IBM PS/2 Server
NetWare® Administrator's Guide

Customer service:

United States:
Hardware: **1-800-IBM-SERV (1-800-426-7378)**
Software: **1-800-241-1620**

Canada:
Hardware/Software: **1-800-465-6666**

Outside of Canada or the U.S.:
Hardware/Software: **Contact the Place of Purchase**

IBM PS/2 Server Administrator's Guide **Part Number 71G1572** (March, 1993)

Table of Contents

Installing Software and Operating the Server (Continued)

Chapter 3: Maintaining the server

Chapter 4: Reconfiguring the Server

Chapter 5: Orthogonal RAID–5 Disk Array/2

Orthogonal RAID–5 Disk Array/2 (Continued)

Chapter 6: Troubleshooting

Troubleshooting (Continued)

Chapter 7: Error Messages

List of Figures

List of Figures (Continued)

List of Tables

WARNING

THIS DOCUMENTATION SET INCLUDES INSTRUCTIONS THAT EXPLAIN HOW TO DO THE FOLLOWING:

- REMOVE THE SERVER SIDE PANEL
- REMOVE THE SERVER REAR PANEL

REMOVING THE SIDE PANEL ALLOWS THE QUALIFIED TECHNICIAN TO ACCESS THE SYSTEM CARD CAGE, IN ORDER TO INSTALL, MOVE, REPLACE, OR REMOVE A SYSTEM PROCESSOR MODULE, MEMORY MODULE, OR SCSI DUAL-CHANNEL INTELLIGENT DISK CONTROLLER (IDC)

REMOVING THE REAR PANEL ALLOWS THE QUALIFIED TECHNICIAN TO ACCESS THE REAR CABLING AREA, IN ORDER TO INSTALL, MOVE, REPLACE, OR REMOVE CABLES FOR IDC-CONTROLLED AND MICRO CHANNEL CONTROLLER/ADAPTER-CONTROLLED PERIPHERALS INSTALLED IN THE SERVER DEVICE BAYS, AND IN ORDER TO REMOVE AND CLEAN THE REAR INTAKE-VENT AIR FILTERS.

CAUTION: ONLY QUALIFIED, AUTHORIZED SERVICE PERSONNEL SHOULD REMOVE EITHER OF THESE PANELS. THERE IS A DANGER OF HAZARDOUS SHOCKS WHEN ACCESSING INTERNAL AREAS OF THE SERVER BY REMOVING THE SIDE OR REAR PANEL WITHOUT TURNING OFF SERVER POWER OR UNPLUGGING THE SERVER.

Who should read this guide

IBM's PS/2 Server computers are full-function servers designed to operate in Local Area Network (LAN) environments that require dependable application support for user's personal computers. This guide is intended for use by the network administrator—that is, by the individual or individuals responsible for configuring, maintaining, managing, and troubleshooting a PS/2 Server computer on one or more networks.

This guide assumes that you are familiar with IBM-DOS, NetWare, and the administrative requirements of your network. Beyond this, use of this guide does not require any technical knowledge other than a general familiarity with computers and their operation.

Further reading

The following manuals provide additional, related reference material:

1. *IBM PS/2 Server 195/295 Installation Guide*, International Business Machines Corporation, 1993

   The Installation Guide provides quick installation instructions and detailed installation procedures for the basic server product. In addition, the guide explains in non-technical terms how the server functions and the services it can provide.

2. *IBM PS/2 Server 195/295 Hardware Reference Manual*, International Business Machines Corporation, 1993

   The Hardware Reference Manual provides a complete description of server options: how to plan for, install, and set up Micro Channel adapters and peripherals, IDC-controlled SCSI devices, and system modules.

Manual organization

This guide provides information about the daily operation of IBM PS/2 Server computers, as well as procedures to follow when maintaining, reconfiguring, and troubleshooting them.

This guide is organized as follows:

Chapter 1, **Introduction**, introduces the server — its components and modes of operation.

Chapter 2, **Installing Software And Operating the Server**, describes how to install server software modules, stop, start, communicate with, and otherwise control the server.

Chapter 3, **Maintaining the Server**, provides instructions for maintaining the server on a day-to-day basis.

Chapter 4, **Reconfiguring the Server**, explains how to make changes to server options and parameter settings.

Chapter 5, **Orthogonal RAID–5 Disk Array/2**, explains how to set-up and maintain the servers disk drives in a RAID–5 configuration using the PDA utility.

Chapter 6, **Troubleshooting**, describes common server problems and the procedures you follow to solve them.

Chapter 7, **Error Messages**, lists the error and information messages you might encounter while operating the server, as well as corrective actions to take when errors occur. For NetWare error and information messages refer to the NetWare manuals.

If you encounter a problem

Your server is designed for simple, dependable installation, management, maintenance, and daily use. However, since the server supports a variety of state-of-the-art hardware and software options, you may occasionally encounter a problem during its use.

A list of the most common problems encountered and the procedures that you take to solve them is provided as needed at the end of chapters in this documentation set. In addition, Chapter 6 describes problem solving in greater detail. Error messages are listed and described in Chapter 7 of this guide.

Conventions used in this guide

This guide observes the conventions listed in this section.

Programs, filenames, and pathnames are capitalized. For example:

PDAUTIL - a system utility
AUTOEXEC.BAT - a system filename
C:\NETWARE - an MS-DOS drive and subdirectory pathname
F:\SYSTEM - a NetWare logical drive and subdirectory pathname
SYS: - a NetWare volume

Italicized characters or words are descriptive names for items that appear in error or information messages or that you must replace with appropriate values when typing a command or response to a prompt. For example, the word

password

in a prompt means that you type in the appropriate password.

The Return, Enter, or ↵ key is referred to as the Enter key.

Warnings and cautions are presented in this form:

▲ **Warning: Before powering down or resetting the server, always alert network users, exit from all applications, and follow normal network and NetWare shutdown procedures.**

Task lists and checklists are presented in this form:

- ✓ Unpack the server.
- ✓ Cable the server.
- ✓ Install the server's dress kit.

Chapter 1: Introduction

Introduction

Your IBM PS/2 Server computer is a high-performance server designed to provide maximum support to users of client/server and file-server applications in NetWare LAN environments. Client/server applications are composed of software programs that run largely on a network server, with user-interface and support software running at the users' network personal computers. The server supports a wide variety of Micro Channel options and fixed-disk configurations. While the server is designed for ease of use, its flexibility and wide range of application require that you have a basic understanding of the system in order to take full advantage of it.

This chapter describes the server, its features and capabilities, and explains how to manage it on a day-to-day basis and how to troubleshoot problems that arise in the course of operation. This guide emphasizes the tasks that you perform to manage, maintain, logically reconfigure, and troubleshoot the server, ensuring efficient and dependable operation.

The information in this guide applies to the PS/2 Server (operating with a single processor) and running Novell NetWare v3.11 with IBM NetWare extension software; and that the server is attached and successfully communicating over at least one LAN. In some cases, information specific to the NetWare operating system or to specific network software is located in the manufacturers documentation. If your server is running network software from some other manufacturer, you should refer to the release note provided with the server or contact your sales or service representative for any special information required to operate the server with that software.

Overview

The PS/2 Server computer contains a system processor module, equipped with a high performance Intel CPU (80486). The PS/2 Server computer also contains specialized processors for disk I/O. This arrangement optimizes data throughput for network users.

The PS/2 Server supports a great variety of configurations. The PS/2 Server provides slots for eight Micro Channel adapters, such as network adapters, communications and tape controllers, and internal modems. The processor module in system slot 0 controls the eight adapters.

The PS/2 Server support up to twenty-eight SCSI devices; non-disk devices, fixed disk drives, individual and/or members of parallel disk arrays, attached to SCSI dual-channel intelligent disk controllers (IDCs) in system slots 4 and 5.

The PS/2 Server can contain up to 128 MB on the memory module in system slot 2. You allocate this memory as needed to the processor module(s), for use with network and file-server software, applications, and custom software.

The PS/2 Server supports operation with or without a console. In the case of unattended operation (no console), the system administrator can communicate with, monitor, and control multiple servers over the network or from a remote personal computer. Physical locks and dress kits, server password, and network security facilities are available. The server can be configured to work around problems that occur at startup or during operation, optionally alerting users and the system administrator over the network and/or dialing out to an administrator's remote personal computer, while maintaining operation—in a reduced configuration if necessary.

PS/2 Server administration consists of:

- Stopping, starting, and resetting the server as required.
- Performing periodic and as-needed maintenance tasks, such as backing up the server and cleaning the air filters.
- Reconfiguring the server as needed by adding, moving, or removing Micro Channel options and SCSI peripherals, and other such tasks.
- Troubleshooting the server.

System components

Server components are located in the following server areas (Figure 1-1):

- System card cage and Micro Channel card cage
- Device bays (with front and rear access)
- Top cabling area
- Front panel
- Power supply/fan area

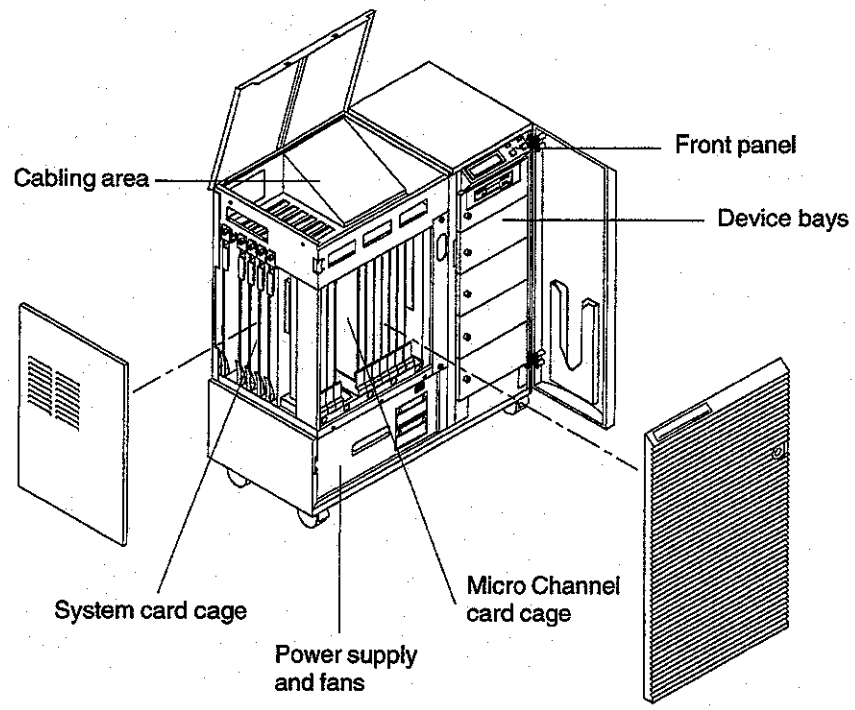


Figure 1-1
Server components

❖ **The server's full specifications are listed in Appendix A of the *PS/2 Server 195/295 Installation Guide*. For planning information when adding server options, refer to Chapter 2 of the *IBM PS/2 Server 195/295 Hardware Reference Manual*.**

▲ **Warning: Access to the server power supply, system card cage (accessed through the side panel), and peripheral cabling area (accessed through the rear panel) is limited to authorized service personnel only. The AC power switch should be off or the server unplugged before these areas are accessed. These are high voltage areas and there is a shock hazard. Always check the AC switch to confirm that it is in the OFF position, since the internal DC power switch can also power off the server.**

The **system card cage**, accessed by removing the server's left side panel, contains six slots, numbered 0 through 5, with module slot connectors located on the system backplane at the rear of the card cage.

