Mylex

DAC960PD PCI to SCSI
Disk Array Controller

Installation Guide
Manual Version 3.1

AA-QXMFA-TH
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3. Plug the equipment into an outlet on a circuit different from that to which the receiver is powered.

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CE mark is rated for the DAC960PD as follows:

CISPR 22 Radiated Emission

EN55022, EN5082-1 Generic immunity standard for the following:
IEC 801-2 ESD, IEC 801-3 Radiated, and IEC 801-4 EFT/Burst

Warning!
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About this Manual

This Installation Guide describes how to make the DAC960PD PCI-to-SCSI Disk Array Controller ready to use. The chapters in this manual contain step-by-step instructions for performing the procedures necessary to:

- Set-up and install the controller board and its options
- Configure and connect the SCSI drives

This manual is designed as a quick reference guide for the system administrator or experienced computer user who is familiar with the principals and conventions of the Peripheral Component Interface (PCI), the Small Computer System Interface (SCSI), and with Redundant Array of Independent Disks (RAID) technology.

Chapter 1 contains an overview of the DAC960PD Controller features, options and specification.

Chapter 2 provides block-diagram level description of the DAC960PD and a description its RAID and SCSI functionality.

Chapter 3 contains an overview of the installation, including the necessary requirements, a helpful quick-reference checklist, instructions for setting the SCSI termination jumpers prior to installation, along with the instructions for configuring the drives and installing the cables.

The Appendices provide troubleshooting reference material with the DAC960PD Power-on self-test error messages.

At the successful conclusion of the procedures in this manual, the disk array system will be ready to:

- Configure and format the disk drives
- Define and initialize the logical units
- Receive the operating system, applications software, and data.

Refer to the DACCF Utilities Installation and User Guide for more information about configuring, initializing, and operating the DAC960PD.
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Chapter 1

Introduction

DAC960PD Product Description

The Mylex DAC960PD PCI-to-SCSI Disk Array Controller is an intelligent, high-performance, advanced RAID controller for PCI-based mid-range to large servers, office management systems, or single-user desktop workstation computing environments.

The DAC960PD supports industry-standard RAID levels (0, 1, 5, and 0+1), for multiple-drive arrays, or for single-drive control functionality. Set-up is by a simple to run software configuration utility (DACCF). And the highly-intuitive graphic user interface software, Global Array Manager (GAM), provides RAID administration and management capabilities.

The controller is available with either one, two, or three fully independent Fast/Wide SCSI channels for connecting SCSI hard drives or other non-disk SCSI devices, specifically CD-ROM and DAT tape drives.

Connectors on the top edge of the DAC960PD board provide the interface for internal SCSI devices. SCSI Channel 0 (and Channel 1 if installed) is also available on the end of the card for connecting to external disk array enclosures or other SCSI devices.

The DAC960PD uses a 32-bit RISC-based microprocessor, ASIC logic arrays, and dedicated read/write cache memory to reduce the host system’s CPU load and to increase disk I/O throughput (up to 60 MB/second on the 3 channel controller).

On-board memory required for operation is either a DRAM or EDRAM SIMM module (72 pin, 36-bit). Controllers equipped with EDRAM deliver enhanced performance through zero wait-state CPU/SIOP burst-cycle transfers between the DAC960 cache and the host system. The memory configuration on controllers equipped with EDRAM may be either 4- or 8 MB (15 ns, 0 ws). Controllers equipped with DRAM may be configured with either 2-, 4-, 8-, 16-, or 32 MB (70ns or faster).
Controller Functions and Features

Key Features
1. Complete RAID/SCSI disk array configuration and management
2. Automatic rebuild after disk failure without user intervention
3. SCSI performance enhancement for faster data transfers
4. Automatic fault monitoring and recovery increases system availability
5. Supports all major operating systems and network environments

Key 1 - Manages RAID/SCSI Disk Arrays
- Supports multiple RAID levels (0, 1, 5, and 0 + 1) allowing user to select the desired combination of storage capacity, data availability (redundancy) and I/O transfer performance for any data application
- Connects up to 21 SCSI drives that can be grouped and managed as a single large-capacity logical drive (up to 32 GB), as multiple large-capacity drive groups (256 GB addressable), or as individual drives
- Up to four DAC960 controllers per host connect up to 84 SCSI devices
- Industry-standard Fast/Wide SCSI-2 interface supports most SCSI drives

Key 2 - Automates RAID Functions
- Automatic failed-drive detection
- Automatic rebuild of the array using stand-by (hot spare) disk after a drive failure
- Transparent drive rebuild permits automatic rebuild of failed drives during normal operation without having to take the array off-line
- Automatic error detection/correction of parity errors, bad blocks, etc.
- Automatic sector remapping recovers defective media and corrects data errors
Key 3 -

Enhances SCSI Performance

- Fast/Wide SCSI channels provide high-performance data transfers at up to 20 MB/second/channel
- PCI bus mastering provides up to 132 MB/second burst data rates
- Tag-queuing to the host allows processing of up to 64 simultaneous multi-thread system commands or data requests
- User-defined performance-tuning through selectable cache write policy, variable stripe width, and rebuild priority to optimize controller performance during rebuild
- Disconnect/reconnect capability for enhanced performance and SCSI bus optimization

Key 4 -

Increases System Availability

- Built-in diagnostics provide controller and drive fault monitoring during-power-on and continuous operation
- Status alerts notify the administrator or user of critical conditions
- Supports AEMI protocols for integrated monitoring of enclosure power supplies, fans, and temperature
- Battery backup option protects data in the controller cache in the event of a power interruption

Key 5 -

Supports Popular Operating Systems

- Novell NetWare 3.1x, 4.0x, 4.1x
- Microsoft Windows NT 3.5x and Advanced Server
- IBM OS/2 2.1, 2.2, 3.0 (WARP), SMP
- SCO UNIX 3.2.4 and SCO ODT
- Novell UnixWare v2.0
- Banyan Vines 6.x
- MS-DOS 5.x, 6.x, and above
Standard Package Contents

