3 Gb SAS HBA v2

Installation and User's Guide

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Note: Before using this information and the product it supports, read the warranty in Appendix C, “IBM Statement of Limited Warranty Z125-4753-10 08/2008,” on page 53 and the general information in Appendix D, “Notices,” on page 71.

First Edition (March 2009)

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Safety

Before installing this product, read the Safety Information.

قبل تركيب هذا المنتج، يجب قراءة الملاحظات الآمنية

Antes de instalar este produto, leia as Informações de Segurança.

在安装本产品之前，请仔细阅读 Safety Information (安全信息)。

安裝本產品之前，請先閱讀「安全資訊」。

Prije instalacije ovog produkta obavezno pročitajte Sigurnosne Upute.

Před instalací tohoto produktu si přečtěte příručku bezpečnostních instrukcí.

Læs sikkerhedsforskrifterne, før du installerer dette produkt.

Lees voordat u dit product installeert eerst de veiligheidsvoorschriften.

Ennen kuin asennat tämän tuotteen, lue turvaohjeet kohdasta Safety Information.

Avant d'installer ce produit, lisez les consignes de sécurité.

Vor der Installation dieses Produkts die Sicherheitshinweise lesen.

Πριν εγκαταστήσετε το προϊόν αυτό, διαβάστε τις πληροφορίες ασφάλειας (safety information).

לפני שתתקינו מוצר זה, קראו את הוראות הבטיחות.

A termék telepítése előtt olvassa el a Biztonsági előírásokat!

Prima di installare questo prodotto, leggere le Informazioni sulla Sicurezza.

製品の設置の前に、安全情報をお読みください。

본 제품을 설치하기 전에 안전 정보를 읽으십시오.

Пред да се инсталира овој продукт, прочитајте информацијата за безбедност.

Les sikkerhetsinformasjonen (Safety Information) før du installerer dette produktet.

Przed zainstalowaniem tego produktu, należy zapoznać się z książką "Informacje dotyczące bezpieczeństwa" (Safety Information).

Antes de instalar este produto, leia as Informações sobre Segurança.

Перед установкой продукта прочтите инструкции по технике безопасности.

Pred inštaláciou tohto zariadenia si pečítaje Bezpečnostné predpisy.

Pred namestitvijo tega proizvoda preberite Varnostne informacije.

Antes de instalar este producto, lea la información de seguridad.

Läs säkerhetsinformationen innan du installerar den här produkten.

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Be sure to read all caution and danger statements in this document before you perform the procedures. Read any additional safety information that comes with the server or optional device before you install the device.

Important:

Each caution and danger statement in this document is labeled with a number. This number is used to cross reference an English-language caution or danger statement with translated versions of the caution or danger statement in the *Safety Information* document.

For example, if a caution statement is labeled “Statement 1,” translations for that caution statement are in the Safety Information document under “Statement 1.”

Be sure to read all caution and danger statements in this document before you perform the procedures. Read any additional safety information that comes with the server or optional device before you install the device.

Statement 1:

DANGER

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

To avoid a shock hazard:

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

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

Contents

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Chapter 1. Introduction

The IBM® 3 Gb SAS HBA v2 provides eight serial ports for connection to Serial Attached SCSI (SAS) or Serial ATA (SATA) devices. Each port is capable of 3.0 Gbps (gigabits per second) SAS link rates and 3.0 Gbps SATA link rates. The PCI Express transmission and reception data rate is 2.5 Gbps in each direction, yielding a total bandwidth of 5.0 Gbps for each full-duplex lane. The 3 Gb SAS HBA v2, referred to throughout this document as SAS HBA, is implemented using eight PCI Express physical layers, which provide possible host-side maximum transmission and reception rates of up to 4.0 GBps (gigabytes per second).

The SAS host bus adapter (HBA) comes with a limited warranty. For more information, see Appendix C, “IBM Statement of Limited Warranty Z125-4753-10 08/2008,” on page 53.

If firmware and documentation updates are available, you can download them from the IBM Web site. The SAS HBA might have features that are not described in the documentation that comes with the SAS HBA, and the documentation might be updated occasionally to include information about those features, or technical updates might be available to provide additional information that is not included in the server documentation. To check for updates, complete the following steps.

Note: Changes are made periodically to the IBM Web site. Procedures for locating firmware and documentation might vary slightly from what is described in this document.

1. Go to http://www.ibm.com/systems/support/.
2. Under **Product support**, click **System x**.
3. Under **Popular links**, click **Software and device drivers**.
4. Under **Related downloads**, click **ServeRAID** for the ServeRAID software matrix.

Overview

The SAS HBA PCI Express interface is compliant with the PCI Express Specification, revision 1.0a. The SAS HBA implements the PCI Express interface physically as an x8 interface, which also functions in a x8 host slot wired as an x4. The SAS HBA SAS interface is compatible with the ANSI Serial Attached SCSI Specification, revision 1.0, and the Serial ATA Specification, revision 1.0a.

The functionality of the SAS HBA comes from the LSI1068E controller chip. The LSI1068E chip integrates eight high-performance SAS or SATA physical layers. The design of the SAS HBA makes it easy to add SAS interfaces to a computer, workstation, or server with a PCI Express bus.

The SAS HBA provides a 2 Mb x 8-bit flash ROM for storing the BIOS code and firmware. The SAS HBA also provides a 32 Kb x 8-bit NVSRAM for storing the nonvolatile RAID information when a system failure occurs, and a 128 Kb x 36-bit pipelined burst static random access memory (PBSRAM) device for storing SAS address port information, which enables connection to more than 128 devices.

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Features

The SAS HBA has the following features:

- Supports narrow port and wide port as described in Table 1.

Table 1. SAS bandwidth

Half duplex	Full duplex
Narrow port (1 lane) - 300 MBps	Narrow port (1 lane) - 600 MBps
Wide port (2 lanes) - 600 MBps	Wide port (2 lanes) - 1200 MBps
Wide port (4 lanes) - 1200 MBps	Wide port (4 lanes) - 2400 MBps

- Supports Serial SCSI Protocol (SSP), Serial Tunneling Protocol (STP), and Serial Management Protocol (SMP) as defined in the Serial Attached SCSI (SAS) Specification, version 1.0.
- Supports SATA as defined in the Serial ATA Specification, version 1.0a.
- Provides configurable drive spin-up sequencing on a per-physical layer basis.
- Simplifies cabling with a serial point-to-point architecture.
- Provides smaller and thinner cables that do not restrict airflow.
- Provides a serial point-to-point, enterprise-level storage interface.
- Transfers data by using SCSI information units.
- Provides two LEDs on the PCI expansion-slot bracket for the SAS HBA. One LED indicates activity on any physical layer. The other LED indicates a heartbeat or a fault condition.
- Provides compatibility with SATA target devices.
- Supports internal connection to hard disk drives for IBM System x3104 and System x3455 servers.
- Supports systems with Unified Extensible Firmware Interface (UEFI) 2.0 and 2.1

PCI performance

The SAS HBA board supports PCI Express interfaces. The SAS HBA has the following PCI Express features:

- Four or eight PCI Express physical layers
- Single-physical layer (1 lane) link transfer rate up to 2.5 Gbps in each direction
- x8 and x4 link width support
- Automatic downshift to a x4 link width if the SAS HBA is connected to a x4 connector or to a x8 connector that is wired as a x4 connector
- Scalable interface
  - Single-lane aggregate bandwidth of up to 0.5 GBps (500 MBps)
  - Quad-lane aggregate bandwidth of up to 2.0 GBps (2000 MBps)
  - 8-lane aggregate bandwidth of up to 4.0 GBps (4000 MBps)
- Serial point-to-point interconnections between devices
  - Reduces the electrical load of the connection
  - Enables higher transmission and reception frequencies
- Lane reversal and polarity inversion
- PCI Express hot plug

- Power management support
  - PCI Power Management 1.2
  - Active State Power Management (ASPM), including the L0, L0s, and L1 states, that places links in a power-saving mode during times of no link activity
- Replay buffer that preserves a copy of the data for retransmission in case a CRC error occurs
- PCI Express Advanced Error Reporting capabilities
- Packetized and layered architecture
- High bandwidth per pin with low overhead and low latency
- PCI Express
  - Is compatible with PCI and PCI-X software
  - Leverages existing PCI device drivers
  - Supports the memory, I/O, and configuration address spaces
  - Supports memory read/write transactions, I/O read/write transactions, and configuration read/write transactions
- 4 KB of PCI configuration address space per device
- Posted and non-posted transactions
- Quality of service (QOS) link configuration and arbitration policies
- Traffic Class 0 and one virtual channel
- Message Signaled Interrupts (both MSI and MSI-X) and INTx interrupt signaling for legacy PCI support
- End-to-end cyclic redundancy check (ECRC) and Advanced Error Reporting

Software

The SAS HBA supports the following operating systems:

- Microsoft® Windows® XP, Windows 2000, Windows Server 2003 32-bit and 64-bit (x86 and AMD), and Windows Server 2008
- Red Hat® Enterprise Linux® 4 and Red Hat Enterprise Linux 5
- SUSE Linux Enterprise Server 9 and SUSE Linux Enterprise Server 10
- Novell NetWare 6.5
- VMware ESX Server 3.5

Specifications

The following sections describe the SAS HBA specifications.

Physical dimensions

The SAS HBA board is 167.6 mm (6.6 in.) x 63.5 mm (2.5 in.). The PCI Express x8 connection is made through the edge connector J1. The component height on the top and bottom of the SAS HBA board follows the PCI Express specifications.

Electrical specifications

The SAS HBA is powered from the PCI Express +12 V power rail. The integrated +1.2 V and +3.3 V voltages are regulated from the PCI Express +12 V rail through switching regulators. The LSI1068E uses +3.3 V and +1.2 V; all other components use +3.3 V. The maximum power requirement for the SAS HBA under normal operation is listed in the following table.

Table 2. Power requirements [1]

Voltage	Current	Power
12.96 V (+8%)	0.40 amps	5.2 watts
12.0 V (nominal)	0.425 amps	5.1 watts
11.04 V (-8%)	0.45 amps	5.0 watts
[1] Power requirements are based on the assumption that no more than half of the LEDs are lit at any point in time.		

Thermal and atmospheric specifications

The SAS HBA has the following atmospheric characteristics:

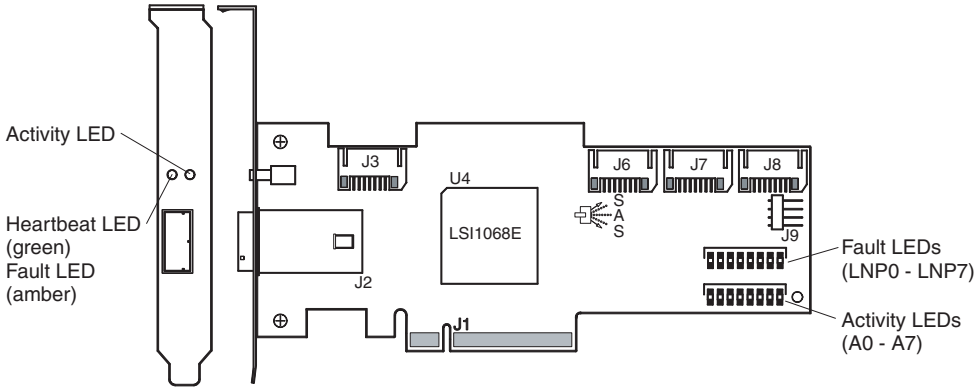
- Temperature range: 0°C to 60°C (dry bulb)
- Relative humidity range: 5% to 90% noncondensing
- Maximum dewpoint: 32°C

The following parameters define the storage and transit environment for the SAS HBA:

- Temperature range: -45°C to +105°C (dry bulb)
- Relative humidity range: 5% to 90% noncondensing

LEDs

The following illustration shows the SAS HBA LEDs.



Heartbeat LED (green) / Fault LED (amber)

This LED is on the PCI bracket. It flashes green to indicate the SAS HBA heartbeat. It turns amber when the SAS HBA firmware detects a fault condition.

Activity LED

This green LED is lit when there is activity on any physical layer.

Fault LEDs (LNP0 - LNP7)

The eight amber fault LEDs correspond to the eight physical layers. When a fault condition occurs on a physical layer, the corresponding LED is lit.

Activity LEDs (A0 - A7)

The eight green activity LEDs correspond to the eight physical layers. When there is activity on a physical layer, the corresponding LED is lit.

Chapter 2. Installing the SAS HBA

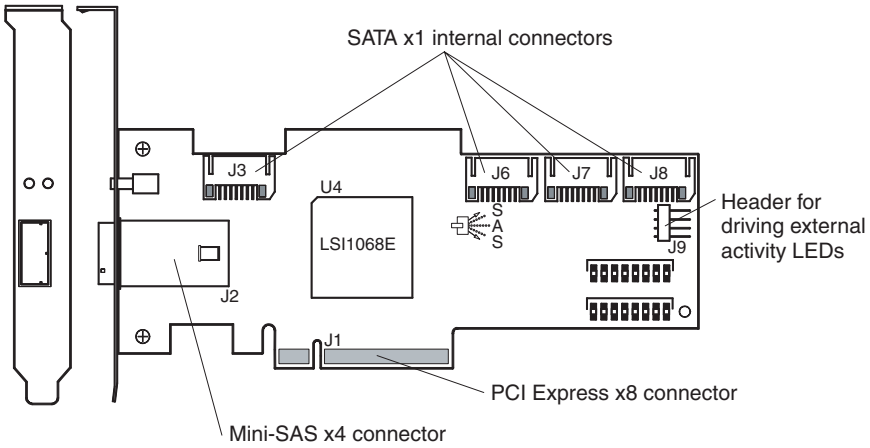
This chapter describes how to install the SAS HBA and provides other information that you must consider when you install the SAS HBA.

Notes:

1. The illustrations in this document might differ slightly from your hardware.
2. A PCI Express connector is smaller than a PCI/PCI-X connector.

Connectors

The SAS HBA connectors are shown in the following illustration.



SATA x1 internal connectors (J3, J6, J7, and J8)
The SATA connectors are SATA x1 internal right-angle latching connectors.

Header for driving external activity LEDs (J9)
The J9 connector is a 4-pin, right-angle header, for driving external activity LEDs. Pins 2 and 3 provide the cathode connection for the two external LEDs. Pins 1 and 4 provide 220 ohm pull-ups to +3.3 V.

PCI Express x8 connector (J1)
The PCI Express interface has eight PCI Express physical layers that provide possible host-side maximum transmission and reception rates of up to 4.0 GBps. The SAS HBA supports x8 PCI Express link widths and automatically downshifts if it is connected to either an x4 connector or an x8 connector that is wired as an x4 connector. The connection is made through the edge connector J1. The signal definitions and pin numbers conform to the PCI Express specifications.

Mini-SAS x4 connector (J2)
The SAS HBA supports a SAS connection through connector J2. The J2 connector is an SFF-8088 mini-SAS external right-angle connector.

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Handling the SAS HBA

Attention: Static electricity can damage the server and other electronic devices. To avoid damage, keep the SAS HBA in its static-protective package until you are ready to install it or change the bracket.

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

- Limit your movement. Movement can cause static electricity to build up around you.
- The use of a grounding system is recommended but is not required. For example, wear an electrostatic-discharge wrist strap, if one is available.
- Handle the SAS HBA carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed circuitry.
- Do not leave the SAS HBA where others can handle and damage it.
- While the SAS HBA is still in its static-protective package, touch it to an unpainted metal part of the server for at least 2 seconds. This drains static electricity from the package and from your body.
- If you do not have to change the bracket, remove the SAS HBA from its package and install it directly into the server without setting down the SAS HBA. If it is necessary to set down the SAS HBA, put it back into its static-protective package. Do not place the SAS HBA on the server cover or on a metal surface.
- If you have to change the bracket, remove the SAS HBA from its package and place the SAS HBA on a flat, static-protective surface. Do not place the SAS HBA on the server cover or on a metal surface.
- Take additional care when you handle the SAS HBA during cold weather. Heating reduces indoor humidity and increases static electricity.