By default, system slot 0 accommodates the processor module. Slot 1 may also used. Slot 2 holds the system memory module. Slots 4 and 5 are expansion slots for the SCSI dual-channel IDCs.

The **Micro Channel card cage** contains two sets of expansion slots, connected to separate Micro Channel buses, with the slots located in the Micro Channel backplane at the back of the cage. The four slots on the left side of the cage are controlled by the processor module in system slot 1. The eight slots on the right side of the cage are controlled by the processor module in system slot 0. Each set of slots uses a separate bus.

The server contains five full-height (or ten half-height) **device bays**. Typically, the top bay contains a 3.5" diskette drive controlled by the processor module. A second, daisy-chained diskette drive can be added. The remaining bays can hold SCSI peripherals controlled by the IDC(s) and peripherals controlled by Micro Channel adapters. Peripherals are installed in the bays from the front and cabled from the rear of the server.

The **top cabling area**, used for external cable connections, is accessed by opening the front grill and lifting the server top. The top cabling area contains console connectors (monitor, keyboard, and mouse); serial and parallel ports on the processor module; SCSI channel connectors on the

IDCs; and any Micro Channel adapter connectors located on the adapter end brackets. In addition, the top cabling area gives access to the system-module end-bracket LEDs.

The **front panel** contains error and power LEDs, a liquid crystal display (LCD), and control buttons used to scroll through error and informational messages, reset the LCD and error LED, and perform other control functions.

The **power-supply/fan area** is located below the card cages and is accessed by removing a pull-out front panel (to which the power supply is attached).

Processor module: AP/FP

Your NetWare server functions as both an application server and as a file server.

As an application server, the computer performs basic networking and file-server tasks while at the same time running client/server software. Client/server software consists of applications that are located partly on the server and partly at the user's personal computer.

As a file server, the computer performs high-volume file-server tasks for users on multiple networks.

- **In a Server 195, both AP and FP functions are performed on the same processor module. Therefore, the AP/FP switches positions are ignored.**

The processor module in system slot 0 controls the eight Micro Channel expansion slots on the right of the card cage. System slot 1 controls the four Micro Channel expansion slots on the left of the card cage. Each set of slots uses its own separate and distinct bus.

The processor controls network adapters, Micro Channel application adapters, including asynchronous and parallel adapters, tape controllers, and internal modems.

The server allocates system memory according to your specifications. Memory requirements depend upon the number of network adapters and applications installed on the server (default configuration) and, if installed, the size of the optional parallel disk array (PDA) cache . The server accommodates up to 128 MB. Note that in the NetWare environment you set the physical memory to the largest amount permitted.

Memory module

PS/2 Server memory is located on the system memory module installed in system slot 2.

The module is divided into four memory banks, each of which can hold eight Single In-line Memory Modules (SIMMs). (A SIMM is a small adapter containing nine memory chips in a row.) The server supports 4-MByte SIMMs.

The server treats memory by bank. Bank 0 is used first, bank 1 second, and so on. You add memory to the server bank-by-bank. The banks each hold eight 4-MBx9 SIMMs. This provides 32 MB of error-correcting data per bank -- up to 128 MB system total.

The system memory module can thus hold 32, 64, 96, or 128 MB of memory, as shown in Table 1-1. The order of the banks is shown in Figure 1-2.

The system processor can use memory as large as the system's physical memory permits. Additional memory is available for disk array buffers, and RAM disk via RMM (Chapter 6).

The server allocates system memory among the processor module memory and reserved memory. Memory allocation is specified at installation or by accepting the system defaults. The reference diskette is used for memory allocation.

The processor memory is used by the operating system software and for file-server, any server applications, application data, and network activities. Typically (with optional PDA software), most processor memory is

Table 1-1
System memory configurations

Total Memory (MB)	SIMM Type			
	Bank 0	**Bank 1**	**Bank 2**	**Bank 3**
32	4 MB	-	-	-
64	4 MB	4 MB	-	-
96	4 MB	4 MB	4 MB	-
128	4 MB	4 MB	4 MB	4 MB

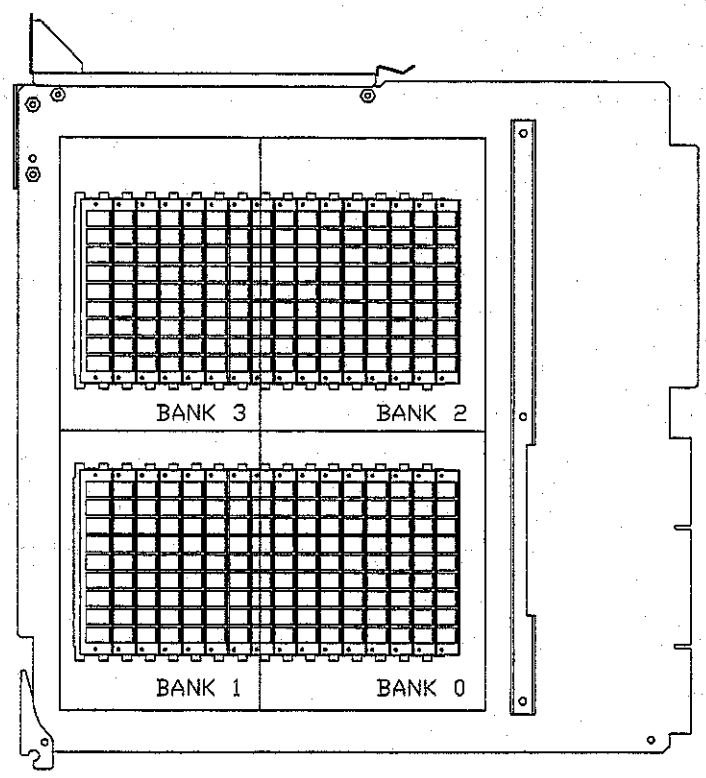


Figure 1-2
Order of memory banks

allocated for use as a file-system cache, which is maintained for data that is read from and written to disk.

You adjust the allocation in order to tune system performance. You can experiment with different allocations once the server is integrated into the network and running applications for personal computer use. Tuning and performance issues and their relation to memory allocation are discussed in Chapter 4.

The system keeps memory-allocation values in CMOS. At power-up, the POST routine tests memory and records how much memory is actually available, comparing this with the CMOS value. If the expected and actual

values differ, perhaps due to bad memory, an error message is displayed and logged. The memory bank containing the bad memory is mapped out of the system and replaced by a higher bank, if one is available.

More complicated scenarios are possible. For example, if two areas of bad memory exist, only the first is mapped out. System memory then consists of that memory available with a higher bank is mapped into the first bank containing bad memory, up to the second area of bad memory.

Refer to Chapter 5 for more on reallocating memory. Refer to Table F-1 for more on the subject of system responses to memory failure.

SCSI dual-channel intelligent disk controllers

PS/2 Server units support SCSI dual-channel intelligent disk controllers (IDCs) in system slots 4 and 5.

Each IDC provides two channels, A and B. Each channel supports up to seven SCSI devices. Each channel has two connectors: one on the system backplane for use by daisy-chained peripherals installed in cabinet device bays, the other in the top cabling area, on the IDC top bracket, for use by peripherals installed in expansion cabinets or otherwise external to the server.

The server supports disk array configurations, allowing from two to 16 drives to be installed as a single logical disk. With Data Sentry enabled (with optional PDA), any single drive in the array can fail and be replaced with no loss of data to the array as a whole.

Micro Channel options

The server provides Micro Channel expansion slots for two buses—four slots for one bus (not used) and eight slots for the other. Each set of slots uses a separate bus. The four slots on the left side of the Micro Channel card cage are controlled by the processor module in system slot 1. The

eight slots on the right side of the card cage are controlled by the processor module in system slot 0.

By default, the server is set up so that the processor module controls LAN network adapters, Micro Channel application adapters, including asynchronous and parallel adapters, tape controllers, and internal modems.

▲ **Warning: The server does not support adapters that provide additional system memory.**

Server operation

The server is designed to provide dependable service to users on one or more networks. Configuration parameters in the following areas allow you to optimize day-to-day operation, administrative access to the server, and server response to operating problems:

- Communications
- Unattended operation
- High availability (system recovery)

Communications

You can communicate with and control the server via console, personal computer directly attached to a serial port, network and dial-in personal computers, and other servers.

At the server console, operation of the server is via NetWare utility menus, such as, MONITOR and INSTALL, and PS/2 Server add-on NetWare parallel disk array utility (PDAUTIL).

From a network personal computer, directly-attached, and dial-in personal computers, you communicate with and control the server using network software via NetWare's command line.

For advanced communications, using third party software, the server can be dialed into through the processor's serial port.

Unattended operation

The server can be configured to start up and operate unattended.

The following server features support unattended operation:

- Front and rear key-locks, limiting access to fixed- and removable-media peripherals, control buttons, and LCD
- No-console operation
- Supported communication with the server from any network personal computer or from a remote connection
- Server password for diskette startup, but automatic startup from fixed disk
- NetWare server security features, including limited local access
- Automatic recovery at startup, on restart, and during operation from a variety of server hardware and software problems

Server administration

As described in this manual, server administration consists of managing the following:

- Daily operation
- Periodic maintenance tasks
- Server reconfiguration
- Troubleshooting

The PS/2 Server requires little attention in the course of day-to-day operation. It can run continuously, unattended. In the absence of network problems, it requires no special supervision.

The PS/2 Server supports NetWare's unattended server facilities. It can operate on a daily basis without an attached console and without intervention.

When equipped with the Maximum Availability and Support System/2 and BIOS recovery features, the server is designed to monitor the system, alert users and the server administrator when error conditions develop, shut down or reset the server when necessary, reconfigure the system automatically to work around failed subsystems or other problems at startup, and log all events.

In general, IBM's enhancement software is transparent to you, the server administrator. Instead, you interact directly with NetWare and your installed applications. Daily operation then consists of monitoring the system, managing user accounts, and performing the other usual network tasks.

Periodic and occasional maintenance or service tasks include making tape and network backups, cleaning the air filters, cleaning diskette and tape drives, upgrading components and software, and tuning the server.

PS/2 Server reconfiguration consists of adding or removing Micro Channel options, fixed disk drives, and parallel and serial connections, as well as changing the settings for passwords, date and time, memory allocation, and the values for other such system operating parameters.

The PS/2 Server is designed to allow the application of straightforward troubleshooting procedures. Server problems fall into the following categories:

- System will not start
- Errors during server operation
- Degraded performance

These categories, the problems they comprise, and the actions you take to correct the problems, are discussed in Chapter 6.

Chapter 2: Installing Software and Operating the Server

Installing Software and Operating the Server

Software installation on the PS/2 Server is a straightforward, although somewhat lengthy, process. There are different software modules that need to be installed. Typically, the appropriate software is pre-loaded on your server at the factory based on your configuration and options you ordered. Therefore, except for installing the NetWare operating system software, and application software, or upgrading to newer server software, you may not need to follow the software instructions provided in this chapter — instead, go directly to "Operating The Server" section on page 2-12.

▲ **Always contact your IBM Customer Support Representative before re-installing your server software. Your Customer Support Representative may have additional information on the latest installation tips or required software revisions.**

After the server software is installed, your server requires little attention in the course of day-to-day operation. It can run continuously, unattended. In the absence of network problems, it requires no special supervision, although you may want to monitor and tune its performance periodically, as described in Chapters 3 and 4.

On occasion you may need to perform one or more of the following tasks:

✓ Start, stop, or reset the server

✓ Communicate with NetWare software and applications running on the server

These tasks can be performed at the server console. This chapter describes how to do so.