- DAC960PD Controller with cache memory (minimum 2 MB required for operation) and Installation Guide manual
- Configuration & Utilities software (DACC5) diskette and manual
- DAC Software Kit (NOS driver software) diskettes and manual
- Global Array Manager (GUI software) diskettes and manual

Options

- Mylex DBB960PD Battery Backup Unit (BBU)

User-Supplied Items

The following items may also be required, depending on the application:

- Cache memory upgrade (One 72-pin SIMM, n x 36, – EDRAM: 8 MB, 15 ns; DRAM: 4, 8, 16, or 32 MB, 70 ns)
- SCSI cables (internal), one per channel
- Internal and/or external SCSI terminators, as required
- 68-pin to 50-pin SCSI Adapter (if required)
- External SCSI cables (if required)
### Specifications

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<th>DAC960PD</th>
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<td>Intel i960CF® RISC 32-bit microprocessor</td>
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<table>
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<th>Memory</th>
<th>DRAM or EDRAM, 72-pin SIMM</th>
</tr>
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<tr>
<td>Module Type</td>
<td>Minimum: 2 MB DRAM, 70ns or faster</td>
</tr>
<tr>
<td>Size</td>
<td>4 MB EDRAM, 15ns (0 ws)</td>
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<td>Optional</td>
<td>DRAM, 4, 8, 16, or 32 MB (n x 36)</td>
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<td>EDRAM, 8 MB (n x 36)</td>
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<tr>
<td>Cache Type</td>
<td>Write: Selectable, Write Through or Write Back</td>
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<td>Read: Always enabled</td>
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<td>32-bit, 33 MHz, PCI Local Bus</td>
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<td>Bus Master</td>
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<tr>
<td>Mode</td>
<td>Transfer Rate: Up to 132 MB/second (burst)</td>
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<td>8 or 16-bit Fast / Wide SCSI-2 compliant</td>
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<tr>
<td></td>
<td>RAID 0 + 1, Striping and Mirroring</td>
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<td>JBOD, Single-drive control</td>
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Electrical requirements

Input Power
- 5V ± 5% @ 2.5 Amp\(^1\) (w/4MB memory)
- 5V ± 5% @ 3.5 Amp\(^1\) (w/16MB memory)
\(^1\) (Supply currents assume drives providing term power)

Environmental

Temperature
- Operating: 5°C to 55°C
- Storage: -60°C to +150°C

Humidity
- Operating: 20% to 90% rh
- Non-operating: 20% to 90% rh

Dimensions

- Length: 12.5 inches
- Height: 4.19 inches
Chapter 2

Functional Description

Overview

The Mylex DAC960PD provides high-performance PCI-to-SCSI disk array control functionality for medium-size to large network servers or workstations. When properly configured, the DAC960PD delivers a high degree of fault tolerance and advanced disk array management features through the use of RAID technology.

The DAC960PD Disk Array Controller plugs into one of the host system’s Peripheral Component Interface (PCI) bus slots and connects to either internal disk drives and/or external drive enclosures via standard SCSI-2 compliant cabling.

![Figure 2-1. System Diagram](image-url)
Controller Components

Key components of the DAC960PD controller, shown in Figure 2-2, are:

- i960 RISC processor
- Cache Memory and Memory Control Unit
- PCI and SCSI I/O subsystems

The i960 Processor

The DAC960PD CPU is a 32-bit Intel i960CF RISC microprocessor. The CPU controls all functions of the DAC960PD, including PCI and SCSI bus transfers, RAID processing, configuration, data striping, error recovery, and drive rebuild.

Cache Memory Subsystem

The DAC960PD can be configured with up to 32 megabytes of cache memory, depending on the type of SIMM modules being used. A minimum of 2MB cache is required for controller operation. Cache write policy is user-selectable for each logical unit in the configuration.

A fast 32-bit interface between the i960 CPU and the cache is provided by the Mylex Memory Control Unit (MCU). In addition to memory control and addressing functions, this discrete logic array provides the device mapping and decode for the non-volatile memory (NVRAM) and the electronically-erasable/programmable read-only memory (Flash EEPROM). The MCU also detects the type of SIMM module installed and automatically sets the wait-state to either zero or one.

Controller Firmware

The DAC960PD firmware contains the programs executed by the i960 CPU. The firmware resides in the on-board Flash EEPROM and operates through the Shadow RAM area of the controller's. The EEPROM retains information after power is off and can also be re-written, to allow the controller firmware to be upgraded without the need to replace any hardware chips.

The NVRAM stores data on the current configuration of the controller and its attached disk drives, and lists of pending write operations issued to any redundant drives. As the configurations change (for example, when a drive fails), the NVRAM keeps a record of the changes. These data are checksum protected so that after a power failure, the controller will recall the configuration and will restore consistency for all outstanding writes on restart.


**Functional Description**

**Figure 2-2. DAC960PD Controller Block Diagram**

**PCI Bus Interface**

The interface between the host system PCI bus and the i960 processor on the DAC960PD is controlled in hardware by the Mylex 189206 PCU ASIC. The PCU provides fast data transfers without the limitations associated with PCI bridge technology. Interface to the host is by 32-bit, 33Mhz PCI local bus, using the single interrupt line, INTA#. Through PCI Bus Mastering, the DAC960PD supports burst data transfers up to 132 MB/second.