Installing the SAS HBA in the server

Statement 1:

DANGER

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

To avoid a shock hazard:

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

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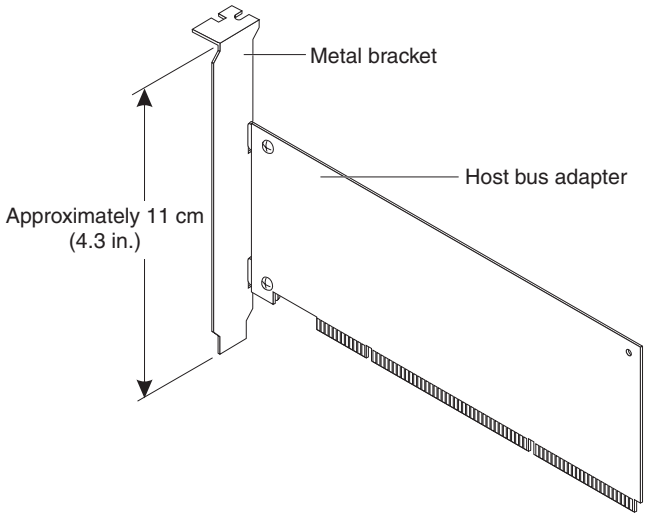
3. Attach signal cables to connectors.	3. Remove signal cables from connectors.
4. Attach power cords to outlet.	4. Remove all cables from devices.
5. Turn device ON.	

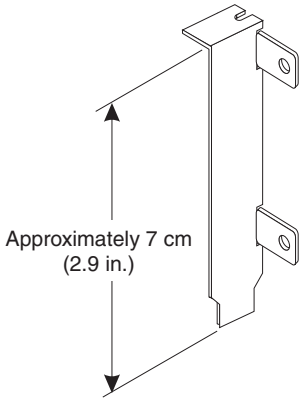
Before you install the SAS HBA, make sure that the preinstalled expansion slot bracket is the correct size for the server in which you are installing the SAS HBA.

Note: The expansion-slot opening is measured along the longest dimension and might be oriented horizontally in some servers.

The SAS HBA comes with a preinstalled expansion-slot bracket that is approximately 11 cm (4.3 in.) long. If the opening for the PCIe expansion slot is approximately 10 cm (4.0 in.) long, you will use the preinstalled bracket.



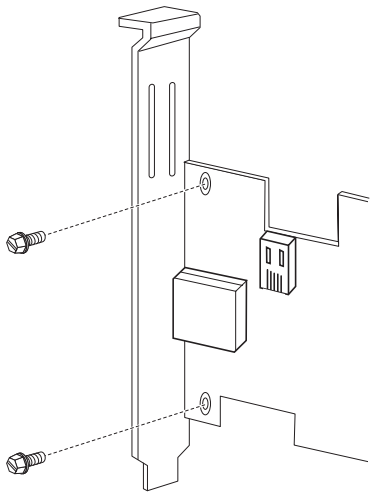
The option package also contains a low-profile expansion-slot bracket that is approximately 7 cm (2.9 in.) long. If the opening for the PCIe expansion slot is approximately 6 cm (2.3 in.) long, you must replace the preinstalled bracket with the low-profile bracket. You will do this in step 5 on page 11 in the following procedure.



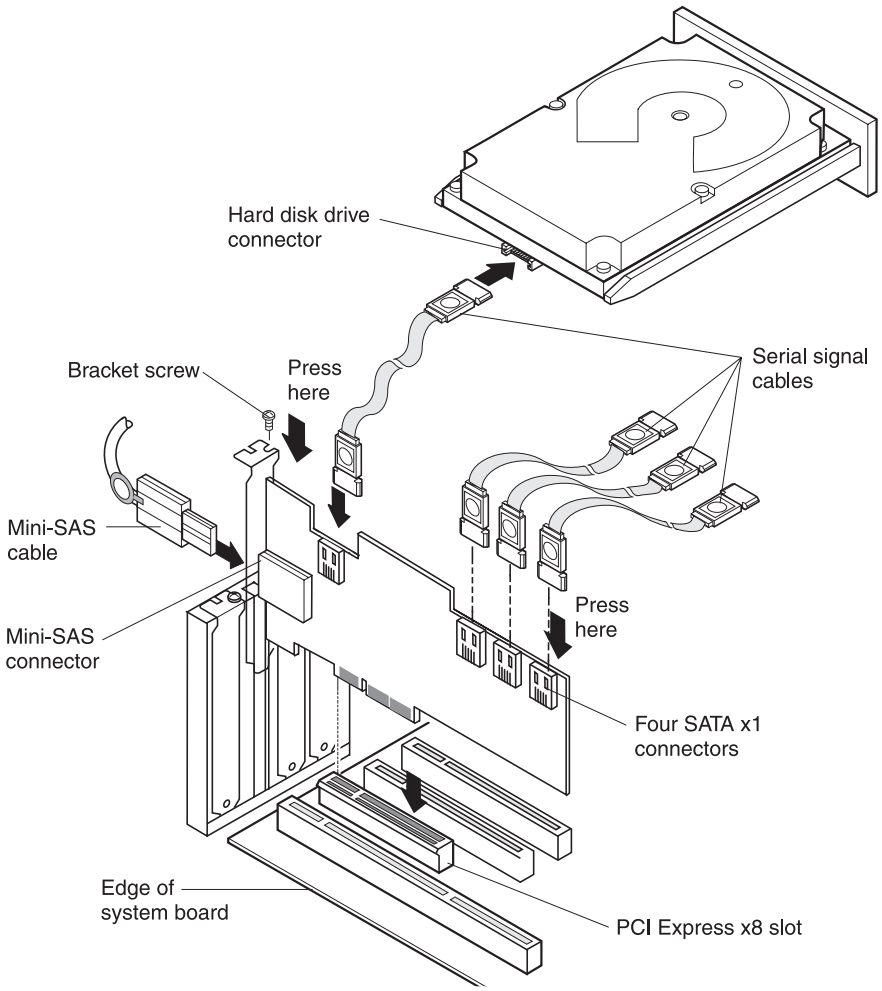
To install the SAS HBA in the server, complete the following steps.

1. Read the safety information that begins on page iii, and “Handling the SAS HBA” on page 8.
2. Turn off the server and peripheral devices and disconnect the power cords.
3. Remove the server cover. For more information, see the *Installation Guide* that comes with the server.

4. Touch the static-protective package that contains the SAS HBA to any unpainted surface on the outside of the server; then, grasp the SAS HBA by the top edge or upper corners and remove it from the package and inspect it for damage. Contact your IBM marketing representative or authorized reseller if the SAS HBA appears to be damaged.
5. If you have to remove the preinstalled expansion-slot bracket and replace it with the low-profile bracket, complete the following steps; otherwise, go to step 6.
   a. Orient the SAS HBA as shown in the following illustration.



   b. Remove the two screws that hold the bracket onto the SAS HBA.
   c. Lift the bracket from the SAS HBA and store the bracket in a safe place for possible reuse.
   d. Align the low-profile bracket so that the tabs are on the back side of the SAS HBA and the holes on the tabs align with the holes on the SAS HBA.
   e. From the front side of the SAS HBA, attach the bracket to the SAS HBA using the two screws that you removed in step 5b.
6. Determine which PCI Express slot that you will use. Depending on the server model, you might have to remove the expansion-slot cover for the selected PCI Express slot. To remove the expansion-slot cover, you might have to remove the expansion slot screw. Place the removed parts in a safe place. For detailed instructions for installing the SAS HBA in your server, see the *User's Guide* that comes with the server.



7. Position the SAS HBA by aligning the PCI Express x8 connector with the PCI Express x8 slot on the system board. Insert the SAS HBA firmly into the connector.

   Note: Depending on the server model, you might have to install the SAS HBA in a riser card and then install the riser card with the SAS HBA in the PCIe slot on the system board.
8. Secure the SAS HBA to the server chassis. Replace the expansion-slot cover and the expansion-slot screw if you removed them in step 6 on page 11, or return the bracket lever to the closed position.
9. Connect the serial cables between the SATA x1 internal connectors on the SAS HBA and the serial hard disk drives.
10. Replace the server cover.
11. Reconnect the power cords and then, turn on the server. Make sure that the green activity LED on the front bracket of the SAS HBA is lit.

Integrated RAID

The SAS HBA integrated RAID has the following two components:

- Integrated Mirroring (IM), which provides features of RAID 1 and RAID 1E (RAID 1 Enhanced). RAID 1E is also called Integrated Mirroring Enhanced (IME)
- Integrated Striping (IS), which provides features of RAID 0

The SAS HBA integrated RAID has the following features:

- The low cost RAID volume creation meets the needs of most internal RAID installations
- The installation and configuration are not complex
- The server can start from an IM, IME, or IS volume
- No special operating-specific software is required
- High reliability and data integrity
  - Non-volatile write journaling
  - Physical disks not visible to the operating system or to application software
- Low host CPU and PCI bus utilization
- Fusion-MPT architecture provides processing power
  - Shared memory architecture minimizes external memory requests
  - Functionality is contained in device hardware and firmware

The remaining chapters in this book provide detailed information about integrated mirroring, integrated striping, and the CFGGEN integrated RAID configuration utility.

Chapter 3. Integrated mirroring overview

This chapter provides an overview of the integrated mirroring (IM) feature.

Introduction

The LSI Logic Integrated Mirroring (IM) feature, which includes Integrated Mirroring Enhanced (IME), provides data protection for the system boot volume to safeguard critical information, such as the operating system on servers and high performance workstations.

The integrated mirroring feature supports simultaneous mirrored volumes with two disks (integrated mirroring) or three to four disks (integrated mirroring enhanced), to provide fault-tolerant protection for critical data. (If a hot spare disk is used, the maximum volume size is three mirrored disks, plus the hot spare disk.)

If a disk in an integrated mirroring volume has failed, the hot swap capability enables the volume to be restored by swapping disks. The firmware then automatically remirrors the swapped disk. Additionally, each controller can have one global hot spare disk available to automatically replace a failed disk in the integrated mirroring or integrated mirroring enhanced volume configured on the controller. The hot spare makes the integrated mirroring volume even more fault-tolerant.

The integrated mirroring feature uses the same device drivers as the standard LSI Logic Fusion-MPT based controllers, providing seamless and transparent fault tolerance. To conserve system resources, the integrated mirroring feature operates independently from the operating system. The BIOS-based configuration utility makes it easy to configure integrated mirroring and integrated mirroring enhanced volumes.

Integrated mirroring features

Integrated mirroring and integrated mirroring enhanced support the following features:

- One integrated mirroring or integrated mirroring enhanced volume. The volume can consist of two mirrored disks (integrated mirroring) or four mirrored disks (integrated mirroring enhanced).
- (Optional) One global hot spare disk. If a global hot spare disk is defined, the upper limit for an integrated mirroring enhanced volume is three mirrored disks.
- Mirrored volumes run in optimal mode or in degraded mode (if one mirrored disk has failed)
- Hot swap capability
- Presents a single virtual drive to the operating system for each integrated mirroring or integrated mirroring enhanced volume
- Supports both SAS and SATA disks
- Fusion-MPT architecture
- BIOS-based configuration utility and a command-line utility
- Error notification: Operating-specific event log updated by device drivers and errors displayed inside the Fusion-MPT BIOS
- SES status LED support for integrated mirroring disks

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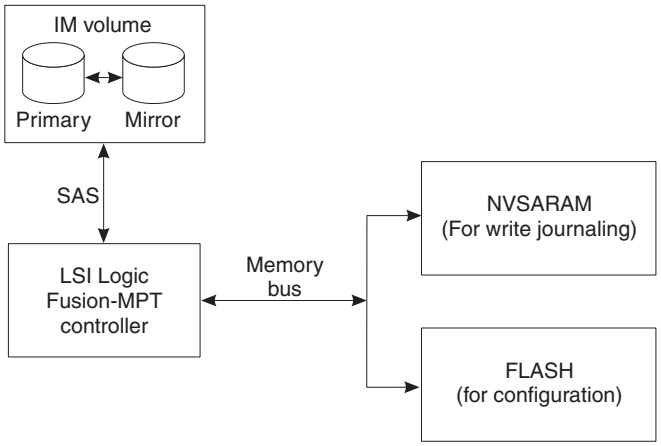
- Write journaling, which allows automatic synchronization of potentially inconsistent data after unexpected power-down situations
- Metadata used to store volume configuration on mirrored disks
- Automatic background resynchronization while host I/O continues
- Background media verification ensures that data on the integrated mirroring volume is accessible

Integrated mirroring and integrated mirroring enhanced descriptions

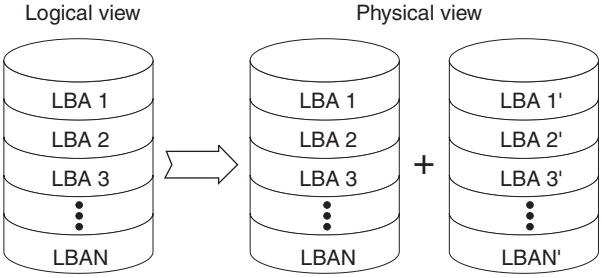
The integrated mirroring feature supports one mirrored volume on each controller, usually, the boot volume. This is accomplished through the firmware on the controller that supports the standard Fusion-MPT interface. The runtime mirroring of the boot disk is transparent to the BIOS, device drivers, and operating system. Host-based status software monitors the state of the mirrored disks and reports any error conditions.

The following illustration shows a typical integrated mirroring implementation. The system is configured with a second disk as a mirror of the first (primary) disk.



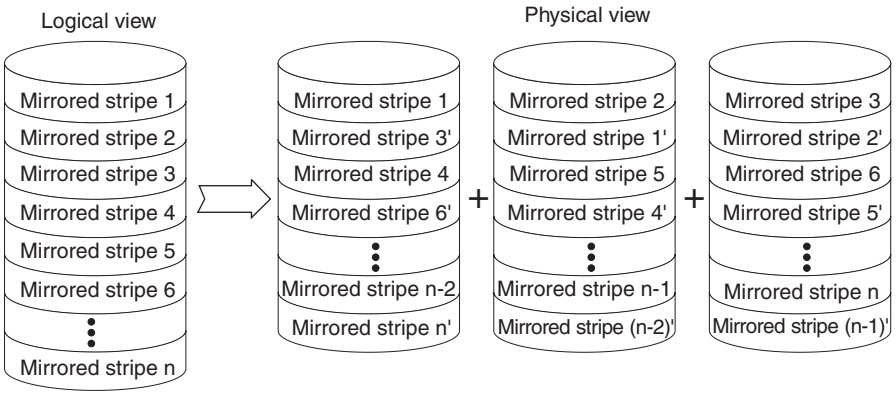
The advantage of integrated mirroring (RAID 1) is that there is always a mirrored copy of the data. The disadvantage is that write operations take longer because data must be written twice. However, performance is actually improved during read operations.

The following illustration shows the logical view and physical view of an integrated mirroring configuration with two disks in the mirrored volume.



An integrated mirroring enhanced volume can be configured with up to four mirrored disks, or three mirrored disks and a global hot spare.

The following illustration shows the logical view and physical view of an integrated mirroring enhanced volume with three mirrored disks. Each mirrored stripe is written to a disk and mirrored to an adjacent disk. This type of configuration is also called RAID 1E. For more information, see Chapter 4, “Creating integrated mirroring volumes,” on page 19.



The controller has a BIOS-based configuration utility. This utility enables you to create integrated mirroring and integrated mirroring enhanced volumes during initial setup and to reconfigure them in response to hardware failures or changes in the environment.

Integrated mirroring firmware

This section describes the features of the integrated mirroring firmware.

Host interface

The integrated mirroring host interface uses the Message Passing Interface, as described in the Fusion-MPT Message Passing Interface Specification. The host operating system has access to the integrated mirroring volume and the physical disks through the Fusion-MPT interface.

Resynchronization with concurrent host I/O operation

The integrated mirroring firmware enables host I/O to continue on the integrated mirroring or integrated mirroring enhanced volume while the volume is being resynchronized in the background. Resynchronization is attempted after a hot spare is activated due to a physical device failure, or after a hot swap has occurred to a physical disk in the integrated mirroring or integrated mirroring enhanced volume.

Metadata support

The integrated mirroring firmware supports metadata, which describes the integrated mirroring or integrated mirroring enhanced logical drive configuration stored on each member disk. When the firmware is initialized, each member disk is queried to read the stored metadata to verify the configuration. The usable disk space for each member disk is adjusted down to leave room for this data.

Hot swapping

The integrated mirroring firmware supports hot swapping. The hot-swapped disk is automatically resynchronized in the background, without any host or user intervention. The firmware detects hot swap removal and disk insertion.

