX-3 to open systems hosts. For the most current information on the Symmetrix system and specific host integration, contact your local EMC Sales Representative, or refer to the EMC Powerlink website.

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 56 on page 283](#)).

Table 56 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 Remote channel directors ^a	
Number of iSCSI channel directors ^a	
Host channel director models used	
Number of channels used per director ^b	
Remote director (SRDF) type (RA-2, RA-4) and quantity	

a. If host mirroring is performed, configure an even number of channel directors.

b. 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 57 on page 284](#), for each host you will attach to the Symmetrix system. When you are done, you should have a checklist for each host.

Table 57 UNIX or PC server host checklist (1 of 2)

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?		
Does the customer have the recommended number of spares? (EMC order entry)		
Will Symmetrix Mirrored (RAID 1) be used, which volumes?		
Will Symmetrix RAID 5 (3+1) or RAID 5 (7+1) be used, which volumes? (You cannot mix RAID 5 (3+1) and RAID 5 (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 1/0 be used?		

Table 57 UNIX or PC server host checklist (2 of 2)

Host Configuration Requirements	Host 1	Host 2
Partitioning?		
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.*

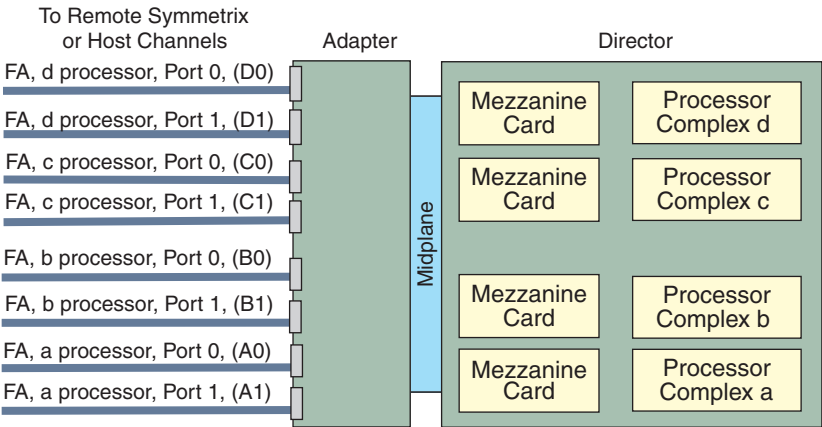
Fibre Channel port designations

Each Symmetrix Fibre Channel director occupies one slot on the Symmetrix DMX-3 midplane. Each director interfaces to the host channels through a Fibre Channel adapter connected to the opposite side of the midplane.

EMC offers several Fibre Channel director models, depending on the host channel connection requirements, such as single mode or multimode. Refer to your local EMC Sales Representative for information about choosing the Fibre Channel adapter that best suits your environment.

Note: Information on Fibre Channel configurations is also available on the EMC Powerlink website.

Figure 72 on page 286 shows the interface and the channel designations for the eight-port Fibre Channel director.



Notes:
Example of SymmWinn designations:
FA = Fibre Channel director. SymmWin
FA 03d = Fibre Channel Director 03, processor d, which is located in slot 2 of the card cage.
MM = Multimode. SM = Singlemode.