**SCSI Bus Interface**

The DAC960PD uses the Symbios Logic 53C720 enhanced performance SCSI I/O processor chip on each SCSI channel to allow the controller to simultaneously read or write data on up to seven disk drives per channel. The DAC960PD supports the Fast/Wide (8/16-bit) SCSI-2 standard, which is backward compatible with earlier SCSI standards. The DAC960PD delivers SCSI data transfer rates up to 20 MB per second per channel (60 MB/sec 3-channel).
SCSI Functions

The DAC960PD i960 RISC processor and SCSI I/O processor(s), provide intelligent, high-performance SCSI interface and control. The DAC960PD manages and controls the SCSI bus arbitration between the controller and its connected devices, and all SCSI activity of the connected devices.

Multiple SCSI Format Support

The standard DAC960PD provides at least one, and optionally up to three, SCSI channels for connecting disk drives or other devices, such as CD-ROM and tape drives. With the correct cabling, these devices may be any combination of Narrow, Fast, or Fast/Wide SCSI formats (see Table 2-1).

SCSI Cabling and Termination Conventions

Disk drives equipped with a SCSI interface should be connected to the controller by means of cables that comply with standard SCSI data-rate, pinout, and cable-length conventions (including all internal wiring). Up to seven SCSI devices can be connected to each of the controller’s drive channels. The first and last device on each channel must be terminated. The DAC960PD supports active termination (alternative-2, or ALT-2).

SCSI Address (Target ID) Selection

Each drive or device on a specific SCSI channel must be configured for a target address (or target ID) that is different from all other devices on that channel. The target ID, a SCSI address number from 0 to 7, is assigned to each device attached to a SCSI channel during installation.

The default SCSI address for the DAC960PD controller is target ID 7. Subsequently, you must assign to each connected disk drive a different (unique) SCSI address, typically a target ID number from 0 to 6.

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<tr>
<th>SCSI Type</th>
<th>Clock Rate</th>
<th>Data Rate</th>
<th>Connector</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide SCSI-2</td>
<td>10 Mhz</td>
<td>20 MB/sec</td>
<td>68-pin</td>
<td>3 m (10 ft)</td>
</tr>
<tr>
<td>(16-bit)</td>
<td>5 Mhz</td>
<td>10 MB/sec</td>
<td></td>
<td>6 m (20 ft)</td>
</tr>
<tr>
<td>Narrow SCSI-2</td>
<td>10 Mhz</td>
<td>10 MB/sec</td>
<td>68-pin or</td>
<td>3 m (10 ft)</td>
</tr>
<tr>
<td>(8-bit)</td>
<td>5 Mhz</td>
<td>5 MB/sec</td>
<td>50-pin*</td>
<td>6 m (20 ft)</td>
</tr>
<tr>
<td>SCSI-1 (8-bit)</td>
<td>5 Mhz</td>
<td>5 MB/sec</td>
<td>50-pin*</td>
<td>6 m (20 ft)</td>
</tr>
</tbody>
</table>

* 50-pin to 68-pin adapter required
Drive Organization

The DAC960PD controller organizes the SCSI drives connected to it as physical drives and logical units.

Physical Drives (Drive Groups or Packs)

Using the DAC960PD, up to eight individual disk drives can be used together to form a pack or drive group of physical drives that will be used to comprise the array’s logical unit capacity:

**Note:** If all of the disks in a drive group are not the same size, the drive group has the effective capacity of the multiple of the smallest drive.

To determine the total size of a drive group, multiply the size of the smallest drive in the drive group by the number of disk drives in the group.

For example, if there are four drives of 4 GB each, and one drive of 2 GB comprising a drive group, the effective capacity available for use is 10 GB (5 x 2), not 18 GB.

The DAC960PD supports up to eight (8) drive groups.

Logical Units (System Drives)

A logical unit (or system drive) is that portion of a drive group (or a combination of up to eight drive groups) seen by the host system as a single logical device. The maximum addressable size of a single logical unit is 32 GB.

Each logical unit is identified to the host by its logical unit number (LUN). The DAC960PD supports up to eight (8) LUNs per drive group. For example, on the first channel of the controller, the third logical unit having a SCSI target ID of 1 will be seen by the host computer as CH 0, ID 1, LUN 2 (since LUN numbering begins at 0, and continues 1, 2, 3, etc.).

**Note:** Use the DACCF software utility to configure the logical units (system drives).
RAID Management

RAID is an acronym for Redundant Array of Independent Disks. The DAC960PD controller implements several different versions of the Berkeley RAID technology, and two special versions that are specific only to the DAC960 family of RAID controllers. Each version (referred to as a RAID Level) that is supported by the DAC960PD controller is shown in Table 2-2.

An appropriate RAID level is selected when the logical drives are defined or created using the configuration software utility (e.g., DACCF). Deciding which RAID level to use is based on the following priorities:

- Disk capacity
- Data availability (fault tolerance or redundancy)
- Disk performance

The DAC960PD controller makes the RAID implementation and the disks’ physical configuration transparent to the host operating system. This means that the host operating system drivers and software utilities are not affected, regardless of the RAID level selected.

Correct installation of the disk array and the DAC960PD controller requires a proper understanding of RAID technology and the concepts described in this chapter and in the DACCF Utilities documentation.

<table>
<thead>
<tr>
<th>RAID Level</th>
<th>Description</th>
<th>Drives/Chnl Min</th>
<th>Drives/Chnl Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Block striping is provided, which yields higher performance than with individual drives. There is no redundancy.</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>Drives are paired and mirrored. All data is 100% duplicated on an equivalent drive (fully redundant).</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Data is striped across several physical drives. Parity protection is used for data redundancy.</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>0+1</td>
<td>(Mylex RAID 6) Combination of RAID levels 0 and 1. This level provides striping and redundancy through mirroring.</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>JBOD</td>
<td>(Mylex RAID 7) &quot;Just a Bunch of Drives.&quot; Each drive can operate independently like with a common host bus adapter, or multiple drives may be spanned and seen as a single very large drive. No redundancy is provided.</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2-2. Supported RAID Levels
RAID Techniques and Terms

The techniques of disk striping, mirroring, and parity (redundancy) are fundamental elements of RAID technology performed by the DAC960PD. More detailed information on how to apply these techniques can be found in the DACCF Utilities manual.