After a hot swap event, the firmware readies the new physical disk by spinning it up and verifying that it has enough capacity for the mirrored volume. The integrated mirroring firmware resynchronizes all hot-swapped disks that are removed, even if the same disk is reinserted. In a two-disk mirrored volume, the integrated mirroring firmware marks the hot-swapped disk as the secondary disk and marks the other mirrored disk as the primary disk. The firmware resynchronizes all data from the primary disk onto the new secondary disk.

SMART support

The integrated mirroring firmware enables Mode 6 SMART on the member disks in the mirrored volume. Mode 6 SMART requires each physical disk to be polled at regular intervals. If a SMART ASC/ASCQ code is detected on a physical disk in the volume, the firmware processes the SMART data, and the last received SMART ASC/ASCQ is stored in nonvolatile memory. The integrated mirroring or integrated mirroring enhanced volume does not support SMART directly, because it is just a logical representation of the physical disks in the volume.

Hot spare disk

One disk can be configured as a global hot spare disk, which protects data on the volume configured on the controller. If the integrated mirroring firmware has failed one of the mirrored disks, the firmware automatically replaces it with the hot spare disk. The integrated mirroring firmware then resynchronizes the mirrored data. The integrated mirroring firmware is automatically notified when the failed disk is replaced, and the firmware then designates that disk as the new hot spare.

Media verification

The integrated mirroring firmware supports a background media verification feature that runs at regular intervals when the integrated mirroring or integrated mirroring enhanced volume is in optimal mode. If the verification command has failed for any reason, the data on the other disk for this segment is read and written to the failing disk in an attempt to refresh the data. The current media verification logical block address is written to nonvolatile memory occasionally to enable media verification to continue approximately where it left off before a power cycle.

Disk write caching

The integrated mirroring firmware disables disk write caching by default. This is done to increase data integrity, so that the disk write log stored in NVSRAM is always valid. If disk write caching is enabled (not preferred), the disk write log might not be valid.

NVSRAM usage

The integrated mirroring firmware uses NVSRAM to perform write journaling. Write journaling is used to verify that the mirrored disks in the integrated mirroring or integrated mirroring enhanced volume are synchronized with each other.

Fusion-MPT support

To enable integrated mirroring, the BIOS uses the LSI Logic Fusion-MPT interface to communicate with the controller and firmware. This includes reading the Fusion-MPT configuration to gain access to the parameters that are used to define behavior between the controller and the devices to which it is connected. The Fusion-MPT device drivers for all supported operating systems implement the Fusion-MPT interface to communicate with the controller and firmware.

Chapter 4. Creating integrated mirroring volumes

This chapter describes how to create integrated mirroring (IM) and integrated mirroring enhanced (IME) volumes using the LSI Logic Configuration Utility, which is a SAS BIOS configuration utility.

Integrated mirroring configuration overview

You can use the SAS BIOS configuration utility to create an integrated mirroring or integrated mirroring enhanced volume on each controller, with an optional global hot spare disk.

You can use disks of different size in integrated mirroring and integrated mirroring enhanced volumes. The smallest disk determines the “logical” size of each disk in the volume. The excess space of the larger member disk is not used.

For more information about integrated mirroring volumes, see “Integrated mirroring features” on page 15.

Creating integrated mirroring and integrated mirroring enhanced volumes

The SAS BIOS configuration utility is part of the Fusion-MPT BIOS. When the BIOS loads during startup and a message is displayed about the configuration utility, press Ctrl-C to start it. The following message is displayed:

```
Please wait, invoking SAS Configuration Utility.
```

After a brief pause, the main menu of the SAS BIOS configuration utility is displayed; however, on some systems, the following message is displayed:

```
LSI Logic Configuration Utility will load following initialization!
```

In this case, the configuration utility will load after the server has completed its power-on self-test (POST).

The following guidelines apply when you create an integrated mirroring or integrated mirroring enhanced volume:

- You can configure one integrated mirroring or integrated mirroring enhanced volume.
- All physical disks in the volume must be either SATA (with extended command set support) or SAS (with SMART support). SAS and SATA disks cannot be combined in the same volume.
- Disks must have 512-byte blocks and must not have removable media.
- An integrated mirroring volume must have two drives, plus an optional global hot spare. An integrated mirroring enhanced volume can have three to four drives, or three drives if you also create a global hot spare.

  Note: If a disk in an integrated mirroring or integrated mirroring enhanced volume has failed, it is rebuilt on the global hot spare if one is available. Adding a global hot spare greatly increases the level of data protection.

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Creating an integrated mirroring volume

To create an integrated mirroring volume with the SAS BIOS configuration utility, complete the following steps:

1. On the Adapter List screen, use the arrow keys to select the controller, and then press Enter. The Adapter Properties screen is displayed.

```
LSI Logic Config Utility    v6.01.03.00
  Adapter Properties -- SAS1068

        Adapter                         SAS1068
        PCI Slot                        03
        PCI Address(Bus/Dev/Func)       03:00:00
        MPT Firmware Revision           00.03.23.00-IT
        SAS Address                     500605B0:0000C580
        Status                          Enabled
        Boot Order                      1
        Boot Support                    [Enabled BIOS & OS]

        RAID Properties

        SAS Topology

        Advanced Adapter Properties

  Esc = Exit Menu       F1/Shift+1 = Help
  Enter = Select Item   -/+ = Change Item
```

2. Select **RAID Properties**, and press Enter.
3. When you are prompted to select a volume type, select **Create IM Volume**.

   The Create New Array screen shows a list of disks that you can add to a volume.
4. Move the cursor to the RAID Disk column and select a disk. To add the disk to the volume, change the No to Yes by pressing the + key, - key, or Spacebar.

   When the first disk is added, the configuration utility prompts you to either keep existing data or overwrite existing data.
5. Press M to keep the existing data on the first disk or press D to overwrite it.

   If you keep the existing data, this is called a migration. The first disk will be mirrored onto the second disk, so the data you want to keep must be on the first disk added to the volume. Any data on the second disk is overwritten.

   As disks are added, the **Array Size** field changes to reflect the size of the new volume.

6. (Optional) Add a global hot spare by moving the cursor to the hot spare column and pressing the + key, - key, or Spacebar. The following illustration shows an integrated mirroring volume configured with a global hot spare disk.

```
LSI Logic Config Utility    v6.01.03.00
  Create New Array -- SAS1068

    Array Type:                         IM
    Array Size(MB)                      34332

  Slot  Device Identifier               RAID   Hot    Drive     Pred  Size
  Num                                   Disk   Spr    Status    Fail  (MB)
    1   MAXTOR ATLAS15K2_36SAS BG34     [Yes]  [No]   Primary   ---   35074
    2   MAXTOR ATLAS15K2_36SAS BG34     [Yes]  [No]   Secondary ---   35074
    8   MAXTOR ATLAS15K2_36SAS BG34     [No]   [Yes]  Hot Spare ---   35074
   11   MAXTOR ATLAS15K2_36SAS BG34     [No]   [No]   Max Dsks  ---   35074




  Esc = Exit Menu       F1/Shift+1 = Help
  Space/+/- = Select disk for array or hot spare    C = Create array
```

7. After the volume is fully configured, press C and then select **Save changes then exit this menu**. The SAS BIOS configuration utility pauses while the array is created.

Creating an integrated mirroring enhanced volume

To create an integrated mirroring enhanced volume with the SAS BIOS configuration utility, complete the following steps:

1. On the Adapter List screen, select the controller, and then press Enter. The Adapter Properties screen is displayed.
2. On the Adapter Properties screen, select **RAID Properties**, and then press Enter.
3. When you are prompted to select a volume type, select **Create IME Volume**. The Create New Array screen is displayed and shows a list of disks that you can add a volume.
4. Move the cursor to the RAID Disk column and select a disk. To add the disk to the volume, change No to Yes by pressing the + key, - key, or Spacebar.

   Repeat this step to select a total of three to four disks for the volume (or three disks if you are creating a global hot spare). All existing data on all the disks you select is overwritten. As you add disks, the **Array Size** field changes to reflect the size of the new volume.
5. (Optional) Add a global hot spare to the volume by moving the cursor to the Hot Spare column and pressing the + key, - key, or Spacebar.
6. When the volume is fully configured, press C and then select **Save changes then exit this menu**. The SAS BIOS configuration utility pauses while the array is created.

Managing hot spares

You can create one global hot spare disk to protect the integrated mirroring or integrated mirroring enhanced volume that is defined on a controller. Usually, you create the global hot spare at the same time you create the integrated mirroring or integrated mirroring enhanced volume.

To add a global hot spare disk for the existing integrated mirroring or integrated mirroring enhanced volumes on the controller, complete the following steps:

1. On the View Array screen, select **Manage Array**, and press Enter. The Manage Array screen is displayed.

```
LSI Logic Config Utility    v6.01.03.00
  Manage Array -- SAS1068

       Identifier                  LSILOGICLogical Volume  3000
       Type                        IM
       Scan Order                  1
       Size(MB)                    34332
       Status                      Optimal

       Manage Hot Spare

       Synchronize Array

       Activate Array

       Delete Array


  Esc = Exit Menu       F1/Shift+1 = Help
  Enter = Choose array type to create     Esc = Return to Adapter Properties
```

2. Select **Manage Hot Spare**, and press Enter.
3. Select a disk from the list by pressing the + key, - key, or Spacebar.
4. After you select the global hot spare disk, press C.

   An error message is displayed if the selected disk is not at least as large as the smallest disk used in the integrated mirroring or integrated mirroring enhanced volume. The global hot spare disk must have 512-byte blocks, it cannot have removable media, and the disk type must be either SATA with extended command set support or SAS with SMART support.

   If SATA disks are used for the integrated mirroring or integrated mirroring enhanced volume, the hot spare disk must also be a SATA disk. If SAS disks are used, the hot spare disk must also be a SAS disk. An error message is displayed if the selected disk is not the same type as the disks used in the integrated mirroring or integrated mirroring enhanced volumes.
5. Select **Save changes then exit this menu**. The configuration utility pauses while the global hot spare is added.

To delete a global hot spare, complete the following steps:

1. On the Manage Array screen, select **Manage Hot Spare**.
2. Select **Delete Hot Spare**, and then press C.
3. Select **Save changes then exit this menu**. The configuration utility pauses while the global hot spare is removed.

Other configuration tasks

This section explains how to perform other tasks related to configuring and maintaining integrated mirroring and integrated mirroring enhanced volumes.

Viewing volume properties

To view the properties of volumes, complete the following steps:

1. In the configuration utility, select a controller from the Adapter List. Select **RAID Properties**. The properties of the current volume are displayed. If a global hot spare is defined, it is also listed.

Note: If you create one volume using SAS disks, another volume using SATA disks, and a global hot spare disk, the hot spare disk is displayed only when you view the volume that has the same type of disks as the hot spare disk.

2. If two volumes are configured, press Alt+N to view the other array.
3. To manage the current array, select **Manage Array**, and then press Enter.

Synchronizing an array

The Synchronize Array command forces the firmware to resynchronize the data on the mirrored disks in the array. It is usually not necessary to use this command, because the firmware automatically keeps the mirrored data synchronized during normal system operation. When you use this command, one disk of the array is placed in the Degraded state until the data on the mirrored disks is resynchronized.

To force the synchronization of a selected array, complete the following steps:

1. On the Manage Array screen, select **Synchronize Array**.
2. Press Y to start the synchronization, or press N to cancel it.

Activating an array

An array can become inactive if, for example, it is removed from one controller or computer and moved to another one. The Activate Array option enables you to reactivate an inactive array that is added to a system. This option is available only when the selected array is currently inactive.

To activate a selected array, complete the following steps:

1. On the Manage Array screen, select **Activate Array**.
2. Press Y to proceed with the activation, or press N to cancel it. After a pause, the array becomes inactive.

   Note: If there is a global hot spare disk on the controller to which you have moved the array, the firmware checks when you activate the array to determine if the hot spare is compatible with the new array. An error message is displayed if the disks in the activated array are larger than the hot spare disk or if the disks in the activated array are not the same type as the hot spare disk (SATA versus SAS).

Deleting an array

Attention: To prevent the loss of data, before you delete an array, you must back up all data on the array that you want to keep.

To delete a selected array, complete the following steps:

1. On the Manage Array screen, select **Delete Array**.
2. Press Y to delete the array.

   After a pause, the firmware deletes the array. If there is another remaining array and a global hot spare disk, the firmware checks the hot spare disk to determine if it is compatible with the remaining array. If the hot spare disk is not compatible (too small or wrong disk type) the firmware deletes it also.

   Note: After a volume is deleted, it cannot be recovered. When a RAID 1 volume is deleted, the data is preserved on the primary disk. The master boot records (MBR) of other disks in the array are deleted. For other RAID types, the master boot records of all disks are deleted.

Locating a disk drive or multiple disk drives in a volume

You can use the SAS BIOS configuration utility to locate and identify a specific physical disk drive by flashing the LED on the drive. You can also use the SAS BIOS configuration utility to flash the LEDs of all the disk drives in a RAID volume. There are several ways to do this:

- When you are creating an integrated mirroring or integrated mirroring enhanced volume, and a disk drive is set to Yes as part of the volume, the LED on the disk drive is flashing. The LED is turned off when you are finished creating the volume.
- You can locate individual disk drives from the SAS Topology screen. To do this, move the cursor to the name of the disk in the Device Identifier column and press Enter. The LED on the disk flashes until the next key is pressed.
- You can locate all the disk drives in a volume by selecting the volume on the RAID Properties screen. The LEDs flash on all disk drives in the volume.

  Note: The LEDs on the disk drives will flash as described in the previous list, if the firmware is configured correctly and the drive or the disk enclosure support disk location.

Selecting a boot disk

You can select a boot disk in the SAS Topology screen. This disk is then moved to scan ID 0 on the next restart and remains at this position. This makes it easier to set BIOS boot device options and to keep the boot device constant when a device is added or removed. There can be only one boot disk.

To select a boot disk, complete the following steps:

1. In the configuration utility, select a controller from the Adapter List, and press Enter.
2. In the Adapter Properties screen, select **SAS Topology** and press Enter.

   The current topology is displayed. If the selection of a boot device is supported, the bottom of the screen lists the Alt+B option. This is the key combination for toggling the boot device. If a device is currently configured as the boot device, the word “Boot” is displayed in the Device Info column on the SAS Topology screen.
3. To select a boot disk, move the cursor to the disk and press Alt+B.
4. To remove the boot designator, move the cursor down to the current boot disk and press Alt+B. This controller no longer has a disk designated as boot.
5. To change the boot disk, move the cursor to the new boot disk and press Alt+B. The boot designator moves to this disk.

   Note: The firmware must be configured correctly for the Alt+B feature to work.

Chapter 5. Integrated striping overview

This chapter provides an overview of the LSI Logic Integrated Striping (IS) feature.

Introduction

The integrated striping feature is useful for applications that require the faster performance and increased storage capacity of striping. A single integrated striping logical drive can be configured as the boot disk or as a data disk.

The integrated striping feature is implemented with controller firmware that supports the Fusion-MPT Interface. IS provides better performance and more capacity than individual disks, without burdening the host processor. The firmware splits host I/O over multiple disks and presents the disks as a single logical drive. In general, striping is transparent to the BIOS, the device drivers, and the operating system.

The SAS BIOS configuration utility is used to configure integrated striping volumes, which can consist of two to four disks.

Integrated striping features

Integrated striping supports the following features:

- Support for one volume with two to four drives
- Presents a single virtual drive to the operating system for each configured volume
- Support for both SAS and SATA drives, although the two types of drives cannot be combined in one volume
- Fusion-MPT architecture
- Easy-to-use SAS BIOS configuration utility
- Error notification
- Use of metadata to store volume configuration on disks
- Operating-system specific event log
- Error display inside the Fusion-MPT BIOS
- SES status LED support for drives used in integrated striping volumes

Integrated striping description

The integrated striping feature writes data across multiple disks instead of onto one disk. The storage space on each disk is partitioned into 64 KB stripes. These stripes are interleaved so that the combined storage space is composed alternately of stripes from each disk.

