MegaRAID® and MegaRAID Enterprise 1200 Hardware Guide

MAN-MR-HW
10/2/99

American Megatrends, Inc.
6145F Northbelt Parkway
Norcross, GA 30071

Revision History

3/2/96 Initial release.
4/1/96 Revised manual to reflect revised MegaRAID Manager.
7/1/96 Updated list of compatible SCSI devices.
10/31/96 Corrected J15 pinout.
2/11/97 Added additional RAID overview information.
4/7/97 Corrections to the manual.
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1/16/98 Folded FlexRAID section into Power Console section.
2/6/98 Added new memory specification information.
7/29/98 Removed references to Banyan Vines and Sun Solaris.
8/12/98 Updated glossary.
9/22/99 Corrected the Cache Memory information on pages 32 and 33.
10/2/99 Changed product name in title to Enterprise 1200.

Table of Contents

The MegaRAID PCI Disk Array Controller supports one, two, or three Ultra and Wide SCSI channels with data transfer rates up to 40 MBs. This manual describes MegaRAID and MegaRAID Enterprise 1200.

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Cont'd

Package Contents You should have received:

- a MegaRAID Enterprise 1200 PCI SCSI Disk Array Controller,
- a CD with drivers, utilities and documentation,
- a *MegaRAID and MegaRAID Enterprise 1200 Hardware Guide* (on CD),
- a *MegaRAID Configuration Software Guide* (on CD),
- a *MegaRAID Operation System Drivers Guide* (on CD),
- a software license agreement (on CD), and
- a warranty registration card (on CD.)

Technical Support If you need help installing, configuring, or running the MegaRAID PCI SCSI Disk Array Controller, call American Megatrends technical support at 770-246-8600. Before you call, please complete the ***MegaRAID Problem Report*** form on the next page.

Web Site We invite you to access the American Megatrends world wide web site at:

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MegaRAID Problem Report Form

Customer Information	MegaRAID Information
Name	Today's Date
Company	Date of Purchase
Address	Invoice Number
City/State	Serial Number
Country	Number of Channels
email address	Cache Memory
Phone	Firmware Version
Fax	BIOS Version
System Information	
Motherboard:	BIOS manufacturer:
Operating System:	BIOS Date:
Op. Sys. Ver.:	Video Adapter:
MegaRAID Driver Ver.:	CPU Type/Speed:
Network Card:	System Memory:
Other disk controllers installed:	Other adapter cards installed:
Description of problem:	
Steps necessary to re-create problem: 1. 2. 3. 4.	

Logical Drive Configuration

Logical Drive	RAID Level	Stripe Size	Logical Drive Size	Cache Policy	Read Policy	Write Policy	# of Physical Drives
LD1							
LD2							
LD3							
LD4							
LD5							
LD6							
LD7							
LD8							

Physical Device Layout

	Channel 1	Channel 2	Channel 3
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			

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Disclaimer

AMI certifies only that this product will work correctly when this product is used with the same jumper settings, the same system configuration, the same memory module parts, and the same peripherals that were tested by AMI with this product. The complete list of tested jumper settings, system configurations, peripheral devices, and memory modules are documented in the AMI Compatibility Report for this product. Call your AMI sales representative for a copy of the Compatibility Report for this product.

FCC Regulatory Statement

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.

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

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a specific installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, try to correct the interference by one or more of the following measures:

1) Reorient or relocate the receiving antenna.
2) Increase the separation between the equipment and the receiver.
3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4) Consult the dealer or an experienced radio/TV technician for help.

Shielded interface cables must be used with this product to ensure compliance with the Class B FCC limits.

American Megatrends MegaRAID PCI SCSI Disk Array Controller
Model Number: Series 428, 418, or 412

FCC ID Number: IUESER418 or IUESER412.

1 Overview

The MegaRAID® and MegaRAID Enterprise 1200 PCI SCSI Disk Array Controllers are high performance intelligent PCI-to-SCSI host adapters with RAID control capabilities. MegaRAID provides reliability, high performance, and fault-tolerant disk subsystem management. MegaRAID has one, two, or three Ultra and Wide SCSI channels, supporting data transfer rates up to 40 Megabytes per second (MBs) per channel. Each SCSI channel supports up to fifteen non-Ultra SCSI devices.

Documentation

The American Megatrends MegaRAID controller documentation set includes:

- the *MegaRAID Enterprise 1200 Hardware Guide,*
- the *MegaRAID Enterprise 1200 Configuration Software Guide,*
- the *MegaRAID Enterprise 1200 Operation System Drivers Guide,*
- the optional *MegaRAID Clustering Software Guide,*
- the optional *MegaRAID Power Console Client User's Guide,* and
- the optional *General Alert Module User's Guide.*

Using MegaRAID Manuals This manual contains the RAID overview, RAID planning, and RAID system configuration information you will need first. Read the *MegaRAID and MegaRAID Enterprise 1200 Hardware Guide* first.

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MegaRAID Configuration Software Guide The MegaRAID Configuration Software Guide contains information about MegaRAID software utilities

MegaRAID Operating System Drivers Guide This manual describes the installation procedure for all MegaRAID operating system drivers. Operating system drivers are provided for:

- MS-DOS version 5.0 or later,
- Windows NT V3.5 and V4.x,
- Windows 95 and Windows 3.x
- Novell NetWare 3.1x and 4.x,
- OS/2 2.x, Warp v3.0, and v4.x,
- SCO UnixWare 2.x, and
- SCO Unix SVR3.2 Release 4.2 ODT 3.0 and 5.0x.

The MegaRAID utilities are used to configure and modify RAID systems. The software utilities include:

- MegaRAID BIOS Setup,
- MegaRAID Manager, and
- Power Console.

Clustering Software Guide The MegaRAID Clustering software utility provides OEM-optional firmware with multi-initiator support. This software provides high system availability by permitting server failover.

Power Console Client Guide Power Console Client allows you to configure and modify RAID systems from a client computer over any TCP/IP line. The optional Power Console Client utility allows you to manage and control RAID systems from any computer connected to the RAID server. See the *Power Console Client Guide* for additional information.

General Alert Guide The General Alert utility provides notification methods to alert you to changing system conditions. pager, program, fax, SNMP, network, audio, email, or native log. See the *General Alert Guide* for additional information.

2 Introduction to RAID

RAID (Redundant Array of Independent Disks) is an array of multiple independent hard disk drives that provide high performance and fault tolerance. A RAID disk subsystem improves I/O performance over a computer using only a single drive. The RAID array appears to the host computer as a single storage unit or as multiple logical units. I/O is expedited because several disks can be accessed simultaneously. RAID systems improve data storage reliability and fault tolerance compared to single-drive computers. Data loss because of a disk drive failure can be prevented by reconstructing missing data from the remaining data and parity drives.

RAID Benefits

RAID has gained popularity because it: improves I/O performance, and increases storage subsystem reliability. RAID provides data security through fault tolerance and redundant data storage. The MegaRAID management software configures and monitors RAID disk arrays.

Improved I/O Although disk drive capabilities have improved drastically, actual performance has improved only three to four times in the last decade. Computing performance has improved over 50 times during the same time period.

Increased Reliability The electromechanical components of a disk subsystem operate more slowly, require more power, and generate more noise and vibration than electronic devices. These factors reduce the reliability of data stored on disks.

In This Chapter

The following topics are discussed:

MegaRAID is a Host-Based RAID Solution

RAID products are either:

- host-based or
- SCSI-to-SCSI.

The MegaRAID controller is a host-based RAID solution. MegaRAID is a PCI adapter card that is installed in any available PCI expansion slot in a host system.

Host-Based

A host-based RAID product puts all of the RAID intelligence on an adapter card that is installed in a network server. A host-based RAID product provides the best performance. MegaRAID is part of the file server, so it can transmit data directly across the computer's buses at data transfer speeds up to 132 MBs. The actual data transfer speed is determined by the number and type of SCSI channels and is usually between 20 and 40 MBs.

Host-based solutions must provide operating system-specific drivers.

SCSI-to-SCSI

A SCSI-to-SCSI RAID product puts the RAID intelligence inside the RAID chassis and uses a plain SCSI Host Adapter installed in the network server. The data transfer rate is limited to the bandwidth of the SCSI channels. A SCSI-to-SCSI RAID product that has two wide SCSI channels that operate at speeds up to 40 MBs must squeeze the data into a single wide SCSI (20 MBs) channel back to the Host computer.

In SCSI-to-SCSI RAID products, the hard drive subsystem uses only a single SCSI ID, which allows you to connect multiple drive subsystems to a single SCSI controller.

RAID Overview

RAID (Redundant Array of Independent Disks) is a collection of specifications that describe a system for ensuring the reliability and stability of data stored on large disk subsystems. A RAID system can be implemented in a number of different versions (or RAID Levels). The standard RAID levels are 0, 1, 3, and 5. MegaRAID supports all standard RAID levels and RAID levels 10, 30, and 50, special RAID versions supported by MegaRAID.

Consistency Check

In RAID, check consistency verifies the correctness of redundant data in an array. For example, in a system with dedicated parity, checking consistency means computing the parity of the data drives and comparing the results to the contents of the dedicated parity drive.

Fault Tolerance

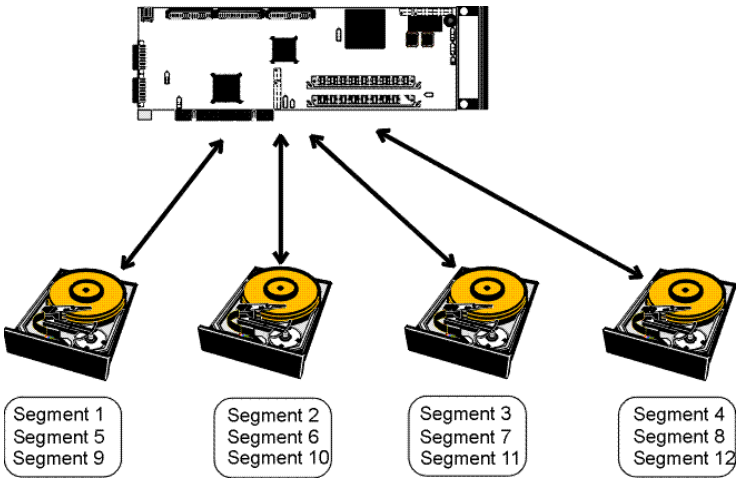
Fault tolerance is achieved through cooling fans, power supplies, and the ability to hot swap drives. MegaRAID provides hot swapping through the hot spare feature. A hot spare drive is an unused online available drive that MegaRAID instantly plugs into the system when an active drive fails.

After the hot spare is automatically moved into the RAID subsystem, the failed drive is automatically rebuilt. The RAID disk array continues to handle request while the rebuild occurs.

Disk Striping

Disk striping writes data across multiple disk drives instead of just one disk drive. Disk striping involves partitioning each drive storage space into stripes that can vary in size from 2 KB to 128 KB. These stripes are interleaved in a repeated sequential manner. The combined storage space is composed of stripes from each drive. MegaRAID supports stripe sizes of 2 KB, 4 KB, 8 KB, 16 KB, 32 KB, 64 KB, or 128 KB.

For example, in a four-disk system using only disk striping (as in RAID level 0), segment 1 is written to disk 1, segment 2 is written to disk 2, and so on. Disk striping enhances performance because multiple drives are accessed simultaneously; but disk striping does not provide data redundancy.



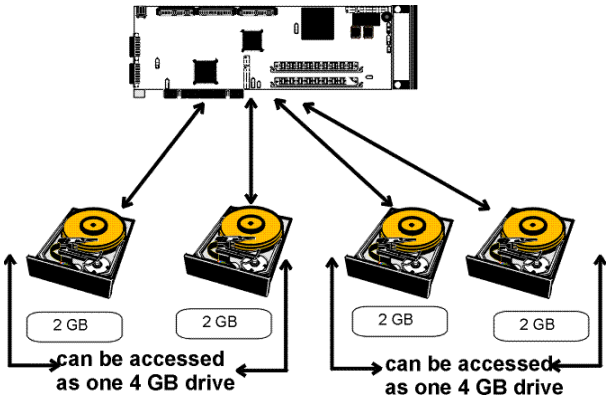
Stripe Width Stripe width is the number of disks involved in an array where striping is implemented. For example, a four-disk array with disk striping has a stripe width of four.

Stripe Size The stripe size is the length of the interleaved data segments that MegaRAID writes across multiple drives. MegaRAID supports stripe sizes of 2 KB, 4 KB, 8 KB, 16 KB, 32 KB, 64 KB, or 128 KB.

Disk Spanning

Disk spanning allows multiple disk drives to function like one big drive. Spanning overcomes lack of disk space and simplifies storage management by combining existing resources or adding relatively inexpensive resources. For example, four 400 MB disk drives can be combined to appear to the operating system as one single 1600 MB drive.

Spanning alone does not provide reliability or performance enhancements. Spanned logical drives must have the same stripe size and must be contiguous. In the following graphic, RAID 1 array is turned into a RAID 10 array.



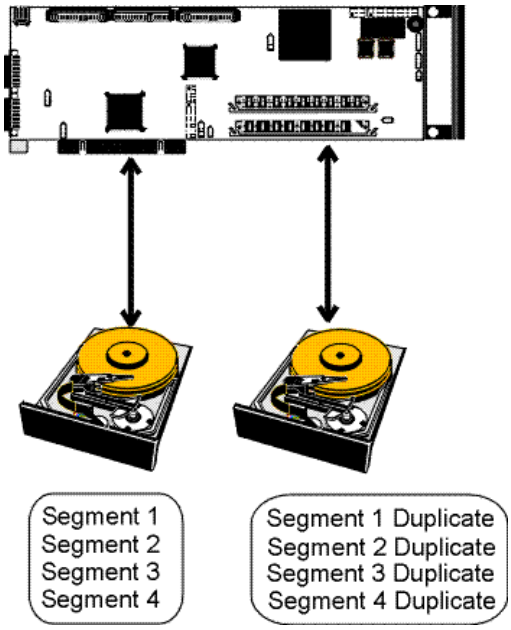
Spanning for RAID 10, RAID 30, or RAID 50

Level	Description
10	Configure RAID 10 by spanning two contiguous RAID 1 logical drives. The RAID 1 logical drives must have the same stripe size.
30	Configure RAID 30 by spanning two contiguous RAID 3 logical drives. The RAID 3 logical drives must have the same stripe size.
50	Configure RAID 50 by spanning two contiguous RAID 5 logical drives. The RAID 5 logical drives must have the same stripe size.
Note:	Spanning two contiguous RAID 0 logical drives does not produce a new RAID level or add fault tolerance. It does increase the size of the logical volume and improves performance by doubling the number of spindles.

Disk Mirroring

With mirroring (used in RAID 1), data written to one disk drive is simultaneously written to another disk drive. If one disk drive fails, the contents of the other disk drive can be used to run the system and reconstruct the failed drive. The primary advantage of disk mirroring is that it provides 100% data redundancy. Since the contents of the disk drive are completely written to a second drive, it does not matter if one of the drives fails. Both drives contain the same data at all times. Either drive can act as the operational drive.

Disk mirroring provides 100% redundancy, but is expensive because each drive in the system must be duplicated.



Parity

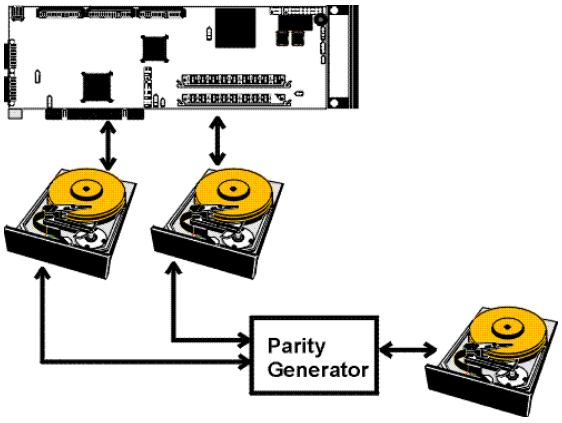
Parity generates a set of redundancy data from two or more parent data sets. The redundancy data can be used to reconstruct one of the parent data sets. Parity data does not fully duplicate the parent data sets. In RAID, this method is applied to entire drives or stripes across all disk drives in an array. The types of parity are:

Type	Description
Dedicated Parity	The parity of the data on two or more disk drives is stored on an additional disk.
Distributed Parity	The parity data is distributed across all drives in the system.

If a single disk drive fails, it can be rebuilt from the parity and the data on the remaining drives.

RAID level 3 combines dedicated parity with disk striping. The parity disk in RAID 3 is the last logical drive in a RAID set.

RAID level 5 combines distributed parity with disk striping. Parity provides redundancy for one drive failure without duplicating the contents of entire disk drives, but parity generation can slow the write process. A dedicated parity scheme during normal read/write operations is shown below:



Hot Spares

A hot spare is an extra, unused disk drive that is part of the disk subsystem. It is usually in standby mode, ready for service if a drive fails. Hot spares permit you to replace failed drives without system shutdown or user intervention.

MegaRAID implements automatic and transparent rebuilds using hot spare drives, providing a high degree of fault tolerance and zero downtime. The MegaRAID RAID Management software allows you to specify physical drives as hot spares. When a hot spare is needed, the MegaRAID controller assigns the hot spare that has a capacity closest to and at least as great as that of the failed drive to take the place of the failed drive.

Important

Hot spares are only employed in arrays with redundancy, for example, RAID levels 1, 3, 5, 10, 30, and 50.

A hot spare connected to a specific MegaRAID controller can only be used to rebuild a drive that is connected to the same controller.

Disk Rebuild

You rebuild a disk drive by recreating the data that had been stored on the drive before the drive failed.

Rebuilding can be done only in arrays with data redundancy such as RAID level 1, 3, 5, 10, 30, and 50.

Standby (warm spare) rebuild is employed in a mirrored (RAID 1) system. If a disk drive fails, an identical drive is immediately available. The primary data source disk drive is the original disk drive.

A hot spare can be used to rebuild disk drives in RAID 1, 3, 5, 10, 30, or 50 systems. If a hot spare is not available, the failed disk drive must be replaced with a new disk drive so that the data on the failed drive can be rebuilt.

The MegaRAID controller automatically and transparently rebuilds failed drives with user-definable rebuild rates. If a hot spare is available, the rebuild starts automatically when a drive fails. MegaRAID automatically restarts the system and the rebuild if the system goes down during a rebuild.

Rebuild Rate

The rebuild rate is the fraction of the compute cycles dedicated to rebuilding failed drives. A rebuild rate of 100 percent means the system is totally dedicated to rebuilding the failed drive.

The MegaRAID rebuild rate can be configured between 0% and 100%. At 0%, the rebuild is only done if the system is not doing anything else. At 100%, the rebuild has a higher priority than any other system activity.

Physical Array

A RAID array is a collection of physical disk drives governed by the RAID management software. A RAID array appears to the host computer as one or more logical drives.

Logical Drive

A logical drive is a partition in a physical array of disks that is made up of contiguous data segments on the physical disks. A logical drive can consist of any of the following:

- an entire physical array,
- more than one entire physical array,
- a part of an array,
- parts of more than one array, or
- a combination of any two of the above conditions.

Hot Swap

A hot swap is the manual replacement of a defective physical disk unit while the computer is still running. When a new drive has been installed, you must issue a command to rebuild the drive. MegaRAID can be configured to detect the new disks via fault bus signals and to rebuild the contents of the disk drive automatically.

SCSI Drive States

A SCSI disk drive can be in one of these states:

State	Description
Online (ONLIN)	The drive is functioning normally and is a part of a configured logical drive.
Ready (READY)	The drive is functioning normally but is not part of a configured logical drive and is not designated as a hot spare.
Hot Spare (HOTSP)	The drive is powered up and ready for use as a spare in case an online drive fails.
Fail (FAIL)	A fault has occurred in the drive placing it out of service.
Rebuild (REB)	The drive is being rebuilt with data from a failed drive.

Logical Drive States

State	Description
Optimal	The drive operating condition is good. All configured drives are online
Degraded	The drive operating condition is not optimal. One of the configured drives has failed or is offline.
Failed	The drive has failed.
Offline	The drive is not available to MegaRAID.

Fault Bus

The fault bus is a hardware interface between the host computer and the disk subsystem. The fault bus communicates subsystem error conditions. It improves fault tolerance by providing access to the disk subsystem from any server or connected node. The MegaRAID and MegaRAID Enterprise 1200 has a 26-pin fault bus connector that informs the controller about subsystem fault conditions, such as a device or power supply failure. The MegaRAID and MegaRAID Enterprise 1200 also has a 10-pin standard RS-232C serial connector for communicating with disk subsystems.