Mirroring (RAID 1)

Mirroring refers to the 100% duplication of data from one disk drive onto another. Each disk contains the mirror image of the data on the other drive.

Striping (RAID 0)

Striping refers to the storing of a sequential block of incoming data across multiple drives in a drive group. For example, if there are three drives in a drive group (or pack), the data will be separated into blocks. Block one of the data will be stored on drive one, block two on drive two, block three on drive three. Drive one will again be the location of the next block (block four); then, block five is stored on drive two, block six on drive three, and so on. This method can significantly increase disk system throughput, particularly for transferring large, sequential data blocks.

Stripe Order

The order in which SCSI drives appear within a drive group is the stripe order. It is critical that the selected stripe order is always maintained, to assure data integrity and the controller's ability to rebuild failed drives.

Stripe Size

The size of the logically contiguous data block recorded on all drives connected to the controller is the stripe size. The default is 8 KB. Other choices are 16, 32 or 64 KB, which may be selected with the DACCF configuration utility (Advanced Functions menu, Physical Parameters option).

Stripe Width

The number of drives within a drive group is referred to as the stripe width.

Striping with Parity (RAID 5)

Striping with parity (rotated XOR redundancy) is a method of providing complete data redundancy that requires only a fraction of the storage capacity than mirroring for storing redundant information.
In a system configured under RAID-5 (which requires at least three SCSI drives), all data and parity blocks are divided between the drives in such a way that if any single drive is removed (or fails), the data on the missing drive can be regenerated using the data on the remaining drives (XOR refers to the Boolean "Exclusive-OR" operator).

**Drive Management**

The DAC960PD functions that monitor and control the operation of the physical drives and logical units are instrumental to the controller’s ability to perform RAID management and automated error recovery tasks.

**Controlling Physical Drive States**

The *state* of a physical drive refers to a SCSI drive’s current operational status. At any given time, a SCSI drive can be in one of several states: ONLINE, STANDBY, READY, DEAD, REBUILD, or WRITE-ONLY.

The controller stores the state of the attached SCSI drives in its non-volatile memory. This information is retained even after power-off. If a SCSI disk is labeled DEAD in one session, it will stay in the dead state until a change is made either by using a system level utility or after a maintenance/rebuild procedure is performed.

**On-line (ONL)**

A SCSI drive (physical drive) is *on-line* if it:

1. Is powered on
2. Has been defined as a member of a drive group
3. Is operating properly.

**Standby (SBY)**

A SCSI disk drive is in a *standby* state if it:

1. Is powered on
2. Is able to operate properly
3. Has *not* been defined as part of any drive group.
4. Has been defined as a standby
Functional Description

Dead (DED)
A drive is *dead* if it:

1. Is not present
2. Is present, but not powered on
3. Failed to operate properly and was killed by the controller

When the controller detects a failure on a disk, it *kills* that disk by changing its state to dead. A SCSI drive that is in the dead state does not participate in any I/O activity. No commands are issued to dead drives.

Write-Only (WOL)
A SCSI drive is in a *write-only* state if it was in the process of being rebuilt, that is ...

- During a RAID 1 rebuild process, data is copied from the mirrored drive to the replacement drive.
- During a RAID 5 or RAID 0+1 rebuild, data is regenerated via the XOR redundancy algorithm and written to the replacement drive.

... and the rebuild was terminated abnormally before it completed.

Ready (RDY)
A SCSI disk drive may be identified by the DACCF utility as *ready* if it:

1. Is powered on
2. Is able to operate properly
3. Has *not* been defined as part of any drive group.
4. Has *not* been defined as a standby

*Ready* is not an actual drive state or command issued by the controller. The drive will change from RDY to SBY (standby) when the configuration is saved to memory.
Functional Description

Controlling Logical Unit States

The state of a DAC960PD logical unit can be ON-LINE, CRITICAL, or OFF-LINE. Notice that the same term on-line is used for both physical drives and logical units.

Note: I/O operations can be performed only with logical units that are either on-line or critical.

On-line

A logical unit is on-line if all of its participating physical drives are on-line.

Critical

A logical unit is considered critical when any failure of another of its physical drives may result in a loss of data.

A logical unit is critical if it meets both of the following conditions:

1. It is configured for RAID 1, RAID 5 or RAID 0+1
2. One (and no more than one) of its physical drives is not on-line (refer to the description of Off-line, below).

Off-line

An off-line logical unit is one on which no data can be read or written. No operations can be performed on off-line logical units. System commands issued to off-line logical units are returned with an error status.

A logical unit can be offline under one of two conditions:

1. It is configured with a redundant RAID level (1, 5, or 0+1) and two or more of its SCSI drives are not online
2. It is configured as RAID 0 or JBOD (or in a spanned set) and one or more of its SCSI drives are not on-line.
Controlling Standby Replacement Drives (Hot Spares)

The *standby replacement* drive, or *hot spare*, is one of the most important features the DAC960PD controller provides to achieve automatic, non-stop service with a high degree of fault-tolerance. With the standby rebuild function, the controller performs a rebuild operation automatically when a SCSI disk drive fails and both of the following conditions are true:

1. A standby SCSI disk drive of identical or larger size is found attached to the same controller;
2. All of the system drives that are dependent on the failed disk are redundant system drives, e.g., RAID 1, RAID 5, or RAID 0+1.

During the automatic rebuild process, system activity continues as normal. System performance may degrade slightly, however, during a rebuild.

**Using Standby Rebuild**

To use the automatic standby rebuild feature, it is necessary to always maintain a standby disk in the system.

A *standby* disk can be created in one of the following ways:

1. When the DAC960PD configuration is created or changed using the DACCF software utility, all disks attached to the controller that are *Online* and not assigned to a drive group will be automatically labeled as standby disks.
2. A disk that is not part of any drive group may be made a standby drive by using the DOS-based DAC960 Toolkit utility, *DAC960TK.EXE*.