Installing server software

The software modules required to be loaded for server operation as described in this document set is listed below. You install this software unless it has been installed for you at the factory.

- DOS v5.0
- Novell NetWare v3.11
- IBM PS/2 NetWare Extensions (or Orthogonal RAID-5 Disk Array/2)
- Applications

You install NetWare and any applications, according to the instructions provided with them.

Information about required software version numbers, upgrades, and patches is provided in the IBM release note and any release note addenda accompanying this document set.

This chapter provides extra information you may need to know when installing NetWare and explains how to install the IBM NetWare Extensions software.

The installation instructions given here assume that your server can startup without errors using the reference diskette, that the server contains a minimum of 32 MB of system memory, and that a fixed disk drive with at least 6 MB of available disk space is present on drive C:. This space is for DOS, NetWare startup files, and the NetWare extensions software.

DOS, NetWare startup files, and NetWare Extensions need a DOS partition on drive C:. The disk need not be partitioned or formatted yet; the NetWare Extensions installation process supports DOS disk partitioning and formatting. The remainder of NetWare is installed from within NetWare on a NetWare 386 partition after basic NetWare is started.

NWINST program

When executed, the NWINST program (located on the IBM PS/2 Server NetWare Extensions Installation diskette), loads all of the drivers and NLMs required to install NetWare on a PS/2 Server. These system files are copied from the PS/2 Server NetWare Extensions (or the Orthogonal RAID-5 Disk Array/2) Installation Diskette into the NETWARE directory on the C: partition of your boot drive. NWINST also creates initial versions of STARTUP.NCF and AUTOEXEC.NCF files. These files contain all of the commands required to load the PS/2 Server drivers and NLMs.

The following system software modules are always required for proper operation of your PS/2 Server:

- **AS2DD.DSK** - This high performance NetWare disk driver interfaces with SCSI devices connected to the system via the IDC boards installed in your system backplane. This driver must be loaded from STARTUP.NCF for proper operation of your PS/2 Server disk subsystem.

- **AS2EXTS.NLM** - This NLM interfaces with PS/2 Server specific hardware, such as ECC memory and the LCD Front Panel. AS2EXTS.NLM also contains a library of system interface software routines that are used by other PS/2 Server software modules. This NLM must be loaded from AUTOEXEC.NCF for proper operation of your PS/2 Server. It should never be unloaded while the system is in operation. Although your PS/2 Server may appear to function properly even if AS2EXTS.NLM is not loaded, some of its functionality will be missing. In particular, the ability of the server to detect certain types of failures and recover from them will be severly compromised.

The following system software modules are required for systems which have one or more Disk Array/2 installed.

- **AS2SCSI.NLM** - This NLM provides a library of system interface software routines which are used by other software modules to interface to the PS2 Server disk I/O subsystem. AS2SCSI.NLM must be loaded from AUTOEXEC.NCF to support other PS/2 software modules such as PDAUTIL and MASS/2.

- **PDAUTIL.NLM** - This NLM provides the user interface and control logic required for Disk Array/2 operation and management. PDAUTIL.NLM must be loaded from AUTOEXEC.NCF and should never be unloaded while your system is operating. Although your PS/2 Server may appear to function properly with one or more Disk Array/2 installed even if PDAUTIL.NLM is not loaded, some very critical Disk Array/2 functionality will be missing. In particular, the ability of the disk I/O subsystem to detect failures on a Disk Array/2 and recover from them will be severly compromised. Data loss may occur as a result of operating the system without PDAUTIL.NLM loaded..

NWINST creates a STARTUP.NCF and an AUTOEXEC.NCF with all of the commands required for proper operation of your PS/2 Server. STARTUP.NCF will contain the following commands:

```
LOAD AS2DD
```

On systems installed without Disk Array/2 support, AUTOEXEC.NCF will contain the following command:

```
LOAD C:\NETWARE\AS2EXTS
```

On systems installed with Disk Array/2 support, AUTOEXEC.NCF will contain the following additional commands:

```
LOAD C:\NETWARE\AS2SCSI
LOAD C:\NETWARE\PDAUTIL
```

▲ **Warning: When editing AUTOEXEC.NCF on your PS/2 Server, make sure you do not make changes that would cause the system to operate without AS2EXTS.NLM. On systems configured with Disk Array/2, also make sure that PDAUTIL.NLM is always loaded.**

As a system administrator, you may wish to install the NetWare Extensions or Disk Arry/2 software manually. This may be done by copying the PS/2 Server disk driver (AS2DD.DSK) to your NETWARE directory on drive C:. All other PS/2 Server NLMs (AS2EXTS.NLM, AS2SCSI.NLM, and PDAUTIL.NLM) may be copied to the same directory on drive C: or to SYS:SYSTEM. Changes to STARTUP.NCF and AUTOEXEC.NCF may be made by running INSTALL.NLM or by using a system editor.

▲ **Warning: NWINST procedures to upgrade PS/2 Server system software and to verify the software installation will only work if all PS/2 Server system software files are installed in C:\NETWARE. If the NLMs installed by NWINST have been copied to SYS:SYSTEM or to some other directory, the upgraded version of these files will also have to be copied to the same directory after the upgrade procedure has been completed.**

Installing DOS, PS/2 NetWare Extensions, and NetWare software

This section explains how to install the portions of DOS v5.0 (DOS bootable system drive and COMMAND.COM), IBM PS/2 NetWare Extensions, NetWare v3.11 startup files, and NetWare. For the PS/2 Server, DOS must be installed before installing the PS/2 NetWare Extensions software and NetWare v3.11. When instructed, use the IBM PS/2 Server NetWare Extensions Diskette for DOS installation. Although, it's not necessay to install all of DOS, you may, by following the instructions that came with DOS v5.0.

❖ **If your server is shipped pre-installed with one or more fixed disk drives, DOS, NetWare, and PS/2 Server NetWare Extensions, skip this section (unless you need to upgrade the PS/2 NetWare Extensions currently installed in your system).**

When installing DOS and NetWare v3.11, note the following:

- The server must have drive C: formatted as a primary DOS partition (of at least 6 MB), for DOS, NetWare extensions and NetWare startup software installation.

DOS installation

The following procedures install DOS on the server:

1. **Insert the IBM PS/2 Server NetWare Extensions (or Orthogonal RAID-5 Disk Array/2) Installation Diskette in drive A: and start the server.**

2. **At the DOS prompt, type FDISK and press <Enter>.**

3. **Ensure "disk drive 1" is the current disk drive.**

4. **Select "1" to "Create DOS Partition".**

5. **Select "1" to "Create Primary DOS Partition".**

   a. When prompted to "use the maximum available size for a Primary DOS Partition", select "N".

   b. When prompted for a "partition size", select a value anywhere between 6 and 10 MBytes.

   c. Press "Esc" to return to the main menu.

▲ **Do not accept FDISK default values for partition size or you will allocate the entire disk to DOS, leaving no space for a NetWare partition.**

6. **Select "2" to "Set Active Partition" and "1" to make the DOS partition created in step 5 active.**

   a. Press "Esc" to return to the main menu.

   b. Again, press "Esc" to exit FDISK.

   c. Press any key to reboot the system.

7. **At the DOS prompt, type**

   FORMAT C: /S

   and press <Enter>.

This action formats the C: drive, makes it a system disk, and copies the COMMAND.COM file from the Installation Diskette to it. When formatting is completed you are returned to the A: prompt.

PS/2 Server NetWare Extensions installation

The following procedures install the PS/2 Server NetWare Extensions (or Orthogonal RAID-5 Disk Array/2 software) in the C:\NETWARE directory on the server.

❖ **Have the NetWare diskettes labeled SYSTEM–1, SYSTEM–2, and SYSTEM–3 ready for insertion in drive A:. You will also need a blank diskette to make a BACKUP COPY of SYSTEM-2 diskette before installation. The following step provides instructions.**

1. **Use the DISKCOPY command to make a duplicate copy of your NetWare SYSTEM-2 diskette. At the DOS prompt, type:**

   DISKCOPY A: A:

   and press <Enter> and follow prompts.

   Use the original NetWare SYSTEM-2 diskette as your "SOURCE diskette" and a blank diskette as your "TARGET diskette". If necessary, DISKCOPY will format the target diskette. When completed, enter "N" to return to the DOS prompt.

2. **Insert the PS/2 Server NetWare Extensions (or Orthogonal RAID-5 Disk Array/2) Installation diskette in drive A:**

3. **At the DOS prompt, type**

   NWINST

   and press <Enter>.

4. **Select "Install IBM PS/2 Server NetWare files" to start the installation procedure.**

   When prompted, press "Y" to confirm your selection.

5. **When prompted, enter the server name and the IPX internal net number.**

   Both the server name and the IPX internal net number need to be unique. Refer to your NetWare installation documentation for additional information.

   NWINST will now create a NETWARE directory on your C: partition and copy all of the PS/2 Server specific system files to this directory. When done, you will be prompted to insert the NetWare SYSTEM-1 diskette into drive A:.

6. **Insert NetWare SYSTEM-1 diskette into drive A: and press any key to continue.**

   NWINST will copy the SERVER.EXE file from the NetWare SYSTEM-1 diskette into the C:\NETWARE directory. When the process has completed, you will be prompted to insert a **BACKUP COPY** of the NetWare SYSTEM-2 diskette in drive A:.

7. **Insert the BACKUP COPY of the NetWare SYSTEM-2 diskette created in step 2 and press any key to continue.**

   NWINST will copy additional NetWare system files into the C:\NETWARE directory. It will also create an AUTOEXEC.NCF file on your NetWare SYSTEM-2 diskette. This file contains the server name and IPX internal net number you entered in step 5 and will be used to start the server.

▲ **Warning: Do not use your original NetWare SYSTEM-2 diskette. Make sure the backup copy you use is not write-protected.**

   You now have an option to start the NetWare installation procedure or to exit to DOS. If you wish to install NetWare on your server, press "Y".

NetWare v3.11 installation

Install NetWare v3.11 according to the instructions provided in your NetWare documemtation. Specifically,installing NetWare 3.11 requires you to do the following:

- ✓ Create NetWare drive partitions
- ✓ Create volumes
- ✓ Copy system and public files

Consult your NetWare documentation for specific instructions on how to do the above.

NetWare Configuration

NetWare configuration consists of:

- Configuring your network adapters
- Setting NetWare's operating environment (AUTOEXEC.NCF and STARTUP.NCF files).

Refer to the NetWare v3.11 System Administration manual for an explanation of how to install LAN drivers. Your PS/2 Server supports only Micro Channel adapters. If your adapter(s) driver is not included with NetWare, you need to install the driver(s) from the option diskette for this adapter.

1. **From the Available System Options menu, select Edit AUTOEXEC.NCF File.**

   Refer to the adapter data that you recorded from the reference diskette and the adapter's diskette. Your server AUTOEXEC.NCF file should already contain your *file server name* and your *ipx internal net* lines. At a minimum, it should also contain the *load as2exts* line. The file should contain *load as2scsi*, and *load pdautil* lines if you have installed the optional Disk Array/2 software (see Figure 2-1).