The MegaRAID and MegaRAID Enterprise 1200 complies with the SAF-TE (SCSI Accessed Fault-Tolerant Enclosure) protocol for reporting enclosure environmental information.

Disk Array Types

The RAID disk array types are:

Type	Description
Software-Based	The array is managed by software running in a host computer using the host CPU bandwidth. The disadvantages associated with this method are the load on the host CPU and the need for different software for each operating system.
SCSI to SCSI	The array controller resides outside of the host computer and communicates with the host through a SCSI adapter in the host. The array management software runs in the controller. It is transparent to the host and independent of the host operating system. The disadvantage is the limited data transfer rate of the SCSI channel between the SCSI adapter and the array controller.
Bus-Based	The array controller resides on the bus (for example, a PCI or EISA bus) in the host computer and has its own CPU to generate the parity and handle other RAID functions. A bus-based controller can transfer data at the speed of the host bus (PCI, ISA, EISA, VL-Bus) but is limited to the bus it is designed for. MegaRAID resides on a PCI bus, which can handle data transfer at up to 132 MBs. With MegaRAID, each channel can handle data transfer rates up to 40 MBs per SCSI channel.

Enclosure Management

Enclosure management is the intelligent monitoring of the disk subsystem by software and/or hardware.

The disk subsystem can be part of the host computer or separate from it. Enclosure management helps you stay informed of events in the disk subsystem, such as a drive or power supply failure. Enclosure management increases the fault tolerance of the disk subsystem.

3 RAID Levels

There are six official RAID levels (RAID 0 through RAID 5). MegaRAID supports RAID levels 0, 1, 3, and 5. American Megatrends has designed three additional RAID levels (10, 30, and 50) that provide additional benefits. The RAID levels that MegaRAID supports are:

RAID Level	Type	turn to
0	Standard	page 19
1	Standard	page 20
3	Standard	page 21
5	Standard	page 23
10	MegaRAID only	page 24
30	MegaRAID only	page 25
50	MegaRAID only	page 26

Select RAID Level To ensure the best performance, you should select the optimal RAID level when you create a system drive. The optimal RAID level for your disk array depends on a number of factors:

- the number of drives in the disk array,
- the capacity of the drives in the array,
- the need for data redundancy, and
- the disk performance requirements.

Selecting a RAID Level The factors you need to consider when selecting a RAID level are listed on the next page

Selecting a RAID Level

	Description and Use	Pros	Cons	Max. Drives	Fault Tolerant
0	Data divided in blocks and distributed sequentially (pure striping). Use for non-critical data that requires high performance.	High data throughput for large files	No fault tolerance. All data lost if any drive fails.	One to 32	No
1	Data duplicated on another disk (mirroring). Use for read-intensive fault-tolerant systems	100% data redundancy	Doubles disk space. Reduced performance during rebuilds.	2, 4, 6, or 8	Yes
3	Disk striping with a dedicated parity drive. Use for non-interactive apps that process large files sequentially.	Achieves data redundancy at low cost	Performance not as good as RAID 1	Three to eight	Yes
5	Disk striping and parity data across all drives. Use for high read volume but low write volume, such as transaction processing.	Achieves data redundancy at low cost	Performance not as good as RAID 1	Three to eight	Yes
10	Data striping and mirrored drives.	High data transfers, complete redundancy	More complicated	4, 6, or 8	Yes
30	Disk striping with a dedicated parity drive.	High data transfers, redundancy	More complicated	Six to 32	Yes
50	Disk striping and parity data across all drives.	High data transfers, redundancy	More complicated	Six to 32	Yes

RAID 0

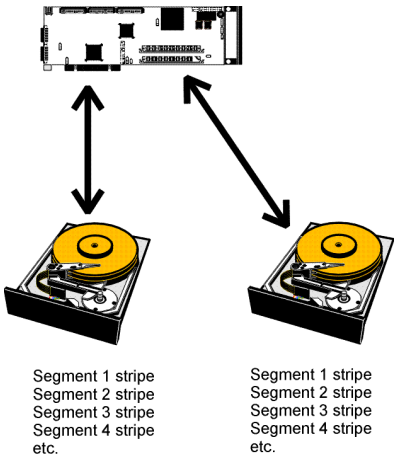
Raid 0 provides disk striping across all drives in the RAID subsystem. RAID 0 does not provide any data redundancy, but does offer the best performance of any RAID level. RAID 0 breaks up data into smaller blocks and then writes a block to each drive in the array. The size of each block is determined by the stripe size parameter, set during the creation of the RAID set. RAID 0 offers high bandwidth. By breaking up a large file into smaller blocks, MegaRAID can use multiple SCSI channels and drives to read or write the file faster. RAID 0 involves no parity calculations to complicate the write operation. This makes RAID 0 ideal for applications that require high bandwidth but do not require fault tolerance.

Uses RAID 0 provides high data throughput, especially for large files. Any environment hat does not require fault tolerance.

Strong Points Provides increased data throughput for large files. No capacity loss penalty for parity.

Weak Points Does not provide fault tolerance. All data lost if any drive fails.

Drives One to 32



RAID 1

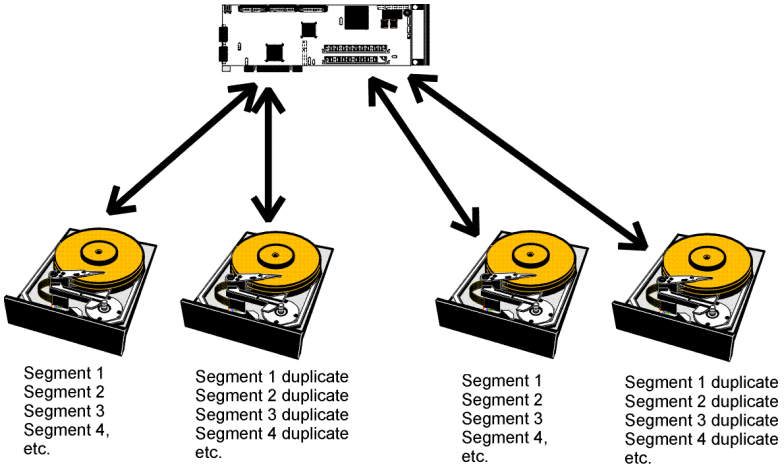
In RAID 1, MegaRAID duplicates all data from one drive to a second drive. RAID 1 provides complete data redundancy, but at the cost of doubling the required data storage capacity.

Uses Use RAID 1 for small databases or any other environment that requires fault tolerance but small capacity.

Strong Points RAID 1 provides complete data redundancy. RAID 1 is ideal for any application that requires fault tolerance and minimal capacity.

Weak Points RAID 1 requires twice as many disk drives. Performance is impaired during drive rebuilds.

Drives 2, 4, 6, or 8 drives.



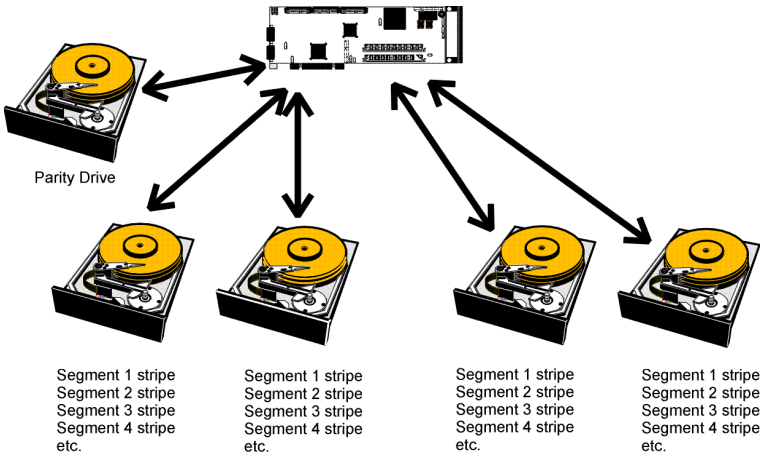
RAID 3

Raid 3 provides disk striping and complete data redundancy though a dedicated parity drive. The stripe size must be 64 KB if RAID 3 is used. RAID 3 handles data at the block level, not the byte level, so it is ideal for networks that often handle very large files, such as graphic images. RAID 3 breaks up data into smaller blocks, calculates parity by performing an exclusive-or on the blocks, and then writes the blocks to all but one drive in the array. The parity data created during the exclusive-or is then written to the last drive in the array. The size of each block is determined by the stripe size parameter, which is set during the creation of the RAID set.

If a single drive fails, a RAID 3 array continues to operate in degraded mode. If the failed drive is a data drive, writes will continue as normal, except no data is written to the failed drive. Reads reconstruct the data on the failed drive by performing an exclusive-or operation on the remaining data in the stripe and the parity for that stripe. If the failed drive is a parity drive, writes will occur as normal, except no parity is written. Reads retrieve data from the disks.

Uses	Best suited for applications such as graphics, imaging, or video that call for reading and writing huge, sequential blocks of data.
Strong Points	Provides data redundancy and high data transfer rates.
Weak Points	The dedicated parity disk is a bottleneck with random I/O.
Drives	Three to eight

Cont’d



RAID 5 vs RAID 3 You may find that RAID 5 is preferable to RAID 3 even for applications characterized by sequential reads and writes, because MegaRAID has very robust caching algorithms and hardware based exclusive-or assist.

The benefits of RAID 3 disappear if there are many small I/O operations scattered randomly and widely across the disks in the logical drive. The RAID 3 fixed parity disk becomes a bottleneck in such applications. For example: The host attempts to make two small writes and the writes are widely scattered, involving two different stripes and different disk drives. Ideally both writes should take place at the same time. But this is not possible in RAID 3, since the writes must take turns accessing the fixed parity drive. For this reason, RAID 5 is the clear choice in this scenario.

RAID 5

Raid 5 includes disk striping at the byte level and parity. In RAID 5, the parity information is written to several drives. RAID 5 is best suited for networks that perform a lot of small I/O transactions simultaneously.

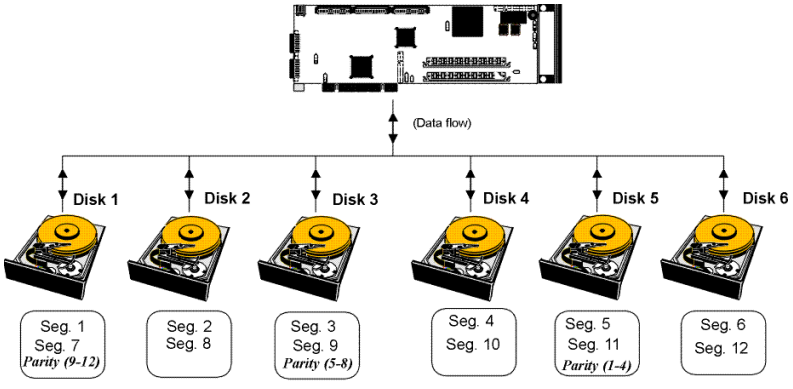
RAID 5 addresses the bottleneck issue for random I/O operations. Since each drive contains both data and parity numerous writes can take place concurrently. In addition, robust caching algorithms and hardware based exclusive-or assist make RAID 5 performance exceptional in many different environments.

Uses RAID 5 provides high data throughput, especially for large files. Use RAID 5 for transaction processing applications because each drive can read and write independently. If a drive fails, MegaRAID uses the parity drive to recreate all missing information. Use also for office automation and online customer service that requires fault tolerance. Use for any application that has high read request rates but low write request rates.

Strong Points Provides data redundancy and good performance in most environments

Weak Points Disk drive performance will be reduced if a drive is being rebuilt. Environments with few processes do not perform as well because the RAID overhead is not offset by the performance gains in handling simultaneous processes.

Drives Three to eight



Parity is distributed across all drives in array.

RAID 10

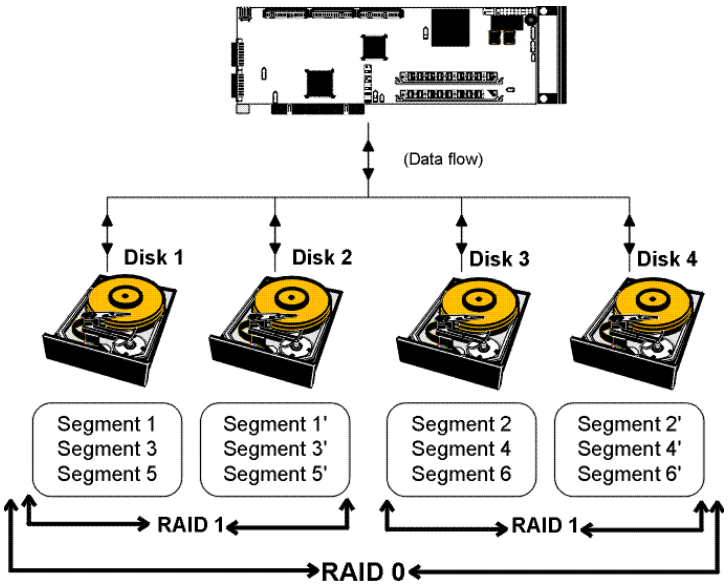
Raid 10 is a combination of RAID 0 and RAID 1. RAID 10 has mirrored drives. RAID 10 breaks up data into smaller blocks, and then stripes the blocks of data to each RAID 1 raid set. Each RAID 1 raid set then duplicates its data to its other drive. The size of each block is determined by the stripe size parameter, which is set during the creation of the RAID set. RAID 10 can sustain one to four drive failures while maintaining data integrity if each failed disk is in a different RAID 1 array.

Uses RAID 10 works best for data storage that must have 100% redundancy of mirrored arrays and that also needs the enhanced I/O performance of RAID 0 (striped arrays). RAID 10 works well for medium-sized databases or any environment that requires a higher degree of fault tolerance and moderate to medium capacity.

Strong Points RAID 10 provides both high data transfer rates and complete data redundancy.

Weak Points RAID 10 requires twice as many drives as all other RAID levels except RAID 1.

Drives 2n, where n is greater than 1.



RAID 30

Raid 30 is a combination of RAID 0 and RAID 3. RAID 30 provides high data transfer speeds and high data reliability. RAID 30 is best implemented on two RAID 3 disk arrays with data striped across both disk arrays. RAID 30 breaks up data into smaller blocks, and then stripes the blocks of data to each RAID 3 raid set. RAID 3 breaks up data into smaller blocks, calculates parity by performing an exclusive-or on the blocks, and then writes the blocks to all but one drive in the array. The parity data created during the exclusive-or is then written to the last drive in each RAID 3 array. The size of each block is determined by the stripe size parameter, which is set during the creation of the RAID set.

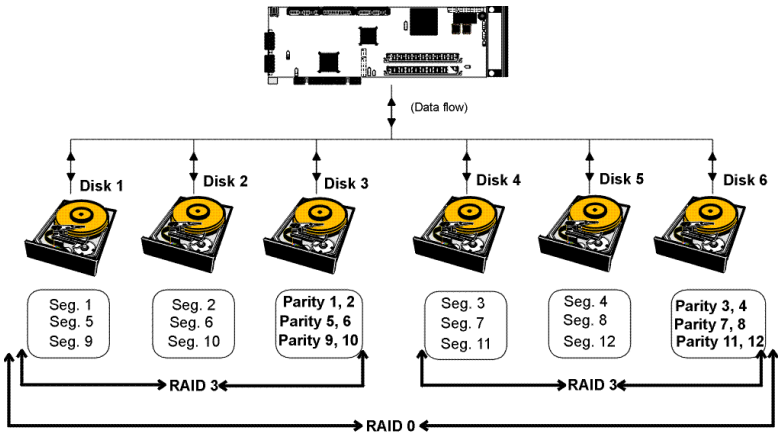
RAID 30 can sustain one to four drive failures while maintaining data integrity if each failed disk is in a different RAID 3 array.

Uses Use RAID 30 for sequentially written and read data, pre-press and video on demand that requires a higher degree of fault tolerance and medium to large capacity.

Strong Points Provides data reliability and high data transfer rates.

Weak Points Requires 2 – 4 times as many parity drives as RAID 3.

Drives Six to 32



RAID 50

Raid 50 provides the features of both RAID 0 and RAID 5. RAID 50 includes both parity and disk striping across multiple drives. RAID 50 is best implemented on two RAID 5 disk arrays with data striped across both disk arrays. RAID 50 breaks up data into smaller blocks, and then stripes the blocks of data to each RAID 5 raid set. RAID 5 breaks up data into smaller blocks, calculates parity by performing an exclusive-or on the blocks, and then writes the blocks of data and parity to each drive in the array. The size of each block is determined by the stripe size parameter, which is set during the creation of the RAID set.

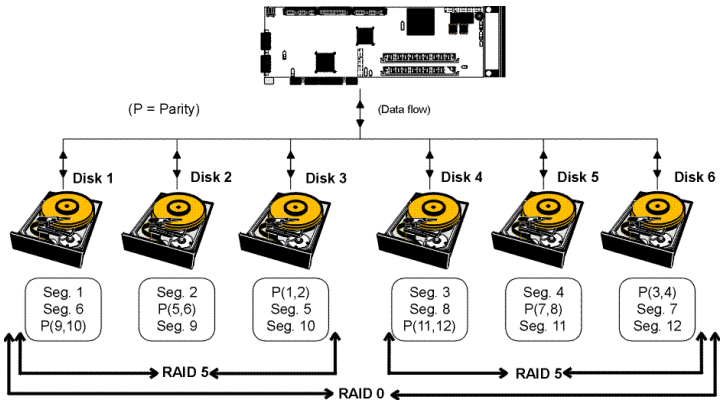
RAID 50 can sustain one to four drive failures while maintaining data integrity if each failed disk is in a different RAID 5 array.

Uses RAID 50 works best when used with data that requires high reliability, high request rates, and high data transfer and medium to large capacity.

Strong Points RAID 50 provides high data throughput, data redundancy, and very good performance.

Weak Points Requires 2 to 4 times as many parity drives as RAID 5.

Drives Six to 32



4 MegaRAID Features

MegaRAID is a family of high performance intelligent PCI-to-SCSI host adapters with RAID control capabilities. MegaRAID has 1, 2, or 3 SCSI channels that support Ultra and Wide SCSI, with data transfer rates of up to 40 MBs per SCSI channel. Each SCSI channel supports up to 15 Wide devices and up to seven non-Wide devices.

In This Chapter Topics described in this chapter include:

- new features,
- configuration features,
- hardware architecture features,
- array performance features,
- RAID management features,
- fault tolerance features,
- utility programs, and
- software drivers.

New Features

The newest MegaRAID features include:

- SMART technology, and
- Configuration on disk.

SMART Technology The MegaRAID Self Monitoring Analysis and Reporting Technology (SMART) detects up to 70% of all predictable drive failures. SMART monitors the internal performance of all motors, heads, and drive electronics. You can recover from drive failures through remapping and online physical drive migration.

Configuration on Disk Configuration on Disk (drive roaming) saves configuration information both in NVRAM on MegaRAID and on the disk drives connected to MegaRAID. If MegaRAID is replaced, the new MegaRAID controller can detect the actual RAID configuration, maintaining the integrity of the data on each drive, even if the drives have changed channel and/or target ID.

Hardware Requirements

MegaRAID can be installed in an IBM AT®-compatible or EISA computer that has 5 volt PCI expansion slots. The computer must support PCI version 2.0 or later. The computer should have an Intel Pentium, Pentium Pro, Pentium II, or more powerful CPU, a floppy drive, a color monitor and VGA adapter card, and a keyboard. A mouse is recommended.