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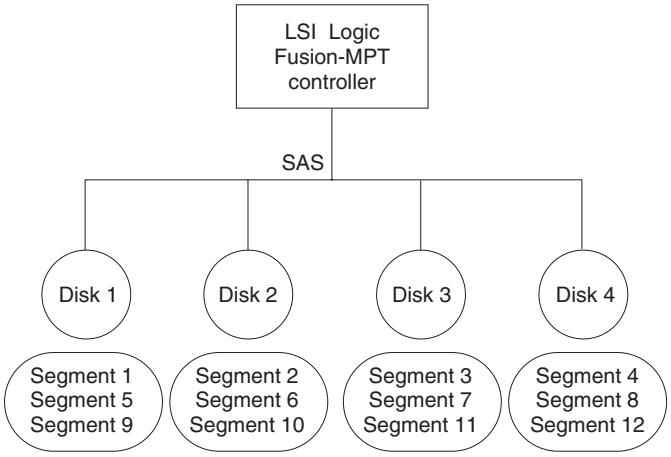
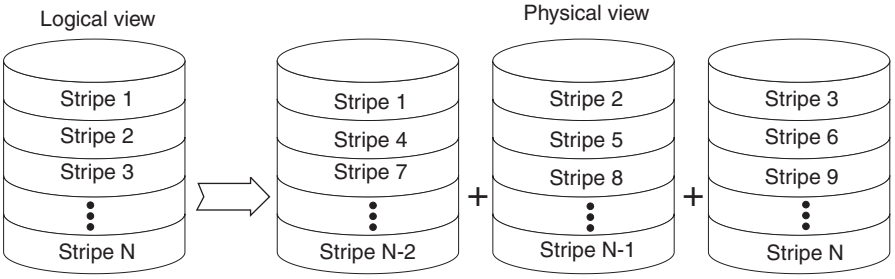
For example, the following illustration shows an example of integrated striping. Segment 1 is written to disk 1, segment 2 is written to disk 2, segment 3 is written to disk 3, and so on. When the system reaches the end of the disk list, it continues writing data at the next available segment of disk 1.



The following illustration shows a logical view and a physical view of an integrated striping configuration.



The primary advantage of integrated striping is speed, because it transfers data to or from multiple disks at one time. However, there is no data redundancy; therefore, if one disk fails, that data is lost.

Integrated striping firmware

This section describes the features of the integrated striping firmware.

Host interface

The integrated striping host interface uses the Message Passing Interface, as described in the Fusion-MPT Message Passing Interface Specification, including integrated striping. The host operating system has access to the logical integrated striping drive and the physical disks through the Fusion-MPT interface.

Metadata support

The firmware supports metadata, which describes the integrated striping logical drive configuration stored on each member disk. When the firmware is initialized, each member disk is queried to read the stored metadata to verify the configuration. The usable disk space for each integrated striping member disk is adjusted down to leave room for this data.

SMART support

The integrated striping firmware enables Mode 6 SMART on the integrated striping member disks. Mode 6 SMART requires each physical disk to be polled at regular intervals. If a SMART ASC/ASCQ code is detected on a physical integrated striping disk, the firmware processes the SMART data, and the last received SMART ASC/ASCQ is stored in nonvolatile memory. The integrated striping volume does not support SMART directly, because it is just a logical representation of the physical disks in the volume.

Disk write caching

Disk write caching is disabled by default on all integrated striping volumes.

Fusion-MPT support

To enable integrated striping, the BIOS uses the LSI Logic Fusion-MPT interface to communicate to the controller and firmware. This includes reading the Fusion-MPT configuration to gain access to the parameters that are used to define behavior between the controller and the devices to which it is connected. The Fusion-MPT device drivers for all supported operating systems implement the Fusion-MPT interface to communicate with the controller and firmware.

Chapter 6. Creating integrated striping volumes

This chapter describes how to create integrated striping volumes using the SAS BIOS configuration utility.

Integrated striping configuration overview

You can use the SAS BIOS configuration utility to create one integrated striping volume, with up to four drives total on a controller. The controller must be in the BIOS boot order.

You can use disks of different size in integrated striping volumes. The smallest disk determines the "logical" size of each disk in the volume. The excess space of the larger member disk is not used. Usable disk space for each disk in an integrated striping volume is adjusted down to leave room for metadata. Usable disk space can be further reduced to maximize the ability to interchange disks in the same size classification. The supported stripe size is 64 KB.

For more information about integrated striping volumes, see "Integrated striping features" on page 25.

Creating an integrated striping volume

The SAS BIOS configuration utility is part of the Fusion-MPT BIOS. When the BIOS loads during startup and a message is displayed about the SAS BIOS configuration utility, press Ctrl-C to start it. The following message is displayed:

```
Please wait, invoking SAS Configuration Utility.
```

After a brief pause, the main menu of the SAS BIOS configuration utility is displayed; however, on some servers the following message is displayed:

```
LSI Logic Configuration Utility will load following initialization!
```

In this case, the configuration utility will load after the server has completed its power-on self-test (POST).

To configure an integrated striping volume with the SAS BIOS configuration utility, complete the following steps.

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Note: The following procedure assumes that the required controllers and disks are already installed in the server. You can configure both integrated mirroring and integrated striping volumes on the same controller.

1. On the Adapter List screen of the SAS BIOS configuration utility, select the controller, and then press Enter. The Adapter Properties screen is displayed.

```
LSI Logic Config Utility    v6.01.03.00
  Adapter Properties -- SAS1068

       Adapter                         SAS1068
       PCI Slot                        03
       PCI Address(Bus/Dev/Func)       03:00:00
       MPT Firmware Revision           00.03.23.00-IT
       SAS Address                     500605B0:0000C580
       Status                          Enabled
       Boot Order                      1
       Boot Support                    [Enabled BIOS & OS]

       RAID Properties

       SAS Topology

       Advanced Adapter Properties

  Esc = Exit Menu       F1/Shift+1 = Help
  Enter = Select Item   -/+ = Change Item
```

2. Select **RAID Properties**, and then press Enter.
3. When you are prompted to select a volume type, select **Create IS Volume**.

   The Create New Array screen shows a list of disks that can be added to a volume.
4. Move the cursor to the RAID Disk column. To add a disk to the volume, change the No to Yes by pressing the + key, - key, or Spacebar. As disks are added, the **Array Size** field changes to reflect the size of the new volume.

   The following illustration shows an integrated striping volume configured with two drives.

```
LSI Logic MPT Setup Utility    v6.01.03.00
  Create New Array -- SAS1068

    Array Type:                         IS
    Array Size(MB)                      70032

  Slot  Device Identifier               RAID   Hot    Drive     Pred  Size
  Num                                   Disk   Spr    Status    Fail  (MB)
    1   MAXTOR ATLAS15K2_36SAS BG34     [Yes]  [No]   Ok        ---   35074
    2   MAXTOR ATLAS15K2_36SAS BG34     [Yes]  [No]   Ok        ---   35074
    8   MAXTOR ATLAS15K2_36SAS BG34     [No]   [No]   Ok        ---   35074
   11   MAXTOR ATLAS15K2_36SAS BG34     [No]   [No]   Ok        ---   35074




  Esc = Exit Menu       F1/Shift+1 = Help
  Space/+/- = Select disk for array or hot spare    C = Create array
```

   There are several limitations when creating an integrated striping (RAID 0) volume:

   - All disks must be either SATA (with extended command set support) or SAS (with SMART support).
   - Disks must have 512-byte blocks and must not have removable media.
   - There must be at least two and no more than four drives in a valid integrated striping volume. Hot spare drives are not allowed.

5. After the volume is fully configured, press C and then select **Save changes then exit this menu**. The SAS BIOS configuration utility pauses while the array is created.

   Note: Integrated striping does not provide any data protection if a disk has failed. It is primarily used to increase speed.

Creating a second integrated striping volume

You can configure two integrated striping volumes, or an integrated striping volume and an integrated mirroring or integrated mirroring enhanced volume. You can add a second volume if one volume is already configured and if there are available disk drives.

To add a second volume, complete the following steps:

1. On the Adapter List screen of the SAS BIOS configuration utility, select the controller, and then press Enter. The Adapter Properties screen is displayed.
2. Select **RAID Properties** and press Enter.
3. When you are prompted to select a volume type, select **Create IS Volume**.

   The Create New Array screen shows a list of disks that can be added to a volume.
4. Move the cursor to the RAID Disk column. To add a disk to the volume, change the No to Yes by pressing the + key, - key, or Spacebar. As disks are added, the **Array Size** field changes to reflect the size of the new volume.
5. After the volume is fully configured, press C and then select **Save changes then exit this menu**. The SAS BIOS configuration utility pauses while the array is created.

Other configuration tasks

This section explains how to perform other tasks related to configuring and maintaining integrated striping volumes.

Viewing integrated striping volume properties

To view the properties of integrated striping volumes, complete the following steps:

1. In the SAS BIOS configuration utility, select a controller from the Adapter List. Select **RAID Properties**. The properties of the current volume are displayed.
2. If more than one volume is configured, press Alt+N to view the next array.
3. To manage the current array, select **Manage Array**, and then press Enter.

Activating an array

An array can become inactive if, for example, it is removed from one controller or computer and moved to another one. The “Activate Array” option enables you to reactivate an inactive array that is added to a server. This option is available only when the selected array is currently inactive.

To activate a selected array, complete the following steps:

1. On the Manage Array screen, select **Activate Array**.
2. Press Y to proceed with the activation, or press N to cancel it. After a pause, the array becomes inactive.

Deleting an array

Attention: To prevent the loss of data, before you delete an array, you must back up all data on the array that you want to keep.

To delete a selected array, complete the following steps:

1. On the Manage Array screen, select **Delete Array**.
2. Press Y to delete the array.

   After a pause, the firmware deletes the array.

   Note: After a volume is deleted, it cannot be recovered. The master boot records of all disks are deleted.

Locating a disk drive or multiple disk drives in a volume

You can use the SAS BIOS configuration utility to locate and identify a specific physical disk drive by flashing the LED on the drive. You can also use the SAS BIOS configuration utility to flash the LEDs of all the disk drives in a RAID volume. There are several ways to do this:

- When you are creating an integrated striping volume, and a disk drive is set to Yes as part of the volume, the LED on the disk drive is flashing. The LED is turned off when you are finished creating the volume.
- You can locate individual disk drives from the SAS Topology screen. To do this, move the cursor to the name of the disk in the Device Identifier column and press Enter. The LED on the disk flashes until the next key is pressed.
- You can locate all the disk drives in a volume by selecting the volume on the RAID Properties screen. The LEDs flash on all disk drives in the volume.

  Note: The LEDs on the disk drives will flash as described in the previous list if the firmware is configured correctly and the drives or the disk enclosure support disk location.

Selecting a boot disk

You can select a boot disk in the SAS Topology screen. This disk is then moved to scan ID 0 on the next restart and remains at this position. This makes it easier to set BIOS boot device options and to keep the boot device constant when a device is added or removed. There can be only one boot disk.

To select a boot disk, complete the following steps:

1. In the SAS BIOS configuration utility, select a controller from the Adapter List, and press Enter.
2. In the Adapter Properties screen, select **SAS Topology**.

   The current topology is displayed. If the selection of a boot device is supported, the bottom of the screen lists the Alt+B option. This is the key combination for toggling the boot device. If a device is currently configured as the boot device, the word “Boot” is displayed in the Device Info column on the SAS Topology screen.
3. To select a boot disk, move the cursor to the disk and press Alt+B.
4. To remove the boot designator, move the cursor down to the current boot disk and press Alt+B. This controller no longer has a disk designated as boot.

5. To change the boot disk, move the cursor to the new boot disk and press Alt+B. The boot designator moves to this disk.

   Note: The firmware must be configured correctly for the Alt+B feature to work.

Appendix A. Using the CFGGEN IR configuration utility

This appendix describes how to use the CFGGEN IR Configuration Utility to create integrated mirroring (IM), integrated mirroring enhanced (IME) and integrated striping (IS) volumes. CFGGEN is a command-line utility that runs in the DOS, Linux, and Microsoft Windows Pre-Installation (WinPE) environments. CFGGEN is a minimally interactive program that you can run from a command prompt or a shell script.

Hardware and software requirements

The CFGGEN configuration utility runs on any Intel®-compatible platform. It works with any SCSI, SATA, or SAS device that is compliant with existing SCSI standards.

The CFGGEN configuration utility is supported in the following operating system environments:

- **DOS version**

  CFGGEN runs in any environment that is fully DOS compatible and has at least 640 KB of memory. The system BIOS must support 32-bit BIOS services, including the PCI BIOS services. CFGGEN uses these services to locate the controller and its interface registers. CFGGEN must be able to directly access the interface registers on the controller chip.

  Note: You cannot run CFGGEN in a virtual DOS window from within Windows.

- **Linux version**

  CFGGEN is a statically linked Linux application. Static linking prevents any library version compatibility problems that might prevent CFGGEN from working with a specific release or distribution of Linux. Version 3.02.04 or later of the LSI mptlinux device driver must be installed on the system. The required modules include mptbase.o, mptscsih.o and mptctl.o.

  Important: The mptbase.o, mptscsih.o and mptctl.o modules must be loaded into the Linux kernel before CFGGEN can function correctly. They can be loaded using the Linux modprobe command.

- **WinPE version**

  CFGGEN will run on a Windows Pre-Installation Environment (WinPE) and is statically compiled with the LSI MptLib Library (MptLib.lib). The WinPE environment must have the applicable LSI Logic MPT Windows device driver (Miniport or Storport) installed and loaded to recognize and communicate with the I/O controller.

CFGGEN interface description

CFGGEN uses a command-line interface. Commands are formatted as follows:

```
cfggen <controller #> <command> <parameters>
```

The program name, controller number, command, and parameter fields must be separated by the ASCII space character. The format of the parameters is command specific, as described in “CFGGEN commands” on page 36.

Information is passed between the user environment and CFGGEN using the command line, the standard output and standard error interfaces, and the program return value. You can redirect the output streams as permitted by the operating

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environment. The program return value is returned to you when the program exits. A value of 0 is returned if the command is successful. Otherwise, a value of 1 is returned.

CFGGEN commands

CFGGEN has the following commands:

- CREATE
- DEFAULTS
- DISPLAY
- FORMAT (DOS and Linux versions only)
- HOTSPARE
- STATUS
- SETOFFLINE (DOS and Linux versions only)
- SETONLINE (DOS and Linux versions only)

CFGGEN is not case sensitive. You can type CFGGEN commands and parameters in uppercase, lowercase, or a combination of the two.

The following conventions are used in the command descriptions:

- Text in italics must be entered exactly as shown on the command line.
- Text surrounded by <> must be replaced with a required parameter.
- Text surrounded by [ ] can be replaced by an optional parameter.
- Parameters surrounded by {} must be entered one or more times, as is applicable for the command you are running.
- The command-line definition characters <>, [ ], and {} must not be entered on the command line.

Common command-line parameters

This section describes CFGGEN command-line parameters that are common to more than one command.

- **<controller #>**

  The unique controller number of a PCI function found in the system, starting with controller # 0. The controller # corresponds to a single controller. For example, in a server containing two controllers, controller # 0 refers to the first controller and controller # 1 refers to the other controller. Valid controller number values are 0 - 255 (decimal).

- **<SCSI ID>**

  The SCSI bus address of a peripheral device attached to a controller. The valid SCSI ID values are 0 - 127 (decimal) per controller.

  Note: With PBSRAM, the controller can support more than 128 devices.

- **<Target ID>**

  The Target ID defines the SCSI address of the device.

Create command

The create command creates integrated mirroring, integrated mirroring enhanced, and integrated striping volumes on the controller. The firmware and hardware limitations for the controller determines the number of configurations that you can create.

When a disk drive is added to an integrated mirroring, integrated mirroring enhanced, or integrated striping volume, its entire storage capacity might be used, depending on drive capacity and volume capacity. For example, if you add a 36 GB disk drive to a volume that only uses 9 GB of capacity on each disk drive, the remaining 27 GB of capacity on the disk drive is unusable.

The disk identified by the first SCSI ID on the command line is assigned as the primary disk drive when an integrated mirroring volume is created. If the controller is allowed to resync the disk drives, the data on the primary disk drive is available when you access the newly created volume.

The following rules must be observed when creating integrated mirroring, integrated mirroring enhanced, and integrated striping volumes and hot spare disks on the controller:

- Integrated mirroring, integrated mirroring enhanced, and integrated striping volumes are supported.
- You can create only one integrated mirroring, integrated mirroring enhanced, or integrated striping volume.
- The total number of disks in a volume, including hot spares disks, cannot exceed four.
- An integrated mirroring volume must have exactly two disks.
- An integrated mirroring enhanced volume can have a minimum of three disks and a maximum of four disks.