**Standby Replacement Table**

A standby replacement table stores data on up to eight automatic replacement events in any session (from one power-on/reset to the next power-off/reset). When the limit of eight is reached and a disk failure occurs, a standby replacement can take place but is not recorded in the replacement table.

The standby replacement table can be cleared from the DAC960PD by using the DACCF software utility *Save Configuration* command under either the New Configuration command or the View/Update Configuration command, System Drive Definition menu.
Hot-Swap Drive Replacement

The DAC960PD supports the ability of certain drive enclosures to perform a hot-swap drive replacement while the system is on-line. A disk can be disconnected, removed, or replaced with a different disk without taking the system off-line. The SCSI bus termination must be arranged so that a drive can be removed without disrupting the termination scheme.

Disk Failure Detection

The DAC960PD controller automatically detects SCSI disk failures. A monitoring process running on the controller checks, among other things, elapsed time on all commands issued to disks. A time-out will cause the disk to be reset and the command will be retried. If the command time-out occurs again, the disk could be killed by the controller (that is, its state changed to dead).

The DAC960PD controller also monitors SCSI bus parity errors and other potential problems. Any disk with too many errors will be killed by the controller.

Disk Media Error Management

The DAC960PD controller manages SCSI disk media errors in a manner transparent to the user.

Disks are programmed to report errors. When a disk reports a media error during a read, the controller reads the data from the mirror (RAID 1 or RAID 0+1), or computes the data from the other blocks (RAID 5), and writes the data back to the disk that encountered the error. If the write fails, or the following verify-of-data fails (media error on write), the controller issues a REASSIGN command to the disk, and then writes the data to a new location. Since the problem has been resolved, no error is reported to the system.

When a disk reports a media error during a write, the controller issues a REASSIGN command to the disk, and writes the data out to a new location on the disk.
Checking Disk Parity

A parity check is a process that verifies the integrity of redundant data. For example, performing a parity check of a mirrored drive assures that the data on both drives of the mirrored pair are exactly the same. To verify RAID 5 redundancy, a parity check reads all associated data blocks, computes parity, reads parity, and verifies that the computed parity matches the read parity.

Cache Management

The DAC960PD provides performance enhancement of data transfers through its on-board cache memory. The controller supports cache memory sizes from 2 MB (minimum) to 32 MB (maximum). Cache memory is allocated by the controller memory management functions for Read Cache and Write Cache. Write cache policy is user-selectable for each logical unit to achieve optimum performance within specific applications.

Read Cache

Read cache is always enabled by the controller. Its operation is transparent and requires no user intervention.

Write-Back Cache

Write-Back Cache refers to a caching strategy whereby write operations result in a completion status being sent to the host operating system as soon as the cache (not the disk drive) receives the data to be written. The target SCSI Drive will receive the data at a more appropriate time in order to increase controller performance.

Write-Through Cache

Write-Through Cache refers to a cache writing strategy whereby data is written to the SCSI Drive before a completion status is returned to the host operating system. This caching strategy is considered more secure, since a power failure will be less likely to cause loss of data. However, a Write-Through cache results in a slightly lower performance in most applications.

Cache Battery Backup

An optional cache battery backup is available that can be used to protect against cache data loss in the event of a power failure.
Chapter 3
Installation

Overview

This chapter describes the installation of the DAC960PD Disk Array Controller hardware, and the proper connection and configuration of its attached SCSI devices.

Requirements

The following items are required to perform this installation:

- DAC960PD PCI Disk Array Controller with memory installed
- Host system with an available PCI slot
- Configuration & Utilities diskette containing the DACCF utility
- SCSI cable(s) to interconnect the controller and the drives/devices
- Fast SCSI-2 or Wide SCSI compliant hard disk drives
- SCSI termination device(s) as required

Refer to the Configuration & Utilities diskette file DISKLIST.TXT for a list of disk drives and other devices that are compatible with the DAC960PD.

Optional Requirements

The following optional items also may be required, depending on your application or the type of installation:

- SCSI cable to interconnect the controller and external devices
- Battery back-up option for controller cache memory.
Before You Begin . . .

Installing the DAC960PD controller is no more difficult than installing any PCI adapter card. Just follow these common-sense rules and the installation procedures should go flawlessly:

**WARNING**

Working with the covers off and power applied to the system can result in electrical shock and serious injury.

1. REMOVE POWER from the system before starting
2. Read all of the instructions in this manual through completely before proceeding, and observe the Notes, Cautions, and Warnings
3. Determine the system’s SCSI ID and termination requirements and set the controller’s jumpers as needed before installing it
4. Make sure that all of the cabling Pin 1 locations are correct
5. Make sure all SCSI conventions (cable type, cable length, termination, etc.) are correct
6. Safety check the installation before powering-on the system.

You may copy the DAC960PD Installation Notes and Installation Checklist in this manual to use as a quick reference guide during the installation and configuration procedures.
**INSTALLATION NOTES:**

**DAC960PD Controller Setup:**

<table>
<thead>
<tr>
<th>SCSI ID</th>
<th>Drive Channel</th>
<th>Termination Jumper</th>
<th>Termination Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>*7</td>
<td>Channel 0</td>
<td>J9</td>
<td>*Yes/_____</td>
</tr>
<tr>
<td></td>
<td>Channel 1</td>
<td>J12</td>
<td>*Yes/_____</td>
</tr>
<tr>
<td></td>
<td>Channel 2</td>
<td>J10</td>
<td>*Yes/_____</td>
</tr>
</tbody>
</table>

* Indicates Default Setting

**SCSI Devices Installed:**

**Drive Channel 0**

<table>
<thead>
<tr>
<th>SCSI ID</th>
<th>Device Description</th>
<th>Termination Enabled (Y/N)</th>
<th>Drive Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Drive Channel 1 (Optional)**