Configuration Features

Specification	Feature
RAID Levels	0, 1, 3, 5, 10, 30, and 50.
SCSI Channels	1, 2, or 3
Maximum number of drives per channel	15
Array interface to host	PCI 2.1
Drive interface	Fast and Wide Ultra SE (SCSI 3)
Upgradable cache size	4 MB, 8 MB, 16 MB, 32 MB, 64 MB, or 128 MB
Cache Function	Write-through, write-back, ARA, NRA, RA
Multiple logical drives/arrays per controller	Up to 8 logical drives per controller
Maximum number of MegaRAID controller per system	4
Online capacity expansion	Yes
Dedicated and pool hot spare	Yes
Flashable firmware	Yes
Hot swap devices supported	Yes
Non-disk devices supported	Yes
Bootable CD-ROM supported	Yes
Mixed capacity hard disk drives	Yes
Number of 16-bit internal connectors	3
Number of 8-bit internal connectors	3
Number of 16-bit external connectors	2
Support for hard disk drives with capacities of more than 8 GB.	Yes
Clustering support (Failover control)	Yes
Online RAID level migration	Yes
RAID remapping	Yes
No reboot necessary after expansion	Yes
More than 200 Qtags per physical drive	Yes
User-specified rebuild rate	Yes

Hardware Architecture Features

The MegaRAID hardware architecture features include:

Specification	Feature
Processor	Intel i960-33
SCSI Controller	Symbios Logic 53C875
AMI ASIC	MG9010
Size of Flash ROM	256 KB
Amount of NVRAM	8 KB
Direct I/O	Yes
Removable battery backed cache memory module	Yes
SCSI bus termination	Active, single-ended
Auxiliary TermPWR source	Yes
Direct I/O bandwidth	132 MBs

Array Performance Features

The MegaRAID array performance features include:

Specification	Feature
Host data transfer rate	132 MBs
Drive data transfer rate	20 or 40 MBs
Maximum Scatter/Gathers	26 elements
Maximum size of I/O requests	6.4 MB in 64 KB stripes
Maximum Queue Tags per drive	211
Stripe Sizes	2 KB, 4 KB, 8 KB, 16 KB, 32 KB, 64 KB, or 128 KB
Maximum number of concurrent commands	255
Support for multiple initiators	Yes

RAID Management Features

The MegaRAID RAID management features include:

Specification	Feature
Support for SNMP	Yes
Performance Monitor provided	Yes
Remote control and monitoring	Yes
Event broadcast and event alert	Yes
Hardware connector	RS232C and DEC fault bus
Drive roaming	Yes
Support for concurrent multiple stripe sizes	Yes
Web-based management tools	Yes
Windows NT and NetWare server support via GUI client utility	Yes
SCO Unix, OS/2, and UnixWare server support via GUI client utility	Yes
DMI support	Yes
Management through an industry-standard browser	Yes

Fault Tolerance Features

The MegaRAID fault tolerance features include:

Specification	Feature
Support for SMART	Yes
Enclosure management	SAF-TE compliant
Drive failure detection	Automatic
Drive rebuild using hot spares	Automatic
Maximum operating time while on battery backup	72 hours
Monitoring temperature and voltage in battery backup module	Yes
Parity Generation and checking	Software and hardware

Software Utilities

The MegaRAID software utility features include:

Specification	Feature
Graphical user interface	Yes
Diagnostic utility	Yes
Management utility	Yes
Bootup configuration via MegaRAID Manager	Yes
Online Read, Write, and cache policy switching	Yes
Internet and intranet support through TCP/IP	Yes

Operating System Software Drivers

Operating System Drivers MegaRAID includes a DOS software configuration utility and drivers for:

- MS-DOS version 3.2 or later (or the PC-DOS equivalent),
- Windows NT V3.5 and V4.0,
- Windows 95 and Windows 3.x
- Novell NetWare 3.1x and 4.x,
- OS/2 2.x, Warp v3.0, and v4.x,
- SCO UnixWare 2.x, and
- SCO Unix SVR3.2 Release 4.2 ODT 3.0 and 5.0x.

See the *MegaRAID Operating System Drivers Guide* for additional information about operating system drivers. The DOS drivers for MegaRAID are contained in the firmware on MegaRAID except the DOS ASPI and CD-ROM drivers.

MegaRAID Specifications

Parameter	Specification
Card Size	12.3" x 4.2" (full length PCI)
Processor	Intel i960CA32-bit RISC processor @ 33 MHz
Bus Type	PCI 2.1
PCI Controller	Custom ASIC
Bus Data Transfer Rate	Up to 132 MBs
BIOS	AMIBIOS MegaRAID BIOS
Cache Configuration	4, 8, 16, 32, or 64 MB in each bank using 70 ns × 36 Fast Page Mode 72-pin SIMMs
Firmware	256 KB × 8 flash ROM
Nonvolatile RAM	8 KB × 8 for storing RAID configuration
Operating Voltage	5.00 V ± 0.25 V
SCSI Controller	Up to 3 SCSI controllers for Ultra and Wide support.
SCSI Data Transfer Rate	Up 20 or 40 MBs for MegaRAID and MegaRAID Enterprise 1200.
SCSI Bus	Single-ended
SCSI Termination	Active
Termination Disable	Automatic through cable detection
Devices per SCSI Channel	Up to 15 wide or seven non-wide SCSI devices. Up to 6 non-disk SCSI drives per MegaRAID controller.
SCSI Device Types Supported	Synchronous or Asynchronous. Disk and non-disk.
RAID Levels Supported	0, 1, 3, 5, 10, 30, and 50
SCSI Connectors	Two or three 68-pin internal high-density connectors for 16-bit SCSI devices. Two or three 50-pin internal connectors for 8-bit SCSI devices. Two ultra-high density 68-pin external connector for Ultra and Wide SCSI.
Serial Port	9-pin RS232C-compatible berg
Maximum number of adapters	Up to 4 MegaRAID adapters per system
Battery Backup	Through plug-in module *(optional)*

CPU

The MegaRAID controller uses the 32-bit Intel i960 RISC processor running at 33 MHz. This processor directs all functions of the controller including command processing, PCI and SCSI bus transfers, RAID processing, drive rebuilding, cache management, and error recovery.

Cache Memory

The MegaRAID controller cache memory resides in two memory banks requiring 1 MB x 36, 4 MB x 36, or 16 MB x 36 72-pin 70 ns Fast Page Mode SIMMs. EDO DRAM is not supported. The memory banks are interleaved. Possible configurations are 4, 8, 16, 32, 64, or 128 MB.

If using two SIMM banks, it is better to use the same-size SIMMs in both banks, but SIMMs of different memory capacities are supported.

The MegaRAID controller supports write-through or write-back caching, selectable for each logical drive. To improve performance in sequential disk accesses, the MegaRAID controller uses read-ahead caching by default. You can disable read-ahead caching.

MegaRAID BIOS

The BIOS resides on a 256 KB × 8 flash ROM for easy upgrade. The MegaRAID BIOS supports INT 13h calls to boot DOS without special software or device drivers.

The MegaRAID BIOS provides an extensive setup utility that can be accessed by pressing <Ctrl> <M> at BIOS initialization. MegaRAID BIOS Setup is described in the *MegaRAID Configuration Software Guide.*

Custom ASIC

The MegaRAID ASIC (Application Specific Integrated Circuit) is an advanced RAID parity engine that provides PCI bus mastering with a burst data transfer rate of 132 MBs. The ASIC handles data transfer between the PCI bus, the cache, and the SCSI bus. This ASIC supports memory write and invalidate commands on the PCI bus. The ASIC also supports DMA chaining. A separate DRAM bus improves concurrent operation. It also performs RAID parity generation and parity checking. MegaRAID supports the PCI Version 2.1 specification.

Onboard Speaker

The MegaRAID controller has an onboard tone generator for audible warnings when system errors occur. Audible warnings can be generated through this speaker. The audible warnings are listed on page 101.

Serial Port

MegaRAID includes a 9-pin RS232C-compatible serial port berg connector, which can connect to communications devices and external storage devices.

SCSI Bus

MegaRAID has one, two, or three Fast and Wide SCSI channels that support single-ended devices with active termination. Both synchronous and asynchronous devices are supported. MegaRAID provides automatic termination disable via cable detection. Each channel supports up to 15 wide or seven non-wide SCSI devices at speeds up to 40 MBs per SCSI channel. MegaRAID supports up to six non-disk devices per controller.

SCSI Connectors

MegaRAID has two types of SCSI connectors:

- one to three 68-pin high density internal connectors and
- two 68-pin external ultra-high-density connectors for SCSI channels 1 and 2.

Both connector *types* can be used for each channel.

SCSI Termination

MegaRAID uses active termination on the SCSI bus conforming to Alternative 2 of the SCSI-2 specifications. Termination enable/disable is automatic through cable detection.

SCSI Firmware

The MegaRAID firmware handles all RAID and SCSI command processing and also supports:

Feature	Description
Disconnect/ Reconnect	Optimizes SCSI Bus seek.
Tagged Command Queuing	Multiple tags to improve random access
Scatter/Gather	Multiple address/count pairs
Multi-threading	Up to 255 simultaneous commands with elevator sorting and concatenation of requests per SCSI channel
Stripe Size	Variable for all logical drives: 2 KB, 4 KB, 8 KB, 16 KB, 32 KB, 64 KB, or 128 KB.
Rebuild	Multiple rebuilds and consistency checks with user-definable priority.

RAID Management

MegaRAID includes software utilities that manage and configure the RAID system and MegaRAID, create and manage multiple disk arrays, control and monitor multiple RAID servers, provide error statistics logging, and provide online maintenance facilities. These utilities include:

- MegaRAID BIOS Setup,
- Power Console,
- MegaRAID Manager
- General Alert Module, and
- Power Console Client.

MegaRAID BIOS Setup BIOS Setup configures and maintains RAID arrays, formats disk drives, and manages the RAID system. BIOS Setup is independent of any operating system. See the *MegaRAID Configuration Software Guide* for additional information.

MegaRAID Manager MegaRAID Manager is a character-based utility that works in DOS, SCO Unix SVR3.2 Release 4.2, SCO UnixWare, OS/2 2.x, OS/2 Warp, NetWare 3.x, and NetWare 4.x. See the *MegaRAID Configuration Software Guide* for additional information.

General Alert This optional utility informs you of system events and failure alerts by pager, program, fax, flash bitmap, network, audio, email, or native log. See the *General Alert Module Guide* for additional information.

Power Console Client Power Console Client (optional) allows you to manage and control RAID systems from any computer connected to the RAID server. See the *MegaRAID Power Console Client Guide* for additional information.

Fault-Tolerance Features

The MegaRAID fault-tolerance features are:

- 26-pin berg connector for fault bus support,
- built-in 10-pin berg connector that provides an RS-232C serial communication interface,
- automatic failed drive detection,
- automatic failed drive rebuild with no user intervention required,
- hot swap manual replacement without bringing the system down,
- SAF-TE compliant enclosure management,
- optional battery backup module provides up to 72 hour data retention,
- battery-backed cache memory.

Fault Bus Support MegaRAID has a separate 26-pin connector that transmits the following events from the disk subsystem to the host computer:

- host notification of device insertion and removal,
- host notification of fan and power supply failure, and
- fault isolation of failed device with visual indication.

See page 14 for additional information about the MegaRAID and MegaRAID Enterprise 1200 fault bus.

Detect Failed Drive The MegaRAID firmware automatically detects and rebuilds failed drives. This can be done transparently with hot spares.

Hot Swap MegaRAID supports the manual replacement of a disk unit in the RAID subsystem without system shutdown.

Battery-backed Cache An optional battery module (on a mezzanine card) is available to provide backup power for the cache in case of a power failure. This backup power prevents cache data loss. See the *MegaRAID Battery Backup Module Guide* for additional information.

Compatibility

MegaRAID compatibility issues include:

- server management,
- SCSI device compatibility, and
- software compatibility

Server Management As an SNMP agent, MegaRAID supports all SNMP managers and RedAlert from Storage Dimensions.

SCSI Device Compatibility MegaRAID supports SCSI hard disk drives, CD-ROMs, tape drives, optical drives, DAT drives and other SCSI peripheral devices.

Software All SCSI backup and utility software should work with MegaRAID. Software that has been tested and approved for use with MegaRAID includes Cheyenne®, CorelSCSI®, Arcserve®, and Novaback®. This software is not provided with MegaRAID.

Clustering Support

American Megatrends provides OEM-optional firmware with multi-initiator support. This software provides high system availability by permitting server failover.

Summary

MegaRAID Features were discussed in this chapter.

Methods for determining RAID system configurations are discussed in Chapter 5.

Hardware installation is discussed in Chapter 6.

5 Configuring MegaRAID

Configuring SCSI Physical Drives

SCSI Channels Physical SCSI drives must be organized into logical drives. The arrays and logical drives that you construct must be able to support the RAID level that you select.

Your MegaRAID adapter supports from one to three SCSI channels.

Distributing Drives If your MegaRAID adapter supports more than one SCSI channel, distribute the disk drives among all available channels for optimal performance. It is best to stripe across channels instead of down channels. Performance is most affected for sequential reads and writes. MegaRAID supports SCSI CD-ROM drives, SCSI tape drives, and other SCSI devices as well as SCSI hard disk drives. For optimal performance, all non-disk SCSI devices should be attached to one SCSI channel.

Basic Configuration Rules You should observe the following guidelines when connecting and configuring SCSI devices in a RAID array:

- attach non-disk SCSI devices to a single SCSI channel that does not have any disk drives,
- distribute the SCSI hard disk drives equally among all available SCSI channels except any SCSI channel that is being reserved for non-disk drives,
- you can place up to eight physical disk drives in an array,
- an array can contain SCSI devices that reside on an array on any channel,
- include all drives that have the same capacity to the same array,
- make sure any hot spare has a capacity that is at least as large as the largest drive that may be replaced by the hot spare, and
- when replacing a failed drive, make sure that the replacement drive has a capacity that is at least as large as the drive being replaced.

Current Configuration

SCSI ID	Device Description	Termination?
SCSI Channel 0		
0		
1		
2		
3		
4		
5		
6		
SCSI Channel 1		
0		
1		
2		
3		
4		
5		
6		
SCSI Channel 2		
0		
1		
2		
3		
4		
5		
6		

Plan the System Configuration

Complete the following tables before you install the MegaRAID controller.

Logical Drive Configuration

Logical Drive	RAID Level	Stripe Size	Logical Drive Size	Cache Policy	Read Policy	Write Policy	# of Physical Drives
LD1							
LD2							
LD3							
LD4							
LD5							
LD6							
LD7							
LD8							

Cont'd

Physical Device Layout

	Channel 1	Channel 2	Channel 3
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			
Target ID			
Device Type			
Logical Drive Number/ Drive Number			
Manufacturer/Model Number			
Firmware level			

Configuring Arrays

Organize the physical disk drives in arrays after the drives are connected to MegaRAID, formatted, and initialized. Each array can consist of one to eight physical disk drives.

MegaRAID supports up to eight arrays. The number of drives in a array determines the RAID levels that can be supported.

Arranging Arrays You must arrange the arrays to provide additional organization for the drive array. You must arrange arrays so that you can create system drives that can function as boot devices.

You can sequentially arrange arrays with an identical number of drives so that the drives in the group are spanned. Spanned drives can be treated as one large drive. Data can be striped across multiple arrays as one logical drive.

You can create spanned drives by using the MegaRAID BIOS Setup utility or the MegaRAID Manager.

Creating Hot Spares Any drive that is present, formatted, and initialized but is not included in a array or logical drive is automatically designated as a hot spare.

You can also designate drives as hot spares via MegaRAID BIOS Setup, the MegaRAID Manager, or Power Console.

Creating Logical Drives Logical drives are arrays or spanned arrays that are presented to the operating system. You must create one or more logical drives.

The logical drive capacity can include all or any portion of a array. The logical drive capacity can also be larger than an array by using spanning. MegaRAID supports up to 8 logical drives.

Configuration Strategies

The most important factors in RAID array configuration are: drive capacity, drive availability (fault tolerance), and drive performance. You cannot configure a logical drive that optimizes all three factors, but it is easy to choose a logical drive configuration that maximizes one factor at the expense of the other two factors, although needs are seldom that simple.

Maximize Capacity RAID 0 achieves maximum drive capacity, but does not provide data redundancy. Maximum drive capacity for each RAID level is shown below. OEM level firmware that can span up to 4 logical drives is assumed.

RAID Level	Description	Drives Required	Capacity
0	Striping without parity	1 – 32	(Number of disks) X capacity of smallest disk
1	Mirroring	2	(Capacity of smallest disk) X (1)
3	Striping with fixed parity drive	3 – 8	(Number of disks) X (capacity of smallest disk) - (capacity of 1 disk)
5	Striping with floating parity drive	3 – 8	(Number of disks) X (capacity of smallest disk) - (capacity of 1 disk)
10	Mirroring and Striping	4 – 8 (Must be a multiple of 2)	(Number of disks) X (capacity of smallest disk) / (2)
30	Raid 3 and Striping	6 – 32 (Must be a multiple of arrays)	(Number of disks) X (capacity of smallest disk) – (capacity of 1 disk X number of Arrays)
50	Raid 5 and Striping	6 – 32 (Must be a multiple of arrays)	(Number of disks) X (capacity of smallest disk) – (capacity of 1 disk X number of Arrays)

Cont’d

Maximizing Drive Availability You can maximize the availability of data on the physical disk drive in the logical array by maximizing the level of fault tolerance. The levels of fault tolerance provided by the RAID levels are:

RAID Level	Fault Tolerance Protection
0	No fault tolerance.
1	Disk mirroring, which provides 100% data redundancy.
3	100% protection through a dedicated parity drive.
5	100% protection through striping and parity. The data is striped and parity data is written across a number of physical disk drives.
10	100% protection through data mirroring.
30	100% protection through data striping. All data is striped across all drives in two or more arrays.
50	100% protection through data striping and parity. All data is striped and parity data is written across all drives in two or more arrays.

Maximizing Drive Performance You can configure an array for optimal performance. But optimal drive configuration for one type of application will probably not be optimal for any other application. A basic guideline of the performance characteristics for RAID drive arrays at each RAID level is:

RAID Level	Performance Characteristics
0	Excellent for all types of I/O activity, but provides no data security.
1	Provides data redundancy and good performance.
3	Provides data redundancy.
5	Provides data redundancy and good performance in most environments.
10	Provides data redundancy and excellent performance.
30	Provides data redundancy and good performance in most environments.
50	Provides data redundancy and very good performance.

Assigning RAID Levels

Only one RAID level can be assigned to each logical drive. The drives required per RAID level is:

RAID Level	Minimum Number of Physical Drives	Maximum Number of Physical Drives
0	One	32
1	Two	Two
3	Three	Eight
5	Three	Eight
10	four	Eight
30	Six	32
50	Six	32

Configuring Logical Drives

After you have installed the MegaRAID controller in the server and have attached all physical disk drives, perform the following actions to prepare a RAID disk array:

Step	Action
1	Optimize the MegaRAID controller options for your system.
2	Perform a low-level format the SCSI drives that will be included in the array and the drives to be used for hot spares.
3	Press <Ctrl> <M> to run the MegaRAID Manager.
4	Define and configure one or more logical drives. Select Easy Configuration in MegaRAID Manager or select New Configuration to customize the RAID array.
5	Create and configure one or more system drives (logical drives). Select the RAID level, cache policy, read policy, and write policy.
6	Save the configuration.
7	Initialize the system drives. After initialization, you can install the operating system.

Optimizing Data Storage

Data Access Requirements Each type of data stored in the disk subsystem has a different frequency of read and write activity. If you know the data access requirements, you can more successfully determine a strategy for optimizing the disk subsystem capacity, availability, and performance.

Servers that support Video on Demand typically read the data often, but write data infrequently. Both the read and write operations tend to be long. Data stored on a general-purpose file server involves relatively short read and write operations with relatively small files.

Array Functions You must first define the major purpose of the disk array. Will this disk array increase the system storage capacity for general-purpose file and print servers? Does this disk array support any software system that must be available 24 hours per day? Will the information stored in this disk array contains large audio or video files that must be available on demand? Will this disk array contain data from an imaging system?

You must identify the purpose of the data to be stored in the disk subsystem before you can confidently choose a RAID level and a RAID configuration.

Planning the Array Configuration

Answer the following questions about this array:

Question	Answer
Number of MegaRAID SCSI channels	
Number of physical disk drives in the array	
Purpose of this array. Rank the following factors:	
Maximize drive capacity	
Maximize the safety of the data (fault tolerance)	
Maximize hard drive performance and throughput	
How many hot spares?	
Have you installed the MegaRAID Battery Backup Module?	
Amount of cache memory installed on the MegaRAID	
Are all of the disk drives and the server that MegaRAID is installed in protected by a UPS?	

Using the Array Configuration Planner The following table lists the possible RAID levels, fault tolerance, and effective capacity for all possible drive configurations for an array consisting of one to eight drives.

The following table does not take into account any hot spare (standby) drives. You should always have a hot spare drive in case of drive failure.

RAID 1 and RAID 10 require 2, 4, 6, or 8 drives. RAID 30 and RAID 50 require at least 6 drives.