Command line:

```
cfggen <controller #> create <volume type> <size> {<SCSI ID>} [qsync] [noprompt]
cfggen <controller #> create <volume type> <size>
{<Target ID>} [qsync] [noprompt]
```

Parameters:

- `<controller #>` – Number of the SCSI bus or controller targeted by this command.
- `<volume type>` – Volume type for the new volume to be created. Valid values are IM (integrated mirroring) or IME (integrated mirroring enhanced) or IS (integrated striping).
- `<size>` – Size of the RAID volume in MB, or MAX for the maximum size available.
- `<SCSI ID>` – SCSI ID of a hard disk drive to be included in the RAID volume.
- `<Target ID>` – The Target ID value for the disk drive to be included in the RAID volume. These values can be obtained from the output of the Display command.

- `qsync` – If this optional parameter is specified, a quick synchronization of the new volume is performed. If the volume type is integrated mirroring enhanced or integrated striping, a quick synchronization is always performed even if qsync is not specified. A quick synchronization means that the first 32 KB of the drives in the volume are cleared to 0.
- `noprompt` – Suppresses the display of warnings and prompts.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Defaults command

The Defaults command deletes any integrated mirroring, integrated mirroring enhanced, and integrated striping volumes and hot spare drives created by the Create and Hotspare commands. No other controller configuration parameters are changed.

Command line

```
cfggen <controller #> defaults [noprompt]
```

Parameters:

- `<controller #>` – Number of the SCSI bus or controller targeted by this command.
- `noprompt` – Suppresses the display of warnings and prompts.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Display command

The Display command displays configuration information for the controller. The information includes controller type, firmware version, BIOS version, volume information, and physical drive information. An example of the information that is output by this command is provided in the sample output section.

Note: 1 MB = 1,048,576 bytes. All sizes displayed in MB are rounded down to the nearest MB.

Command line

```
cfggen <controller #> display [filename]
```

Parameters:

- `<controller #>` – Number of the SCSI bus or controller targeted by this command.
- `[filename]` – Optional valid file name to which the output of the command is stored.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Sample output:

The following example shows the output of the Create command when used to create an integrated mirroring configuration on a controller.

Note: The format and content of the Display command output varies, depending on the CFGGEN version that is used.

```
LSI LOGIC Integrated RAID Configuration utility.  v2.00.10.00
Read configuration has been initiated for controller 0
------------------------------------------------------------------------
Controller information
------------------------------------------------------------------------
  Controller type                       : SAS1068E
  BIOS version                          : 6.08.04.00
  Firmware version                      : 1.15.00.00
  Channel description                   : 1 Serial Attached SCSI
  Initiator ID                          : 63
  Maximum physical devices              : 62
  Concurrent commands supported         : 511
  Slot                                  : 3
  Bus                                   : 13
  Device                                : 0
  Function                              : 0
  RAID Support                          : Yes
------------------------------------------------------------------------
IR Volume information
------------------------------------------------------------------------
IR volume 1
  Volume ID                             : 15
  Status of volume                      : Degraded (DGD)
  RAID level                            : 1
  Size (in MB)                          : 69618
  Physical hard disks (Target ID)       : 19 26
------------------------------------------------------------------------
Physical device information
```

```
-------------------------------------------------------------------------
Initiator at ID #63
Target on ID #13
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 3
  Target ID                               : 13
  State                                   : Ready (RDY)
  Size (in MB)/(in sectors)               : 70006/143374000
  Manufacturer                            : IBM-ESXS
  Model Number                            : GNA073C3ESTT0Z N
  Firmware Revision                       : BH0D
  Serial No                               : J20SX89K
  Drive Type                              : SAS
Target on ID #14
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 2
  Target ID                               : 14
  State                                   : Ready (RDY)
  Size (in MB)/(in sectors)               : 70006/143374000
  Manufacturer                            : IBM-ESXS
  Model Number                            : GNA073C3ESTT0Z N
  Firmware Revision                       : BH0D
  Serial No                               : J20SDCHK
  Drive Type                              : SAS
Target on ID #16
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 7
  Target ID                               : 16
  State                                   : Ready (RDY)
  Size (in MB)/(in sectors)               : 70006/143374000
  Manufacturer                            : IBM-ESXS
  Model Number                            : BBA073C3ESTT0Z N
  Firmware Revision                       : BH0C
  Serial No                               : K4049N0K
  Drive Type                              : SAS
Target on ID #17
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 6
  Target ID                               : 17
  State                                   : Ready (RDY)
  Size (in MB)/(in sectors)               : 70006/143374000
  Manufacturer                            : IBM-ESXS
  Model Number                            : GNA073C3ESTT0Z N
  Firmware Revision                       : BH0D
  Serial No                               : J20SDELK
  Drive Type                              : SAS
Target on ID #18
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 5
  Target ID                               : 18
  State                                   : Ready (RDY)
  Size (in MB)/(in sectors)               : 35074/71833096
  Manufacturer                            : MAXTOR
  Model Number                            : ATLAS15K2_36SAS
  Firmware Revision                       : BG3R
  Serial No                               : E20NEN2K
  Drive Type                              : SAS
Target on ID #19
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 0
  Target ID                               : 19
```

```
  State                                 : Online (ONL)
  Size (in MB)/(in sectors)             : 286102/585937500
  Manufacturer                          : IBM-ESXS
  Model Number                          : GNA300C3ESTT0Z N
  Firmware Revision                     : BH0D
  Serial No                             : D807AZFK
  Drive Type                            : SAS
Target on ID #20
  Device is a Hard disk
  Enclosure #                           : 2
  Slot #                                : 11
  Target ID                             : 20
  State                                 : Ready (RDY)
  Size (in MB)/(in sectors)             : 70006/143374000
  Manufacturer                          : IBM-ESXS
  Model Number                          : GNA073C3ESTT0Z N
  Firmware Revision                     : BH0D
  Serial No                             : J20RK8FK
  Drive Type                            : SAS
Target on ID #21
  Device is a Hard disk
  Enclosure #                           : 2
  Slot #                                : 10
  Target ID                             : 21
  State                                 : Ready (RDY)
  Size (in MB)/(in sectors)             : 70006/143374000
  Manufacturer                          : IBM-ESXS
  Model Number                          : GNA073C3ESTT0Z N
  Firmware Revision                     : BH0D
  Serial No                             : J20SX64K
  Drive Type                            : SAS
Target on ID #22
  Device is a Hard disk
  Enclosure #                           : 2
  Slot #                                : 9
  Target ID                             : 22
  State                                 : Ready (RDY)
  Size (in MB)/(in sectors)             : 70006/143374000
  Manufacturer                          : IBM-ESXS
  Model Number                          : GNA073C3ESTT0Z N
  Firmware Revision                     : BH0D
  Serial No                             : J20SMZRK
  Drive Type                            : SAS
Target on ID #23
  Device is a Hard disk
  Enclosure #                           : 2
  Slot #                                : 4
  Target ID                             : 23
  State                                 : Ready (RDY)
  Size (in MB)/(in sectors)             : 70006/143374000
  Manufacturer                          : IBM-ESXS
  Model Number                          : GNA073C3ESTT0Z N
  Firmware Revision                     : BH0D
  Serial No                             : D219NPLK
  Drive Type                            : SAS
Target on ID #24
  Device is a Hard disk
  Enclosure #                           : 2
  Slot #                                : 8
  Target ID                             : 24
  State                                 : Ready (RDY)
  Size (in MB)/(in sectors)             : 34715/71096640
  Manufacturer                          : IBM-ESXS
  Model Number                          : ST336754SS
  Firmware Revision                     : BA17
  Serial No                             : 3KQ10ESY000076101FS6
  Drive Type                            : SAS
```

```
Target on ID #25
  Device is a Enclosure services device
  Enclosure #                             : 2
  Slot #                                  : 12
  Target ID                               : 25
  State                                   : Standby (SBY)
  Manufacturer                            : IBM
  Model Number                            : EXP3000
  Firmware Revision                       : 0142
  Serial No                               :
  Drive Type                              : SAS
Target on ID #26
  Device is a Hard disk
  Enclosure #                             : 2
  Slot #                                  : 1
  Target ID                               : 26
  State                                   : Out of Sync (OSY)
  Size (in MB)/(in sectors)               : 70006/143374000
  Manufacturer                            : IBM-ESXS
  Model Number                            : BBA073C3ESTT0Z N
  Firmware Revision                       : BH0C
  Serial No                               : K405VVFK
  Drive Type                              : SAS
------------------------------------------------------------------------
Enclosure information
------------------------------------------------------------------------
Enclosure#                                : 1
  Logical ID                              : 500605b0:000704c0
  Numslots                                : 8
  StartSlot                               : 0
  Start TargetID                          : 0
  Start Bus                               : 0
Enclosure#                                : 2
  Logical ID                              : 100000a0:b81d2a12
  Numslots                                : 13
  StartSlot                               : 0
  Start TargetID                          : 0
  Start Bus                               : 0
```

A logical drive has the following status values:

- `Okay (OKY)` – The volume is Active and the drives are functioning correctly. The user data is protected if the volume is integrated mirroring or integrated mirroring enhanced.
- `Degraded (DGD)` – The volume is Active. The user data is not fully protected due to a configuration change or drive failure.
- `Rebuilding (RBLD)` – A data resynchronization or rebuild might be in progress.
- `Inactive, Okay (OKY)` – The volume is inactive and the drives are functioning correctly. The user data is protected if the current RAID level is RAID 1 (IM) or RAID 1E (IME).
- `Inactive, Degraded (DGD)` – The volume is inactive and the user data is not fully protected due to a configuration change or drive failure; a data resync or rebuild might be in progress.

A physical device has the following status values:

- `Online (ONL)` – The drive is operational and is part of a logical drive.
- `Hot Spare (HSP)` – The drive is a hot spare that is available for replacing a failed drive in an array.
- `Ready (RDY)` – The drive is ready for use as a normal disk drive; or it is available to be assigned to a disk array or hot spare pool.

- `Available (AVL)` – The drive might or might not be ready, and it is not suitable for inclusion in an array or hot spare pool (for example, it did not spin up, its block size is incorrect, or its media is removable).
- `Failed (FLD)` – The drive was part of a logical drive or was a hot spare drive, and it has failed. It has been taken offline.
- `Standby (SBY)` – This status is used to tag all non-hard disk drive devices.

Format command

The Format command is used to perform a low-level format of a disk drive. The drive cannot be a hot spare drive or a member of an integrated mirroring, integrated mirroring enhanced, or integrated striping volume.

Attention: A low-level format erases all data on the hard disk drive. To prevent irreparable damage to the hard disk drive, do not interrupt the Format command.

Warning messages are displayed during the formatting, unless the noprompt parameter is included on the command line. If you do not quickly respond to a series of prompts, the command is cancelled. The answers are case sensitive and must be entered in uppercase.

The Format command does not complete and return to a shell prompt until the format operation is complete. This might take a long time for a large disk drive.

Command line:

```
cfggen <controller #> format <SCSI ID> [noprompt]
cfggen <controller #> format bay <Target ID> [noprompt]
```

Parameters:

- `<controller #>` – The number of the controller that is targeted by this command.
- `bay` – This parameter indicates that the Target ID values are specified instead of SCSI ID values.
- `<SCSI ID>` – The SCSI ID of the hard disk drive to be formatted.
- `<Target ID>` – The Target ID value for the disk drive to be formatted. This value is obtained from the output of the Display command.
- `noprompt` – This parameter suppresses the display of warnings and prompts.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Hotspare command

The Hotspare command creates a hot spare disk drive, which is added to hot spare pool 0. The number of disk drives in an integrated mirroring, integrated mirroring enhanced, or integrated striping volume, including the hot spare disk, cannot exceed four. Only one hot spare disk can be created.

The capacity of the hot spare disk must be greater than or equal to the capacity of the smallest disk in the logical drive. You can verify this by using the Display command.

The following rules must be observed when creating hot spare disks:

- A hot spare disk cannot be created unless at least one integrated mirroring or integrated mirroring enhanced volume is already created.
- CFGGEN does not allow adding a hot spare disk of a type (SAS or SATA) that is different from the disk types in any of the volumes.

Command line:

```
cfggen <controller #> hotspare <SCSI ID>
cfggen <controller #> hotspare bay <Target ID>
```

Parameters:

- `<controller #>` – The number of the SCSI bus or controller targeted by this command.
- `<SCSI ID>` – The SCSI ID of the drive targeted by this command.
- `<Target ID>` – The Target ID value for the disk drive to use for the new hot spare disk. This value is obtained from the output of the Display command.
- `noprompt` – Suppresses the display of warnings and prompts.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Status command

The Status command displays the status of any volume synchronization operation that is currently in progress on the controller. If no such operation is in progress, CFGGEN displays a message indicating this before it exits. The Status command adds the flag Inactive to the **Volume State** field, if the controller firmware marks the volume as Inactive.

Command line:

```
cfggen <controller #> status
```

Parameter:

<controller #> – Number of the SCSI bus or controller targeted by this command.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Sample output:

The following example shows the status information returned when a volume resynchronization is in progress:

```
Background command progress status for controller 0...
IR Volume 1
Current operation                       : Synchronize
Volume ID                               : 6
Volume status                           : Enabled
Volume state                            : Degraded
Physical disk I/Os                      : Not quiesced
Volume size (in sectors)                : 70311936
Number of remaining sectors             : 68250624
Percentage complete                     : 2.93%
```

The following example shows the status information returned when no background volume operation is in progress:

```
Background command progress status for controller 0...
IR Volume 1
Current operation                   : None
Volume ID                           : 6
Volume status                       : Enabled
Volume state                        : Optimal
Physical disk I/Os                  : Not quiesced
```

The status fields in the data displayed can have the following values:

Current operation: `Synchronize` or `None`

Volume status: `Enabled` or `Disabled`

Volume state: `[Inactive] Optimal`, `Degraded`, or `Failed`

Physical disk I/Os: `Quiesced` or `Not quiesced`

Setoffline command

The Setoffline command takes a physical disk in a volume offline. A physical disk that is taken offline changes its state to Failed (FLD), but the disk is still associated with the volume and, therefore, cannot be addressed by normal I/O requests. If a new disk replaces an offline disk, the new disk is automatically brought online. Otherwise, the disk remains offline until brought online by the Setonline command.

Command line:

```
cfggen <controller #> setoffline <SCSI ID>
```

Parameters:

- `<controller #>` – Number of the SCSI bus or controller targeted by this command.
- `<SCSI ID>` – SCSI target ID of the drive targeted by this command.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Setonline command

The Setonline command takes a physical disk in a volume online, which is required only after the physical disk is taken offline by the Setoffline command. When a physical disk is brought online, the IOC synchronizes the volume.

Command line:

```
cfggen <controller #> setonline <SCSI ID>
```

Parameters:

- `<controller #>` – Number of the controller targeted by this command.
- `<SCSI ID>` – SCSI target ID of the drive targeted by this command.

Program return values:

00x00	SUCCESS: command completed successfully.
0x01	FAILURE: bad command Line argumentS or operational failure.

Appendix B. Getting help and technical assistance

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

Before you call

Before you call, make sure that you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system and any optional devices are turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system. Information about diagnostic tools is in the *Problem Determination and Service Guide* on the IBM *Documentation* CD that comes with your system.
- Go to the IBM support Web site at http://www.ibm.com/systems/support/ to check for technical information, hints, tips, and new device drivers or to submit a request for information.

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

Using the documentation

Information about your IBM system and preinstalled software, if any, or optional device is available in the documentation that comes with the product. That documentation can include printed documents, online documents, readme files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software. IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. To access these pages, go to http://www.ibm.com/systems/support/ and follow the instructions. Also, some documents are available through the IBM Publications Center at http://www.ibm.com/shop/publications/order/.

Getting help and information from the World Wide Web

On the World Wide Web, the IBM Web site has up-to-date information about IBM systems, optional devices, services, and support. The address for IBM System x® and xSeries® information is http://www.ibm.com/systems/x/. The address for IBM BladeCenter® information is http://www.ibm.com/systems/bladecenter/. The address for IBM IntelliStation® information is http://www.ibm.com/intellistation/.

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You can find service information for IBM systems and optional devices at http://www.ibm.com/systems/support/.