   ❖ **NOTE: AS2EXTS is always required.** *AS2SCSI* **and** *PDAUTIL* **are only installed if you have loaded the PDA option.**

File Server AUTOEXEC.NCF File

```
file server name SERVER
ipx internal net 3
search add c:\netware
load SMCPLUSS slot=7 frame=ETHERNET_802.3
bind IPX to SMCPLUSS net=55
load as2exts
load as2scsi
load pdautil
```

Figure 2-1
File Server AUTOEXEC.NCF File

2. **If your adapter's driver was not supplied in NetWare v3.11 release, add the following line:**

   SEARCH ADD C:\NETWARE

3. **Add the load *LAN driver* slot-*x* frame-*type* line for each adapter in your server.**

4. **Add the bind IPX to *LAN driver* net=*number* line for each adapter in your server.**

   Figure 2-1 shows a single Western Digital EtherCard Plus/A (WD8003E/A or WD8003ET/A) adapter in slot 7, with a frame type of ETHERNET_802.3. The LAN driver (SMCPLUSS) was not available in the NetWare release requiring the LAN driver to be copied to the C:\NETWARE directory. This required the *"search add c:\netware"* line so that NetWare could find the driver. Finally, the IPX protocol was bound to the SMCPLUSS driver on net 55.

   The file can contain other configuration parameters and load modules.

5. **Verify in the STARTUP.NCF file that it contains the *load as2dd* line (see Figure 2-2).**

   Note that NetWare's STARTUP.NCF file is located on the C:\NETWARE directory.

File Server STARTUP.NCF File
load as2dd

Figure 2-2
NetWare's STARTUP.NCF File

6. **Exit the Installation Options menu.**

PDAUTIL Utility

The optional PDAUTIL utility is used in conjunction with the SCSI disk subsystem, its primary purpose is to set-up Othogonal RAID-5 disk arrays. Refer to Chapter 5 for a details on how to set-up and maintain the server disk drives using RAID-5 PDAs.

Applications

You can now install client/server and other applications.

No special setup is necessary for a server application, beyond that specified by the application manufacturer and NetWare.

Software installation problems

For problem-solving information about your particular versions of the PS/2 Server computer, refer to the *PS/2 Server Release Note* provided with the computer.

Operating the server

The server requires little attention in the course of day-to-day operation. It can run continuously, unattended. In the absence of network problems, it requires no special supervision. Daily operation then consists of monitoring the system, managing user accounts, and performing the other usual network tasks.

Starting the server

To start the server, simply turn on the power (both the external and internal power switches must be in the ON position).

At the C: prompt, change to the NETWARE directory by typing

```
CD NETWARE
```

At the NETWARE directory, type

```
SERVER
```

The IBM reference diskette can be used to configure the server to require a password when starting up from diskette, or when powering up.

Starting an expansion cabinet

PS/2 Server expansion cabinets are designed to function as integrated add-ons to the server system. Once an expansion cabinet is connected to the main cabinet and powered on, it will power cycle with the main cabinet. However, you can start or stop an expansion cabinet independently if the server is already running (although in general this is not recommended).

Stopping or resetting the server

Server shutdown can occur in the following ways:

- The system administrator manually powers down or resets the server (locally or remotely) after issuing the appropriate warnings to users, exiting from applications, discontinuing network services, and shutting down NetWare. This might occur on a daily or other scheduled basis as a matter of operational policy, periodically for hardware maintenance, for system reconfiguration or upgrade, software installation, or troubleshooting.

Reset the server manually, at the console or remotely, when the server encounters a fatal software or hardware error and halts operations, or as required when installing or reconfiguring network or application software.

To stop or reset the server at the console, use the procedure provided below. As discussed in your network documentation, ensure against loss of data on the network by following this procedure exactly.

▲ **Warning: Never power down or reset the server without first performing the following steps, unless the server has already halted operations because of an error condition and does not respond to keyboard commands. Many NetWare processes other than those used for network services may be running.**

1. **Send electronic mail, use network messages, or otherwise issue alerts to all network users of the impending server shutdown.**

   Multiple, early warnings are best.

2. **Discontinue any applications currently running on the server.**

3. **At the server console, toggle (<Alt><Esc>) through the various .NLMs until the server prompt (:) is displayed. Type DOWN and press <Return>, type EXIT and press <Return>.**

❖ **Note: If you have background processes running, you maybe prompted at this stage to confirm that you want to shut down NetWare. Type "Yes" to stop these processes and DOWN continues.**

Wait for the C: prompt to display.

4. **To reset the server, press <Ctrl><Alt><Del>; to stop the server, turn off power using the internal or external power switch.**

▲ **Warning: Do not turn off the server without performing the steps above, because data loss may occur or NetWare may hang during startup (SERVER command).**

Communicating with the server

Communication with the server is accomplished from a console attached to it, from a personal computer directly attached to a serial port, from a network personal computer or other server, or from a dial-in personal computer. Since the server supports full functionality in unattended mode, a local console is mandatory only when you do the following:

- Install system software
- Reconfigure the system using the reference diskette
- Reconfiguring network software, or install certain applications

Local console

The server contains built-in ports for keyboard, VGA monitor, and mouse, as well as a 16-bit Micro Channel slot that includes logic for an EVGA adapter. Once attached, the local console is used with DOS and network software.

▲ **Never attach or detach a mouse or monitor to the server while it is powered on.**

Chapter 3: Maintaining the server

Maintaining the server

IBM PS/2 Server computers are reliable, high-performance servers that require little day-to-day attention. This chapter describes the routine and occasional maintenance tasks you may be required to perform to assure optimum system performance.

Maintaining service

IBM PS/2 Server computers are designed to maintain service to network users even if error conditions occur. As system administrator, you take the following steps to minimize the possibility of any interruption in service:

- Install an uninterruptible power supply (refer to Chapter 2 of the *IBM PS/2 Server 195/295 Installation Guide*).
- Install an auxiliary (redundant) power supply (usually installed at factory).
- Install Novell's NetWare disk mirroring system, or IBM's optional Orthogonal Raid–5 Disk Array/2.
- Use NetWare's error and event logs to monitor (MONITOR utility) system activity, status, etc. (refer to NetWare's documentation for details).
- Tune the server (refer to "Tuning the system" on page 3-3).

Maintenance tasks

IBM PS/2 Server equipment requires little maintenance. It is designed to operate reliably and unattended in a wide range of office environments. You perform the following maintenance tasks periodically:

- ✓ Back up the system
- ✓ Tune the system
- ✓ Clean removable-media devices, such as tape drives
- ✓ Clean air filters

On occasion, you may also be required to do the following:

- ✓ Recover from a system crash
- ✓ Recover from a lost password
- ✓ Relocate the server

This chapter provides the procedures you follow to perform these tasks.

In addition, you may be required to perform a variety of troubleshooting procedures beyond the recovery procedures listed above. These are described in Chapter 6, "Troubleshooting."

Maintaining application, file server, and network software is described in the documentation provided with that software.

To reconfigure the server by adding or removing options or changing system settings, refer to Chapter 4 and to the *IBM PS/2 Server 195/295 Hardware Reference Manual.*

To add, move, replace, or remove a system module (processor module, IDC, or the memory module), refer to Chapter 3 of the *IBM PS/2 Server 195/295 Hardware Reference Manual.*

Backing up the system

You can back up server data to any installed DAT or tape drive, or to a network storage facility.

If a drive fails in a parallel disk array (Orthogonal RAID–5 Disk Array/2 with Data Sentry enabled), no data is lost. Note that in the following cases, however, you lose all data in the PDA. Back up the PDA just as you would an individual disk.

- When you re-install your PDA members as individual drives or as a PDA configured with a different set of parameters (e.g., PDA drive order, stripping factor, etc.).
- When two or more drives fail in a PDA.

Tuning the system

To improve server performance, check and adjust the server's configuration in the following areas as needed (Table 3-1):

- Memory allocation
- Micro Channel option performance
- Distribution of SCSI devices among available IDCs and IDC channels
- Network software parameters

Use NetWare's MONITOR utility for status and utilization facilities, error and event logs to monitor .NLM modules, CPU, memory, and network activity. Use the PDA utility (PDAUTIL) SCSI disk status, utilization, and configuration facilities, error and event logs to monitor the disk drives.

This section describes tuning considerations in these areas. The information provided is in part qualitative, rather than quantitative, because effective tuning of a multiprocessor, multidisk system such as the PS/2

Table 3-1
Tuning the server

Subsystem	Tuning procedure
Memory	Allocate as much memory to the processor module as possible. Refer to the *Novell NetWare v3.11 System Administration (183-000296-001)* for detailed tuning information (see buffers, cache buffers, and Maintenance Tips).
Micro Channel options	When possible, eliminate slow Micro Channel adapters. A slow adapter degrades overall performance on the Micro Channel bus that the adapter shares with other options. In particular, for network adapters favor 32-bit over 16-bit, favor bus master over shared memory or I/O, and avoid DMA.
Fixed disk drives	Distribute system fixed disk drives evenly among all available IDC channels. Distribute files and databases among as many drives as possible. Use NetWare disk mirroring or IBM PS/2 Server Orthogonal RAID–5 Disk Array/2s (optional). Check CPU utilization and SCSI traffic using the MONITOR and PDAUTIL facilities, to determine if additional SCSI devices or controllers are needed in the server. (This is typically an experimental, not a theoretical, procedure.)
NetWare operating system	NetWare default settings work best with small networks. Change parameters in NetWare's AUTOEXEC.NCF, STARTUP.NCF, System Login Script, and User Login Script files as necessary for a larger network. Refer to the *Novell NetWare v3.11 System Administration (183-000296-001)* for detailed information.
Network utilization	Monitor network resource utilization to avoid under-allocating resources, which can cause degraded performance, and over-allocating resources, which can reduce available memory and cause swapping. Use the MONITOR utility to view workstation and server status and utilization; and the PDAUTIL utility for disk drive performance and utilitization.

Server computer can require experimentation and a broad perspective of the system.

For example, suppose that you are setting up a multidisk topology together with a new client/server application. If the PDAUTIL and MONITOR status screens indicate that CPU utilization is low, but disk activity is high for selected disks, you might seek to *increase* CPU utilization and overall server performance by spreading the application database over additional disks, preferably on different channels.

In another example, however, your server might emphasize network throughput. If the MONITOR status screen indicates that CPU utilization is high, you might seek to *decrease* CPU utilization by installing bus-mastering network adapters, to improve response time.

When tuning the server, monitor all PDAUTIL and MONITOR utilization meters and seek to average out utilization over all subsystems.

General performance issues

Note the following:

- Spread files and/or databases over as many drives as possible. This increases the performance of your disk I/O subsystem significantly.

- With few exceptions, configure your entire SCSI drive(s) as a single NetWare partition, except for your boot drive (C:). NetWare supports only one NetWare partition per drive with up to 8 volumes per drive and a total of 64 per server.

❖ **Since the IBM PS/2 Server disk driver does not perform any internal write caching, it is safe for use with other applications that require non-caching writes to preserve data integrity.**

Allocating system memory

Refer to the documemtation supplied with NetWare for recommended memory allocation techniques.

From the reference disk memory allocation screen (invoked at the Feature Contol screen), you can allocate memory between AP/FP processors and reserved. The rules are as follows:

- For a single processor PS/2 Server 195 without the PDA option:
  - allocate all the available memory to the boot CPU.
- For a single processor PS/2 Server 195 with the PDA option:
  - Reserve memory for each PDA in the server (make sure you have at least 2 MBytes for the first PDA and 1 MByte for each additional PDA).
- For a multiprocessor PS/2 Server 295:
  - Enable the "Symmetric Multiprocessor Mode" at the Startup Mode screen (invoked at the Feature Control screen) and use the same memory allocation rules (found above) for the Server 195.

Micro Channel options

When possible, use the highest-performance Micro Channel adapters. A slower adapter degrades overall performance on the Micro Channel bus that the adapter shares with other options. For network adapters, favor 32-bit over 16-bit, favor bus master over shared memory or I/O, and avoid Micro Channel DMA. NetWare does not support shared memory or DMA adapters.