Array Configuration Planner

Number of Drives	Possible RAID Levels	Relative Performance	Fault Tolerance	Effective Capacity
1	None	Excellent	No	100%
1	RAID 0	Excellent	No	100%
2	None	Excellent	No	100%
2	RAID 0	Excellent	No	100%
2	RAID 1	Good	Yes	50%
3	None	Excellent	No	100%
3	RAID 0	Excellent	No	100%
3	RAID 3	Good	Yes	67%
3	RAID 5	Good	Yes	67%
4	None	Excellent	No	100%
4	RAID 0	Excellent	No	100%
4	RAID 1	Good	Yes	50%
4	RAID 3	Good	Yes	75%
4	RAID 5	Good	Yes	75%
4	RAID 10	Good	Yes	50%
5	None	Excellent	No	100%
5	RAID 0	Excellent	No	100%
5	RAID 3	Good	Yes	80%
5	RAID 5	Good	Yes	80%
6	None	Excellent	No	100%
6	RAID 0	Excellent	No	100%
6	RAID 1	Good	Yes	50%
6	RAID 3	Good	Yes	83%
6	RAID 5	Good	Yes	83%
6	RAID 10	Good	Yes	50%
6	RAID 30	Good	Yes	67%
6	RAID 50	Good	Yes	67%
7	None	Excellent	No	100%
7	RAID 0	Excellent	No	100%
7	RAID 3	Good	Yes	86%
7	RAID 5	Good	Yes	86%

6 Hardware Installation

Requirements You must have the following items before installing the MegaRAID controller in a server:

- a MegaRAID Controller,
- a host computer with an available PCI expansion slot,
- the MegaRAID Installation program (on CD),
- the necessary SCSI cables and terminators (depends on the number and type of SCSI devices to be attached),
- an Uninterruptible Power Supply (UPS) for the entire system, and
- Fast SCSI 2 or Wide SCSI hard disk drives and other SCSI devices, as desired.

Optional Equipment You may also want to install:

- the MegaRAID Battery Backup Module (highly recommended), and
- SCSI cables that interconnect MegaRAID to external SCSI devices,

Warning

If you have a Series 418 MegaRAID controller, you must set jumper **J28 Chipset Selector** *J28 is only installed on Series 418 Rev A MegaRAID Controllers with ECN 418.01 implemented.* J28 is a 3-pin header. J28 lets you specify if the host computer has a motherboard with an Intel Triton chipset.

Do Not Use EDO DRAM

The Series 412, 418, and 428 MegaRAID controllers do not support EDO DRAM for cache memory. Do not use EDO DRAM in the MegaRAID controllers. Only Fast Page Memory with parity is supported.

Checklist

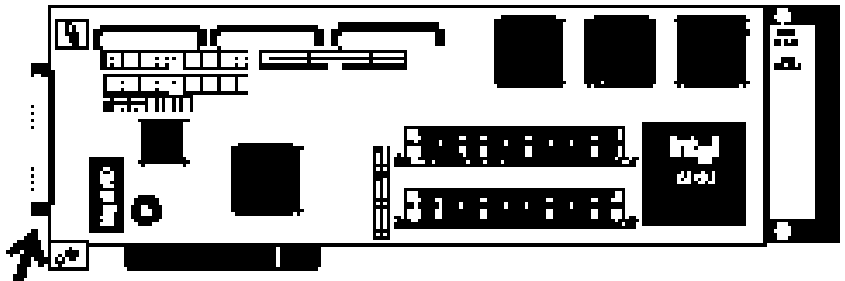
Perform the steps in the installation checklist:

Check	Step	Action
❑	1	Turn all power off to the server and all hard disk drives, enclosures, and system, components.
❑	2	Prepare the host system. See the host system technical documentation.
❑	3	Determine the SCSI ID and SCSI termination requirements.
❑	4	Make sure the jumper settings on the MegaRAID controller are correct. Install the cache memory, if necessary.
❑	5	Install the MegaRAID card in the server and attach the SCSI cables and terminators as needed. Make sure Pin 1 on the cable matches Pin 1 on the connector. Make sure that the SCSI cables you use conform to all SCSI specifications.
❑	6	Perform a safety check. Make sure all cables are properly attached. Make sure the MegaRAID card is properly installed. Turn power on after completing the safety check.
❑	7	Install and configure the MegaRAID software utilities and drivers.
❑	8	Format the hard disk drives as needed.
❑	9	Configure system drives (logical drives).
❑	10	Initialize the logical drives.
❑	11	Install the network operating system drivers as needed.

Identifying the MegaRAID Model

American Megatrends sells several MegaRAID controller models. Determine the MegaRAID controller model that you have purchased by examining the key features shown below:

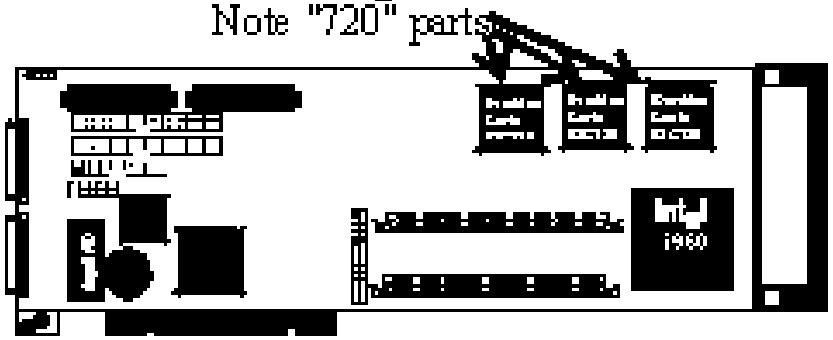
Series 412 MegaRAID Controller



Note single large SCSI connector.

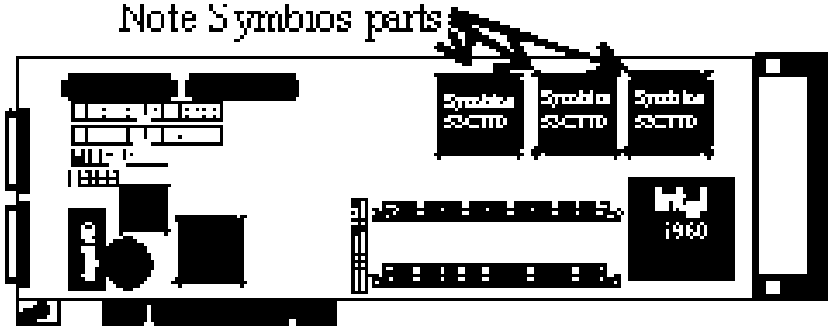
Series 418 MegaRAID Controller

Note "720" parts



Series 428 MegaRAID Controller

Note Symbios parts



Installation Steps

MegaRAID provides extensive customization options. If you need only basic MegaRAID features and your computer does not use other adapter cards with resource settings that may conflict with MegaRAID settings, even custom installation can be quick and easy.

Step	Action	Additional Information
1	Unpack the MegaRAID controller and inspect for damage. Make sure all items are in the package.	If damaged, call American Megatrends technical support at 770-246-8645.
2	Turn the computer off and remove the cover.	
3	Make sure the motherboard jumper settings are correct.	
4	Install cache memory on the MegaRAID card.	4 MB minimum cache memory is required.
5	Check the jumper settings on the MegaRAID controller.	See page 58 for the MegaRAID jumper settings.
6	Set SCSI termination.	
7	Set SCSI terminator power (TermPWR).	
8	Install the MegaRAID card.	
9	Connect the SCSI cables to SCSI devices.	
10	Set the target Ids for the SCSI devices.	
11	Install the battery backup for cache memory.	Optional.
12	Replace the computer cover and turn the power on.	Be sure the SCSI devices are powered up before or at the same time as the host computer.
13	Run MegaRAID BIOS Setup.	Optional.
14	Install software drivers for the desired operating systems.	

Each step is described in detail below.

Cont'd

Step 1 Unpack

Unpack and install the hardware in a static-free environment. The MegaRAID controller card is packed inside an anti-static bag between two sponge sheets. Remove the controller card and inspect it for damage. If the card appears damaged, or if any of items listed below are missing, contact American Megatrends Technical Support at 770-246-8645. The MegaRAID Controller is also shipped with:

- the *MegaRAID Configuration Software Guide,*
- the *MegaRAID Operating System Drivers Guide,*
- the *MegaRAID and MegaRAID Enterprise 1200 Hardware Guide,*
- the software license agreement,
- the MegaRAID Operating System Drivers and Configuration Utilities (on CD), and
- the warranty registration card.

Step 2 Power Down

Turn off the computer and remove the cover. Make sure the computer is turned off and disconnected from any networks before installing the controller card.

Step 3 Configure Motherboard

Make sure the motherboard is configured correctly for MegaRAID. MegaRAID is essentially a SCSI Controller. Each MegaRAID card you install will require an available PCI IRQ; make sure an IRQ is available for each controller you install.

Step 4 Install Cache Memory

> ***Important***
>
> *A minimum of 4 MB of Fast Page Mode DRAM cache memory is required. The cache memory must be installed before MegaRAID is operational. EDO DRAM is NOT supported*.
>
> Call the American Megatrends RAID Support Department at 770-246-8600 for additional information about supported SIMMs.

SIMMs Tested with MegaRAID The following SIMMs have been thoroughly tested with MegaRAID:

Manufacturer	Model #	Capacity
IBM	B1D13600A-70	4 MB
IBM	B1D43600A-70	16 MB
PNY	P361000-70	4 MB
PNY	P364000-70	16 MB

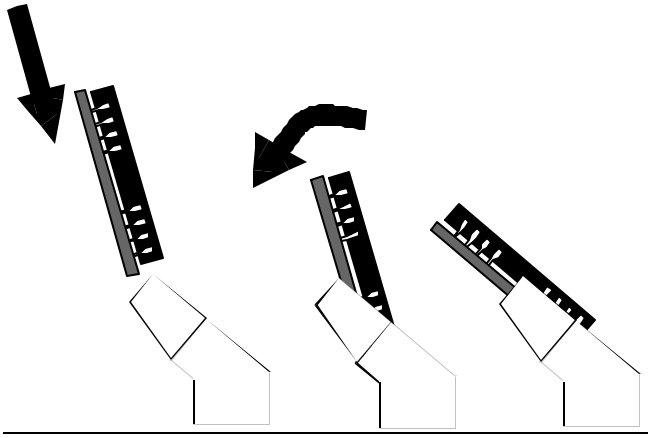
Memory Specifications Only single-sided x 36 SIMMs are supported. The speed is the RAS Access Time.

Memory Type	Voltage	Speed	Parity	Type	BBU Support	Bank I	Bank 2	Total Memory
FPM	5 V	60ns	Yes	Single-sided	Yes	1M x 36	Not Used	4MB
FPM	5 V	60ns	Yes	Single-sided	Yes	1M x 36	1M x 36	8MB
FPM	5 V	60ns	Yes	Single-sided	Yes	4M x 36	Not Used	16MB
FPM	5 V	60ns	Yes	Single-sided	Yes	4M x 36	4M x 36	32MB
FPM	5 V	60ns	Yes	Single-sided	Yes	16M x 36	Not Used	64MB
FPM	5 V	60ns	Yes	Single-sided	Yes	16M x 36	16M x 36	128MB

Cont'd

Step 4 Install Cache Memory, Continued

SIMM Installation Install cache memory (SIMMs) on the MegaRAID controller card. J22 is the Bank 0 SIMM socket and J18 is the Bank 1 SIMM socket. These sockets accept 72-pin SIMMs (× 36-type), available in 1MB × 36, 4 MB x 36, or 16 MB x 36 SIMMs. If only using one SIMM socket, use J22. If using both sockets, make sure that the two SIMMs are the same type and capacity. If SIMMs with different capacities are used, the cache size is twice the capacity of the *smaller* SIMM. Lay the controller card component-side up on a clean static-free surface and install the SIMMs. The SIMMs click into place, indicating proper seating in the socket, as shown below.



Supported Cache Memory Configurations Using Fast Page Mode

Bank 0	Bank 1	Total Cache Memory
1 MB × 36	Empty	4 MB
1 MB × 36	1 MB × 36	8 MB
4 MB × 36	Empty	16 MB
4 MB × 36	4 MB × 36	32 MB
16 MB × 36	Empty	64 MB
16 MB × 36	16 MB × 36	128 MB

Step 5 Set Jumpers

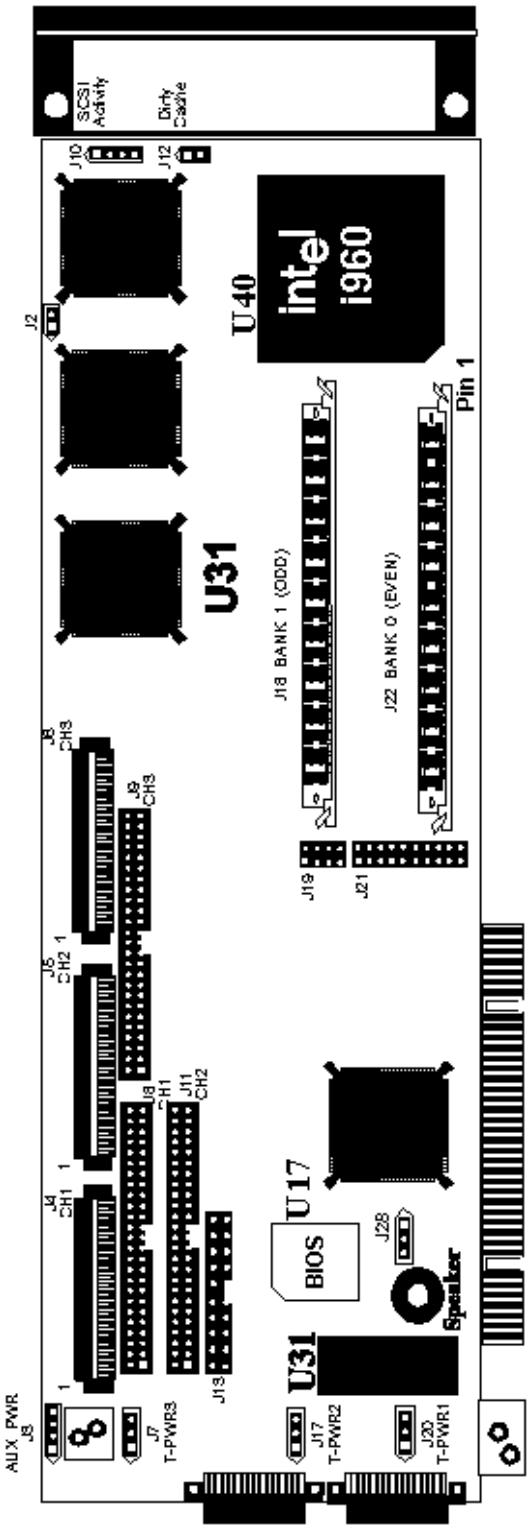
Make sure the jumper settings on the MegaRAID card are correct. The MegaRAID jumpers and connectors are:

Connector	Description	Type
J2	PCI Expansion BIOS Enable. The factory setting is Enabled (Jumpered).	two-pin header
J3	Auxiliary TermPWR for SCSI channels	four-pin connector
J4	Channel 1 Wide (16-bit) SCSI	68-pin connector
J5	Channel 2 Wide (16-bit) SCSI	68-pin connector
J6	Channel 3 Wide (16-bit) SCSI; *3-Channel Version Only*	68-pin connector
J7	Channel 3 TermPWR source. The factory setting is the PCI Bus (short Pins 1-2); *3-Channel Version Only*	three-pin header
J8	Channel 1 (8-bit) SCSI	50-pin connector
J9	Channel 3 (8-bit) SCSI; *3-Channel Version Only*	50-pin connector
J10	Disk Activity LED	four-pin connector
J11	Channel 2 (8-bit) SCSI	50-pin connector
J12	Dirty cache LED	two-pin connector
J13	Fault bus connector	26-pin connector
J15	Serial port connector	9-pin connector
J15	*(Series 412 MegaRAID only). Flash BIOS Programming Voltage Selector*	*3-pin header*
J16	*(Series 412 MegaRAID only). Optional External 120-pin SCSI connector*	*120-pin connector*
J26	External 68-pin high-density SCSI channel 2	68-pin connector
J27	External 68-pin high-density SCSI channel 1	68-pin connector
J17	Channel 2 TermPWR source. The factory setting is the PCI Bus (short Pins 1-2).	three-pin header
J18	Bank 1 (odd) SIMM socket	72-pin (× 36) socket
J19	Cache battery backup connector	eight-pin connector
J20	Channel 1 TermPWR source. The factory setting is the PCI Bus (short Pins 1-2).	three-pin header
J21	Cache battery backup connector	20-pin connector
J22	Bank 0 (even) SIMM socket	72-pin (x36) socket
J28	Chipset Selector	3-pin berg

Cont'd

Step 5 Set Jumpers, Continued

Three-Channel Series 418 MegaRAID Card Layout



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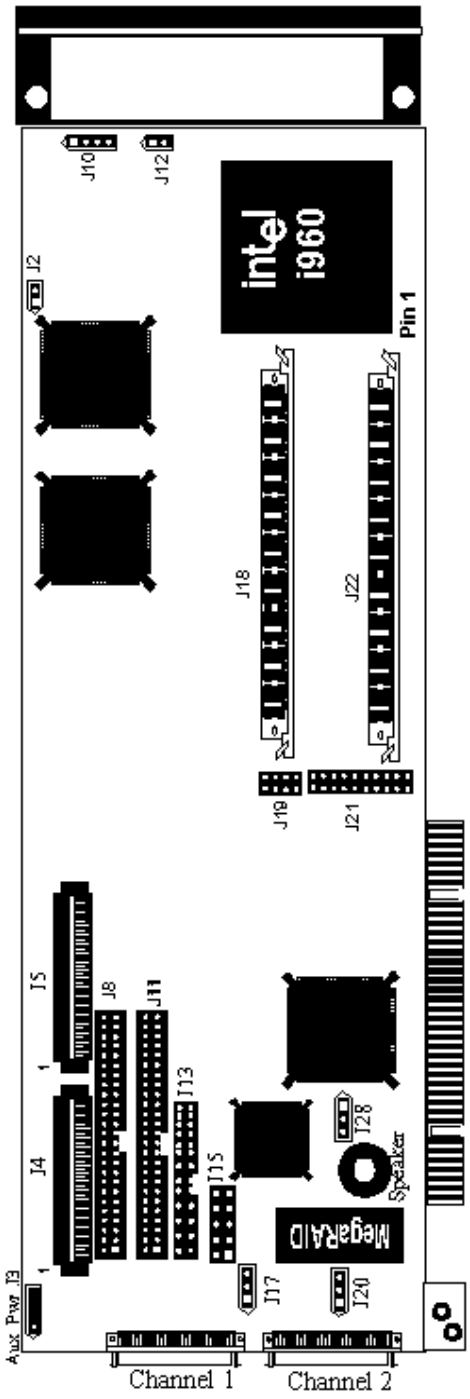
Series 418 2-Channel Card Layout



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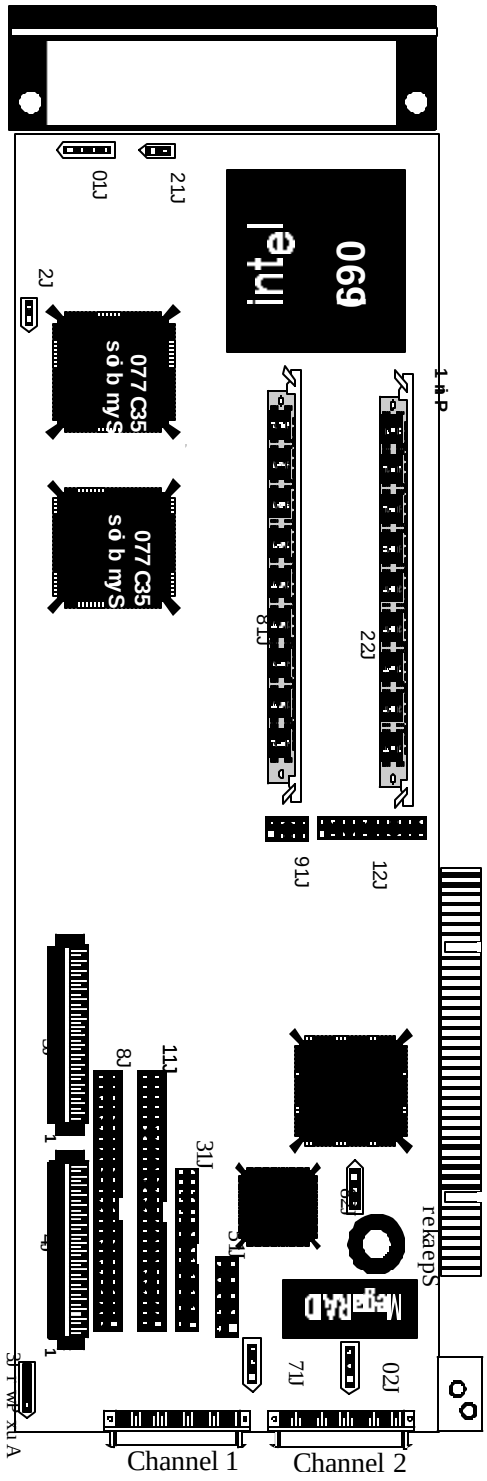
Step 5 Set Jumpers, Continued