Software service and support

Through IBM Support Line, you can get telephone assistance, for a fee, with usage, configuration, and software problems with System x and xSeries servers, BladeCenter products, IntelliStation workstations, and appliances. For information about which products are supported by Support Line in your country or region, see http://www.ibm.com/services/sl/products/.

For more information about Support Line and other IBM services, see http://www.ibm.com/services/, or see http://www.ibm.com/planetwide/ for support telephone numbers. In the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

Hardware service and support

You can receive hardware service through your IBM reseller or IBM Services. To locate a reseller authorized by IBM to provide warranty service, go to http://www.ibm.com/partnerworld/ and click **Find a Business Partner** on the right side of the page. For IBM support telephone numbers, see http://www.ibm.com/planetwide/. In the U.S. and Canada, call 1-800-IBM-SERV (1-800-426-7378).

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

IBM Taiwan product service

台灣 IBM 產品服務聯絡方式：
台灣國際商業機器股份有限公司
台北市松仁路 7 號 3 樓
電話：0800-016-888

IBM Taiwan product service contact information:
IBM Taiwan Corporation
3F, No 7, Song Ren Rd.
Taipei, Taiwan
Telephone: 0800-016-888

Appendix C. IBM Statement of Limited Warranty Z125-4753-10 08/2008

Part 1 - General Terms

This Statement of Limited Warranty includes Part 1 - General Terms, Part 2 - Country-unique Terms, and Part 3 - Warranty Information. The terms of Part 2 replace or modify those of Part 1. For purposes of this Statement of Limited Warranty, “IBM” means the IBM entity that provided your Machine to you or to your reseller–for example, International Business Machines Corporation in the U.S. or IBM World Trade Corporation or the local IBM entity in your country.

The warranties provided by IBM in this Statement of Limited Warranty apply only to Machines you purchase for your use, and not for resale. The term “Machine” means an IBM machine, its features, conversions, upgrades, elements, or accessories, or any combination of them. The term “Machine” does not include any software programs, whether pre-loaded with the Machine, installed subsequently, or otherwise. **NOTHING IN THIS STATEMENT OF LIMITED WARRANTY AFFECTS ANY STATUTORY RIGHTS OF CONSUMERS THAT CANNOT BE WAIVED OR LIMITED BY CONTRACT.**

This Statement of Limited Warranty is available, in multiple languages, at the following IBM Internet website: http://www.ibm.com/systems/support/machine_warranties/.

What this Warranty Covers

IBM warrants that each Machine is free from defects in materials and workmanship and conforms to its Specifications. “Specifications” is information specific to a Machine in a document entitled “Official Published Specifications”, which is available upon request.

During the warranty period, IBM provides repair and exchange service for the Machine under the type of warranty service IBM designates for the Machine. The warranty period for the Machine is a fixed period starting on its original Date of Installation. The date on your purchase invoice or sales receipt is the Date of Installation unless IBM or your reseller informs you otherwise. The warranty period, type of warranty, and service level that apply to your Machine are designated in Part 3.

Many features, conversions, or upgrades involve the removal of parts and their return to IBM. An IBM part that replaces a removed part will assume the warranty service status of the removed part. An IBM part that is added to a Machine without replacing a previously-installed part is subject to warranty effective on its Date of Installation. Unless IBM specifies otherwise, the warranty period, type of warranty, and service level of such part is the same as the Machine on which it is installed.

Unless IBM specifies otherwise, these warranties apply only in the country or region in which you purchased the Machine.

THESE WARRANTIES ARE YOUR EXCLUSIVE WARRANTIES AND REPLACE ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTY OF TITLE OR NON-INFRINGMENT. SOME

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STATES OR JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF EXPRESS OR IMPLIED WARRANTIES, SO THE ABOVE EXCLUSION MAY NOT APPLY TO YOU. IN THAT EVENT, SUCH WARRANTIES ARE LIMITED IN DURATION TO THE WARRANTY PERIOD. NO WARRANTIES APPLY AFTER THAT PERIOD. SOME STATES OR JURISDICTIONS DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

What this Warranty Does not Cover

This warranty does not cover the following:

a. failure or damage resulting from misuse (including, but not limited to, use of any Machine capacity or capability, other than that authorized by IBM in writing), accident, modification, unsuitable physical or operating environment, operation in other than the specified operating environment or improper maintenance by you or a third party;

b. failure due to events beyond IBM's control;

c. failure caused by a product for which IBM is not responsible;

d. any non-IBM products, including those provided with, or installed on, an IBM Machine at your request;

e. accessories, supply items and consumables (e.g. batteries and printer cartridges), and structural parts (e.g. frames and covers);

f. service of Machine alterations; and

g. service of a Machine on which you are using capacity or capability, other than that authorized by IBM in writing.

The warranty is voided by removal or alteration of identification labels on the Machine or its parts.

IBM does not warrant uninterrupted or error-free operation of a Machine.

Any technical or other support provided for a Machine under warranty, such as assistance with “how-to” questions and those regarding Machine set-up and installation, is provided **WITHOUT WARRANTIES OF ANY KIND**.

How to Obtain Warranty Service

If the Machine does not function as warranted during the warranty period, refer to the service documentation that shipped with your Machine for support assistance and problem determination procedures. A copy of the service documentation for your Machine can also be found at the following IBM website: http://www.ibm.com under “Support and downloads”.

If you are unable to resolve your problem with the service documentation, contact IBM or your reseller to obtain warranty service. Contact information for IBM is provided in Part 3. If you do not register the Machine with IBM, you may be required to present proof of purchase as evidence of your entitlement to warranty service.

What IBM Will Do to Correct Problems

IBM will attempt to diagnose and resolve your problem over the telephone or electronically by access to an IBM Internet website. Certain Machines contain

remote support capabilities for direct problem reporting, remote problem determination, and resolution with IBM. When you contact IBM for service, you must follow the problem determination and resolution procedures that IBM specifies. Following problem determination, if IBM determines on-site service is required, a service technician will be scheduled for service at your location.

You are responsible for downloading or obtaining from IBM, and installing designated Machine Code (microcode, basic input/output system code (called "BIOS"), utility programs, device drivers, and diagnostics delivered with an IBM Machine) and other software updates in a timely manner from an IBM Internet website or from other electronic media, and following the instructions that IBM provides. You may request IBM to install Machine Code changes, however, you may be charged for that service.

Some parts of IBM Machines are designated as Customer Replaceable Units ("CRUs"). If your problem can be resolved with a CRU (e.g. keyboard, memory, hard disk drive), IBM will ship the CRU to you for you to install.

If the Machine does not function as warranted during the warranty period and your problem cannot be resolved over the telephone or electronically, through your application of Machine Code or software updates, or with a CRU, IBM or its subcontractor or a reseller that has been approved by IBM to provide warranty service, will either, at its discretion, 1) repair it to make it function as warranted, or 2) replace it with one that is at least functionally equivalent. If IBM or its subcontractor or the reseller is unable to do either, you may return the Machine to your place of purchase and your money will be refunded.

IBM or its subcontractor or the reseller will also manage and install selected engineering changes that apply to the Machine.

Exchange of a Machine or Part

When the warranty service involves the exchange of a Machine or part, the item IBM or its subcontractor or the reseller replaces becomes IBM's property, and the replacement becomes yours. You represent that all removed items are genuine and unaltered. The replacement may not be new, but will be in good working order and at least functionally equivalent to the item replaced. The replacement assumes the warranty service status of the replaced item.

Your Additional Responsibilities

You agree:

a. before IBM or its subcontractor or the reseller exchanges a Machine or part, to remove all features, parts, options, alterations, and attachments not under warranty service and ensure that the Machine is free of any legal obligations or restrictions that prevent its exchange;

b. to obtain authorization from the owner to have IBM or its subcontractor or the reseller service a Machine that you do not own;

c. where applicable, before service is provided:
   1. follow the service request procedures that IBM or its subcontractor or its reseller provides;
   2. backup and secure all programs, data, and funds contained in the Machine; and
   3. inform IBM or its subcontractor or the reseller of changes in the Machine's location;

d. to provide IBM or its subcontractor or the reseller with sufficient and safe access to your facilities to permit IBM to fulfill its obligations;

e. to allow IBM or its subcontractor or the reseller to install mandatory engineering changes, such as those required for safety;

f. when the type of warranty service requires that you deliver a failing Machine to IBM, you agree to ship it suitably packaged, as IBM specifies, to a location IBM designates. After the Machine has been repaired or exchanged, IBM will return the repaired Machine or provide a replacement Machine to you at its expense, unless IBM specifies otherwise. IBM is responsible for loss of, or damage to, your Machine only while it is 1) in IBM's possession; or 2) in transit in those cases where IBM is responsible for the transportation charges; and

g. to securely erase from any Machine you return to IBM for any reason all programs not provided by IBM with the Machine, and data, including without limitation the following: 1) information about identified or identifiable individuals or legal entities ("Personal Data"); and 2) your confidential or proprietary information and other data. If removing or deleting Personal Data is not possible, you agree to transform such information (e.g., by making it anonymous or encrypting it) so that it no longer qualifies as Personal Data under applicable law. You also agree to remove all funds from Machines returned to IBM. IBM is not responsible for any funds, programs not provided by IBM with the Machine, or data contained in a Machine that you return to IBM. You acknowledge that, to perform its responsibilities under this Statement of Limited Warranty, IBM may ship all or part of the Machine or its software to other IBM or third party locations around the world, and you authorize IBM to do so.

Limitation of Liability

Circumstances may arise where, because of a default on IBM's part or other liability, you are entitled to recover damages from IBM. Regardless of the basis on which you are entitled to claim damages from IBM (including fundamental breach, negligence, misrepresentation, or other contract or tort claim), except for any liability that cannot be waived or limited by applicable laws, IBM's entire liability for all claims in the aggregate arising from or related to each Product will not exceed:

a. damages for bodily injury (including death) and damage to real property and tangible personal property; and

b. the amount of any other actual direct damages, up to the charges (if recurring, 12 months' charges apply) for the Machine that is subject of the claim. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code ("LIC").

This limit also applies to IBM's suppliers, subcontractors, and resellers. It is the maximum for which IBM and its suppliers, subcontractors, and resellers are collectively responsible.

UNDER NO CIRCUMSTANCES IS IBM OR ITS SUPPLIERS, SUBCONTRACTORS, OR RESELLERS LIABLE FOR ANY OF THE FOLLOWING EVEN IF INFORMED OF THEIR POSSIBILITY: 1) THIRD PARTY CLAIMS AGAINST YOU FOR DAMAGES (OTHER THAN THOSE UNDER THE FIRST ITEM LISTED ABOVE); 2) LOSS OF, OR DAMAGE TO, DATA; 3) SPECIAL, INCIDENTAL, OR INDIRECT DAMAGES OR FOR ANY ECONOMIC CONSEQUENTIAL DAMAGES; OR 4) LOST PROFITS, BUSINESS, REVENUE, GOODWILL OR ANTICIPATED SAVINGS. SOME STATES OR JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

Governing Law

Both you and IBM consent to the application of the laws of the country in which you acquired the Machine to govern, interpret, and enforce all of your and IBM's rights, duties, and obligations arising from, or relating in any manner to, the subject matter of this Statement of Limited Warranty, without regard to conflict of law principles.

THESE WARRANTIES GIVE YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE OR JURISDICTION TO JURISDICTION.

Jurisdiction

All of our rights, duties, and obligations are subject to the courts of the country in which you acquired the Machine.

Part 2 - Country-unique Terms

AMERICAS

Jurisdiction:

The following sentence is added to this section as it applies to countries in bold print below:

Any litigation arising from this Statement of Limited Warranty will be settled exclusively by 1) in **Argentina**; the Ordinary Commercial Court of the city of Buenos Aires; 2) in **Bolivia**; the courts of the city of La Paz; 3) in **Brazil**; court of Rio de Janeiro, RJ; 4) in **Chile**; the Civil Courts of Justice of Santiago; 5) in **Colombia**; the Judges of the Republic of Colombia; 6) in **Equador**; the civil judges of Quito for executory or summary proceedings (as applicable); 7) in **Mexico**; the courts located in Mexico City, Federal District; 8) in **Paraguay**; the courts of the city of Asuncion; 9) in **Peru**; the judges and tribunals of the judicial district of Lima, Cercado; 10) in **Uruguay**; the courts of the city of Montevideo; 11) in **Venezuela**; the courts of the metropolitan area of the city of Caracas.

BRAZIL

Exchange of a Machine or Part:

Delete the last sentence:

The replacement assumes the warranty service status of the replaced item.

CANADA

What this Warranty Covers:

The following replaces the 2nd paragraph to this section:

During the warranty period, IBM provides repair and exchange service for the Machine under the type of warranty service IBM designates for the Machine. The warranty period for the Machine is a fixed period starting on its original Date of Installation. The date on your purchase invoice or sales receipt is the Date of Installation unless IBM informs you otherwise. The warranty period, type of warranty, and service level that apply to your Machine are designated in Part 3.

Limitation of Liability:

The following replaces item a and item b of this section:

a. damages for bodily injury (including death) or physical harm to real property and tangible personal property caused by IBM's negligence; and

b. the amount of any other actual direct damages, up to the greater of $100,000.00 or the charges (if recurring, 12 months' charges apply) for the Machine that is subject of the claim. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code ("LIC").

Governing Law:

The following replaces "laws of the country in which you acquired the Machine" in the first sentence:

laws in the Province of Ontario.

PERU

Limitation of Liability:

The following is added at the end of this section:

In accordance with Article 1328 of the Peruvian Civil Code the limitations and exclusions specified in this section will not apply to damages caused by IBM's willful misconduct ("dolo") or gross negligence ("culpa inexcusable").

UNITED STATES

Governing Law:

The following replaces "laws of the country in which you acquired the Machine" in the first sentence:

laws of the State of New York

ASIA PACIFIC

AUSTRALIA

What this Warranty Covers:

The following paragraph is added to this section:

The warranties specified in this Section are in addition to any rights you may have under the Trade Practices Act 1974 or other similar legislation and are only limited to the extent permitted by the applicable legislation.

Limitation of Liability:

The following is added to this section:

Where IBM is in breach of a condition or warranty implied by the Trade Practices Act 1974 or other similar legislation, IBM's liability is limited to the repair or

replacement of the goods or the supply of equivalent goods. Where that condition or warranty relates to right to sell, quiet possession or clear title, or the goods are of a kind ordinarily acquired for personal, domestic or household use or consumption, then none of the limitations in this paragraph apply.

Governing Law:

The following replaces "laws of the country in which you acquired the Machine" in the first sentence:

laws of the State or Territory

CAMBODIA AND LAOS

Governing Law:

The following replaces "laws of the country in which you acquired the Machine" in the first sentence:

laws of the State of New York, United States of America

CAMBODIA, INDONESIA AND LAOS

Arbitration:

The following is added under this heading:

Disputes arising out of or in connection with this Statement of Limited Warranty shall be finally settled by arbitration which shall be held in Singapore in accordance with the Arbitration Rules of Singapore International Arbitration Center ("SIAC Rules") then in effect. The arbitration award shall be final and binding for the parties without appeal and shall be in writing and set forth the findings of fact and the conclusions of law.

The number of arbitrators shall be three, with each side to the dispute being entitled to appoint one arbitrator. The two arbitrators appointed by the parties shall appoint a third arbitrator who shall act as chairman of the proceedings. Vacancies in the post of chairman shall be filled by the president of the SIAC. Other vacancies shall be filled by the respective nominating party. Proceedings shall continue from the stage they were at when the vacancy occurred.

If one of the parties refuses or otherwise fails to appoint an arbitrator within 30 days of the date the other party appoints its, the first appointed arbitrator shall be the sole arbitrator, provided that the arbitrator was validly and properly appointed.

All proceedings shall be conducted, including all documents presented in such proceedings, in the English language. The English language version of this Statement of Limited Warranty prevails over any other language version.

HONG KONG S.A.R.

As applies to transactions initiated and performed in Hong Kong S.A.R., phrases throughout this Agreement containing the word "country" (for example, "country of purchase" and "country of Installation") are replaced with "Hong Kong S.A.R."

INDIA

Limitation of Liability:

The following replaces item a and item b of this section:

a. liability for bodily injury (including death) or damage to real property and tangible personal property will be limited to that caused by IBM's negligence; and

b. as to any other actual damage arising in any situation involving nonperformance by IBM pursuant to, or in any way related to the subject of this Statement of Limited Warranty, the charge paid by you for the individual Machine that is the subject of the claim. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code ("LIC").