Fixed disks

Distribute system fixed disk drives evenly among all available IDC channels. Distribute files and databases evenly among all available drives, manually or by configuring multiple disks as a PDA (Orthogonal RAID–5 Disk Array/2). Beyond these simple procedures, tuning the performance of a multiple-disk, single-CPU, multiple-channel system is largely a matter of trial-and-error. The theory of maximizing such performance is complex, even for simple systems. For an introduction to the subject, refer to, for example, *Measurement and Tuning of Computer Systems* by Ferrari, Serrazi, and Zeigner (Prentice-Hall, 1981).

Disk Array/2s

Under heavy loads that have greater than two-to-one read/write ratios, overall performance of the optional Disk Array/2 (PDA) exceeds that of an individual drive with the same capacity for file servers and most client/server applications. Although a single read operation is not any faster on a PDA than on an individual drive, concurrent reads benefit from the fact that multiple spindles are available. Instead of all reads being directed to a single drive, the reads are spread out among multiple drives.

Write-performance improvements occur in the same way when the PDA is configured without Data Sentry (Data Sentry is a configuration parameter of PDAs that enables redundancy and allows the loss of a drive in the PDA with no loss of data). On a PDA configured with Data Sentry (a RAID–5 array), however, each write is broken down into two reads and two writes plus computational overhead. In this case, a write operation incurs four times the amount of I/O when writing to a Data Sentry PDA than when writing to an individual drive. Since both reads and both writes can be overlapped, in most cases a Data Sentry PDA write takes about twice as much time as a non-PDA write. This loss of performance is the cost of protecting data by using write redundancy.

Overall performance on a Data Sentry PDA (that is, reads plus writes) benefits from higher read/write ratios (5:1 in most cases). Thus, the improvements on reads have more impact on over-all performance than the degradation causes by writes. On a Fault Tolerant Disk Pair (i.e., a two drive PDA) write performance is optimized so that only two writes are required (i.e., no reads are necessary in this case).

Additional information about PDAs is presented in Chapter 5.

Cleaning removable-media devices

Maintain diskette and tape devices by cleaning them on a regular basis. Refer to the instructions provided with each device for information on how to do so.

Cleaning the air filters

The server contains several air filters, made of washable plastic material. These filters should be removed and washed as needed.

One filter is mounted on the inside of the front grill. In some server models, three others are mounted over the air intake vents behind the device bays. In other models, one other is mounted on an opening at the bottom of the system backplane.

▲ **Warning: Cleaning the rear filters requires removal of the server's rear panel. Because of electrical shock hazard, any task requiring removal of this panel should be performed only by qualified service personnel.**

To clean the grill filter, follow this procedure:

1. **Open the front grill.**
2. **Unscrew the three filter-retainer screws (Figure 3-1).**
3. **Rotate the filter retainer back and remove the filter.**
4. **Wash in warm water with mild detergent.**
5. **Rinse; shake out excess water and let dry thoroughly prior to reinstallation.**
6. **Replace in the filter retainer.**

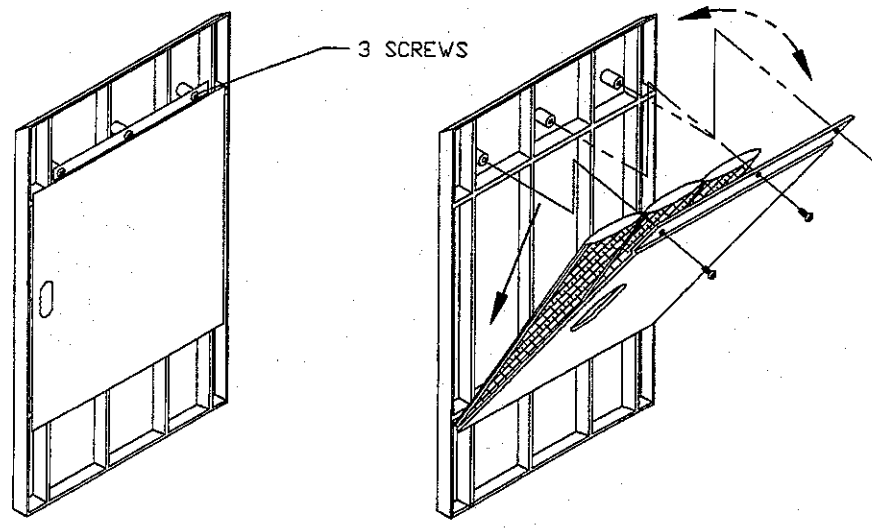


Figure 3-1
Removing the grill filter

7. **Rotate the filter into an upright position and reattach the retainer screws.**

8. **Close the grill.**

To clean the three small filters in the cabling area behind the device bays (if present in your server model), use the following procedure.

1. **Unlock and then remove the rear panel by unscrewing the three retaining screws.**

2. **Peel off the three filters (Figure 3-2).**

3. **Wash in warm water with mild detergent.**

4. **Rinse and let dry thoroughly prior to reinstallation.**

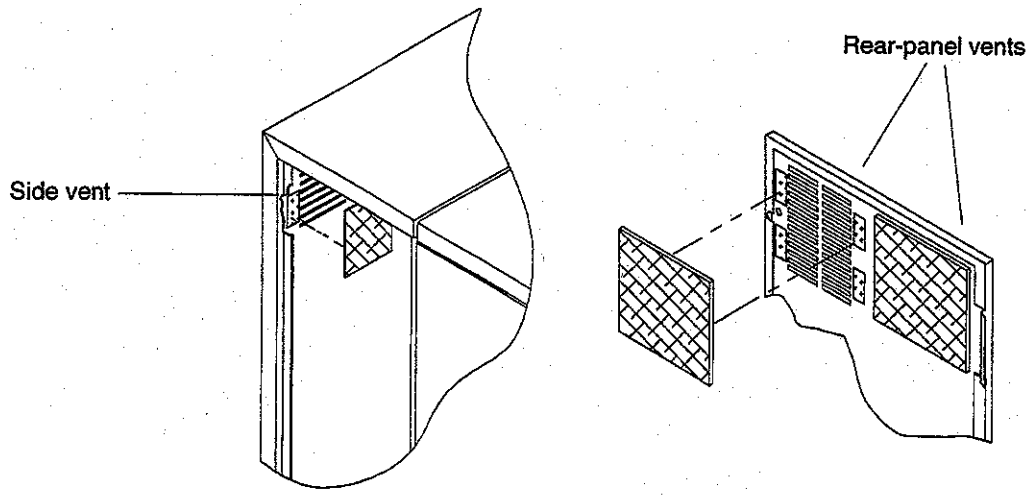


Figure 3-2
Removing the filters in the rear cabling area (some models) (#1)

5. **Press the dry filters back over the intake vents.**

6. **Replace and then close the rear panel; reattach the retaining screws.**

To clean the small filter at tyhe bottom of the system backplane in the cabling area (if present in your server module), use the following procedure.

1. **Unlock and then remove the rear panel by unscrewing the three retaining screws.**

2. **Peel off the filter (Figure 3-3).**

3. **Wash in warm water with mild detergent.**

4. **Rinse and let dry thoroughly prior to reinstallation.**

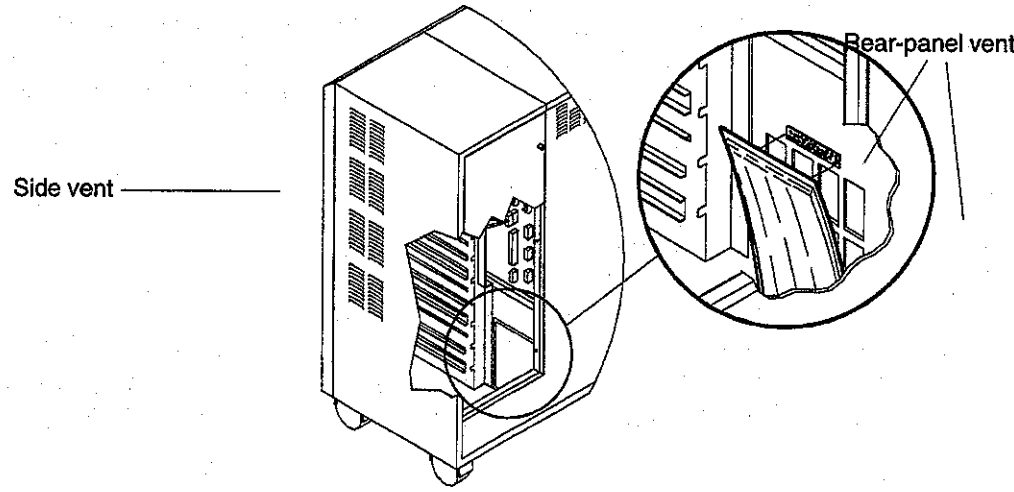


Figure 3-3
Removing the filters in the rear cabling area (some models) (#2)

5. **Press the dry filters back over the intake vents.**
6. **Replace and then close the rear panel; reattach the retaining screws.**

Occasional maintenance and recovery tasks

This section describes tasks that you will need to perform only on occasion, as the need arises.

Recovering from a system crash

If you suffer a catastrophic system crash caused by corrupted software, power surge, sudden power loss, CPU failure, or some other such event, data in memory and on disk, and CMOS contents, are the most likely areas to experience damage.

In the case of a disk failure, the data stored on that disk is at risk. Data in memory is lost when the system crashes. Data in CMOS is lost if the processor-module battery loses power or if the system crashes while CMOS is being updated.

Lost data

To avoid the loss of stored data in the event of a disk failure, you can use fault-tolerant strategies, such as setting up one or more Data Sentry Disk Array/2s and by performing regular backups. Additionally, you can use NetWare disk mirroring if you do not have the PDA option.

Corrupted CMOS

To recover from an event that corrupts the processor module CMOS, start up using the reference diskette. From the reference diskette, use the Configuration Restore option to copy the backup version of CMOS to the system, or use the Automatic Configuration option. If you use the Restore options, the processor module must be in its original slot. If you use the Automatic option, follow it with any necessary customizing changes. For example, some adapters will not function with the parameter settings that Automatic assigns to them. Refer to Chapter 4, and Chapters 2 and 4 in the *PS/2 Server 195/295 Hardware Reference Manual* for details.

Use the Feature Control option to reset date and time, password, startup mode, and other parameters as necessary. Use the SCSI Subsystem backup option to restore IDC-controlled device information, and update as required.

If a CMOS is permanently damaged, contact your authorized service representative.

Recovering from a lost password

If you forget the power-on password or its location in CMOS is corrupted, the password must be cleared from the processor module CMOS and a new one defined. For the password to be cleared, the entire contents of CMOS must be cleared and replaced.