Series 428 MegaRAID Enterprise 1200 2-Channel Card Layout



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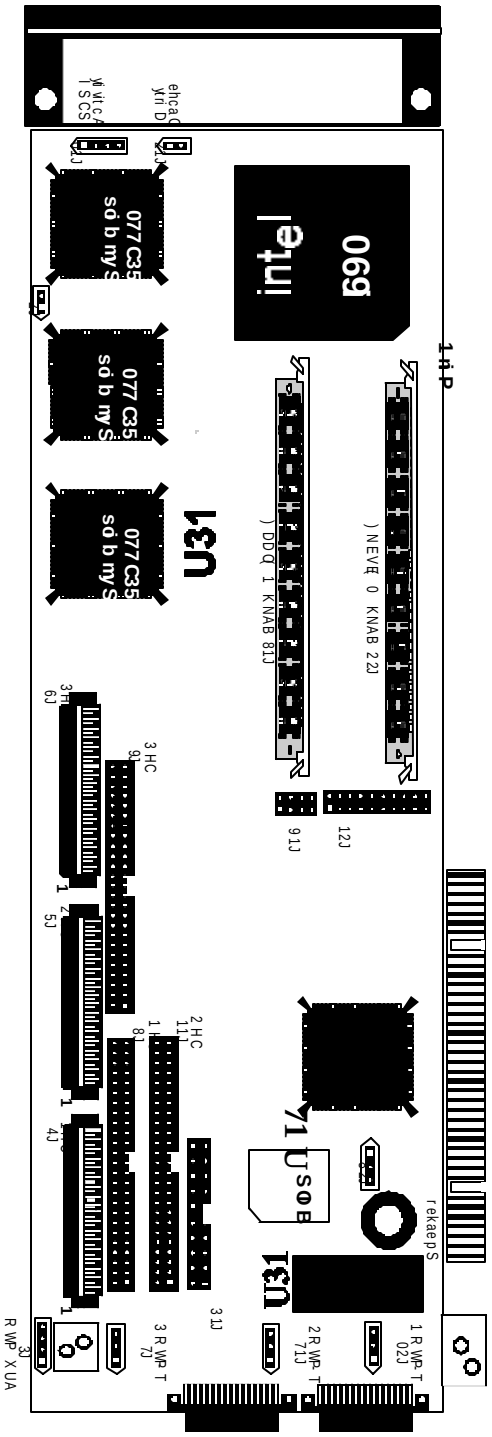
Series 428 MegaRAID Enterprise 1200 3-Channel Card Layout



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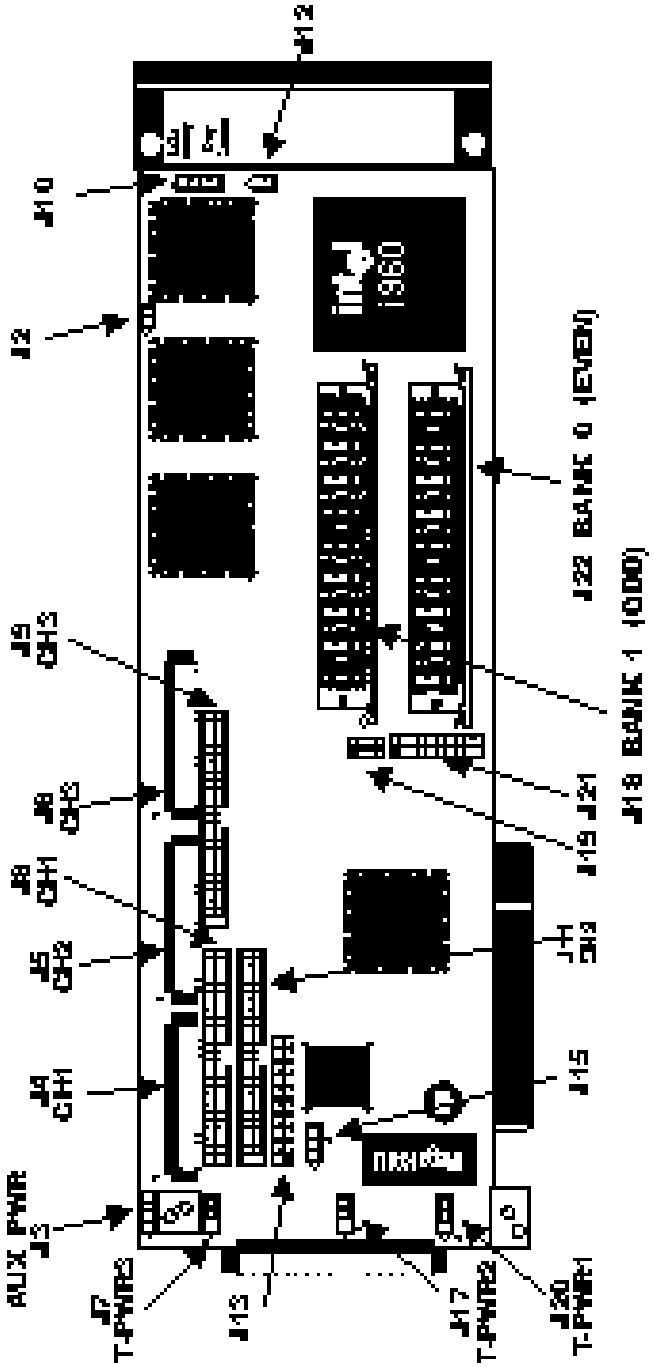
Series 412 MegaRAID Card Layout



Cont'd

J2 Expansion BIOS A jumper is installed on J2 at the factory, enabling the expansion BIOS. Remove the jumper (leave J2 OPEN) to disable the expansion BIOS. If more than one MegaRAID controller is installed in the host system, disable the expansion BIOS by removing the jumper from J2 on *all but one* of the MegaRAID cards. The MegaRAID controller that has the enabled expansion BIOS will handle all MegaRAID controllers in the host system.

J3 Auxiliary TermPWR J3 is the connector for an auxiliary SCSI terminator power (TermPWR) source. J3 accepts a four-pin Molex plug typically used for 3½" floppy disk drives. Use auxiliary TermPWR if:

- the SCSI device does not provide TermPWR,
- you have Wide termination on two or more channels, and
- you are using all three channels on a three-channel card with at least one channel having Wide termination.

Use this connector only when J7, J17, and/or J20 are configured for auxiliary-source SCSI TermPWR.

J16 Connector *J16 is an optional 120-pin SCSI connector only available with the Series 412 MegaRAID.* Attach the AMIRAID cable to J16. This cable allows you to connect three Fast and Wide channels.

> ***Caution***
> Any unused branch of the AMIRAID cable should be fitted with an active single-ended terminator.

AMIRAID Cable The AMIRAID cable must be ordered from American Megatrends at 800-828-9264:

Part Number	Description
CBLR368HD	120-pin to three 68-pin SCSI connectors.
CBLR350HD	120-pin to three high-density 50-pin SCSI connectors.
CBVLR350C	120-pin to three low-density 50pin SCSI connectors.

Cont'd

J7, J17, J20 TermPWR Source J7, J17, and J20 select the TermPWR source for each SCSI channel:

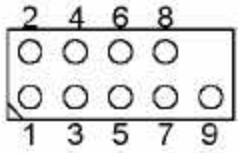
Jumper	TermPWR	Setting Options
J20	SCSI Channel 1	Short Pins 1-2 to have the PCI bus on the host computer provide TermPWR. This is the factory setting. Short Pins 2-3 to use the auxiliary power source (J3 to provide TermPWR). Leave Open to let the SCSI bus provide TermPWR.
J17	SCSI Channel 2	Short Pins 1-2 to have the PCI bus on the host computer provide TermPWR. This is the factory setting. Short Pins 2-3 to use the auxiliary power source (J3 to provide TermPWR). Leave Open to let the SCSI bus provide TermPWR.
J7	SCSI Channel 3	Short Pins 1-2 to provide TermPWR on the PCI bus in the host computer. This is the factory setting. Short Pins 2-3 to use the auxiliary power source (J3 to provide TermPWR). Leave Open to let the SCSI bus provide TermPWR.

J15 Flash BIOS J15 *(Only on the Series 412 MegaRAID*) controls Flash BIOS programming voltage:

J15 Pins	Description
Short Pins 1-2	Normal operation (5 volts).
Short Pins 2-3	12 volts for programming the Flash ROM. *Only short pins 2-3 when programming the Flash ROM.*

J15 Serial Port J15 is a 9-pin berg (Pin 10 is cut) that attaches to a serial cable. The J15 pinout is:

Pin	Signal Description	Pin	Signal Description
1	Carrier Detect	2	Data Set Ready
3	Receive Data	4	Request to Send
5	Transmit Data	6	Clear to b Send
7	Data Terminal Ready	8	Ring Indicator
9	Ground	10	CUT



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J10 Hard Disk LED J10 Disk LED J10 is a four-pin connector for the hard disk LED mounted on the computer enclosure. The LED indicates data transfers on any SCSI Channel.

Pin	Description
1	High
2	SCSI Activity Signal
3	SCSI Activity Signal
4	High

J12 Dirty Cache LED J12 is a two-pin connector for an LED mounted on the computer enclosure. The LED indicates when the data in the cache has not yet to been written to the storage devices.

Pin	Description
1	High
2	Dirty Cache Signal

J28 Chipset Selector *J28 is only installed on Series 418 Rev A MegaRAID Controllers with ECN 418.01 implemented.* J28 is a 3-pin header. Specify if the host computer has a motherboard with an Intel Triton chipset, as follows:

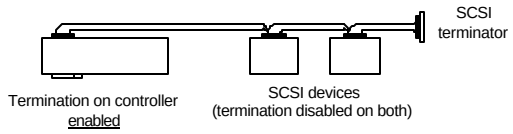
Pins Shorted	Description
Short Pins 1-2	No Intel Triton chipset. This is the factory setting.
Short Pins 2 - 3	Motherboard has Triton chipset.

You must also select the proper chipset in the MegaRAID BIOS Setup utility. The chipset selected must correspond to the J28 setting. Run MegaRAID BIOS Setup. Select *Objects*, then *Adapter*, then *Chipset Type*. Select the option that corresponds to the J28 setting:

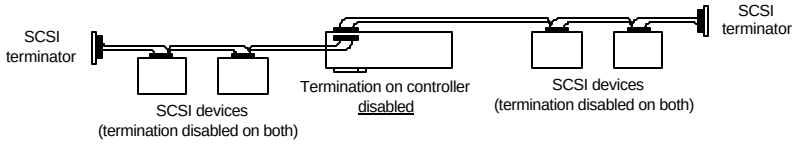
Menu option	J28 Setting
Intel Neptune/Mercury	Short pins 1 and 2
Intel Triton	Short pins 2 and 3
Others	Short pins 1 and 2

Step 6 Set Termination

You must terminate the SCSI bus properly. Set termination at both ends of the SCSI cable. The SCSI bus is an electrical transmission line and must be terminated properly to minimize reflections and losses. Termination should be set at each end of the SCSI cable(s), as shown below.



Setup using one connector for one channel



Setup using two connectors for one channel

If the MegaRAID controller is at one end of a cable for a specific channel, it sets termination automatically at that end. Otherwise, MegaRAID disables its own termination and you must set termination at the cable ends. If another connector on MegaRAID is also used for the same channel, the termination on MegaRAID is disabled automatically and termination should be set on the device at the farthest end of the cable.

For a disk array, set SCSI bus termination so that removing or adding a SCSI device does not disturb termination. An easy way to do this is to connect the MegaRAID card to one end of the SCSI cable for each channel and to connect an external terminator module at the other end of each cable. The connectors between the two ends can connect SCSI devices. Disable termination on the SCSI devices. See the manual for each SCSI device to disable termination. MegaRAID has three connectors for SCSI channels 1 and 2 and two connectors for channel 3 (if channel 3 is present). Use no more than two connectors per channel. If a third connector is used, it compromises SCSI bus impedance-matching.

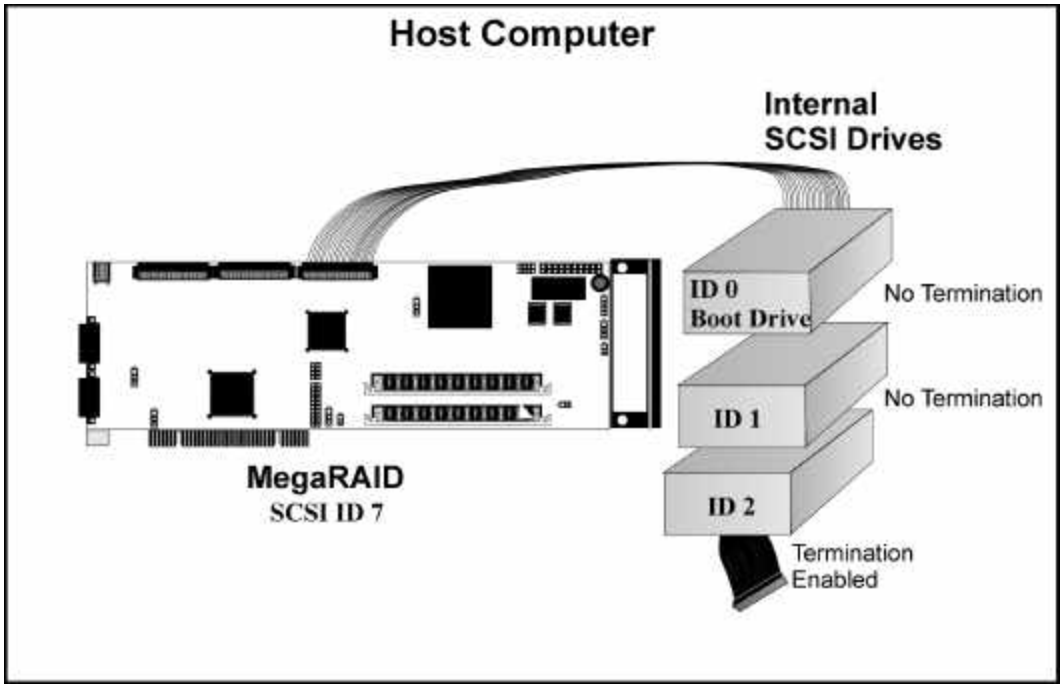
SCSI Termination

The SCSI bus on each SCSI channel is an electrical transmission line and it must be terminated properly to minimize reflections and losses. You complete the SCSI bus by setting termination at both ends.

You can let MegaRAID automatically provides SCSI termination at one end of the SCSI bus for each channel. You can terminate the other end of the SCSI bus by attaching an external SCSI terminator module to the end of the cable for each channel or by attaching a SCSI device that internally terminates the SCSI bus at the end of each SCSI channel.

Selecting a Terminator Use ALT-2 type external SCSI terminators on SCSI channels operating at 10 MBs or higher synchronous data transfer.

Terminating Internal SCSI Disk Arrays Set the termination so that SCSI termination and termination power are intact when any disk drive is removed from a SCSI channel, as shown below:



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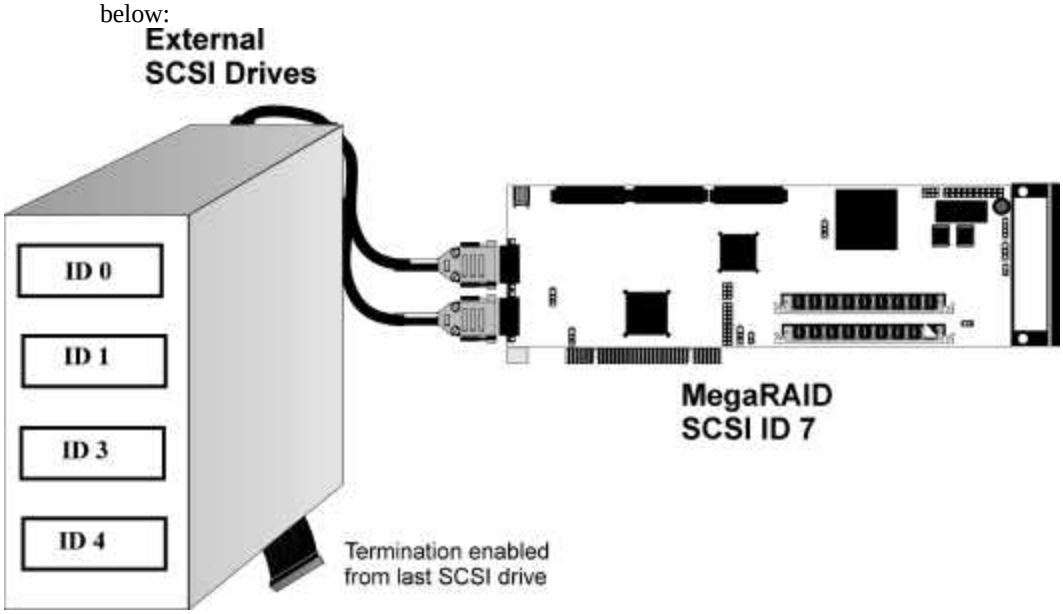
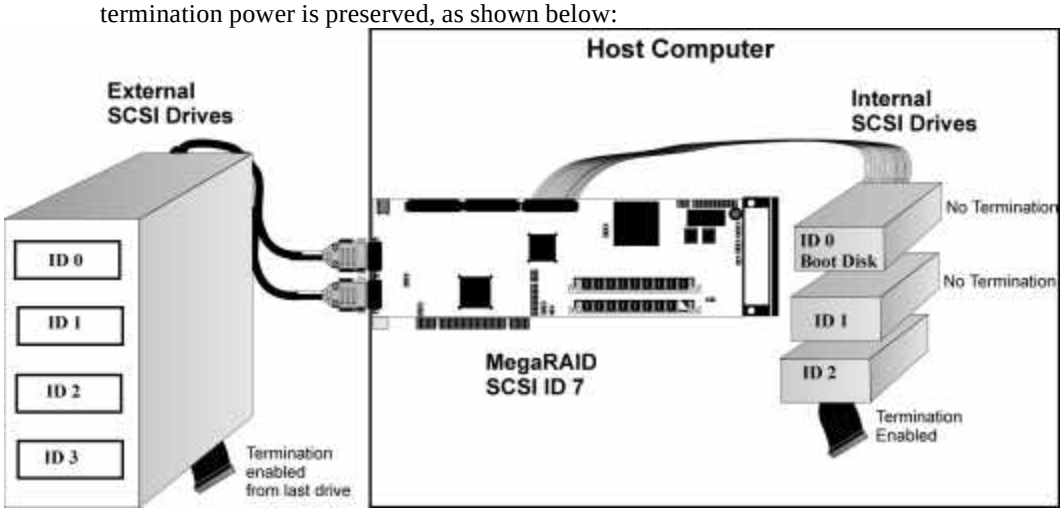
SCSI Termination, Continued

Terminating External Disk Arrays In most array enclosures, the end of the SCSI cable has an independent SCSI terminator module that is not part of any SCSI drive. In this way, SCSI termination is not disturbed when any drive is removed, as shown below:



Terminating Internal and External Disk Arrays You can use both internal and external drives with MegaRAID. You still must make sure that the proper SCSI termination and termination power is preserved, as shown below:



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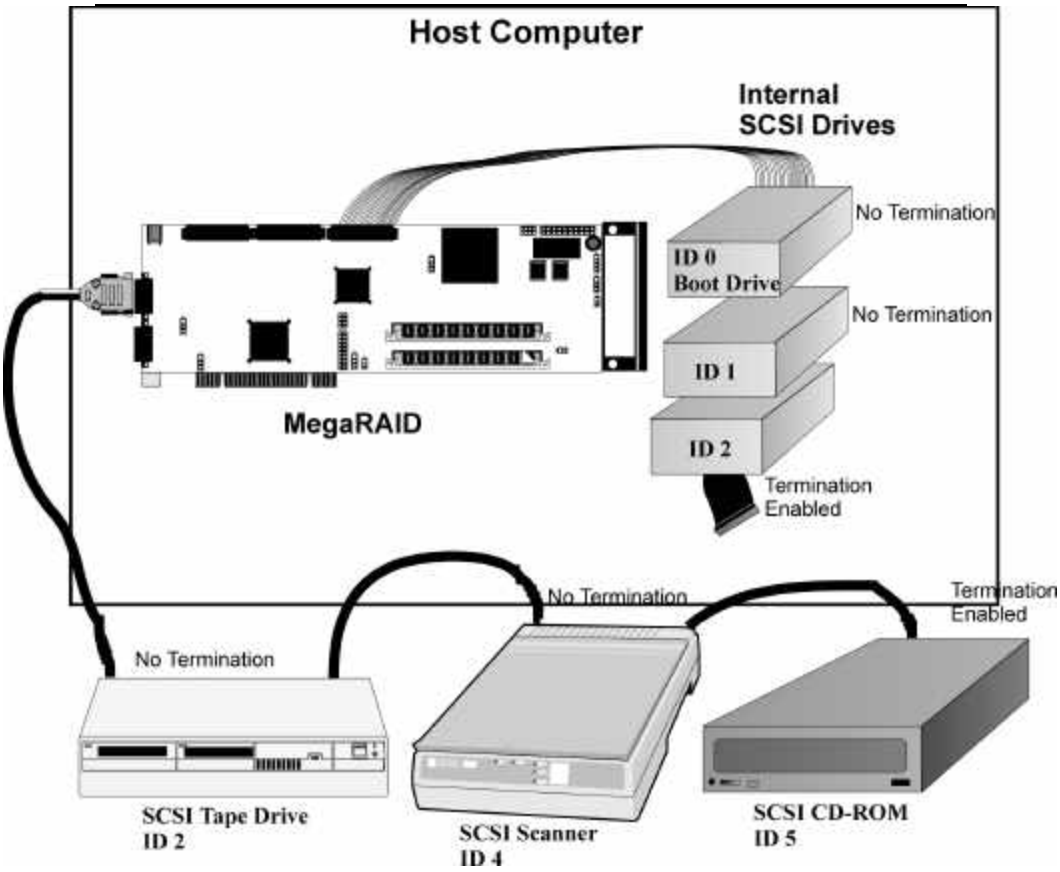
Connecting Non-Disk SCSI Devices SCSI Tape drives, scanners, CD-ROM drives, and other non-disk drive devices must each have a unique SCSI ID regardless of the SCSI channel they are attached to. The general rule for Unix systems is:

- tape drive set to SCSI ID 2,
- CD-ROM drive set to SCSI ID 5, and
- all non-disk SCSI devices attached to SCSI channel 0.