Fibre Channel Dir, 8 MM Ports M/N DMX3-80000		Fibre Channel Dir, 7 MM, 1 SM Ports M/N DMX3-71000		Fibre Channel Dir, 6 MM, 2 SM Ports M/N DMX3-62000	
Processor Port	8 Fibre Chan MM Ports	Processor Port	1 Fibre Chan SM Port 7 Fibre Chan MM Ports	Processor Port	2 Fibre Chan SM Ports 6 Fibre Chan MM Ports
D0	Fibre Channel MM SFP	D0	Fibre Channel SM SFP	D0	Fibre Channel SM SFP
D1	Fibre Channel MM SFP	D1	Fibre Channel MM SFP	D1	Fibre Channel MM SFP
C0	Fibre Channel MM SFP	C0	Fibre Channel MM SFP	C0	Fibre Channel SM SFP
C1	Fibre Channel MM SFP	C1	Fibre Channel MM SFP	C1	Fibre Channel MM SFP
B0	Fibre Channel MM SFP	B0	Fibre Channel MM SFP	B0	Fibre Channel MM SFP
B1	Fibre Channel MM SFP	B1	Fibre Channel MM SFP	B1	Fibre Channel MM SFP
A0	Fibre Channel MM SFP	A0	Fibre Channel MM SFP	A0	Fibre Channel MM SFP
A1	Fibre Channel MM SFP	A1	Fibre Channel MM SFP	A1	Fibre Channel MM SFP

Figure 72 Fibre Channel front-end port designations

Available EMC Fibre Channel cables

Table 58 on page 287 lists the Symmetrix Fibre Channel cables currently available from EMC. To obtain these cables, contact your local EMC Sales Representative.

Table 58 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

GigE and iSCSI port designations

The physical connection to a GigE or the iSCSI interface occurs at the connectors on the adapters located at the rear of the Symmetrix unit.

Note: When connecting to hosts with GigE/iSCSI interfaces, consult your local 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>.

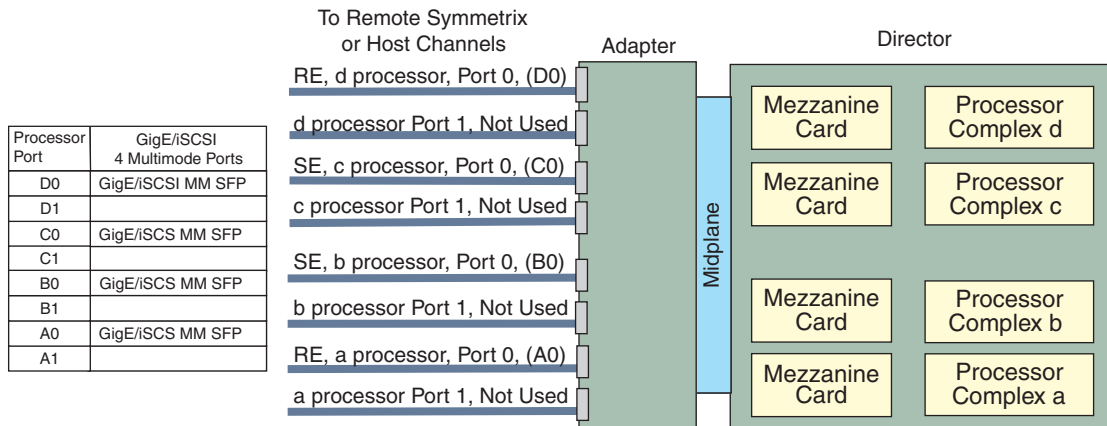
Several GigE/iSCSI channel adapters are available in the Symmetrix system with multimode configuration connections to the host channel connection requirements. Refer to your local EMC Sales Representative for information about choosing the GigE/iSCSI channel adapter that best suits your environment.

Note: To obtain adapter part numbers for iSCSI configurations, consult your local EMC Sales Representative, or refer to the EMC Powerlink website.

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-3 midplane. 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 four advanced microprocessors. [Figure 73 on page 289](#) shows the interface and the channel designations for the four-port GigE Remote and iSCSI director.