▲ **Clearing and replacing the CMOS contents requires access to the system card cage. Since a shock hazard is present in the system card cage, the procedure described in this section should be performed only by qualified service personnel.**

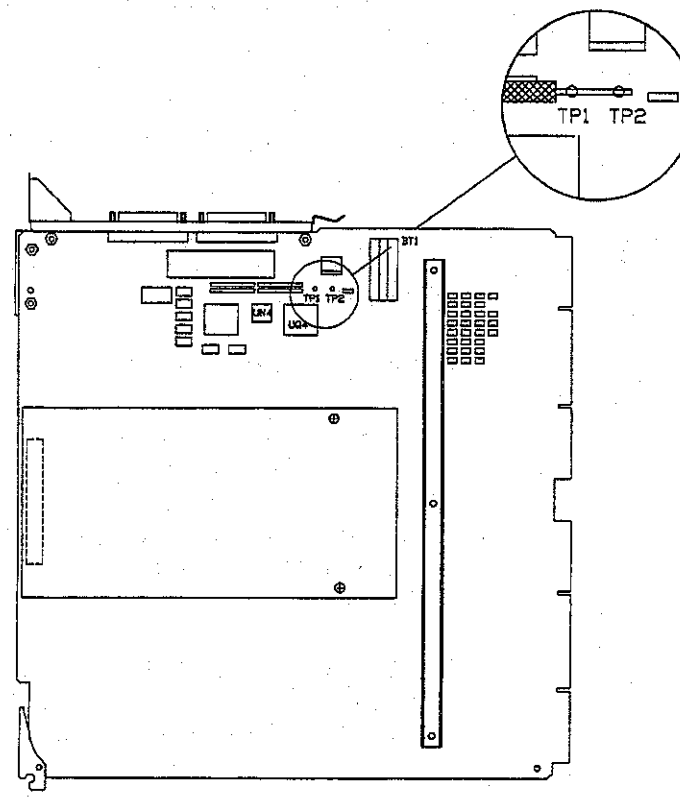


Figure 3-4
Shorting a CMOS battery

The technician clears the contents of CMOS by removing the processor module from the server and momentarily connecting jumper pins TP2 and TP3 (Figure 3-4). This shorts out power to CMOS and erases the settings therein. The connection can be made by, for example, laying a metal screwdriver shaft against both pins at the same time.

▲ **Warning: When performing this operation, the technician should take care not to touch any other areas of the module. Permanent damage to the module from static discharge could result. The technician should always wear a grounding strap.**

To restore the erased CMOS settings, refer to "Restoring a configuration to CMOS" in Chapter 4.

If you forgot the password you must reconfigure the server with the reference diskette by selecting Automatic Configuration option.

Relocating the server

If you decide to relocate the server and its expansion cabinets, use the following procedure to do so:

1. **Back up any fixed-disk files onto DAT or tape cartridges.**

   Ensure that the cartridges are not exposed to electrical or magnetic impulses while stored or in transit.

2. **Shut down the server using normal procedures (early warning to users, applications shutdown, NetWare shutdown, and power down).**

3. **The IDC-controlled fixed disks need no special attention before a move, since their drive heads lock automatically when the power is turned off. Refer to step 11 for details.**

4. **Turn off the server, any expansion cabinets, and all peripheral devices AC and/or DC power switches.**

5. **Remove any diskette head protector or blank diskette in each diskette drive.**

   Do not use diskettes you plan to use again.

6. **Disconnect the external power cords from the power outlets and from the server and any expansion cabinets.**

Label the cords as necessary.

7. **Disconnect all server peripherals from any independent power supplies.**

   This includes any UPS equipment attached to the system.

8. **Disconnect all cables from the server and server expansion-cabinet ports and connectors.**

   Label as necessary.

9. **If instructed by your service representative, remove any Micro Channel adapters present in the Micro Channel card cage.**

10. **If instructed by your service representative, remove any fixed disk drives that you have installed. Noting each drives physical position in the server and its board ID, channel ID, and SCSI ID.**

11. **Remove the bay covers from any fixed disk drives not removed, and confirm that retaining screws are installed in the ends of the rails attached to the drives (Figure 3-5).**

    Replace the bay covers.

12. **Pack system components, peripherals, and cables in their original packing boxes or similar packaging, with sufficient padding to protect them.**

▲ **Warning: Do not attempt to roll or carry an unpackaged server to a new location. Any bumps, jars, other sudden impacts, movement away from the cabinet's vertical orientation, or variations in environmental factors may result in damage to the equipment. Do not attempt to move a server and expansion cabinet while they are connected.**

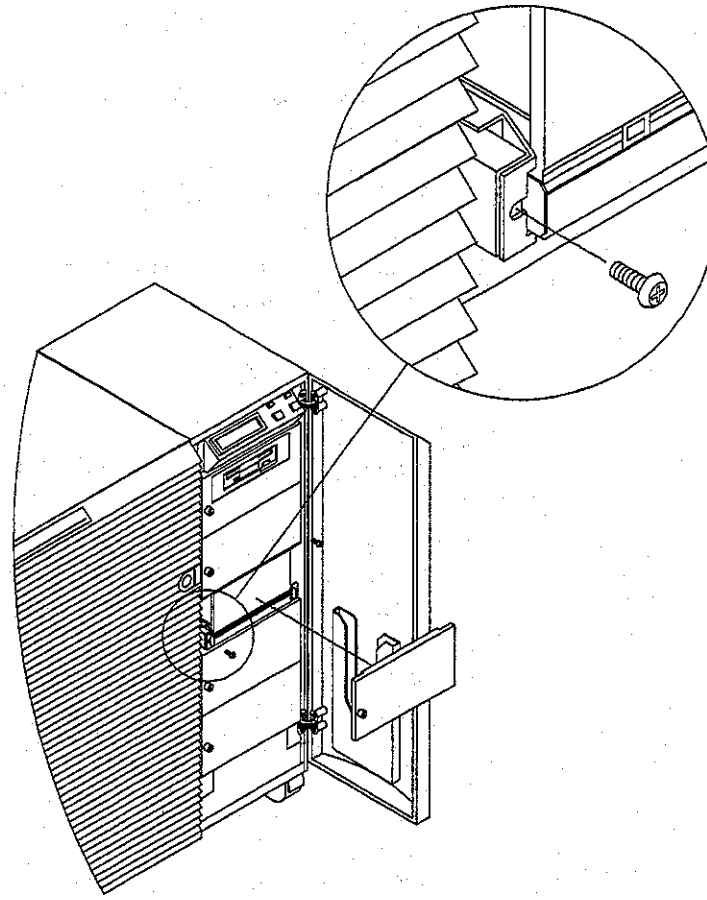


Figure 3-5
Installing shipping screws

13. **To repack the server for return to the factory or relocation, follow these steps:**

    a. Lay the shipping container and protective foam beside the server, tip the server, and carefully lower the server onto it.

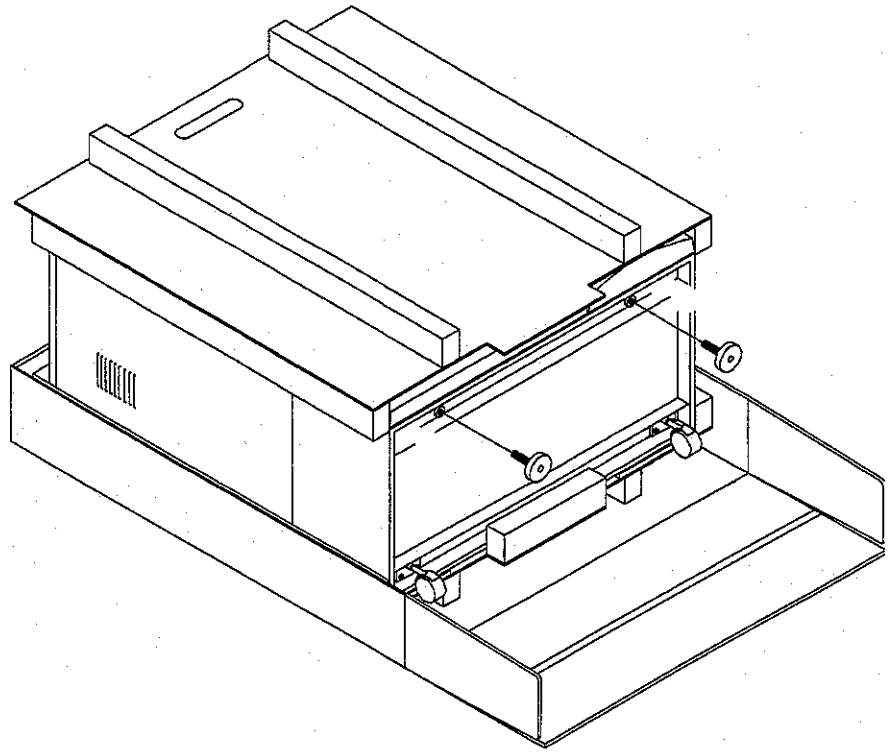


Figure 3-6
Removing anti-tip stops

b. Remove the server anti-tip stops (Figure 3-6).

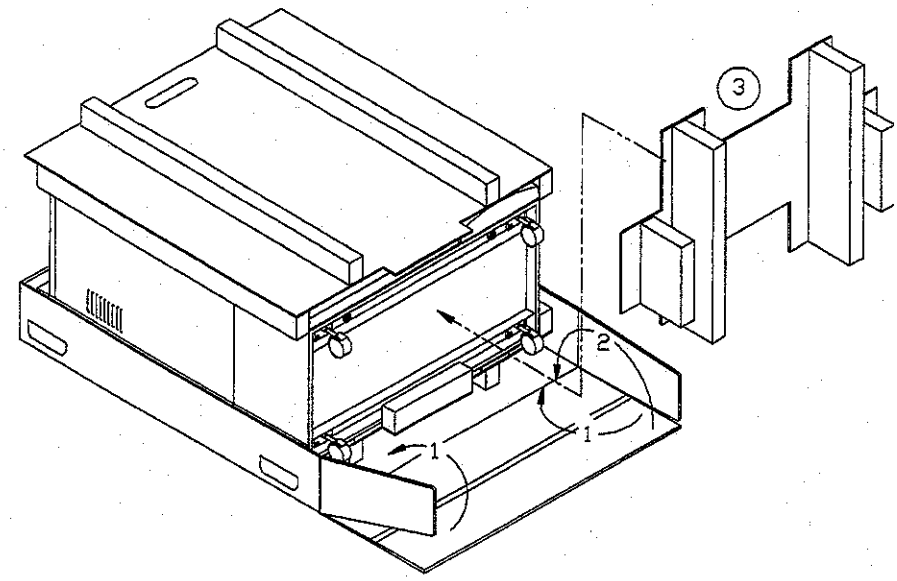


Figure 3-7
Folding up the packing container

c. Fold the container tabs ①; fold up the container side ② over the server bottom; replace the protective bottom foam ③ (Figure 3-7).

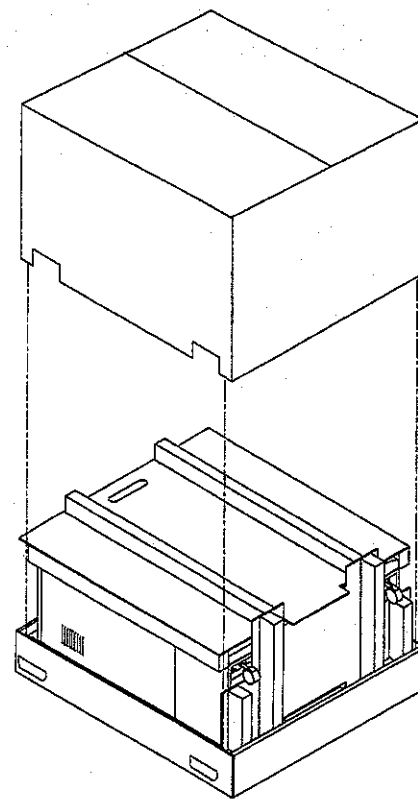


Figure 3-8
Putting on the container top

d. Put on the container cover (Figure 3-8).

e. Strap the container securely shut.

14. **Confirm that the environmental requirements for the server are met at the new location.**

    Refer to the server specifications in Appendix A of the *IBM PS/2 Server 195/295 Installation Guide*.