Make sure that no hard disk drives are attached to the same SCSI channel as the non-disk SCSI devices. Drive performance will be significantly degraded if SCSI hard disk drives are attached to this channel.



Step 7 Set SCSI Terminator Power

J20, J17, and J7 control TermPWR for the MegaRAID SCSI channels. See the documentation for each SCSI device for information about enabling TermPWR. The factory settings supply TermPWR from the PCI bus.

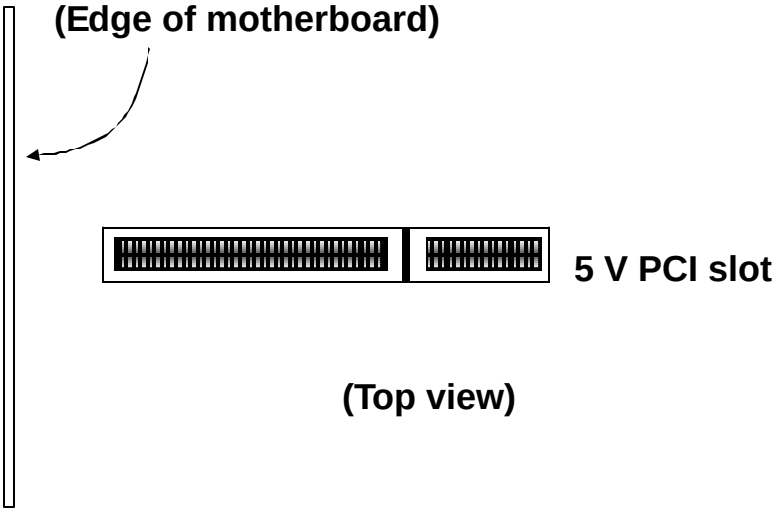
Important

All MegaRAID SCSI channels need TermPWR to operate. If a channel is not being used and no auxiliary power source is connected, change the jumper setting for that channel to supply TermPWR from the PCI bus.

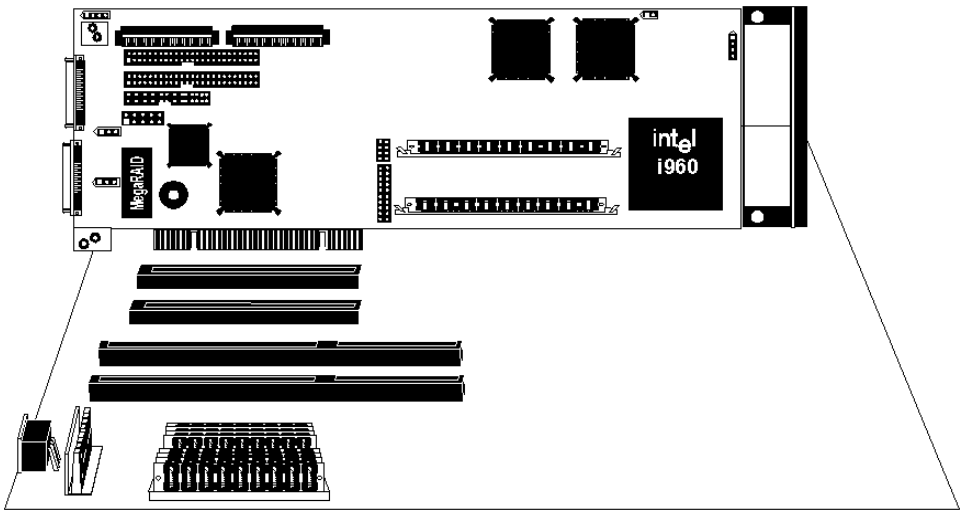
Auxiliary TermPWR Use auxiliary TermPWR if using Wide termination on two or more channels, or if using all three SCSI channels on a three-channel card with at least one channel using Wide termination. Use J3 as an auxiliary SCSI TermPWR source. J3 should be used in conjunction with J7, J17, and J20.

Step 8 Install MegaRAID

Choose a 5 V PCI slot and align the MegaRAID controller card bus connector to the slot. Press down gently but firmly to make sure that the card is properly seated in the slot. The bottom edge of the controller card should be flush with the slot.



Insert the MegaRAID card in a PCI slot as shown below:



Screw the bracket to the computer frame.

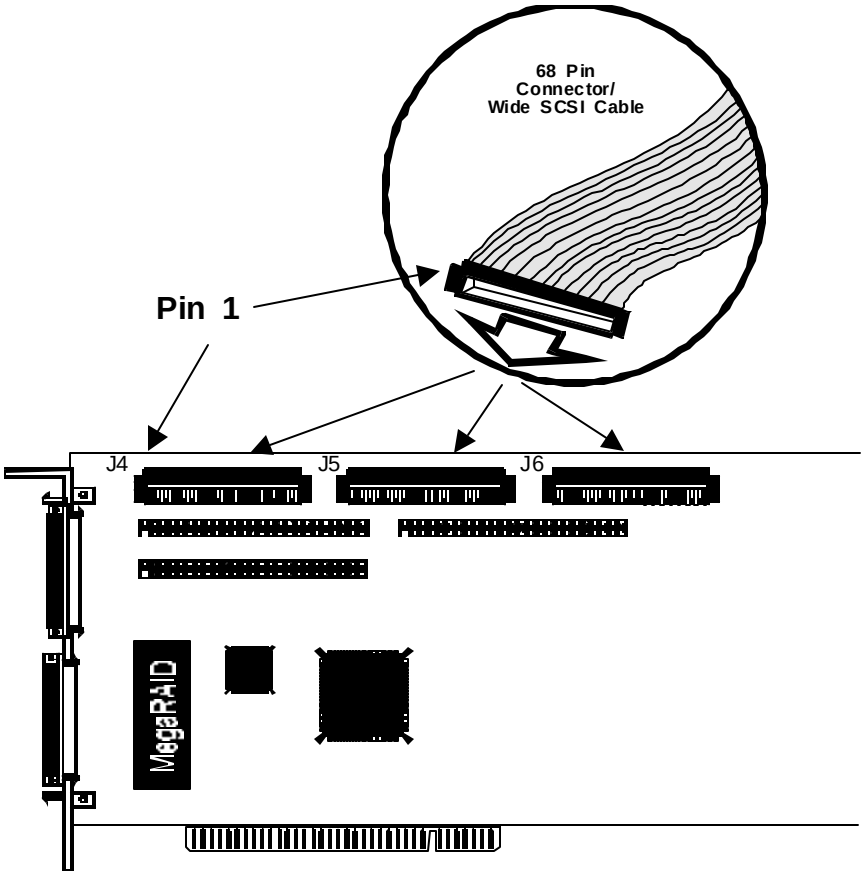
Step 9 Connect SCSI Cables

Connect the SCSI cables to the SCSI Devices. The MegaRAID controller provides three types of SCSI connectors:

J4 is the SCSI Channel 1 internal high-density 68-pin connector for Wide (16-bit) SCSI.

J5 is the SCSI Channel 2 internal high-density 68-pin connector for Wide (16-bit) SCSI.

J6 is the SCSI Channel 3 internal high-density 68-pin connector for Wide (16-bit) SCSI.



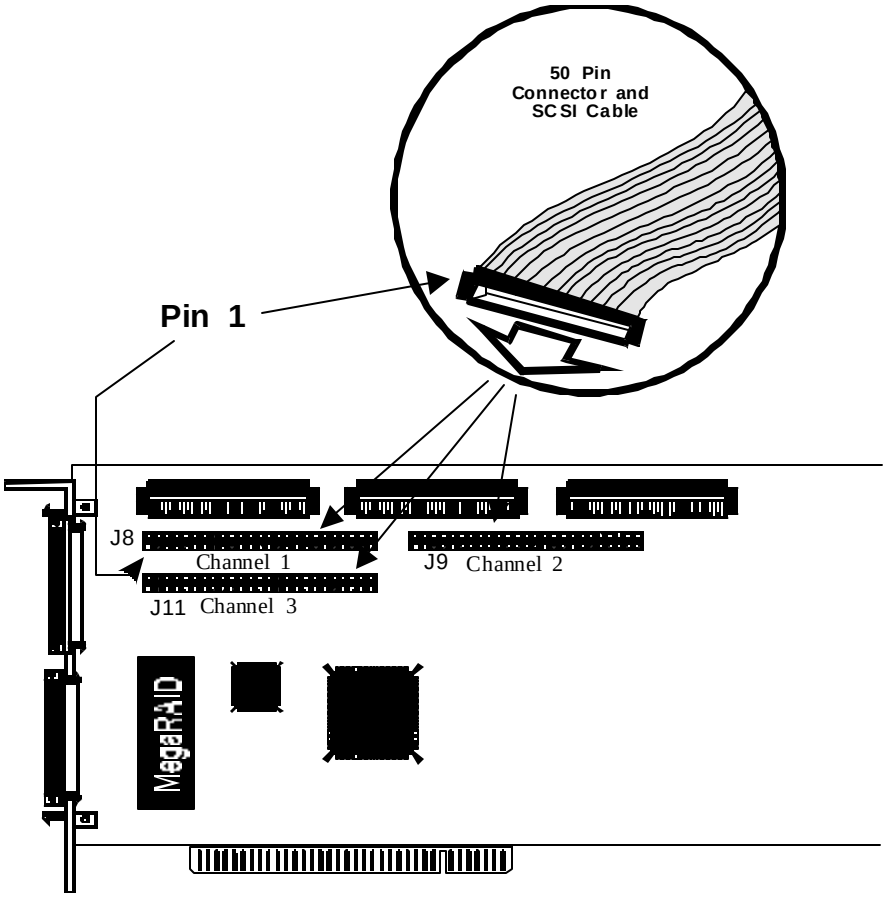
Cont'd

Step 9 Connect SCSI Cables, Continued

50-Pin SCSI Connectors J8 is the 50-pin internal 8 bit SCSI connector for SCSI channel 1.

J11 is the 50-pin internal 8-bit SCSI connector for SCSI channel 2.

J9 is the 50-pin internal 8-bit SCSI connector for SCSI channel 3.



Caution

Do not use more than two types of connectors for each SCSI channel.

Cont'd

J26 Channel 2 External Connector
J27 Channel 1 External Connector J26 and J27 are 68-pin ultra-high density external SCSI connectors. They are on the MegaRAID mounting bracket.

Connect SCSI Devices When connecting SCSI devices:

Action	Description
1	Disable termination on any SCSI device that does *not* sit at the end of the SCSI bus.
2	Configure all SCSI devices to supply TermPWR.
3	Set proper target IDs (TIDs) for all SCSI devices.
4	Distribute SCSI devices evenly across the SCSI channels for optimum performance.
5	The cable length should not exceed three meters for Fast and Wide SCSI (10 MBs) devices or 1.5 meters for Ultra (20 MBs) SCSI devices.
6	The cable length should not exceed six meters for non-Fast SCSI devices.
7	Try to connect all non-disk SCSI devices to a SCSI channel that has no SCSI disk drives connected to it.

Cable Suggestions System throughput problems can occur if SCSI cable use is not maximized. You should:

- use the shortest SCSI cables (no more than 3 meters),
- use active termination,
- avoid clustering the stubs,
- cable stub length should be no more than 0.1 meter (4 inches),
- route SCSI cables carefully,
- use high impedance cables,
- do not mix cable types (choose either flat or rounded and shielded or non-shielded), and
- ribbon cables have fairly good cross-talk rejection characteristics.

Step 10 Set Target IDs

Set target identifiers (TIDs) on the SCSI devices. Each device in a specific SCSI channel must have a unique TID in that channel. Non-disk devices (CD-ROM or tapes) should have unique SCSI IDs *regardless of the channel where they are connected*. See the documentation for each SCSI device to set the TIDs. The MegaRAID controller automatically occupies TID 7 in each SCSI channel. Eight-bit SCSI devices can only use the TIDs from 0 to 6. 16-bit devices can use the TIDs from 0 to 15. The arbitration priority for a SCSI device depends on its TID.

Priority	Highest											Lowest
TID	7	6	5	…	2	1	0	15	14	…	9	8

Important

Non-disk devices (CD-ROM or tapes) should have unique SCSI IDs regardless of the channel they are connected to.

Device Identification on MegaRAID Controllers

All Logical Drives on each SCSI bus are identified to the host as ID 0. Differentiation is made possible by utilizing Logical Unit Identifiers (LUNs). ID 0 cannot be used for non-disk devices because they are limited to IDs 1 through 6. The MegaRAID is limited to eight logical drives because LUNs are used to present logical drives. The SCSI-2 ANSI specification has a limit of 8 LUNs per ID. The SCSI-3 specification has increased the number of LUNs to 16. An example of the MegaRAID ID mapping method is shown below.

Cont’d

Device Identification on MegaRAID Controllers, Continued

Example of MegaRAID ID Mapping

ID	Channel 1	Channel 2	Channel 3
0	A1-1	A1-2	A1-3
1	A2-1	Scanner	A2-2
2	CD	A2-3	A2-4
3	A2-5	A2-6	Tape
4	CD	A3-1	A3-2
5	A4-1	Tape	A4-2
6	Optical	A5-1	A5-1
7	Reserved	Reserved	Reserved
8	A5-2	A5-3	A5-4
9	A5-6	A5-7	A5-8
10	A6-1	A6-2	A6-3
11	A6-4	A6-5	A6-6
12	A6-7	A6-8	A7-1
13	A7-2	A7-3	A7-4
14	A7-5	A7-6	A7-7
15	A7-8	A8-1	A8-2

As Presented to the Operating System

ID	LUN	Device	ID	LUN	Device
0	0	Disk (A1-X)	1	0	Scanner
0	1	Disk (A2-X)	2	0	CD
0	2	Disk (A3-X)	3	0	Tape
0	3	Disk (A4-X)	4	0	CD
0	4	Disk (A5-X)	5	0	Tape
0	5	Disk (A6-X)	6	0	Optical
0	6	Disk (A7-X)			
0	7	Disk (A8-X)			

Step 11 Connect Battery

The optional MegaRAID Battery Backup Module connects to J19 and J21.

> ***Warning***
> Disconnect battery pack before removing or adding DRAM modules.

If power fails, the module provides backup power for the SIMM banks for a certain length of time depending on the capacity of the SIMMs.

Step 12 Power Up

Replace the computer cover and reconnect the AC power cords. Turn power on to the host computer. Set up the power supplies so that the SCSI devices are powered up at the same time as or before the host computer. If the computer is powered up before a SCSI device, the device might not be recognized.

During boot, the MegaRAID BIOS message appears:

```
MegaRAID Disk Array Adapter BIOS Version x.xx date
Copyright (c) American Megatrends, Inc.
Firmware Initializing... [ Scanning SCSI Device ...(etc.)... ]
```

The firmware takes several seconds to initialize. During this time the adapter will scan each SCSI channel. When it is ready, the following lines appear:

```
Host Adapter-1 Firmware Version x.xx DRAM Size 4 MB
0 Logical Drives found on the Host Adapter
0 Logical Drives handled by BIOS
Press <Ctrl><M> to run MegaRAID BIOS Configuration Utility
```

The <Ctrl> <M> prompt times out after several seconds. The MegaRAID host adapter (controller) number, firmware version, and cache DRAM size are displayed in the second portion of the BIOS message. The numbering of the controllers follows the PCI slot scanning order used by the host motherboard.

Step 13 Run MegaRAID BIOS Setup

Press <Ctrl> <M> to run the MegaRAID BIOS Setup utility. You must configure the RAID subsystem. You can use any of the three configuration utilities. Only MegaRAID Manager allows you to set the chipset type.

Step 14 Install Operating System Driver

Install the operating system drivers. For DOS, insert the accompanying MegaRAID CD and access the DOS drivers self-extracting zip file.

The MegaRAID ASPI driver can be used in the DOS, Windows 3.*x*, and Windows 95 environments. The DOS ASPI driver supports:

- up to six non-disk SCSI devices (each SCSI device must use a unique SCSI ID regardless of the SCSI channel it resides on - with the exception of SCSI ID = 0),
- up to four MegaRAID adapters, and
- virtual DMA services (VDS) for up to eight logical drives.

Cont'd

Step 14 Install Operating System Driver, Continued

ASPI Driver *CorelSCSI, Novaback, and PC Tools are not provided with MegaRAID.*

Drivers	Devices Supported	Application Software	Features
MEGASPI.SYS	CD-ROM, tape, optical drives, etc.	CorelSCSI, Novaback, and PC Tools.	VDS

Copy MEGASPI.SYS to your hard disk drive. Add the following line to CONFIG.SYS:

```
device=<path>\MEGASPI.SYS /v
```

Parameters The MEGASPI.SYS parameters are:

Parameter	Description
/h	INT 13h support is not provided.
/v	Verbose mode. All message are displayed on the screen.
/q	Quiet mode. All message except error message are suppressed.

CD-ROM Driver A device driver is provided with MegaRAID for CD-ROM drives operating under DOS, Windows 3.*x*, and Windows 95. The driver filename is AMICDROM.SYS. The MEGASPI.SYS ASPI manager must be added to the CONFIG.SYS file before you can install the CD-ROM device driver. See the instructions on the previous page for adding the MEGASPI.SYS driver. Copy AMICDROM.SYS to the root directory of the C: drive. Add the following line to CONFIG.SYS, making sure it is preceded by the line for MEGASPI.SYS:

```
DEVICE=C:\AMICDROM.SYS
```

Add the following to AUTOEXEC.BAT. Make sure it precedes the SMARTDRV.EXE line.

```
MSCDEX /D:MSCD001
```

MSCDEX is the CD-ROM drive extension file that is supplied with MS-DOS® and PC-DOS® Version 5.0 or later. See your DOS manual for the command line parameters for MSCDEX.