4-port GigE/iSCSI Director and Adapter with 4 Multimode Ports, M/N DMX3-00400



Notes:

Examples of SymmWinn designations:

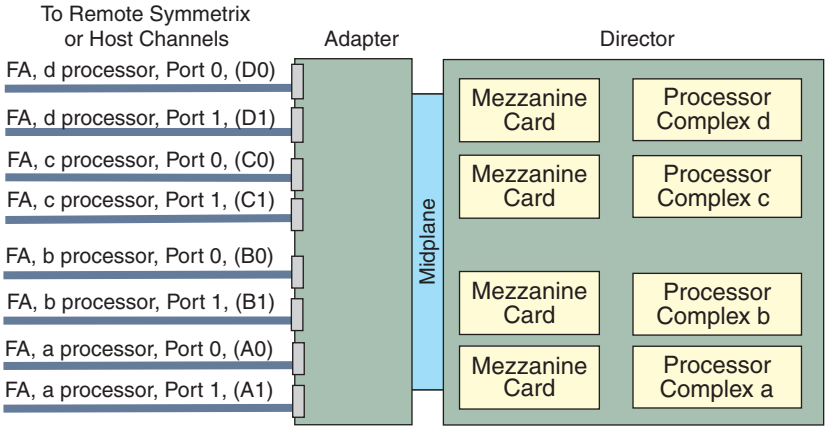
SE = iSCSI Channel director in SymmWin.

RE = GigE Remote director.

SE 03d = iSCSI Director 03, processor d, which is located in slot 2 of the card cage.

Figure 73 GigE and iSCSI port designations

Figure 74 and Figure 75 on page 291 show the interfaces for the Multiprotocol director with GigE/iSCSI, FICON, and Fibre Channel port designations.



Notes:
 Example of SymmWinn designations:
 FA = Fibre Channel director.
 EF = FICON Channel director.
 SE = iSCSI Channel director.
 RE = GigE Remote director.
 SE 03d = iSCSI Director 03, processor d, which is located in slot 2 of the card cage.
 MM = Multimode. SM = Single-mode.

6-Port Multi-Protocol Director with 4 Fibre Channel MM Ports and 2 FICON SM Ports M/N DMX3-40002	
Processor Port	2 FICON SM Port 4 Fibre Chan MM Ports
D0	FICON SM SFP
D1	
C0	FICON SM SFP
C1	
B0	Fibre Channel MM SFP
B1	Fibre Channel MM SFP
A0	Fibre Channel MM SFP
A1	Fibre Channel MM SFP

6-Port Multi-Protocol Director with 4 Fibre Channel MM Ports and 2 GigE/iSCSI MM Ports M/N DMX3-40200	
Processor Port	2 GigE/iSCSI MM Port 4 Fibre Chan MM Ports
D0	GigE/iSCSI MM SFP
D1	
C0	GigE/iSCSI MM SFP
C1	
B0	Fibre Channel MM SFP
B1	Fibre Channel MM SFP
A0	Fibre Channel MM SFP
A1	Fibre Channel MM SFP

7-Port Multi-Protocol Director with 6 Fibre Channel MM Ports and 1 GigE/iSCSI MM Ports M/N DMX3-60100	
Processor Port	1 GigE/iSCSI MM Ports 6 Fibre Chan MM Ports
D0	GigE/iSCSI MM SFP
D1	
C0	Fibre Channel SM SFP
C1	Fibre Channel MM SFP
B0	Fibre Channel MM SFP
B1	Fibre Channel MM SFP
A0	Fibre Channel MM SFP
A1	Fibre Channel MM SFP

Figure 74 Multiprotocol director with Fibre Channel, GigE and iSCSI, and FICON port designations

Figure 75 on page 291 shows the port designations for the Multiprotocol director configured with FICON, iSCSI, and Remote GigE connections.