15. **Assemble the equipment at the new site according to the instructions in Chapter 2 of the *IBM PS/2 Server 195/295 Installation Guide*.**

Chapter 4: Reconfiguring the Server

Reconfiguring the Server

In the course of server use, you may need to reconfigure one or more of the following:

- Date and time (server and/or DOS)
- Password (server and/or NetWare)
- Startup mode (system recovery level, keyboard speed)
- Software mode (multiprocessor or uniprocessor)
- Processor module memory allocation
- IDC-controlled fixed disk drives
- Micro Channel options
- NetWare options

In addition, you may need to perform the following tasks:

- Reinstall or upgrade DOS, NetWare, or BIOS
- Update system files
- Restore a system configuration to CMOS

Procedures for reconfiguring DOS date and time, server password, startup mode, software mode, processor memory allocation, and processor cache are provided in this section. In addition, the section explains how to upgrade restore data to CMOS.

Reinstallation and upgrade procedures for DOS, NetWare, and the BIOS are version-specific and are not described in this documentation set.

Procedures for reconfiguring system modules, system fixed disks, and Micro Channel options are provided in the *IBM PS/2 Server 195/295 Hardware Reference Manual.*

Procedures for reconfiguring NetWare date, time, and password are provided in Chapter 3.

Refer to Table 4-1 for more information on where to find reconfiguration information.

Warning

The CONFIG.SYS and AUTOEXEC.BAT files, if present, in the root directory is used by DOS when the system is powered up. DO NOT EDIT OR DELETE THE CONFIG.SYS AND/OR AUTOEXEC.BAT FILES unless explicitly instructed to do so by a IBM procedure or by your authorized customer service representative.

Table 4-1
Finding information about reconfiguring the server

System component or setting	Refer to
Date and time (server and DOS)	Page 4-4
Server password	Page 4-4
Startup mode (system recovery level and keyboard speed)	Page 4-5
Reallocating memory	Page 4-8
Restoring a backed-up CMOS configuration	Page 4-9
Adding or removing an IDC terminator	Chapters 2 and 3 of the *IBM PS/2 Server 195/295 Hardware Reference Manual*
Changing a Drive ID	Chapter 4 of the *IBM PS/2 Server 195/295 Hardware Reference Manual*
Adding, moving, removing, and replacing fixed disk drives and Disk Array/2s.	Chapters 5

Changing date and time

To change DOS date and time on the server, using the reference diskette, do the following. You can also set server date and time using DOS.

1. **From the reference-diskette main menu, select Feature Control.**
2. **From the Feature Control screen, select Date and Time.**
3. **Type in the correct date and time.**

   The date format is mm-dd-yyyy where m, d, and y are digits from 0 to 9. You do not type the hyphens. The time format is hh:mm:ss where h, m, and s are digits from 0 to 9. You do not type the colons.
4. **Press Enter.**

Changing the server password

To change the server password, perform these steps:

1. **Reboot the server (after warning network users and shutting down DOS) with a boot diskette in drive A; or, if the password is configured in power-on mode, power cycle the server, with or without a boot diskette in drive A.**
2. **When prompted to enter the current password, type the password followed by a slash (/) and the new password.**

   The password can be up to seven characters. Any character is allowed, including blanks and control characters. Case (upper or lower) is ignored. Use the Backspace key to correct errors. Press Enter when finished.

   To remove a password, when prompted enter the current password followed by a slash.

- **Exact keystrokes are required when the password is entered. That is, if a "6" from the top row of the keyboard is entered as part of the password when the password is defined, a "6" from the numeric keypad cannot be substituted when you type in the password. For this reason, you may want to avoid numbers in your password.**

To remove a password, when prompted enter the current password followed by a slash.

Changing the server mode

"Server mode" includes the following:

- Startup mode (recovery level, keyboard speed, and symmetric mutiprocessor mode (Server 295 only)).

Changing the startup mode

The reference diskette's Feature Control menu includes a selection called "Startup modes." The choices are:

- System recovery level - How the server handles startup errors.
- Keyboard speed - How quickly keystrokes are displayed on the server console and how quickly keystrokes are repeated when a key is held down.
- Symmetric multiprocessor mode (Server 295 only) - Defines whether or not the Server 295 is to operate allowing both processors to have access to all available memory in multiprocessor mode.

System recovery level

This selection offers the following startup modes. These modes are enabled using the reference diskette.

- Stop on all errors - The server pauses if an error is encountered during startup, and displays an error message and the prompt "Press F1 to continue." Pressing F1 causes the server to start up, working around the error if possible. This mode requires that a console be connected to the server and is not for use when the server is unattended. You may find the mode useful when installing the server for the first time, reconfiguring the server, and troubleshooting.

- Console-optional - The server does not pause when encountering console or diskette errors. Otherwise, operation is identical to "Stop on all errors."

To change the system recovery level setting:

1. **Start up using the reference diskette.**

2. **From the main menu, select Feature Control.**

3. **Select Startup modes.**

4. **Select System Recovery and press Enter (Figure 4-1).**

   Select the desired option from those displayed and press Enter.

5. **Press F10 to save your choice.**

Keyboard speed

The keyboard-speed feature controls **keyboard speed** and **keyboard speed delay** for the console keyboard if present. The choices are "Normal" or "Fast."

Keyboard speed defines how quickly a keystroke is recorded and printed to the screen. "Fast" records a keystroke if you barely touch a key, and repeats rapidly. "Normal," the factory setting, is 10.9 characters per second. "Fast" is 30.0 characters per second. Use "Normal" for regular typing, and "Fast" if you are a very fast typist.

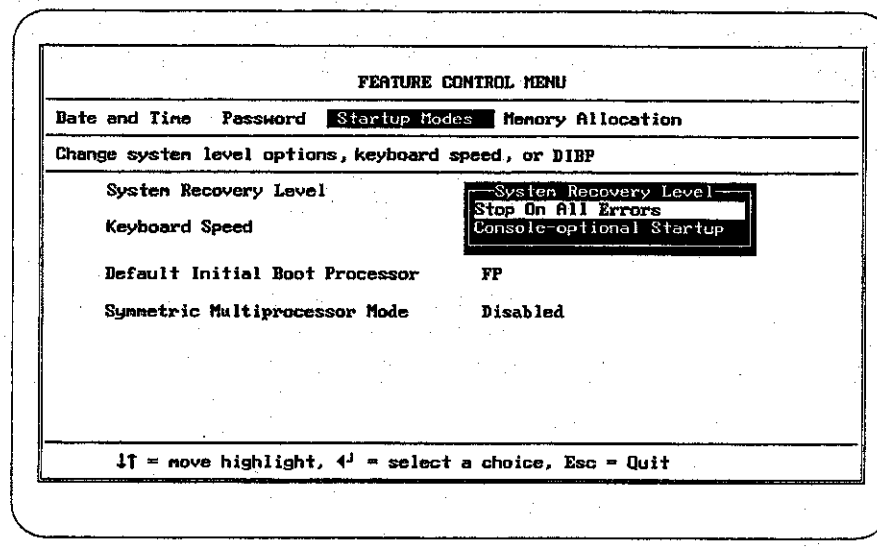


Figure 4-1
System recovery level

Keyboard speed delay defines the time between successive letters when a key is pressed and held down. "Normal" is 250 milliseconds. "Fast" is 500 milliseconds.

To change the keyboard speed setting:

1. **Start up using the reference diskette.**
2. **From the main menu, select Feature Control.**
3. **Select Startup modes.**
4. **Select Keyboard Speed and press Enter.**

   Select the desired option from those displayed and press Enter.
5. **Press F10 to save your choice.**

Symmetric Multiprocessor Mode

With the Server 295 in multiprocessor mode, and this feature *enabled,* both processors can access all of the available memory. Always enable this feature if running NetWare in a multiprocessor system.

Reallocating memory

The server allocates system memory for use for PDA buffers and NetWare file-server and network activities. You specify the allocation at installation, or accept the system defaults. You can change the allocation at any time.

If you install a Disk Array/2, the server uses 2 MB of this memory as PDA buffer space. The server assigns 1 MB buffer space to each additional Disk Array/2 installed.

Total system memory above 16 MB is unavailable to systems containing a 16-bit bus-master network adapter, in general do not use 16-bit adapters wherever possible.

To allocate memory for NetWare volumes refer to Chapter 3 in the NetWare Installation manual for details.

You reallocate memory on the following occasions:

- After adding additional memory to the memory module
- When tuning server performance
- When operating the server in a reduced configuration with a bank of memory automatically mapped out by the server BIOS at startup

You use the reference diskette to reallocate memory to NetWare and to change PDA buffer size.

If you have one or more Disk Array/2 configured in your system, allocate at least 2 MByte of PDA buffer space for the first PDA plus 1 MByte for each additional PDA. The server may experience severe performance degradation if the PDA buffer size is reduced below this minimum.

Since memory is allocated in 2 MByte increments, round-up your PDA buffer allocation to the next 2 MByte increment. For example, with 2 PDAs, you should have 4 MBytes allocated to PDA buffers. Allocate all remaining memory to the boot procesor. If you have two processors installed in your system (Server 295), enable Symmetric Multiprocessor Mode from the Reference Disk.

- **Do not use the NetWare "REGISTER MEMORY" command to change your memory allocation.**

Restoring a back-up CMOS configuration

When you change the server's configuration by adding or removing devices or changing server settings such as serial and parallel port names, you configure the changes into system CMOS using the reference diskette. When CMOS memory is corrupted, you use the reference diskette to recover the CMOS configuration.

If you decide to return the system to a previous configuration, you can restore the previous configuration to CMOS by using the reference diskette Restore options (under Configuration Change for processor modules and Micro Channel adapters and under SCSI Subsystem for SCSI devices). This assumes that you have backed up the previous configuration to the reference diskette using the reference diskette's Configuration Backup and SCSI Subsystem Backup options. If you have not, you "restore" a configuration by running the Automatic Configuration option, editing the configured settings, and entering additional setting values manually.

When CMOS memory is corrupted, you recover the CMOS configuration using the reference diskette. To do so, you run the Automatic Configuration option and then use the Configuration and SCSI Subsystem Restore options.

- **To use the SCSI Subsystem Restore option, the disk drives listed in the configuration must be present and responding.**

The Restore options replace CMOS values with the values in the backup files on the reference diskette. You then manually enter date and time.

Passwords are not backed up to diskette. If the backup CMOS configuration included a server password, the *current* password, if any, remains enabled. If no password is currently set, the password function is disabled. If the backup configuration did not include a password, any current password is disabled.

- **In contrast to the *Configuration Restore* option, the *Automatic Configuration* option recalculates nonconflicting values for the parameters you set using the Configure Change option, and the *BIOS recovery* for a corrupted CMOS copies all existing information from a good CMOS to a corrupted one.**

To restore a configuration, do the following:

1. **Start up the server with the reference diskette in drive A.**
2. **From the main menu select Configuration.**
3. **From the Configuration menu select Restore.**
4. **The CMOS information currently stored in the reference diskette file SYSCONF.PTL is copied to CMOS.**
5. **Restore date and time manually.**
6. **From the SCSI Subsystem menu, restore the SCSI device topology (it must be the same now as when the backup was made), or reinstall all SCSI devices.**
7. **If no password is set, optionally enter one using the Feature Control Password option.**

Chapter 5: Orthogonal RAID–5 Disk Array/2

Orthogonal RAID–5 Disk Array/2 (Continued)

Orthogonal RAID–5 Disk Array/2

This chapter describes the installation, configuration, management, and troubleshooting of the IBM PS/2 Server parallel disk arrays.

- **Support for PS/2 Server Orthogonal RAID–5 Disk Array/2 (PDA) is an optional server feature. This chapter is provided for use by those system installers and administrators using PS/2 Server computers that are to be configured with this optional feature.**

Introduction

PS/2 Server computers support parallel disk arrays (PDA) when the PS/2 Server Orthogonal RAID–5 Disk Array/2 software is installed. A Disk Array/2 (or PDA) is a collection of fixed disk drives treated by the operating system as a single drive. Disk Array/2s can improve server disk-subsystem performance and reliability. After physically installing the individual drives to be members of a PDA, you set up the PDA using the reference disk. The current section describes the configurable parameters in a PDA, and how you choose values for parameter settings.