<table>
<thead>
<tr>
<th>SCSI ID</th>
<th>Device Description</th>
<th>Termination Enabled (Y/N)</th>
<th>Drive Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Drive Channel 2 (Optional)**

<table>
<thead>
<tr>
<th>SCSI ID</th>
<th>Device Description</th>
<th>Termination Enabled (Y/N)</th>
<th>Drive Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
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<td></td>
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<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DAC960PD Installation Checklist

1. POWER-OFF all enclosure and system components
2. Prepare the host system according to its documentation
3. Determine the SCSI ID and termination requirements
4. Check the DAC960PD jumper settings
5. Mount the controller into the system, connect the cables and terminators
6. Safety check the installation, then power-on the system
7. Load the DACCF configuration utilities software
8. Format the drives (use the DACCF Tools Format Drive utility)
9. Configure the Drive Groups (packs) and the logical units (System Drives)
10. Initialize the logical units
11. Install any required network operating system drivers (from Software Kit)
12. (Optional) Install the Global Array Manager array monitoring software
Connectors and Jumpers

Connector and jumper locations on the DAC960PD are shown in Figure 3-1 and described in Table 3-1.

![Diagram of DAC960PD Component Locator]

**Figure 3-1. DAC960PD Component Locator**

**Table 3-1. DAC960PD Connectors and Jumpers**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>AEMI (Array Enclosure Management Interface) Port</td>
</tr>
<tr>
<td>J2</td>
<td>Connector, Battery Backup Module*</td>
</tr>
<tr>
<td>J3</td>
<td>Fast/Wide SCSI Connector, 68-pin, Drive Channel 0</td>
</tr>
<tr>
<td>J4</td>
<td>Fast/Wide SCSI Connector, 68-pin, Drive Channel 1*</td>
</tr>
<tr>
<td>J5</td>
<td>Fast/Wide SCSI Connector, 68-pin, Drive Channel 2*</td>
</tr>
<tr>
<td>J6</td>
<td>Connector block, Bus/Drive Activity LEDs</td>
</tr>
<tr>
<td>J7</td>
<td>Reserved (Factory test use only)</td>
</tr>
<tr>
<td>J9</td>
<td>Jumper, SCSI Termination, Drive Channel 0</td>
</tr>
<tr>
<td>J10</td>
<td>Jumper, SCSI Termination, Drive Channel 2*</td>
</tr>
<tr>
<td>J11</td>
<td>External Fast/Wide SCSI Connector, 8mm Champ, Drive Channel 0</td>
</tr>
<tr>
<td>J12</td>
<td>Jumper, SCSI Termination, Drive Channel 1*</td>
</tr>
<tr>
<td>J14</td>
<td>External Fast/Wide SCSI Connector, 8mm Champ, Drive Channel 1*</td>
</tr>
</tbody>
</table>

* Optional
External LED Connectors

Jumper J6 is a six-pin header that provides connection for three status LEDs. The pins are listed in Table 3-2. In each case, the odd-numbered pin is the +5V source (Pins 1, 3 and 5). Pin 1 is on the top. An external series resistor is not required for connecting LEDs.

![J6 Connector](image)

**Figure 3-2. Status LED Connectors**

<table>
<thead>
<tr>
<th>Connector</th>
<th>Indicator</th>
<th>Meaning if ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>J6, Pin 1-2</td>
<td>SCSI Activity</td>
<td>One (or more) of the SCSI channels on the controller is transmitting or receiving data</td>
</tr>
<tr>
<td>J6, Pin 3-4</td>
<td>PCI Activity</td>
<td>The controller is transmitting or receiving data to or from the host</td>
</tr>
<tr>
<td>J6, Pin 5-6</td>
<td>Write Pending</td>
<td>The cache memory on the DAC960 holds data that is more current than the data on the hard drive(s).</td>
</tr>
</tbody>
</table>

**WARNING**

DATA WILL BE LOST if the system either loses power or is reset while the Write Pending LED is ON (indicating the cache contains data not yet written to disk). To prevent data loss, install the optional cache battery backup module.

AEMI Interface Connector

Connector J1 is the AEMI (Array Enclosure Management Interface) connector and provides a set of inputs and outputs that can be used to interface the DAC960PD disk array controller with certain AEMI compliant Disk Array subsystem cabinets.
**SCSI Termination**

Terminating a SCSI chain is accomplished either by adding a terminator, or by terminating the devices, on each of the two ends of the SCSI bus.

The DAC960PD has on board ALT-2 type SCSI terminators on all drive channels. Jumpers J9, J12, and J10 are used to enable or disable the SCSI termination for Channels 0, 1, and 2 respectively.

By default, all three jumpers are installed when shipped from the factory (termination enabled). This is the normal termination required when the controller is installed at one end of the SCSI cable. In this case, whenever J9, J10, or J12 are shunted, the controller will provide termination to each SCSI channel, and will also power the SCSI TERMPWR signal for that SCSI bus.

**Terminating Internal Disk Arrays**

On a disk array system, the termination should be set in such a way that when any drive is removed from the SCSI bus, termination and termination power are left intact.

---

**Figure 3-3. Internal Disk Array, Single-ended SCSI Termination**
Terminating External Disk Arrays

There are up to five SCSI connectors on the DAC960PD disk array controller. The shielded .8mm champ 68-pin ultra high-density SCSI connectors on the external bracket are for external connection to Channel 0 and Channel 1. Channel 0 and Channel 1 signals are also available from the unshielded 68 pin D type SCSI connectors at the top of the controller.

For most array enclosures, the other end of the cable should have an independent terminator that is connected to the SCSI bus and is not part of any of the drives. This way the termination is not disturbed when any of the drives are removed or replaced.