Summary

This chapter discussed hardware installation. The *MegaRAID Configuration Software Guide* describes the MegaRAID BIOS Setup utility, MegaRAID Manager, Power Console configuration utilities. You configure the RAID system via software configuration utilities. The utility programs for configuring MegaRAID are:

Configuration Utility	Operating System
MegaRAID BIOS Setup	independent of the operating system
MegaRAID Manager	DOS SCO UNIX SVR3.2 Novell NetWare 3.x, 4.x UnixWare
Power Console	Microsoft Windows NT

7 Troubleshooting

Problem	Suggested Solution
Some operating systems do not load in a computer with a MegaRAID adapter.	Check the system BIOS configuration for PCI interrupt assignments. Make sure some Interrupts are assigned for PCI. Initialize the logical drive before installing the operating system.
One of the hard drive in the array fails often	Check the drive error counts using Power Console. Format the drive. Rebuild the drive If the drive continues to fail, replace the drive with another drive with the same capacity.
Pressed <Ctrl> <M>. Ran Megaconf.exe and tried to make a new configuration. The system hangs when scanning devices.	Check the drives IDs on each channel to make sure each device has a different ID. Check the termination. The device at the end of the channel must be terminated. Replace the drive cable.
Multiple drives connected to MegaRAID using the same power supply. There is a problem spinning the drives all at once.	Set the drives to spin on command. This will allow MegaRAID to spin two devices simultaneously.
Pressing <Ctrl> <M> or running megaconf.exe does not display the Management Menu.	These utilities require a color monitor.
At system power-up with the MegaRAID installed, the screen display is garbled.	At least 1 MB of memory must be installed in bank 0 (the lower memory socket) before power-up. For proper cache memory operation, you should install at least 4 MB of memory in MegaRAID.
Cannot flash or update the EEPROM.	Make sure that Pins 2-3 of J5 are shorted on the MegaRAID adapter card. If J5 is OK, you may need a new EEPROM.
The MegaRAID BIOS and firmware banner does not appear.	Make sure that J2 (Enable Expansion BIOS) is jumpered on at least one of the MegaRAID controllers in the system.

Problem	Suggested Solution
`Firmware Initializing...` appears and remains on the screen.	Make sure that TERMPWR is being properly provided to each peripheral device populated channel. Make sure that each end of the channel chain is properly terminated using the recommended terminator type for the peripheral device. The channel is automatically terminated at the MegaRAID card if only one cable is connected to a channel. Make sure that (on a channel basis) that only two type of cables are connected at any one time. Both internal SCSI connectors on a channel can used, but both internal SCSI connectors and the external SCSI connector for the same channel cannot be used. Make sure that memory modules are rate at 70 ns or faster. Make sure that the MegaRAID controller is properly seated in the PCI slot.
What is the maximum number of MegaRAID adapters per computer?	Currently, all the utilities and drivers support up to six MegaRAID adapters per system.
What SCSI IDs can a non-hard disk device have and what is maximum number allowed per adapter?	Non-hard disk devices can only accommodate SCSI IDs 1, 2, 3, 4, 5 or 6, regardless of the channel used. A maximum of six non-hard disk devices are supported per MegaRAID adapter.
Why does a failed logical array still get a drive assignment?	To maintain the DOS Path statement integrity.

DOS ASPI Driver Error Messages

Message	Corrective Action
American Megatrends Inc. ASPI Manager has NOT been loaded.	The ASPI manager is not loaded. One of the failure codes listed below is displayed next.
Controller setup FAILED error code=[0xab]	Correct the condition that caused the failure. The failure codes are: 0x40 No MegaRAID adapters found 0x80 Timed out waiting for interrupt to be posted 0x81 Timed out waiting for MegaRAID Response command. 0x82 Invalid command completion count. 0x83 Invalid completion status received. 0x84 Invalid command ID received. 0x85 No MegaRAID adapters found or no PCI BIOS support. 0x90 Unknown Setup completion error
No non-disk devices were located	The driver did not find any non-hard drive devices during scanning. A SCSI device that is not a hard disk drive, such as a tape drive or CD-ROM drive, must be attached to this SCSI channel. The SCSI ID must be unique for each adapter and cannot be SCSI ID 0. The supported SCSI IDs are 1, 2, 3, 4, 5, and 6.
'ERROR: VDS support is *INACTIVE* for MegaRAID logical drives	The /h option is appended to driver in CONFIG.SYS or this driver is used with a BIOS that is earlier than v1.10, or no logical drives are configured.

Additional Topics

Topic	Information
DOS ASPI	MEGASPI.SYS, the MegaRAID DOS ASPI manager, uses 6 KB of system memory once it is loaded.
CD-ROM drives under DOS	At this time, copied CDs are not accessible from DOS even after loading MEGASPI.SYS and AMICDROM.SYS.
Physical Drive Errors	To display the MegaRAID Manager Media Error and Other Error options, press <F2> after selecting a physical drive under the Physical Drive menu, selected from the Objects menu. A Media Error is an error that occurred while actually transferring data. An Other Error is an error that occurs at the hardware level because of a device failure, poor cabling, bad termination, signal loss, etc.
Virtual Sizing	The Virtual Sizing option enables RAID expansion. Virtual Sizing must be enabled to increase the size of a logical drive or add a physical drive to an existing logical drive. Run MegaRAID Manager by pressing <Ctrl> <M> to enable Virtual Sizing. Select the Objects menu, then select the Logical Drive menu. Select View/Update Parameters. Set Virtual Sizing to Enabled.
BSD Unix	We do not provide a driver for BSDI Unix. MegaRAID does not support BSDI Unix.
Multiple LUNs	MegaRAID supports one LUN per each target ID. No multiple LUN devices are supported.
MegaRAID Power Requirements	The Maximum MegaRAID power requirements are 15 watts at 5V and 3 Amps.

Topic	Information
SCSI Bus Requirements	The ANSI specification dictates the following: The maximum signal path length between terminators is 3 meters when using up to 4 maximum capacitance (25 pF) devices and 1.5 meters when using more than 4 devices. SCSI devices should be uniformly spaced between terminators, with the end devices located as close as possible to the terminators. The characteristic impedance of the cable should be 90 +/- 6 ohms for the /REQ and /ACK signals and 90 +/- 10 ohms for all other signals. The stub length(the distance from the controller's external connector to the mainline SCSI bus) shall not exceed.1m (approximately 4 inches). The spacing of devices on the mainline SCSI bus should be at least three times the stub length. All signal lines shall be terminated once at both ends of the bus powered by the TERMPWR line.
Windows NT v3.51 Upgrades	Installing Windows NT v3.51 using the 3.51 upgrade CD without creating boot floppies causes Windows NT to overwrite the installed MegaRAID drivers with generic SCSI drivers. You must create and use Windows NT boot floppies from the upgrade CD to install the Windows NT v3.51 upgrades.

Topic	Information
Windows NT Installation	When Windows NT is installed via a bootable CD, the devices on the MegaRAID will not be recognized until after the initial reboot. The Microsoft documented workaround is in SETUP.TXT: SETUP.TXT is on the CD To install drivers when Setup recognizes one of the supported SCSI host adapters without making the devices attached to it available for use: 1 Restart Windows NT Setup. 2 When Windows NT Setup displays Setup is inspecting your computer's hardware configuration..., press <F6> to prevents Windows NT Setup from performing disk controller detection. This allows you to install the driver from the Drivers disk you created. All SCSI adapters must be installed manually. 3 When Windows NT Setup displays Setup could not determine the type of one or more mass storage devices installed in your system, or you have chosen to manually specify an adapter, press S to display a list of supported SCSI host adapters. 4 Select Other from the bottom of the list. 5 Insert the Drivers Disk you made when prompted to do so and select MegaRAID from this list. In some cases, Windows NT Setup repeatedly prompts to swap disks. Windows NT will now recognize any devices attached to this adapter. Repeat this step for each host adapter not already recognized by Windows NT Setup.

A SCSI Cables and Connectors

Cable Considerations

MegaRAID Single-Ended Ultra SCSI Understanding the cable requirements, termination and stub lengths is key to the successful implementation of an Ultra-SCSI subsystem.

SCSI Cables - Up to Four Devices The total external SCSI cable length for single-ended when using up to 4 Ultra-SCSI devices (maximum. capacitance of device = 25pf) should be less than or equal to:

```
(3 meter-(SCSI signal length on the MegaRAID)-(SCSI length in storage box)

= (3 meter - 0.305 meter - SCSI length in storage box)

= 2.695 - SCSI length in Storage box
```

SCSI Cables - More than Four Devices The total external SCSI cable length for single-ended when using from five to eight Ultra-SCSI devices (max. cap of device = 25pf) should be less than or equal to:

```
(1.5 meter-(SCSI signal length on MegaRAID)-(SCSI length in storage box)

= (1.5 meter - 0.305 meter - SCSI length in storage box)

= 1.195 - SCSI length in Storage box
```

Spacing Devices The SCSI devices should be uniformly spaced between terminators with the end devices located as close as possible to the terminators.

SCSI Signal Path The SCSI signal path is a controlled impedance environment with the following characteristic impedance:

```
90 ohms +/- 6 ohms for the REQ and ACK signals

90 ohms +/- 10 ohms for all other signals
```

Termination and Stub Placement for MegaRAID and MegaRAID Enterprise 1200 Adapters

Termination placement	For a well behaved SCSI bus/cabling system, there should be termination enabled at both ends of the SCSI bus. Avoid adding terminators in the middle of the bus. The end devices must be located as close as possible to the terminators. Active terminators must be used. Terminators employing a 220 ohm resistor to 5 Volts and a 330 ohm resistor to ground on each signal shall not be used.
Stub length	The stub length shall not exceed 0.1 meter. The spacing of devices on the SCSI bus should be at least three times the stub length to avoid stub clustering.
Cables	Teflon flat ribbon cables give the best performance in the Ultra-SCSI environment. These cables should be used for all internal cabling. To minimize discontinuities and signal reflections, the use of cables with different impedance's on the same bus should be minimized.

SCSI Connectors

MegaRAID provides several different types of SCSI connectors for each channel. The connectors are:

- 68-pin high density internal connectors,
- 68-pin ultra high density external connectors.

68-Pin High Density SCSI Internal Connectors

Each of the two SCSI channels on the MegaRAID Controller has a 68-pin high density 0.050 inch pitch unshielded connector.

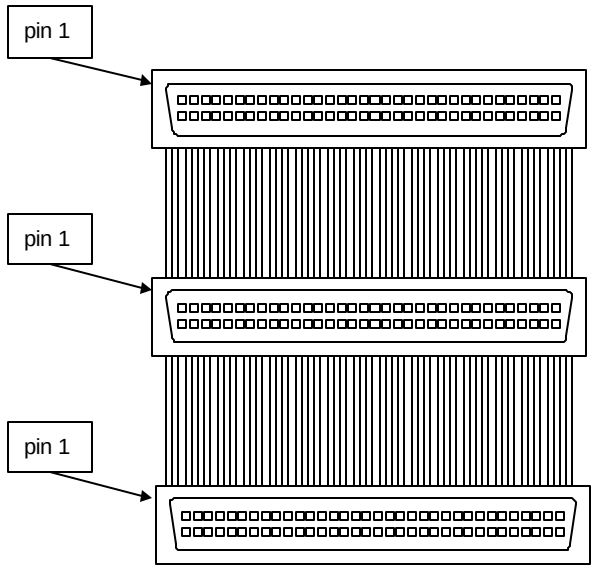
These connectors provide all signals needed to connect MegaRAID to wide SCSI devices. The connector pinouts are for a single-ended primary bus (P-CABLE) as specified in SCSI-3 Parallel Interface X3T9.2, Project 885-D, revision 12b, date July 2, 1993.

The cable assemblies that interface with this 68-pin connector are:

- flat ribbon or twisted pair cable for connecting internal wide SCSI devices,
- flat ribbon or twisted pair cable for connecting internal and external wide SCSI devices,
- cable assembly for converting from internal wide SCSI connectors to internal non-wide (Type 2) connectors,
- cable assembly for converting from internal wide to internal non-wide SCSI connectors (Type 30), and
- cable assembly for converting from internal wide to internal non-wide SCSI connectors.

Cont’d

Cable Assembly for Internal Wide SCSI Devices The cable assembly for connecting internal wide SCSI devices is shown below:

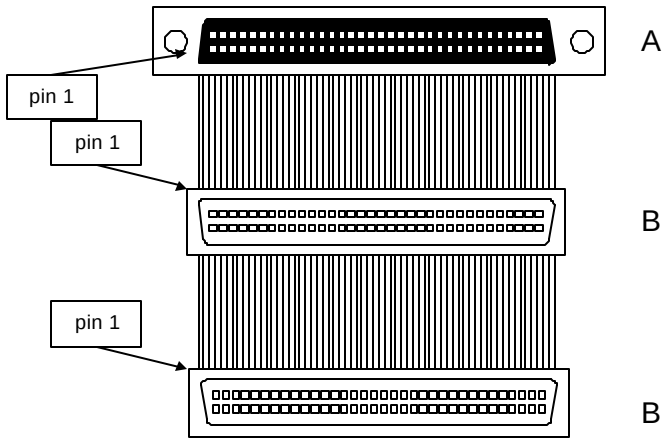


Connectors: 68 position plug (male)
AMP - 786090-7
Cable: Flat Ribbon or Twisted-Pair Flat Cable
68 Conductor 0.025 Centerline
30 AWG

Cont'd

68-Pin High Density Connectors, Continued

Connecting Internal and External Wide Devices The cable assembly for connecting internal wide and external wide SCSI devices is shown below:



Connector A: 68 position panel mount receptacle
with 4-40 holes (female)
AMP - 786096-7

NOTE: To convert to 2-56 holes, use screwlock kit 749087-1, 749087-2, or 750644-1 from AMP

Connector B: 68 position plug (male)
AMP - 786090-7

Cable: Flat Ribbon or Twisted-Pair Flat Cable
68 Conductor 0.025 Centerline
30 AWG

Cont'd

Converting Internal Wide to Internal Non-Wide (Type 2) The cable assembly for converting internal wide SCSI connectors to internal non-wide SCSI connectors is shown below:

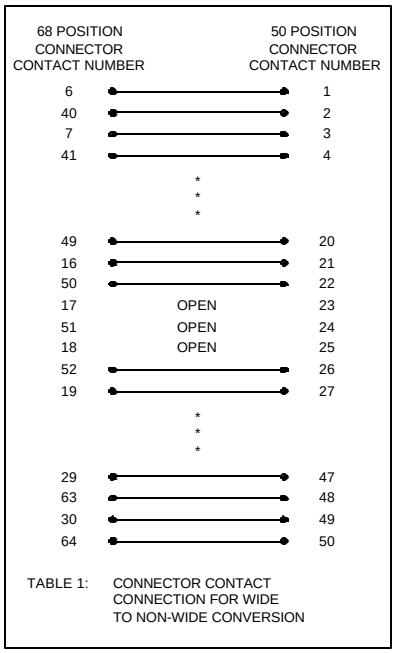
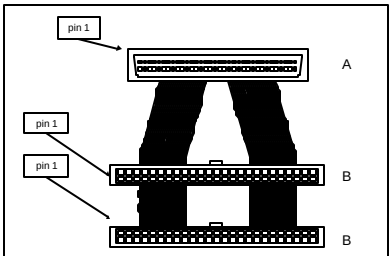


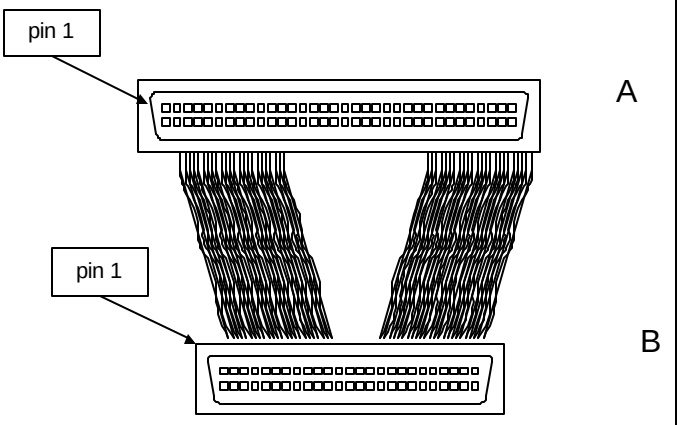
TABLE 1: CONNECTOR CONTACT CONNECTION FOR WIDE TO NON-WIDE CONVERSION



Connector A: 68 position plug (male)
AMP - 749925-5
Connector B: 50 position IDC receptacle (female)
AMP - 499252-4, 1-746285-0, 1-746288-0
Wire: Twisted-Pair Flat Cable or
Laminated Discrete Wire Cable
25 pair 0.050 centerline
28 AWG

Cont'd

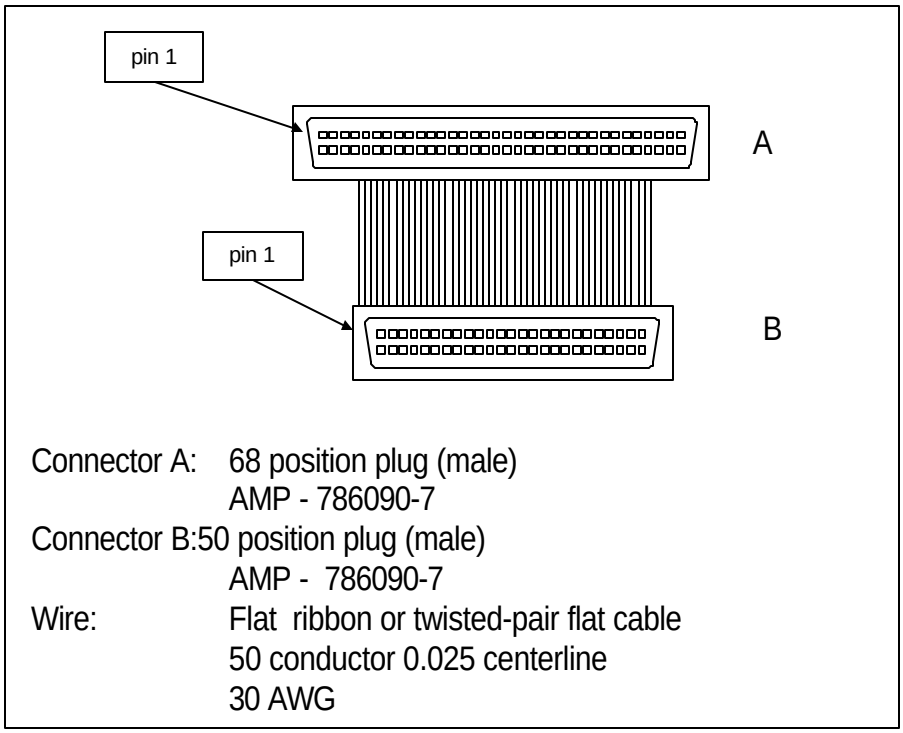
Converting Internal Wide to Internal Non-Wide (Type 30) The cable assembly for connecting internal wide SCSI devices to internal non-wide SCSI devices is shown below:



Connector A: 68 position plug (male)
AMP - 749925-5
Connector B:50 position plug (male)
AMP - 749925-3
Wire: Twisted-Pair Flat Cable or
Laminated Discrete Wire Cable
25 pair 0.050 centerline
28 AWG

Cont'd

Converting from Internal Wide to Internal Non-Wide (Type 3) The cable assembly for connecting internal wide SCSI devices to internal non-wide (Type 3) SCSI devices is shown below:



SCSI Cable Vendors

Manufacturer	Telephone Number
Cables To Go	Voice: 800-826-7904 Fax: 800-331-2841
System Connection	Voice: 800-877-1985
Technical Cable Concepts	Voice: 714-835-1081
GWC	Voice: 818-579-0888

SCSI Connector Vendors

Manufacturer	Connector Part Number	Back Shell Part Number
AMP	749111-4	749193-1
Fujitsu	FCN-237R050-G/F	FCN-230C050-D/E
Honda	PCS-XE50MA	PCS-E50LA

High-Density 68-Pin SCSI Connector Pinout

Signal	Connector Pin	Cable Pin	Cable Pin	Connector Pin	Signal
Ground	1	1	2	35	-DB(12)
Ground	2	3	4	36	-DB(13)
Ground	3	5	6	37	-DB(14)
Ground	4	7	8	38	-DB(15)
Ground	5	9	10	39	-DB(P1)
Ground	6	11	12	40	-DB(0)
Ground	7	13	14	41	-DB(1)
Ground	8	15	16	42	-DB(2)
Ground	9	17	18	43	-DB(3)
Ground	10	19	20	44	-DB(4)
Ground	11	21	22	45	-DB(5)
Ground	12	23	24	46	-DB(6)
Ground	13	25	26	47	-DB(7)
Ground	14	27	28	48	-DB(P)
Ground	15	29	30	49	SWAP L
Ground	16	31	32	50	SHELF_OK
TERMPWR	17	33	34	51	TERMPWR
TERMPWR	18	35	36	52	TERMPWR
Reserved	19	37	38	53	Reserved
Ground	20	39	40	54	FAULT_CLK H
Ground	21	41	42	55	-ATN
Ground	22	43	44	56	FAULT_DATA H
Ground	23	45	46	57	-BSY
Ground	24	47	48	58	-ACK
Ground	25	49	50	59	-RST
Ground	26	51	52	60	-MSG
Ground	27	53	54	61	-SEL
Ground	28	55	56	62	-C/D
Ground	29	57	58	63	-REQ
Ground	30	59	60	64	-I/O
Ground	31	61	62	65	-DB(8)
Ground	32	63	64	66	-DB(9)
Ground	33	65	66	67	-DB(10)
Ground	34	67	68	68	-DB(11)

Cont’d

68-Pin SCSI Connector Pinout, Continued

High-Density Connector The following applies to the high-density SCSI connector table on the previous page:

- A hyphen before a signal name indicates that signal is active low.
- The connector pin refers to the conductor position when using 0.025 inch centerline flat ribbon cable with a high-density connector (AMPLIMITE.050 Series connectors).
- Eight-bit devices connected to the P-Cable must leave the following signals open: -DB (8), -DB (9), -DB (10), -DB (11), -DB(12), -DB (13), -DB (14), -DB 15), and -DB (P1).
- All other signals should be connected as defined.