Arbitration:

The following is added under this heading:

Disputes arising out of or in connection with this Statement of Limited Warranty shall be finally settled by arbitration which shall be held in Bangalore, India in accordance with the laws of India then in effect. The arbitration award shall be final and binding for the parties without appeal and shall be in writing and set forth the findings of fact and the conclusions of law.

The number of arbitrators shall be three, with each side to the dispute being entitled to appoint one arbitrator. The two arbitrators appointed by the parties shall appoint a third arbitrator who shall act as chairman of the proceedings. Vacancies in the post of chairman shall be filled by the president of the Bar Council of India. Other vacancies shall be filled by the respective nominating party. Proceedings shall continue from the stage they were at when the vacancy occurred.

If one of the parties refuses or otherwise fails to appoint an arbitrator within 30 days of the date the other party appoints its, the first appointed arbitrator shall be the sole arbitrator, provided that the arbitrator was validly and properly appointed.

All proceedings shall be conducted, including all documents presented in such proceedings, in the English language. The English language version of this Statement of Limited Warranty prevails over any other language version.

JAPAN

Governing Law:

The following sentence is added to this section:

Any doubts concerning this Statement of Limited Warranty will be initially resolved between us in good faith and in accordance with the principle of mutual trust.

MACAU S.A.R.

As applies to transactions initiated and performed in Macau S.A.R., phrases throughout this Agreement containing the word "country" (for example, "country of purchase" and "country of Installation") are replaced with "Macau S.A.R."

MALAYSIA

Limitation of Liability:

*The word "**SPECIAL**" in item 3 of the last paragraph is deleted.*

NEW ZEALAND

What this Warranty Covers:

The following paragraph is added to this section:

The warranties specified in this section are in addition to any rights you may have under the Consumer Guarantees Act 1993 or other legislation which cannot be excluded or limited. The Consumer Guarantees Act 1993 will not apply in respect of any goods which IBM provides, if you require the goods for the purposes of a business as defined in that Act.

Limitation of Liability:

The following is added to this section:

Where Machines are not acquired for the purposes of a business as defined in the Consumer Guarantees Act 1993, the limitations in this Section are subject to the limitations in that Act.

PEOPLE'S REPUBLIC OF CHINA (PRC)

Governing Law:

The following replaces "laws of the country in which you acquired the Machine" in the first sentence:

laws of the State of New York, United States of America (except when local law requires otherwise).

PHILIPPINES

Limitation of Liability:

Item 3 in the last paragraph is replaced by the following:

SPECIAL (INCLUDING NOMINAL AND EXEMPLARY DAMAGES), MORAL, INCIDENTAL, OR INDIRECT DAMAGES FOR ANY ECONOMIC CONSEQUENTIAL DAMAGES; OR

Arbitration:

The following is added under this heading:

Disputes arising out of or in connection with this Statement of Limited Warranty shall be finally settled by arbitration which shall be held in Metro Manila, Philippines in accordance with the laws of the Philippines then in effect. The arbitration award shall be final and binding for the parties without appeal and shall be in writing and set forth the findings of fact and the conclusions of law.

The number of arbitrators shall be three, with each side to the dispute being entitled to appoint one arbitrator. The two arbitrators appointed by the parties shall appoint a third arbitrator who shall act as chairman of the proceedings. Vacancies in the post of chairman shall be filled by the president of the Philippine Dispute Resolution

Center, Inc. Other vacancies shall be filled by the respective nominating party. Proceedings shall continue from the stage they were at when the vacancy occurred.

If one of the parties refuses or otherwise fails to appoint an arbitrator within 30 days of the date the other party appoints its, the first appointed arbitrator shall be the sole arbitrator, provided that the arbitrator was validly and properly appointed.

All proceedings shall be conducted, including all documents presented in such proceedings, in the English language. The English language version of this Statement of Limited Warranty prevails over any other language version.

SINGAPORE

Limitation of Liability:

*The words "**SPECIAL**" and "**ECONOMIC**" in item 3 in the last paragraph are deleted.*

EUROPE, MIDDLE EAST, AFRICA (EMEA)

THE FOLLOWING TERMS APPLY TO ALL EMEA COUNTRIES:

The terms of this Statement of Limited Warranty apply to Machines purchased from IBM or an IBM reseller.

How to Obtain Warranty Service:

*Add the following paragraphs in **Western Europe** (Andorra, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Vatican State, and any country subsequently added to the European Union, as from the date of accession):*

The warranty for Machines acquired in Western Europe shall be valid and applicable in all Western Europe countries provided the Machines have been announced and made available in such countries.

If you purchase a Machine in one of the Western European countries, as defined above, you may obtain warranty service for that Machine in any of those countries from either (1) an IBM reseller approved to perform warranty service or (2) from IBM, provided the Machine has been announced and made available by IBM in the country in which you wish to obtain service.

If you purchase a Machine in a Middle East or African country, you may obtain warranty service for that Machine from the IBM entity within the country of purchase, if that IBM entity provides warranty service in that country, or from an IBM reseller, approved by IBM to perform warranty service on that Machine in that country. Warranty service in Africa is available within 50 kilometers of an IBM approved service provider. You are responsible for transportation costs for Machines located outside 50 kilometers of an IBM approved service provider.

Governing Law:

The phrase "the laws of the country in which you acquired the Machine" is replaced by:

1) "the laws of Austria" in **Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, FYR Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan**; 2) "the laws of France" in **Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Comoros, Congo Republic, Djibouti, Democratic Republic of Congo, Equatorial Guinea, French Guiana, French Polynesia, Gabon, Gambia, Guinea, Guinea-Bissau, Ivory Coast, Lebanon, Libya, Madagascar, Mali, Mauritania, Mauritius, Mayotte, Morocco, New Caledonia, Niger, Reunion, Senegal, Seychelles, Togo, Tunisia, Vanuatu, and Wallis & Futuna**; 3) "the laws of Finland" in **Estonia, Latvia, and Lithuania**; 4) "the laws of England" in **Angola, Bahrain, Botswana, Burundi, Egypt, Eritrea, Ethiopia, Ghana, Jordan, Kenya, Kuwait, Liberia, Malawi, Malta, Mozambique, Nigeria, Oman, Pakistan, Qatar, Rwanda, Sao Tome, Saudi Arabia, Sierra Leone, Somalia, Tanzania, Uganda, United Arab Emirates, the United Kingdom, West Bank/Gaza, Yemen, Zambia, and Zimbabwe**; 5) "the laws of South Africa" in **South Africa, Namibia, Lesotho and Swaziland**; 6) "the laws of Switzerland" in **Liechtenstein**; and 7) "the laws of Czech republic" in **Czech republic**.

Jurisdiction:

The following exceptions are added to this section:

1) In **Austria**; the choice of jurisdiction for all disputes arising out of this Statement of Limited Warranty and relating thereto, including its existence, will be the competent court of law in Vienna, Austria (Inner-City); 2) in **Angola, Bahrain, Botswana, Burundi, Egypt, Eritrea, Ethiopia, Ghana, Jordan, Kenya, Kuwait, Liberia, Malawi, Malta, Mozambique, Nigeria, Oman, Pakistan, Qatar, Rwanda, Sao Tome, Saudi Arabia, Sierra Leone, Somalia, Tanzania, Uganda, United Arab Emirates, United Kingdom, West Bank/Gaza, Yemen, Zambia, and Zimbabwe**; all disputes arising out of this Statement of Limited Warranty or related to its execution, including summary proceedings, will be submitted to the exclusive jurisdiction of the English courts; 3) in **Belgium and Luxembourg**; all disputes arising out of this Statement of Limited Warranty or related to its interpretation or its execution, the law, and the courts of the capital city, of the country of your registered office and/or commercial site location only are competent; 4) in **France, Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Comoros, Congo Republic, Djibouti, Democratic Republic of Congo, Equatorial Guinea, French Guiana, French Polynesia, Gabon, Gambia, Guinea, Guinea-Bissau, Ivory Coast, Lebanon, Libya, Madagascar, Mali, Mauritania, Mauritius, Mayotte, Morocco, New Caledonia, Niger, Reunion, Senegal, Seychelles, Togo, Tunisia, Vanuatu, and Wallis & Futuna**; all disputes arising out of this Statement of Limited Warranty or related to its violation or execution, including summary proceedings, will be settled exclusively by the Commercial Court of Paris; 5) in **South Africa, Namibia, Lesotho and Swaziland**; both of us agree to submit all disputes relating to this Statement of Limited Warranty to the jurisdiction of the High Court in Johannesburg; 6) in **Turkey**; all disputes arising out of or in connection with this Statement of Limited Warranty shall be resolved by the Istanbul Central (Sultanahmet) Courts and Execution Directorates of Istanbul, the Republic of Turkey; 7) in each of the following specified countries, any legal claim arising out of this Statement of Limited Warranty will be brought before, and settled exclusively by, the competent court of a) Athens for **Greece**, b) Tel Aviv-Jaffa for **Israel**, c) Milan for **Italy**, d) Lisbon for **Portugal**, and e) Madrid for **Spain**; 8) in **the United**

Kingdom; both of us agree to submit all disputes relating to this Statement of Limited Warranty to the exclusive jurisdiction of the English courts; 9) in **Liechtenstein**; all of our rights, duties, and obligations are settled exclusively by the competent court of Zurich; and 10) “to the competent courts of Czech republic”.

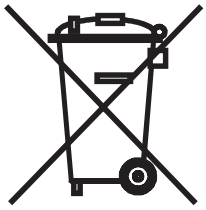
Arbitration:

The following is added under this heading:

In **Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Libya, FYR Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan** all disputes arising out of this Statement of Limited Warranty or related to its violation, termination or nullity will be finally settled under the Rules of Arbitration and Conciliation of the International Arbitral Center of the Federal Economic Chamber in Vienna (Vienna Rules) by three arbitrators appointed in accordance with these rules. The arbitration will be held in Vienna, Austria, and the official language of the proceedings will be English. The decision of the arbitrators will be final and binding upon both parties. Therefore, pursuant to paragraph 598 (2) of the Austrian Code of Civil Procedure, the parties expressly waive the application of paragraph 595 (1) figure 7 of the Code. IBM may, however, institute proceedings in a competent court in the country of installation.

In **Estonia, Latvia and Lithuania** all disputes arising in connection with this Statement of Limited Warranty will be finally settled in arbitration that will be held in Helsinki, Finland in accordance with the arbitration laws of Finland then in effect. Each party will appoint one arbitrator. The arbitrators will then jointly appoint the chairman. If arbitrators cannot agree on the chairman, then the Central Chamber of Commerce in Helsinki will appoint the chairman.

EUROPEAN UNION (EU) BATTERY DIRECTIVE



Notice: This mark applies only to countries within the European Union (EU).

Batteries or packaging for batteries are labeled in accordance with European Directive 2006/66/EC concerning batteries and accumulators and waste batteries and accumulators. The Directive determines the framework for the return and recycling of used batteries and accumulators as applicable throughout the European Union. This label is applied to various batteries to indicate that the battery is not to be thrown away, but rather reclaimed upon end of life per this Directive.

In accordance with the European Directive 2006/66/EC, batteries and accumulators are labeled to indicate that they are to be collected separately and recycled at end of life. The label on the battery may also include a chemical symbol for the metal concerned in the battery (Pb for lead, Hg for mercury, and Cd for cadmium). Users of batteries and accumulators must not dispose of batteries and accumulators as unsorted municipal waste, but use the collection framework available to customers for the return, recycling, and treatment of batteries and accumulators. Customer

participation is important to minimize any potential effects of batteries and accumulators on the environment and human health due to the potential presence of hazardous substances.

The retail price of batteries, accumulators and power cells includes the cost of the environmental management of their waste. For proper collection and treatment, contact your local IBM representative.

THE FOLLOWING TERMS APPLY TO ALL EU COUNTRIES:

The warranty for Machines acquired in EU countries is valid and applicable in all EU countries provided the Machines have been announced and made available in such countries.

DENMARK, FINLAND, GREECE, ITALY, LIECHTENSTEIN, NETHERLANDS, NORWAY, PORTUGAL, SPAIN, SWEDEN AND SWITZERLAND

Limitation of Liability:

The following replaces the terms of this section in its entirety:

Except as otherwise provided by mandatory law:

a. IBM's liability for any damages and losses that may arise as a consequence of the fulfillment of its obligations under or in connection with this Statement of Limited Warranty or due to any other cause related to this Statement of Limited Warranty is limited to the compensation of only those damages and losses proved and actually arising as an immediate and direct consequence of the non-fulfillment of such obligations (if IBM is at fault) or of such cause, for a maximum amount equal to the charges you paid for the Machine. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code ("LIC").

   The above limitation shall not apply to damages for bodily injuries (including death) and damages to real property and tangible personal property for which IBM is legally liable.

b. **UNDER NO CIRCUMSTANCES IS IBM, OR ITS SUPPLIERS, SUBCONTRACTORS, OR RESELLERS LIABLE FOR ANY OF THE FOLLOWING, EVEN IF INFORMED OF THEIR POSSIBILITY: 1) LOSS OF, OR DAMAGE TO, DATA; 2) INCIDENTAL OR INDIRECT DAMAGES, OR FOR ANY ECONOMIC CONSEQUENTIAL DAMAGES; 3) LOST PROFITS, EVEN IF THEY ARISE AS AN IMMEDIATE CONSEQUENCE OF THE EVENT THAT GENERATED THE DAMAGES; OR 4) LOSS OF BUSINESS, REVENUE, GOODWILL, OR ANTICIPATED SAVINGS.**

FRANCE AND BELGIUM

Limitation of Liability:

The following replaces the terms of this section in its entirety:

Except as otherwise provided by mandatory law:

a. IBM's liability for any damages and losses that may arise as a consequence of the fulfillment of its obligations under or in connection with this Statement of Limited Warranty is limited in the aggregate to the compensation of only those damages and losses proved and actually arising as an immediate and direct consequence of the non-fulfillment of such obligations (if IBM is at fault), for a maximum amount equal to the charges you paid for the Machine that has caused the damages. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code ("LIC").

   This limit also applies to IBM's suppliers, subcontractors, and resellers. It is the maximum for which IBM and its suppliers, subcontractors and resellers are collectively responsible.

   The above limitation shall not apply to damages for bodily injuries (including death) and damages to real property and tangible personal property for which IBM is legally liable.

b. **UNDER NO CIRCUMSTANCES IS IBM, OR ITS SUPPLIERS, SUBCONTRACTORS, OR RESELLERS LIABLE FOR ANY OF THE FOLLOWING, EVEN IF INFORMED OF THEIR POSSIBILITY: 1) LOSS OF, OR DAMAGE TO, DATA; 2) INCIDENTAL OR INDIRECT DAMAGES, OR FOR ANY ECONOMIC CONSEQUENTIAL DAMAGES; 3) LOST PROFITS, EVEN IF THEY ARISE AS AN IMMEDIATE CONSEQUENCE OF THE EVENT THAT GENERATED THE DAMAGES; OR 4) LOSS OF BUSINESS, REVENUE, GOODWILL, OR ANTICIPATED SAVINGS.**

THE FOLLOWING TERMS APPLY TO THE COUNTRY SPECIFIED:

AUSTRIA AND GERMANY

What this Warranty Covers:

The following replaces the first sentence of the first paragraph of this section:

The warranty for an IBM Machine covers the functionality of the Machine for its normal use and the Machine's conformity to its Specifications.

The following paragraph is added to this section:

The minimum warranty period for Machines is 12 months. In case IBM or your reseller is unable to repair an IBM Machine, you can alternatively ask for a price reduction as far as justified by the reduced value of the unrepaired Machine or ask for a cancellation of the respective agreement for such Machine and get your money refunded.

The second paragraph does not apply.

What IBM Will Do to Correct Problems:

The following is added to this section:

During the warranty period, transportation for the delivery of the failing Machine to IBM will be at IBM's expense.

Limitation of Liability:

The following paragraph is added to this section:

The limitations and exclusions specified in the Statement of Limited Warranty will not apply to damages caused by IBM with fraud or gross negligence and for express warranty.

The following sentence is added to the end of item "b":

IBM's liability under this item is limited to the violation of essential contractual terms in cases of ordinary negligence.