Figure 3-4. External Disk Array, Single-ended SCSI Termination
Terminating Combined Internal and External Disk Arrays

Both of the internal and external connectors can be used simultaneously. However, the termination jumper on the DAC960PD must be removed for that channel because the controller is in the middle of the chain, and the SCSI bus must be terminated at both ends.

For most array enclosures, the end of the cable should have an independent terminator that is connected to the SCSI cable and is not part of any of the drives. This way the termination is not disturbed when any of the drives are removed or replaced.

Whenever a channel on the DAC960PD controller is not at the end of a SCSI cable, remove the appropriate termination jumper for that channel and terminate the SCSI cable properly at both ends.

Figure 3-5. Combination External/Internal Disk Array, SCSI Termination

Selecting the Correct Terminator

Use ALT-2 type external SCSI terminators for operating a SCSI channel at 10M Bytes/second (or faster) synchronous transfer rates. Use ALT-1 type external SCSI terminators for operating a SCSI channel at 5M Bytes/sec synchronous or asynchronous transfer rate. The DACCF Configuration Utility can be used to set the transfer rate and mode for each channel.
Configuring the SCSI Devices

SCSI disk drives and other devices that will be connected to the controller will need a certain amount of preparation before they are installed. This may include setting jumpers to control termination power on the bus, drive spin-up order, and parity protocols.

Setting Device Termination Power

All of the SCSI drives connected to the DAC960PD should be shunted to apply power on the SCSI TERMPWR line, as well as having any of their built-in terminators disabled or removed. It is important that all drives supply termination power, so that power is applied to the SCSI bus even if drives are removed or replaced.

The same rules also apply to ‘non disk’ SCSI devices connected to any of the DAC960PD SCSI channels.

Setting Drive Spin-up & Parity Jumpers

If all of the SCSI drives are connected to a single power supply, or if the power supply cannot supply the power needed to spin-up all of the drive motors simultaneously, then the controller should be configured to spin-up the drives separately. By spinning up the hard drives separately, the power supply is not unnecessarily loaded by the large starting current required to spin-up drives simultaneously. If drives are to be spun-up individually by the controller, they may need to be shunted to spin-up on command, not at power-on. See the specifications accompanying the SCSI drive for proper jumper settings.

Also, the DAC960PD Disk Array controller should be configured to spin-up the drives at regular intervals by giving each drive a spin-up command. See the DACCF Configuration Utility manual for more information on the disk drive spin-up options. Tape and CD-ROM spinup options should be left at the factory defaults.

The drive parity jumpers, if any, should be set to always enable parity on the SCSI data coming in, and to send parity with the data sent to the controller.
SCSI Cabling

Three things must be kept in mind while cabling the controller to the drives:

- SCSI Bus Termination
- System Performance
- SCSI Cable Length.

Every SCSI channel needs to be properly terminated with an appropriate SCSI terminator, as previously mentioned. In general, no drives should be terminated, and all drives must be shunted to supply TERMPWR on the SCSI bus.

**Note:** When connecting a Narrow SCSI (8-bit) cable to any DAC960 channel, the controller must be at one end of the bus and *Termination Enabled* must be set for that channel.

To get the best performance from the controller, the SCSI drives should be equally distributed across the SCSI channels, and the controller’s data transfer rate should be set to the optimum rate for the drives being used.

**Note:** The SCSI transfer rate can be individually selected for each of the three channels on the DAC960PD. For more information, refer to the DACCF Configuration Utility manual.

The overall cable length should be restricted to the SCSI specification of 20 feet (6 meters) for a SCSI bus operating at a 5 MB/sec transfer rate and 10 feet (3 meters) for a 10 MB/sec (or faster) transfer rate.
Connecting Non-Disk Devices

Non-disk SCSI devices, such as a tape drives or CD-ROM drives, will need to have their own unique SCSI ID, regardless of the channel of the DAC960PD to which they are connected. For instance, the general rule for UNIX systems is to set the tape to SCSI ID 2, the CD-ROM to SCSI ID 5, with both devices connected to channel 0.

Figure 3-6. Connecting Non-disk Devices

Caution

Connecting non-disk devices to DAC960 drive channels can result in disk drive performance loss.

While the DAC960PD does support non-disk devices, their use on SCSI channels containing disk drives is not recommended. The affect these devices have is to slow the controller’s performance on that channel to the...
I/O transfer rate of the tape or CD-ROM drive, instead of the much faster rates supported by most hard drives.

You can work around this problem by connecting the non-disk devices to one channel of the DAC960PD, while connecting the hard drives to the other channels. However, most people do not wish to give up one channel of a high-performance, caching disk array controller for this purpose. The simple solution is to use a dedicated SCSI host bus adapter for connecting all non-disk devices.

For more information on configuring the DAC960PD controller, be sure to read the *DACCF Utilities Installation Guide and User Manual*, Chapter 2, *Configuration Strategies*.

**Using a UPS**

Installation of an uninterruptable power supply (UPS) is highly recommended on systems that use a DAC960PD controller not equipped with the battery backup option. Loss of power to the controller during system activity can result in loss of data; because data in the controller cache that is waiting to be written to disk will be lost unless the controller has the optional cache battery backup installed.

Installation of a UPS may eliminate this situation completely. If properly installed, the UPS will supply uninterrupted power to the host system and its drives and allow the operating system to properly shut down before power is removed from the system.
Cache Battery Backup Option

The optional cache battery backup provides temporary protection for unwritten data in the controller's cache memory in the event of a system reset or power loss. Data maintained in the cache will be written to disk after power is restored.

The optional cache battery backup module is available for the DAC960PD disk array controller to provide, in the event of a power failure, battery backup to the SIMM module installed on the controller.

Battery Backup Module Connector

Connector J2 is available for the optional cache battery backup module. If the optional cache battery backup module is not installed, the loop-back plug must be present on connector J2 for proper controller operation.