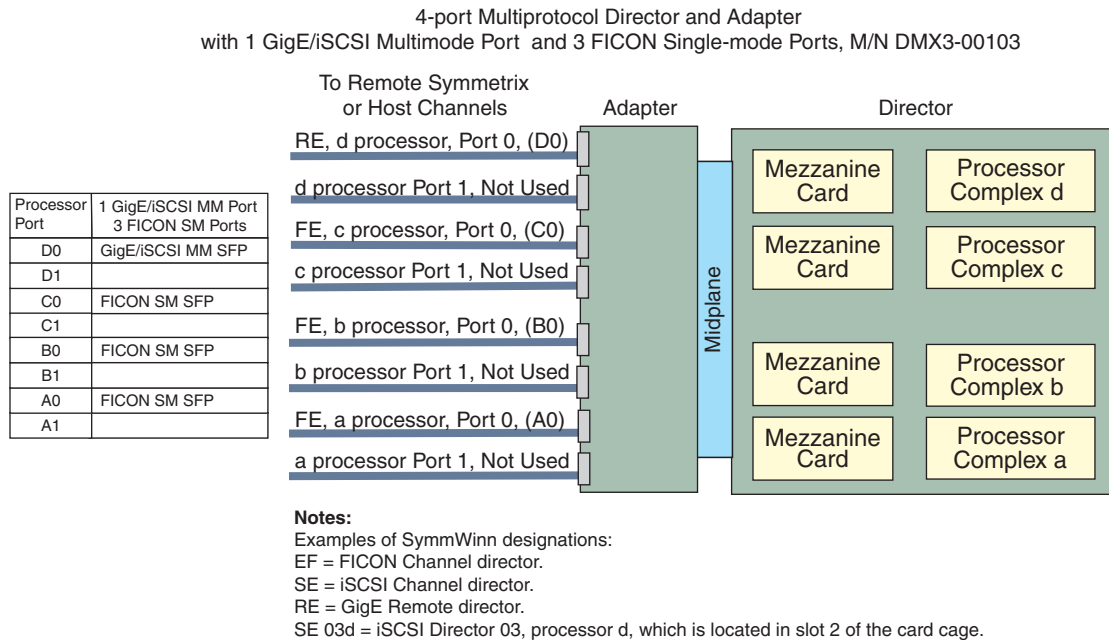


Figure 75 Multiprotocol director with FICON, GigE and iSCSI port designations

**Available EMC
GigE/iSCSI cables**

Table 59 on page 292 lists the Symmetrix GigE/iSCSI Channel cables currently available from EMC. To obtain these cables, contact your local EMC Sales Representative.

Table 59 GigE/iSCSI channel cables

Model	Description	Where Used
FC5M-62MSLC	SC/LC-5 meter	For Symmetrix DMX-3 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-3 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	

Mainframe systems installations

Note: For open systems installation requirements, refer to [“Open systems installations” on page 283](#).

Note: This section contains hardware and host checklists to be used when connecting a Symmetrix DMX-3 to mainframe systems hosts. For the most current information on the Symmetrix system and specific host integration, contact your local EMC Sales Representative, or refer to the EMC Powerlink website.

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 60 on page 293](#)).

Table 60 Symmetrix checklist for mainframe hosts

Symmetrix DMX-3 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 ESCON directors ^a	
Number of FICON directors ^a	
Host channel director models used	
Number of channels used per director ^b	
Remote director (SRDF) type (RA-2, RA-4) and quantity	

- a. If host mirroring is performed, configure an even number of channel directors.
- b. From a performance perspective, it is better to spread channels across as many channel directors as possible.

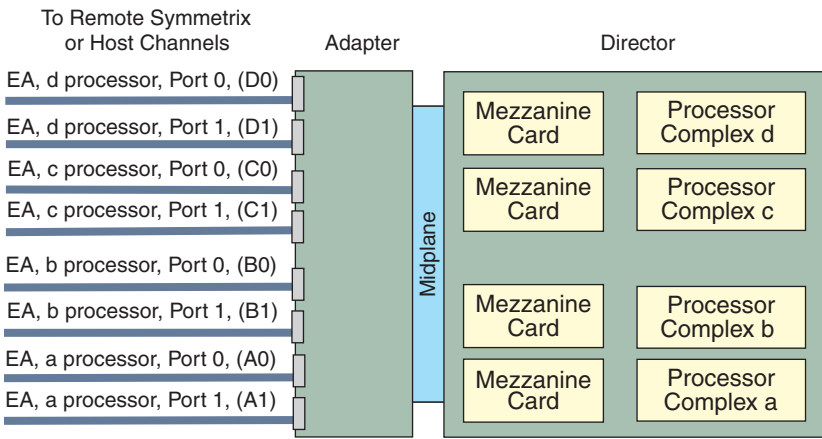
ESCON port designations

When connecting Symmetrix ESCON channels to host channels, it is important to know Symmetrix ESCON hardware components and their channel designations.