Caution

Lines labeled RESERVED should be connected to Ground in the bus terminator assemblies or in the end devices on the SCSI cable.

RESERVED lines should be open in the other SCSI devices, but can be connected to Ground.

68-Pin Connector Pinout for Differential SCSI

Signal	Connector Pin	Cable Pin	Cable Pin	Connector Pin	Signal
+DB(12)	1	1	2	35	-DB(12)
+DB(13)	2	3	4	36	-DB(13)
+DB(14)	3	5	6	37	-DB(14)
+DB(15)	4	7	8	38	-DB(15)
+DB(P1)	5	9	10	39	-DB(P1)
Ground	6	11	12	40	SWAP L
+DB(0)	7	13	14	41	-DB(0)
+DB(1)	8	15	16	42	-DB(1)
+DB(2)	9	17	18	43	-DB(2)
+DB(3)	10	19	20	44	-DB(3)
+DB(4)	11	21	22	45	-DB(4)
+DB(5)	12	23	24	46	-DB(5)
+DB(6)	13	25	26	47	-DB(6)
+DB(7)	14	27	28	48	-DB(7)
+DB(P)	15	29	30	49	-DB(P)
DIFFSENS	16	31	32	50	SHELF_OK H
TERMPWR	17	33	34	51	TERMPWR
TERMPWR	18	35	36	52	TERMPWR
RESERVED	19	37	38	53	Reserved
_ATN H	20	39	40	54	-ATN H
Ground	21	41	42	55	FAULT_CLK H
+BSY	22	43	44	56	-BSY
+ACK	23	45	46	57	-ACK
+RST	24	47	48	58	-RST
+MSG	25	49	50	59	-MSG
+SEL	26	51	52	60	-SEL
+C/D	27	53	54	61	-C/D
+REQ	28	55	56	62	-REQ
+I/O	29	57	58	63	-I/O
Ground	30	59	60	64	FAULT_DAT A H
+DB(8)	31	61	62	65	-DB(8)
+DB(9)	32	63	64	66	-DB(9)
+DB(10)	33	65	66	67	-DB(10)
+DB(11)	34	67	68	68	-DB(11)

B Audible Warnings

MegaRAID has an onboard tone generator that indicates events and errors.

Tone Pattern	Meaning	Examples
Three seconds on and one second off	A logical drive is offline.	One or more drives in a RAID 0 configuration failed. Two or more drives in a RAID 1, 3, or 5 configuration failed.
One second on and one second off	A logical drive is running in degraded mode.	One drive in a RAID 3 or 5 configuration failed.
One second on and three seconds off	An automatically initiated rebuild has been completed.	While you were away from the system, a disk drive in a RAID 1, 3, or 5 configuration failed and was rebuilt.

Glossary

Array A grouping or array of disk drives combines the storage space on the disk drives into a single segment of contiguous storage space. MegaRAID can group disk drives on one or more SCSI channels into an array. A hot spare drive does not participate in an array.

Array Management Software Software that provides common control and management for a disk array. Array Management Software most often executes in a disk controller or intelligent host bus adapter, but can also execute in a host computer. When it executes in a disk controller or adapter, Array Management Software is often called firmware.

Array Spanning Array spanning by a logical drive combines storage space in two arrays of disk drives into a single, contiguous storage space in a logical drive. MegaRAID logical drives can span consecutively numbered arrays that each consist of the same number of disk drives. Array spanning promotes RAID levels 1, 3, and 5 to RAID levels 10, 30, and 50, respectively. See also *Disk Spanning* and *Spanning*.

Asynchronous Operations Operations that bear no relationship to each other in time and can overlap. The concept of asynchronous I/O operations is central to independent access arrays in throughput-intensive applications.

Cache I/O A small amount of fast memory that holds recently accessed data. Caching speeds subsequent access to the same data. It is most often applied to processor-memory access, but can also be used to store a copy of data accessible over a network. When data is read from or written to main memory, a copy is also saved in cache memory with the associated main memory address. The cache memory software monitors the addresses of subsequent reads to see if the required data is already stored in cache memory. If it is already in cache memory (a cache hit), it is read from cache memory immediately and the main memory read is aborted (or not started.) If the data is not cached (a cache miss), it is fetched from main memory and saved in cache memory.

Channel An electrical path for the transfer of data and control information between a disk and a disk controller.

Cont’d

Consistency Check An examination of the disk system to determine whether all conditions are valid for the specified configuration (such as parity.)

Cold Swap A cold swap requires that you turn the power off before replacing a defective hard drive in a disk subsystem.

Data Transfer Capacity The amount of data per unit time moved through a channel. For disk I/O, bandwidth is expressed in megabytes per second (MBs).

Degraded A drive that has become non-functional or has decreased in performance.

Disk A non-volatile, randomly addressable, rewritable mass storage device, including both rotating magnetic and optical disks and solid-state disks, or non-volatile electronic storage elements. It does not include specialized devices such as write-once-read-many (WORM) optical disks, nor does it include so-called RAM disks implemented using software to control a dedicated portion of a host computer volatile random access memory.

Disk Array A collection of disks from one or more disk subsystems combined with array management software. It controls the disks and presents them to the array operating environment as one or more virtual disks.

Disk Duplexing A variation on disk mirroring where a second disk adapter or host adapter and redundant disk drives are present.

Disk Mirroring Writing duplicate data to more than one (usually two) hard disks to protect against data loss in the event of device failure. It is a common feature of RAID systems.

Disk Spanning Disk spanning allows multiple disk drives to function like one big drive. Spanning overcomes lack of disk space and simplifies storage management by combining existing resources or adding relatively inexpensive resources. For example, four 400 MB disk drives can be combined to appear to the operating system as one single 1600 MB drive. See also *Array Spanning* and *Spanning*.

Cont'd

Disk Striping A type of disk array mapping. Consecutive stripes of data are mapped round-robin to consecutive array members. A striped array (RAID Level 0) provides high I/O performance at low cost, but provides lowers data reliability than any of its member disks.

Disk Subsystem A collection of disks and the hardware that connects them to one or more host computers. The hardware can include an intelligent controller or the disks can attach directly to a host computer I/O a bus adapter.

Double Buffering A technique that achieves maximum data transfer bandwidth by constantly keeping two I/O requests for adjacent data outstanding. A software component begins a double-buffered I/O stream by issuing two requests in rapid sequence. Thereafter, each time an I/O request completes, another is immediately issued. If the disk subsystem is capable of processing requests fast enough, double buffering allows data to be transferred at the full-volume transfer rate.

Failed Drive A drive that has ceased to function or consistently functions improperly.

Fast SCSI A variant on the SCSI-2 bus. It uses the same 8-bit bus as the original SCSI-1, but runs at up to 10MB (double the speed of SCSI-1.)

Firmware Software stored in read-only memory (ROM) or Programmable ROM (PROM). Firmware is often responsible for the behavior of a system when it is first turned on. A typical example would be a monitor program in a computer that loads the full operating system from disk or from a network and then passes control to the operating system.

FlexRAID Power Fail Option The FlexRAID Power Fail option allows a reconstruction to restart if a power failure occurs. This is the advantage of this option. The disadvantage is, once the reconstruction is active, the performance is slower because an additional activity is added.

Cont'd

Format	The process of writing zeros to all data fields in a physical drive (hard drive) to map out unreadable or bad sectors. Because most hard drives are factory formatted, formatting is usually only done if a hard disk generates many media errors.
GB	Shorthand for 1,000,000,000 (10 to the ninth power) bytes. It is the same as 1,000 MB (megabytes).
Host-based Array	A disk array with an Array Management Software in its host computer rather than in a disk subsystem.
Host Computer	Any computer that disks are directly attached to. Mainframes, servers, workstations, and personal computers can all be considered host computers.
Hot Spare	A stand-by drive ready for use if another drive fails. It does not contain any user data. Up to eight disk drives can be assigned as hot spares for an adapter. A hot spare can be dedicated to a single redundant array or it can be part of the global hot-spare pool for all arrays controlled by the adapter.
Hot Swap	The substitution of a replacement unit in a disk subsystem for a defective one, where the substitution can be performed while the subsystem is running (performing its normal functions). Hot swaps are manual.
I/O Driver	A host computer software component (usually part of the operating system) that controls the operation of peripheral controllers or adapters attached to the host computer. I/O drivers communicate between applications and I/O devices, and in some cases participates in data transfer.
Initialization	The process of writing zeros to the data fields of a logical drive and generating the corresponding parity to put the logical drive in a Ready state. Initializing erases previous data and generates parity so that the logical drive will pass a consistency check. Arrays can work without initializing, but they can fail a consistency check because the parity fields have not been generated.

Cont'd

Logical Disk A set of contiguous chunks on a physical disk. Logical disks are used in array implementations as constituents of logical volumes or partitions. Logical disks are normally transparent to the host environment, except when the array containing them is being configured.

Logical Drive A virtual drive within an array that can consist of more than one physical drive. Logical drives divide the contiguous storage space of an array of disk drives or a spanned group of arrays of drives. The storage space in a logical drive is spread across all the physical drives in the array or spanned arrays. Each MegaRAID adapter can be configured with up to eight logical drives in any combination of sizes. Configure at least one logical drive for each array.

Mapping The conversion between multiple data addressing schemes, especially conversions between member disk block addresses and block addresses of the virtual disks presented to the operating environment by Array Management Software.

MB (Megabyte) An abbreviation for 1,000,000 (10 to the sixth power) bytes. It is the same as 1,000 KB (kilobytes).

Multi-threaded Having multiple concurrent or pseudo-concurrent execution sequences. Used to describe processes in computer systems. Multi-threaded processes allow throughput-intensive applications to efficiently use a disk array to increase I/O performance.

Operating Environment The operating environment includes the host computer where the array is attached, any I/O buses and adapters, the host operating system, and any additional software required to operate the array. For host-based arrays, the operating environment includes I/O driver software for the member disks, but does not include Array Management Software, which is regarded as part of the array itself.

Cont’d

Parity Parity is an extra bit added to a byte or word to reveal errors in storage (in RAM or disk) or transmission. Parity is used to generate a set of redundancy data from two or more parent data sets. The redundancy data can be used to reconstruct one of the parent data sets. However, parity data does not fully duplicate the parent data sets. In RAID, this method is applied to entire drives or stripes across all disk drives in an array. Parity consists of dedicated parity, in which the parity of the data on two or more drives is stored on an additional drive, and distributed parity, in which the parity data are distributed among all the drives in the system. If a single drive fails, it can be rebuilt from the parity of the respective data on the remaining drives.

Partition An array virtual disk made up of logical disks rather than physical ones. Also known as logical volume.

Physical Disk A hard disk drive that stores data. A hard disk drive consists of one or more rigid magnetic discs rotating about a central axle with associated read/write heads and electronics.

Physical Disk Roaming The ability of some adapters to detect when hard drives have been moved to a different slots in the computer, for example, after a hot swap.

Protocol A set of formal rules describing how to transmit data, especially across a network. Low level protocols define the electrical and physical standards to be observed, bit- and byte- ordering, and the transmission and error detection and correction of the bit stream. High level protocols deal with the data formatting, including the message syntax, the terminal-to-computer dialogue, character sets, and sequencing of messages.

RAID Redundant Array of Independent Disks (originally Redundant Array of Inexpensive Disks) is an array of multiple small, independent hard disk drives that yields performance exceeding that of a Single Large Expensive Disk (SLED). A RAID disk subsystem improves I/O performance on a server using only a single drive. The RAID array appears to the host server as a single storage unit. I/O is expedited because several disks can be accessed simultaneously.

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RAID Levels A style of redundancy applied to a logical drive. It can increase the performance of the logical drive and can decrease usable capacity. Each logical drive must have a RAID level assigned to it. The RAID level drive requirements are: RAID 0 requires one or more physical drives, RAID 1 requires exactly two physical drives, RAID 3 requires at least three physical drives, RAID 5 requires at least three physical drives. RAID levels 10, 30, and 50 result when logical drives span arrays. RAID 10 results when a RAID 1 logical drive spans arrays. RAID 30 results when a RAID 3 logical drive spans arrays. RAID 50 results when a RAID 5 logical drive spans arrays.

RAID Migration RAID migration is used to move between optimal RAID levels or to change from a degraded redundant logical drive to an optimal RAID 0. In Novell, the utility used for RAID migration is MEGAMGR and in Windows NT its Power Console. If a RAID 1 is being converted to a RAID 0, instead of performing RAID migration, one drive can be removed and the other reconfigured on the controller as a RAID 0. This is due to the same data being written to each drive.

Read-Ahead A memory caching capability in some adapters that allows them to read sequentially ahead of requested data and store the additional data in cache memory, anticipating that the additional data will be needed soon. Read-Ahead supplies sequential data faster, but is not as effective when accessing random data.

Ready State A condition in which a workable hard drive is neither online nor a hot spare and is available to add to an array or to designate as a hot spare.

Rebuild The regeneration of all data from a failed disk in a RAID level 1, 3, 4, 5, or 6 array to a replacement disk. A disk rebuild normally occurs without interruption of application access to data stored on the array virtual disk.

Rebuild Rate The percentage of CPU resources devoted to rebuilding.

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Reconstruct The act of remaking a logical drive after changing RAID levels or adding a physical drive to an existing array.

Redundancy The provision of multiple interchangeable components to perform a single function to cope with failures or errors. Redundancy normally applies to hardware; a common form of hardware redundancy is disk mirroring.

Replacement Disk A disk available to replace a failed member disk in a RAID array.

Replacement Unit A component or collection of components in a disk subsystem that are always replaced as a unit when any part of the collection fails. Typical replacement units in a disk subsystem includes disks, controller logic boards, power supplies, and cables. Also called a hot spare.

SAF-TE SCSI Accessed Fault-Tolerant Enclosure. An industry protocol for managing RAID enclosures and reporting enclosure environmental information.

SCSI (Small Computer System Interface) A processor-independent standard for system-level interfacing between a computer and intelligent devices, including hard disks, floppy disks, CD-ROM, printers, scanners, etc. SCSI can connect up to 7 devices to a single adapter (or host adapter) on the computer's bus. SCSI transfers eight or 16 bits in parallel and can operate in either asynchronous or synchronous modes. The synchronous transfer rate is up to 40 MBs. SCSI connections normally use single ended drivers, as opposed to differential drivers. The original standard is now called SCSI-1 to distinguish it from SCSI-2 and SCSI-3, which include specifications of Wide SCSI (a 16-bit bus) and Fast SCSI (10 MBs transfer).

SCSI Channel MegaRAID controls the disk drives via SCSI-2 buses (channels) over which the system transfers data in either Fast and Wide or Ultra SCSI mode. Each adapter can control up to three SCSI channels. Internal and external disk drives can be mixed on channels 0 and 1, but not on channel 2.

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SCSI ID

A SCSI disk drive (physical drive) can be in one of these four states:

- Online — Powered-on and operational.
- Hot Spare — Powered-on stand-by disk drive, ready for use if an online disk fails.
- Rebuild — A disk drive to which one or more logical drives is restoring data.
- Not Responding — The disk drive is not present, is not powered-on, or has failed.

Service Provider

The Service Provider, (SP), is a program that resides in the desktop system or server and is responsible for all DMI activities. This layer collects management information from products (whether system hardware, peripherals or software) stores that information in the DMI's database and passes it to management applications as requested.

SMARTer

Self-Monitoring, Analysis, and Reporting Technology with Error Recovery. An industry standard protocol for reporting server system information. Self-Monitoring, Analysis and Reporting Technology for disk drives is a specification designed to offer an early warning for some disk drive failures. These failures are predicted based upon actual performance degradation of drive components that are then reported back to a user through a graphical interface.

SNMP

Simple Network Management Protocol, the most widely used protocol for communication management information between the managed elements of a network and a network manager. SNMP focuses primarily on the network backbone. The Internet standard protocol developed to manage nodes on an Internet Protocol (IP) network.

Spanning

Array spanning by a logical drive combines storage space in two arrays of disk drives into a single, contiguous storage space in a logical drive. MegaRAID logical drives can span consecutively numbered arrays that each consist of the same number of disk drives. Array spanning promotes RAID levels 1, 3, and 5 to RAID levels 10, 30, and 50, respectively. See also *Disk Spanning* and *Spanning*.

Cont'd

Spare	A hard drive available to back up the data of other drives.
Stripe Size	The amount of data contiguously written to each disk. You can specify stripe sizes of 4 KB, 8 KB, 16 KB, 32 KB, 64 KB, and 128 KB for each logical drive. For best performance, choose a stripe size equal to or smaller than the block size used by the host computer.
Stripe Width	The number of disk drives across which the data are striped.
Striping	Segmentation of logically sequential data, such as a single file, so that segments can be written to multiple physical devices in a round-robin fashion. This technique is useful if the processor can read or write data faster than a single disk can supply or accept it. While data is being transferred from the first disk, the second disk can locate the next segment. Data striping is used in some modern databases and in certain RAID devices.
Terminator	A resistor connected to a signal wire in a bus or network for impedance matching to prevent reflections, e.g., a 50 ohm resistor connected across the end of an Ethernet cable. SCSI chains and some LocalTalk wiring schemes also require terminators.
Ultra-SCSI	An extension of SCSI-2 that doubles the transfer speed of Fast-SCSI, providing 20MBs on an 8-bit connection and 40MBs on a 16-bit connection.
Virtual Sizing	FlexRAID Virtual Sizing is used to create a logical drive up to 80 GB. A maximum of eight logical drives can be configured on a RAID controller and RAID migration is possible for all logical drives except the eighth. Because it is not possible to do migration on the last logical drive, the maximum space available for RAID migration is 560 GB.
Wide SCSI	A variant on the SCSI-2 interface. Wide SCSI uses a 16-bit bus, double the width of the original SCSI-1. Wide SCSI devices cannot be connected to a SCSI-1 bus. Wide SCSI supports transfer rates up to 20 MBs, like Fast SCSI.

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Write-Through/Write-Back When the processor writes to main memory, the data is first written to cache memory, assuming that the processor will probably read this data again soon. In write-through cache, data is written to main memory at the same time it is written to cache memory. In write-back cache, data is written only to main memory when it is forced out of cache memory. Write-through caching is simpler than write-back because an entry to cache memory that must be replaced can be overwritten in cache memory because it will already have been copied to main memory. Write-back requires cache memory to initiate a main memory write of the flushed entry followed (for a processor read) by a main memory read. However, write-back is more efficient because an entry can be written many times to cache memory without a main memory access.

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