WARNING

Be careful to observe proper orientation when inserting a battery backup module or the loop-back plug in connector J2. Check to make sure that Pin 1 on the module corresponds to Pin 1 on connector J2, and that all pins are mating properly before full insertion. Improper insertion may result in physical damage to the controller.
Appendix A

Startup Messages
Appendix A

Startup Messages

Introduction

This Appendix describes the DAC960PD startup procedures and messages produced by the BIOS during startup or re-boot.

The DAC960PD BIOS provides a single threaded interface to access up to eight logical units (system drives) on each controller.

The BIOS presents "system drives" to the host as large disk drives with 32 sectors per track and 128 heads per cylinder (giving 2MB per cylinder). Because of the 1024 byte cylinder limit, only the first 2GB of a large system drive can be accessed through the BIOS. An operating system specific driver is required to access data beyond this limit.

Refer to the documentation for the DAC960 Software Kit for more information on installing and using the various network operating system drivers with the DAC960PD.

Instructions on using the DOS driver and creating a DOS-bootable disk are located in the DACC6 Configuration & Utilities diskette DOS subdirectory in the file README.TXT.

System Power-Up Sequence

If the SCSI drives are powered up separately from the system, you should always power up the SCSI drives before the host system. The drives and the host system can power up simultaneously, as they would when there is a common power switch for both.

BIOS Startup Sequence

When invoked during power up, the BIOS will display a sign-on message with its version number and date. The sign-on message looks similar to the following:

    DAC960PD BIOS Version x.xx--
After the startup sequence, the BIOS tries to locate the DAC960PD disk array controller. Once the DAC960PD controller is located, it determines if the controller firmware is operational.

**Startup Error Messages**

The BIOS also looks for any initialization message that may be posted by the firmware during the startup sequence. If it finds a message, it displays one of the following errors on the screen and aborts the installation process.

- **DAC960 fatal error--memory test failed**
- **DAC960 fatal error--command interface test failed**
- **DAC960 hardware error--run diagnostics to pinpoint error**
- **DAC960 firmware checksum error--reload firmware**

**Drive Check Error Messages**

If the firmware finds a valid DAC960 configuration, but it doesn't match the SCSI drives currently installed, one or more of the following messages will be displayed:

- **Unidentified device found at channel x....**
- **Device identified for chn x, tgt y found at chn x', tgt y'**
- **SCSI device at chn x, tgt y not responding**

If any of the above messages are displayed, the firmware will not proceed any further in the initialization process, except to find other mismatches. Then, the BIOS will print out the following:

- **DAC960 Configuration Checksum error--run configuration utility**

Mismatch between NVRAM and Flash EEPROM configuration

At the next stage the following message may appear:

**Recovery from mirror race in progress**

This will be displayed if the firmware detects that during the last power cycle, the system was turned off abruptly, leaving some incomplete write operations.
The following messages may also appear:

*Adapter cannot recover from mirror race!*

*Some system drives are inconsistent!*

During the initialization, if the firmware fails to respond to the BIOS inquiry within two minutes, the following message will be displayed:

*DAC960 not responding--no drives installed.*

The BIOS then inquires the firmware for its version number and other information, and prints out the following message:

*DAC960 firmware version x.xx*

One or more of the following messages will be displayed if the firmware reports the following conditions:

*Warning: X system drives are offline*

*Warning: X system drives are critical*

*Warning: The following SCSI devices are dead--chn x, tgt y...*

*No system drives found: None installed*

*X system drives installed*

The BIOS repeats the same process for additional DAC960 controllers present in the system. Then it proceeds to boot, if possible, from the first system drive on the first DAC960PD controller.

**Aborted Installation**

The installation aborted message is displayed when the BIOS finds that the configuration of the disk drives, as stored in the NVRAM and flash EEPROM, is different from what it sees at boot time. When this happens, the cause is often a faulty cable or drive, or a loose connection. Check all of the connectors, cables, drives, and try to boot. If the error persists, it most likely indicates a genuine failure and needs to be corrected. To correct it, boot DOS and run the configuration utility. For more information, refer to the "Disk Array Configuration Utility" chapter.
NVRAM Error

If the BIOS displays a mismatch between the NVRAM and the flash EEPROM configuration, no drives will be installed. Normally this error will not be displayed. If it is, boot DOS and run the configuration utility to recover from the error. For more information, refer to the "Disk Array Configuration Utility" chapter.

System Reboot or Power Down

Status messages may also be available from LED indicators connected to the DAC960PD controller. The ‘Write Pending’ indicator is especially important when preparing to power-down the system.

The DAC960PD is a caching controller with up to 32MB of cache memory, data may still be in the cache, waiting to be written to the disk drives, when the system reports that a write command was completed. It is very important to make sure that all data is written to the disk before rebooting or powering down the system, or you may lose data. It is always a good idea to wait for 15 seconds before any resetting/rebooting of the system.

If using the 'Write Pending' LED indicator, wait for 3 seconds after the LED has gone off before resetting or rebooting the system (the optional cache battery backup may also be used to prevent data loss).
# Mylex DAC960 Problem Report

## Customer Identification

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<td>Non-Disk:</td>
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## System Information

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<td>Other Disk Ctrl:</td>
<td>Other Cards:</td>
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## Pack Configuration

Indicate in matrix below 1, 2... for member of pack 1, pack 2... respectively. Indicate S, T, C, or O for Standby, Tape, CDROM and other drives.

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## System Drive Configuration

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## Problem Description

This DPR form has been included with your Mylex product as a convenience to both you and our Technical Services Department. If filled out completely, this will greatly assist Mylex personnel in quickly resolving any technical problems or questions you may have. Use the Mylex fax number (510) 745-7715 to transmit this form to the Technical Services Department, or mail to Mylex Corporation, Technical Services Department 34551 Ardenwood Blvd., Fremont, CA 94555-3607
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