Note: Contact your local EMC Sales Representative for information on current ESCON availability.

Each Symmetrix ESCON channel director occupies one slot on the Symmetrix DMX-3 midplane. Each director interfaces to the host channels through an ESCON channel adapter connected to the opposite side of the midplane. [Figure 76 on page 294](#) shows the interface and channel designations of the eight-port 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.

8-Port, 4-Processor ESCON Director and Adapter all Multimode Ports, Model Number DXMX3-ESCD8



Notes:
 Examples of SymmWinn designations:
 EA = ESCON Channel director.
 EA 03d = ESCON Director 03, processor d, which is located in slot 2 of the card cage.

Figure 76 **ESCON port designations**

Available EMC ESCON cables

Table 61 on page 295 lists the Symmetrix DMX-3 ESCON cables currently available from EMC. To obtain these cables, contact your local EMC Sales Representative.

Table 61 **ESCON channel cables**

Model	Description	Where Used
FC3M-62MSLC	SC/LC-3 meter w/SC coupler	For Symmetrix DMX-3 ESCON connections to existing 62.5 micron multimode cabling using SC connectors.
FC5M-62MSLC	SC/LC-5 meter	
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-3 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-3 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, Symmetrix DMX-2, and Symmetrix DMX-3 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-3 systems by way of 62.5 micron cabling to IBM directors using new MTRJ connectors.

FICON port designations

Figure 77 on page 296 shows the interface and channel designations of the four-port FICON director that serves as the interface between the Symmetrix system and the mainframe host.

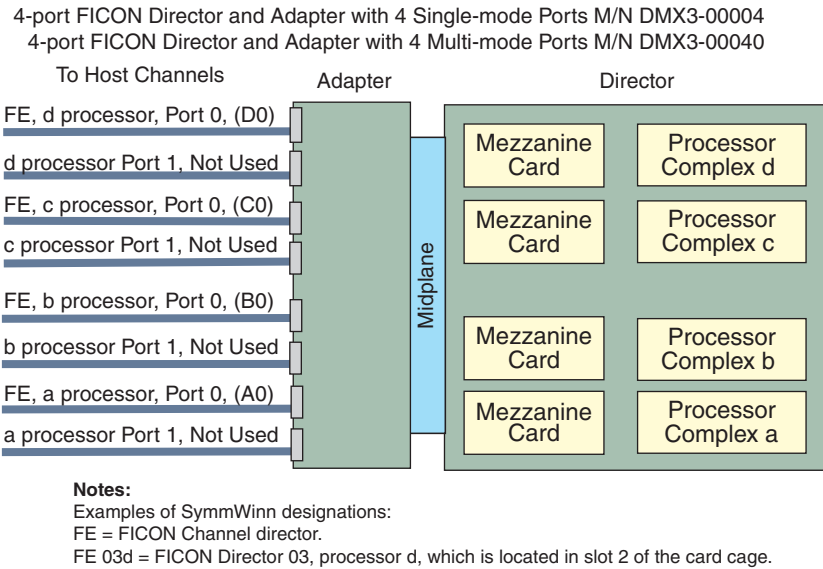
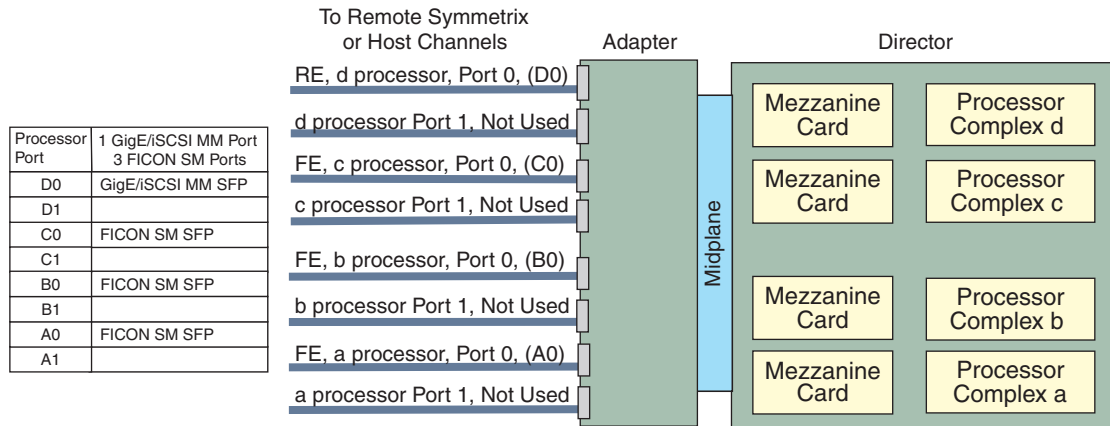