IRELAND

What this Warranty Covers:

The following is added to this section:

Except as expressly provided in these terms and conditions or Section 12 of the Sale of Goods Act 1893 as amended by the Sale of Goods and Supply of Services Act, 1980 ("the 1980 Act"), all conditions or warranties (express or implied, statutory or otherwise) are hereby excluded including, without limitation, any warranties implied by the Sale of Goods Act 1893 as amended by the 1980 Act (including, for the avoidance of doubt, section 39 of the 1980 Act).

Limitation of Liability:

The following replaces the terms of this section in its entirety:

For the purposes of this section, a "Default" means any act, statement, omission, or negligence on the part of IBM in connection with, or in relation to, the subject matter of this Statement of Limited Warranty in respect of which IBM is legally liable to you, whether in contract or tort. A number of Defaults which together result in, or contribute to, substantially the same loss or damage will be treated as one Default occurring on the date of occurrence of the last such Default.

Circumstances may arise where, because of a Default, you are entitled to recover damages from IBM.

This section sets out the extent of IBM's liability and your sole remedy.

a. IBM will accept unlimited liability for death or personal injury caused by the negligence of IBM.

b. Subject always to the **Items for Which IBM is Not Liable** below, IBM will accept unlimited liability for physical damages to your tangible property resulting from the negligence of IBM.

c. Except as provided in items "a" and "b" above, IBM's entire liability for actual damages for any one Default will not in any event exceed the greater of 1) EUR 125,000, or 2) 125% of the amount you paid for the Machine directly relating to the Default.

Items for Which IBM is Not Liable

Save with respect to any liability referred to in item "a" above, under no circumstances is IBM, its suppliers or resellers liable for any of the following, even if IBM or they were informed of the possibility of such losses:

a. loss of, or damage to, data;

b. special, indirect, or consequential loss; or

c. loss of profits, business, revenue, goodwill, or anticipated savings.

SOUTH AFRICA, NAMIBIA, BOTSWANA, LESOTHO AND SWAZILAND

Limitation of Liability:

The following is added to this section:

IBM's entire liability to you for actual damages arising in all situations involving nonperformance by IBM in respect of the subject matter of this Statement of Warranty will be limited to the charge paid by you for the individual Machine that is the subject of your claim from IBM.

TURKEY

What this Warranty Covers:

The following is added to this section:

The minimum warranty period for Machines is 2 years.

UNITED KINGDOM

Limitation of Liability:

The following replaces the terms of this section in its entirety:

For the purposes of this section, a "Default" means any act, statement, omission, or negligence on the part of IBM in connection with, or in relation to, the subject matter of this Statement of Limited Warranty in respect of which IBM is legally liable to you, whether in contract or tort. A number of Defaults which together result in, or contribute to, substantially the same loss or damage will be treated as one Default.

Circumstances may arise where, because of a Default, you are entitled to recover damages from IBM.

This section sets out the extent of IBM's liability and your sole remedy.

a. IBM will accept unlimited liability for:
   1. death or personal injury caused by the negligence of IBM; and
   2. any breach of its obligations implied by Section 12 of the Sale of Goods Act 1979 or Section 2 of the Supply of Goods and Services Act 1982, or any statutory modification or re-enactment of either such Section.

b. IBM will accept unlimited liability, subject always to the Items for Which IBM is Not Liable below, for physical damage to your tangible property resulting from the negligence of IBM.

c. IBM's entire liability for actual damages for any one Default will not in any event, except as provided in items a and b above, exceed the greater of 1) Pounds Sterling 75,000, or 2) 125% of the total purchase price payable or the charges for the Machine directly relating to the Default.

These limits also apply to IBM's suppliers and resellers. They state the maximum for which IBM and such suppliers and resellers are collectively responsible.

Items for Which IBM is Not Liable

Save with respect to any liability referred to in item a above, under no circumstances is IBM or any of its suppliers or resellers liable for any of the following, even if IBM or they were informed of the possibility of such losses:

a. loss of, or damage to, data;

b. special, indirect, or consequential loss;

c. loss of profits, business, revenue, goodwill, or anticipated savings; or

d. third party claims against you for damages.

Part 3 - Warranty Information

Machine Type(s)	Country of Purchase	Warranty Period	Type of Warranty Service*	Service Level*
IBM 3 Gb SAS HBA v2	Worldwide	1 year	1	Not applicable
* See "Types of Warranty Service" and "Service Levels" for explanations of warranty-service types and service levels.				

Scheduling of a warranty service will depend upon the following: 1) the time your request for service is received, 2) Machine technology and redundancy, and 3) availability of parts. Contact your local IBM representative or the subcontractor or reseller performing services on behalf of IBM for country and location specific information.

Types of Warranty Service

Type 1 - Customer Replaceable Unit ("CRU") Service
IBM provides replacement CRUs to you for you to install. CRU information and replacement instructions are shipped with your Machine and are available from IBM at any time on your request. CRUs are designated as being either a Tier 1 (mandatory) or a Tier 2 (optional) CRU. Installation of a Tier 1 CRU is your responsibility. If IBM installs a Tier 1 CRU at your request, you will be charged for the installation. You may install a Tier 2 CRU yourself or request IBM to install it, at no additional charge, under the type of warranty service designated for your Machine. IBM specifies in the materials shipped with a replacement CRU whether a defective CRU must be returned to IBM. When return is required, 1) return instructions and a container are shipped with the replacement CRU, and 2) you may be charged for the replacement CRU if IBM does not receive the defective CRU within 15 days of your receipt of the replacement.

Type 5 - CRU and On-site Service
At IBM's discretion you will receive CRU service or IBM or your reseller will repair the failing Machine at your location and verify its operation. You must provide suitable working area to allow disassembly and reassembly of the IBM Machine. The area must be clean, well lit and suitable for the purpose.

Type 6 - CRU and Courier or Depot Service
At IBM's discretion you will receive CRU service or you will disconnect the failing Machine for collection arranged by IBM. IBM will provide you with a

shipping container for you to return your Machine to a designated service center. A courier will pick up your Machine and deliver it to the designated service center. Following its repair or exchange, IBM will arrange the return delivery of the Machine to your location. You are responsible for its installation and verification of operation.

Type 7 - CRU and Customer Carry-In or Mail-In Service
At IBM's discretion you will receive CRU service or you will deliver or mail as IBM specifies (prepaid unless IBM specifies otherwise) the failing Machine suitably packaged to a location IBM designates. After IBM has repaired or exchanged the Machine, IBM will make it available for your collection or, for Mail-in Service, IBM will return it to you at IBM's expense, unless IBM specifies otherwise. You are responsible for its installation and verification of operation.

Type 8 - CRU and Machine Exchange Service
At IBM's discretion you will receive specified CRU service or IBM will initiate shipment of a replacement Machine to your location. You must pack the failing Machine into the shipping container that contained the replacement Machine and return the failing Machine to IBM. Transportation charges, both ways, are paid by IBM. You may be charged for the replacement Machine if IBM does not receive the failing Machine within 15 days of your receipt of the replacement Machine. You are responsible for its installation and verification of operation.

Service Levels

Service levels specified below are response-time objectives only and are not guarantees. The specified service level may not be available in all worldwide locations. Charges may apply outside IBM's normal service area. Response times are based on local standard business days and working hours. Unless otherwise specified, all responses are measured from the time the customer contacts IBM for problem determination until IBM has resolved the problem remotely or scheduled service to be performed. Same Business Day Warranty Service (SBD) is based on local standard business days and working hours. Next Business Day Warranty Service (NBD) is based on commercially reasonable effort.

IBM encourages you to use available remote support technologies. Failure to install and use available remote connectivity tools and equipment for direct problem reporting, remote problem determination and resolution may result in an increased service level response-time due to resource requirements.

1. Next Business Day (NBD), 9X5
2. Same Business Day (SBD), 9X5
3. Same Day (SD), 24X7

IBM Contact Information

For IBM in Canada or the United States, call 1-800-IBM-SERV (or 1-800-426-7378). For IBM in the European Union (EU), Asia Pacific, and Latin America countries, contact IBM in that country or visit the IBM Directory of Worldwide Contacts at the following IBM Internet website: http://www.ibm.com/planetwide/.

Appendix D. Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

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Other company, product, or service names may be trademarks or service marks of others.

Important notes

Processor speed indicates the internal clock speed of the microprocessor; other factors also affect application performance.

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1024 bytes, MB stands for 1 048 576 bytes, and GB stands for 1 073 741 824 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity can vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives that are available from IBM.

Maximum memory might require replacement of the standard memory with an optional memory module.

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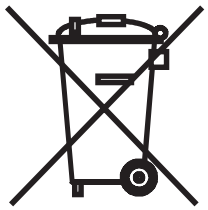
IBM makes no representations or warranties with respect to non-IBM products. Support (if any) for the non-IBM products is provided by the third party, not IBM.

Some software might differ from its retail version (if available) and might not include user manuals or all program functionality.

Product recycling and disposal

This unit must be recycled or discarded according to applicable local and national regulations. IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of product return programs and services in several countries to assist equipment owners in recycling their IT products. Information on IBM product recycling offerings can be found on IBM's Internet sites at http://www.ibm.com/ibm/recycle/us/index.shtml and http://www.ibm.com/ibm/environment/products/index.shtml.

Esta unidad debe reciclarse o desecharse de acuerdo con lo establecido en la normativa nacional o local aplicable. IBM recomienda a los propietarios de equipos de tecnología de la información (TI) que reciclen responsablemente sus equipos cuando éstos ya no les sean útiles. IBM dispone de una serie de programas y servicios de devolución de productos en varios países, a fin de ayudar a los propietarios de equipos a reciclar sus productos de TI. Se puede encontrar información sobre las ofertas de reciclado de productos de IBM en el sitio web de IBM http://www.ibm.com/ibm/recycle/us/index.shtml y http://www.ibm.com/ibm/environment/products/index.shtml.



Notice: This mark applies only to countries within the European Union (EU) and Norway.

This appliance is labeled in accordance with European Directive 2002/96/EC concerning waste electrical and electronic equipment (WEEE). The Directive determines the framework for the return and recycling of used appliances as applicable throughout the European Union. This label is applied to various products to indicate that the product is not to be thrown away, but rather reclaimed upon end of life per this Directive.

注意: このマークは EU 諸国およびノルウェーにおいてのみ適用されます。

この機器には、EU 諸国に対する廃電気電子機器指令 2002/96/EC(WEEE) のラベルが貼られています。この指令は、EU 諸国に適用する使用済み機器の回収とリサイクルの骨子を定めています。このラベルは、使用済みになった時に指令に従って適正な処理をする必要があることを知らせるために種々の製品に貼られています。

Remarque : Cette marque s'applique uniquement aux pays de l'Union Européenne et à la Norvège.

L'etiquette du système respecte la Directive européenne 2002/96/EC en matière de Déchets des Equipements Electriques et Electroniques (DEEE), qui détermine les dispositions de retour et de recyclage applicables aux systèmes utilisés à travers

l'Union européenne. Conformément à la directive, ladite étiquette précise que le produit sur lequel elle est apposée ne doit pas être jeté mais être récupéré en fin de vie.

In accordance with the European WEEE Directive, electrical and electronic equipment (EEE) is to be collected separately and to be reused, recycled, or recovered at end of life. Users of EEE with the WEEE marking per Annex IV of the WEEE Directive, as shown above, must not dispose of end of life EEE as unsorted municipal waste, but use the collection framework available to customers for the return, recycling, and recovery of WEEE. Customer participation is important to minimize any potential effects of EEE on the environment and human health due to the potential presence of hazardous substances in EEE. For proper collection and treatment, contact your local IBM representative.

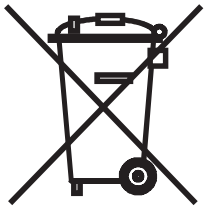
Battery return program

This product may contain a sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or lithium ion battery. Consult your user manual or service manual for specific battery information. The battery must be recycled or disposed of properly. Recycling facilities may not be available in your area. For information on disposal of batteries outside the United States, go to http://www.ibm.com/ibm/environment/products/index.shtml or contact your local waste disposal facility.

In the United States, IBM has established a return process for reuse, recycling, or proper disposal of used IBM sealed lead acid, nickel cadmium, nickel metal hydride, and battery packs from IBM equipment. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333. Have the IBM part number listed on the battery available prior to your call.

For Taiwan: Please recycle batteries.

For the European Union:



Notice: This mark applies only to countries within the European Union (EU).

Batteries or packaging for batteries are labeled in accordance with European Directive 2006/66/EC concerning batteries and accumulators and waste batteries and accumulators. The Directive determines the framework for the return and recycling of used batteries and accumulators as applicable throughout the European

Union. This label is applied to various batteries to indicate that the battery is not to be thrown away, but rather reclaimed upon end of life per this Directive.

Les batteries ou emballages pour batteries sont étiquetés conformément aux directives européennes 2006/66/EC, norme relative aux batteries et accumulateurs en usage et aux batteries et accumulateurs usés. Les directives déterminent la marche à suivre en vigueur dans l'Union Européenne pour le retour et le recyclage des batteries et accumulateurs usés. Cette étiquette est appliquée sur diverses batteries pour indiquer que la batterie ne doit pas être mise au rebut mais plutôt récupérée en fin de cycle de vie selon cette norme.

バッテリーあるいはバッテリー用のパッケージには、EU 諸国に対する廃電気電子機器指令 2006/66/EC のラベルが貼られています。この指令は、バッテリーと蓄電池、および廃棄バッテリーと蓄電池に関するものです。この指令は、使用済みバッテリーと蓄電池の回収とリサイクルの骨子を定めているもので、EU 諸国にわたって適用されます。このラベルは、使用済みになったときに指令に従って適正な処理をする必要があることを知らせるために種々のバッテリーに貼られています。

In accordance with the European Directive 2006/66/EC, batteries and accumulators are labeled to indicate that they are to be collected separately and recycled at end of life. The label on the battery may also include a chemical symbol for the metal concerned in the battery (Pb for lead, Hg for mercury, and Cd for cadmium). Users of batteries and accumulators must not dispose of batteries and accumulators as unsorted municipal waste, but use the collection framework available to customers for the return, recycling, and treatment of batteries and accumulators. Customer participation is important to minimize any potential effects of batteries and accumulators on the environment and human health due to the potential presence of hazardous substances. For proper collection and treatment, contact your local IBM representative.

This notice is provided in accordance with Royal Decree 106/2008 of Spain: The retail price of batteries, accumulators, and power cells includes the cost of the environmental management of their waste.

For California:

Perchlorate material – special handling may apply. See http://www.dtsc.ca.gov/hazardouswaste/perchlorate/.

The foregoing notice is provided in accordance with California Code of Regulations Title 22, Division 4.5 Chapter 33. Best Management Practices for Perchlorate Materials. This product/part may include a lithium manganese dioxide battery which contains a perchlorate substance.

Electronic emission notices

Federal Communications Commission (FCC) statement

Note: 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 when the equipment is operated 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.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Class A emission compliance statement

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

Avis de conformité à la réglementation d'Industrie Canada

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

Australia and New Zealand Class A statement

Attention: 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.

United Kingdom telecommunications safety requirement

Notice to Customers

This apparatus is approved under approval number NS/G/1234/J/100003 for indirect connection to public telecommunication systems in the United Kingdom.

European Union EMC Directive conformance statement

This product is in conformity with the protection requirements of EU Council Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a nonrecommended modification of the product, including the fitting of non-IBM option cards.

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22/European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Attention: 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.

European Community contact:
IBM Technical Regulations
Pascalstr. 100, Stuttgart, Germany 70569

Telephone: 0049 (0)711 785 1176
Fax: 0049 (0)711 785 1283
E-mail: tjahn@de.ibm.com

Taiwanese Class A warning statement

警告使用者:
這是甲類的資訊產品，在
居住的環境中使用時，可
能會造成射頻干擾，在這
種情況下，使用者會被要
求採取某些適當的對策。

Chinese Class A warning statement

声　　明
此为 A 级产品。在生活环境中，
该产品可能会造成无线电干扰。
在这种情况下，可能需要用户对其
干扰采取切实可行的措施。

Japanese Voluntary Control Council for Interference (VCCI) statement

この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に
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引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求
されることがあります。

Korean Class A warning statement

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이오니, 판매자 또는 사용자는 이점을 주의하시기
바라며, 만약 잘못 구입하셨을 때에는 구입한 곳에
서 비업무용으로 교환하시기 바랍니다.

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