Figure 77 FICON port designations

Figure 78 on page 297 shows the Multiprotocol director configured with FICON GigE Remote/ iSCSI connections.

4-port Multiprotocol Director and Adapter
with 1 GigE/iSCSI Multimode Port and 3 FICON Single-mode Ports, M/N DMX3-00103



Notes:

Examples of SymmWinn designations:

EF = FICON Channel director.

SE = iSCSI Channel director.

RE = GigE Remote director.

SE 03d = iSCSI Director 03, processor d, which is located in slot 2 of the card cage.

Figure 78

Multiprotocol director with FICON, GigE Remote/iSCSI port designations

Available EMC FICON cables

Table 62 on page 298 lists the Symmetrix DMX-3 FICON cables currently available from EMC. To obtain these cables, contact your local EMC Sales Representative.

Table 62 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

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 primary track.
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 (disk adapter), and various host channels (Fibre Channel, iSCSI, GigE, FICON, and ESCON adapters).
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 directors, disk directors, global memory directors, channel adapters, and the XCM.
------------------	---

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 volume.
device address	The hexadecimal value that uniquely defines a physical I/O device on a channel path in an MVS environment. See also unit address.
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 channel director or disk director .
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, RAID 5, 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 * 1024 * 1024 bytes.
 The GB₁₀ value is based on the convention:
 1 GB = 1000 * 1000 * 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 RAID 5 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 device support facilities program (ICKDSF) .
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	An indicator for 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 MB₂ value is based on the convention:
 1 MB = 1024 * 1024 bytes.
 The MB₁₀ value is based on the convention:
 1 MB = 1000 * 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-3 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.

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 5

RAID 5 data protection implements data striping and rotating parity across all hypervolumes of a RAID 5 device. RAID 5 (3+1) configurations consists of four Symmetrix devices with parity and data striped across each device. RAID 5 (7+1) configurations consists of eight Symmetrix devices with data and parity striped across each device.

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 <i>target ID</i> and <i>LUN</i> , or <i>Initiator ID</i> and <i>LUN</i> , 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.
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 promotion, destage.

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 channel director.
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 nonblocking 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 = 1024 * 1024 * 1024 * 1024 bytes. The TB₁₀ value is based on the convention: 1 TB = 1000 * 1000 * 1000 * 1000 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 subdirectory.

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

vault device A vault device is a volume on a designated physical disk drive for DMX-3 systems that reserve a dedicated 5 GB space for vaulting data including metadata.

volume A general term referring to a storage device. In the Symmetrix subsystem, a volume corresponds to a single disk device.

W

write hit There is room in global memory for the data presented by the write operation.

write miss There is no room in global memory for the data presented by the write operation.

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