Non-PDA drives and PDAs are assigned Drive IDs by the reference disk; the operating system assigns logical drive letters according to Drive IDs.

- **While it is possible to use NetWare mirroring on PDAs, there are no benefits in using such a configuration. The additional data protection does not typically justify the effort in this case.**

In the example in Figure 5-1, four drives are members of a bootable Disk Array/2. Each drive has its own physical ID, consisting of IDC slot number, channel letter, and SCSI ID jumpered on the drive, but all four drives have the same Drive ID ("1" in the example). The drives are distributed over all available channels to maximize throughput and to

increase reliability by protecting against data loss caused by the failure of any one channel. Order of the drives within the Disk Array/2, indicated by the PDA order number, is not related to the drives' physical positions in the server. Drives can be moved to new physical positions, but logical drive order, specified using the reference disk, must always remain the same.

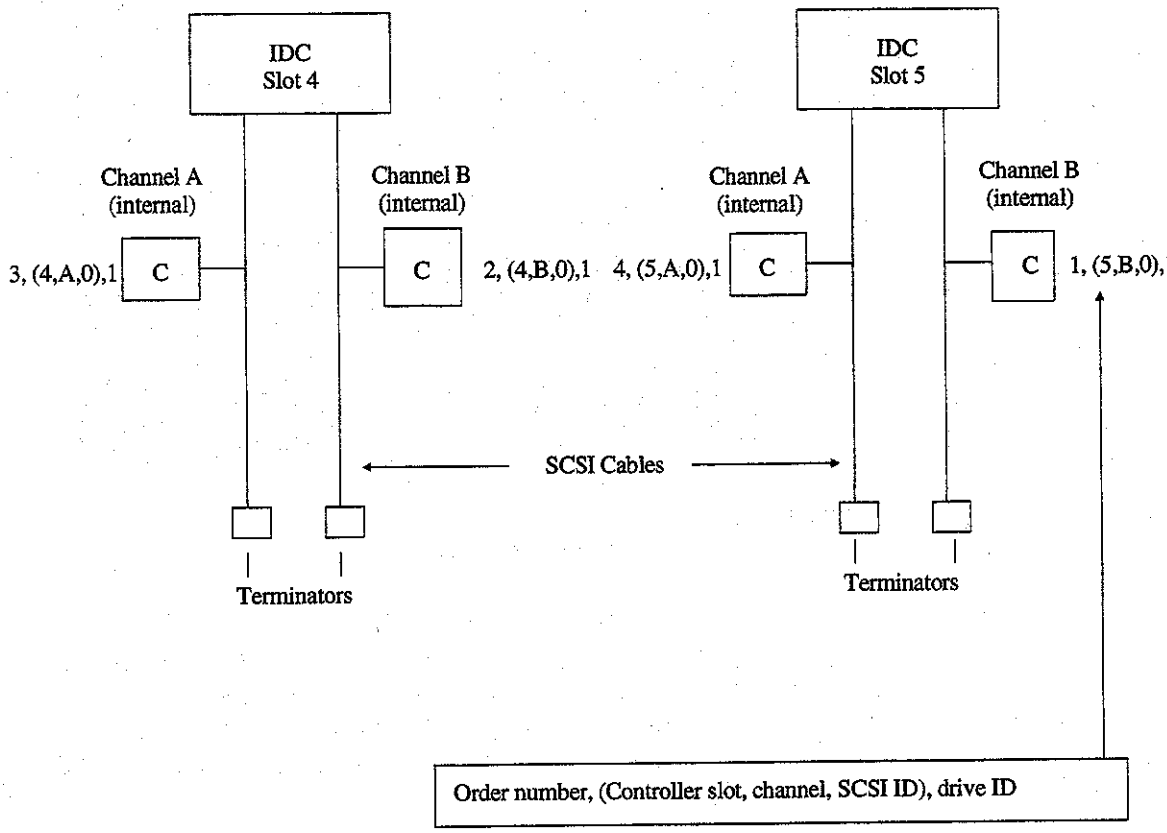
In a Disk Array/2, member drives are divided into "bands." Bands are used to spread data over the drives. In Figure 5-2, a three-member Disk Array/2 is divided into bands. You define the size of the individual bands by specifying a "striping factor." The striping factor sets the number of 512-byte sectors contained in each band. For example, in the figure, bands 1, 2, and 3 belong to stripe 1 when Data Sentry is not enabled (Data Sentry, which provides data redundancy in the Disk Array/2, is explained in the following section). When Data Sentry is enabled, a band of Data Sentry consistency information and bands 1 and 2 belong to stripe 1. Band size can range from 32 to 1024 sectors, in any incremental power of 2 (e.g., 32, 64, 128,...). The reference diskette default is 512 sectors per band, which provides 256 KB of data per band. This setting is adequate for most applications.

Data Sentry

Data Sentry is a Disk Array/2 feature that duplicates data in such a way that the loss of a single drive does not cause the loss of the data on that drive—the data can be reconstructed from the information remaining on the other drives.

- **Data Sentry protects the drive from media failure(s). If the information on the drive becomes incorrect as a result of a server malfunction or a failure in one of the server applications, Data Sentry cannot be used to recover the correct information.**

For a Disk Array/2, you can disable Data Sentry or leave Data Sentry enabled (default is enabled). You specify which when you setup the Disk Array/2 using the reference disk. If Data Sentry is enabled, one of each N bands is reserved for Data Sentry consistency information, where N is the



The four drives in this system have been installed as a Disk Array/2. All are assigned Drive ID 1 by the reference diskette and logical drive letter C by the operating system. The drives are distributed over all available channels to maximize throughput and increase reliability. PDA drive order, indicated by the order number, is not related to the drive's physical location in the server. Drives can be moved to a new physical location, but logical drive order, specified using the reference diskette, must always remain the same.

Figure 5-1
A Disk Array/2

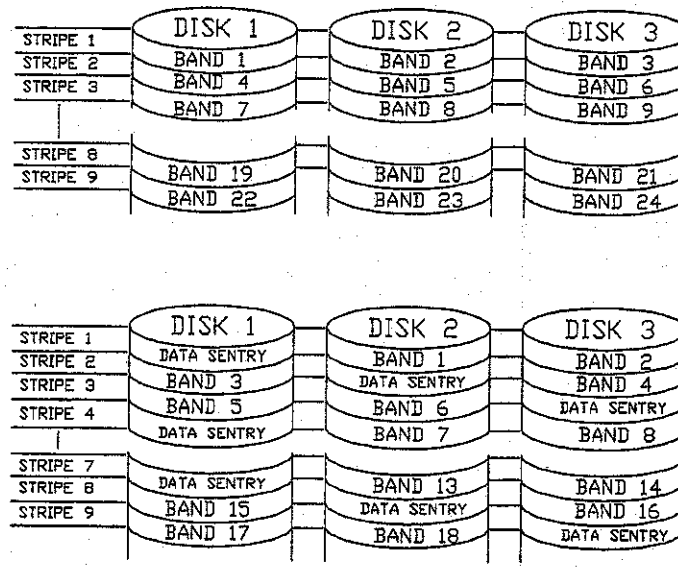


Figure 5-2
PDA bands with and without Data Sentry enabled

number of drives in the Disk Array/2—that is, the number of bands equivalent to one drive are dedicated to Data Sentry data. The N-drive Disk Array/2 then has the capacity of N-1 drives. If Data Sentry is not enabled, the capacity of the Disk Array/2 is the same as the total of the member drives.

If Data Sentry is enabled, the Disk Array/2 is configured as a RAID–5 array. The Disk Array/2 can lose a drive and continue to function without loss of data. In the minimal case of a two-drive Disk Array/2, this is equivalent to drive mirroring or duplexing and is called an FT Pair.

- **If a server configured with a Data Sentry Disk Array/2 is shut down abnormally, or if CMOS is corrupted, the Disk Array/2 may develop inconsistencies between the data contained on the drives and the Data Sentry information used to maintain data integrity in the Disk Array/2. These inconsistencies could prevent the server from reconstructing the Disk Array/2 correctly should a drive in the Disk Array/2 fail. For this reason, the Disk Array/2 software automatically verifies Data Sentry consistency at startup**

following any abnormal server shutdown or incidence of corrupted CMOS, repairing any inconsistencies found. The process is carried out in the background at a lowered priority, to minimize the impact on server performance.

You can also check Data Sentry consistency on a periodic basis, as described in the section "Verifying data integrity" on page 5-51.

Fault tolerant pairs

A 2-drive PDA configured with Data Sentry is referred to as a Fault Tolerant (FT) Pair. FT pairs provide the same level of data protection as disk mirroring or disk duplexing.

The installation procedure for FT pairs is slightly different than that of other PDAs. Certain performance optimization has been implemented in the SCSI disk driver. In all other respects, FT pairs are treated the same as other PDAs by the PS/2 Server system software.

Spare drives, hot fixing, and hot replacement

PS/2 Server computers support spare drives, hot fixing, and hot replacement.

Spare drives are fixed disk drives that you set up in the server using the reference disk or PDAUTIL facility running under NetWare. These drives are not visible to the operating system, but can be used by the PDA utility to replace any failed Disk Array/2 drive while the server is running and Data Sentry is enabled.

You can install a spare drive physically with server power off, or, while the server is running, by inserting the drive into a carrier module previously installed in the server. If you install the drive with the server power off, you can logically configure the drive into the server as a spare drive by using the reference disk, or, while the server is running, by using

PDAUTIL (see page 5-46 for PDAUTIL usage). If you use PDAUTIL with power on, it quiets the channel that the drive is to use (stop all activity on the channel), and allows you to insert the drive in a carrier module. Since any other drives connected to that channel cannot use it while it is quiet, you need to plan for any interruption to network service this causes.

Hot fixing is the automatic repair of bad sectors on a disk (Disk Array/2 or individual drives) by the system software while the server is running. IBM's Orthogonal RAID–5 Disk Array/2 hot fixing prevents the most common drive failure—media corruption—from halting operations.

Hot replacement is the replacement of a bad drive, with no loss of data, while the server is running, using a spare drive or using a new drive. Hot replacement is possible only with Data Sentry enabled.

Hot replacement of a bad drive, individual or Disk Array/2 without Data Sentry, is not supported.

- **The replacement drive must be factory-qualified. Any drive may be used as a replacement as long as its formatted capacity is equal to, or larger than, the smallest drive presently available in the PDA. If the replacement drive is substantially larger than it needs to be, a warning is issued. When possible, use the same make and model as the other PDA drivers.**

Hot removal/insertion is the physical replacement of a bad drive with a new drive with the same SCSI ID in the same carrier module while the server is running—that is, replacement of a bad drive when no spare is available. This can only be done for a member of a Disk Array/2 with Data Sentry enabled, using PDAUTIL, because you must use the PDAUTIL to quiet the SCSI bus while power is removed from the faulty drive and returned to the new drive.

PDAUTIL also allows you to verify Data Sentry consistency and data integrity, and fix damaged consistency in a Data Sentry Disk Array/2. Refer to page 5-46 for PDAUTIL usage.

Memory allocation

By default, the reference diskette assigns 2 MB of system memory for the management of the first Disk Array/2, for buffer space. The reference disk assigns 1 MB of buffer space to manage each additional Disk Array/2. The reference disk allocates this memory from overall memory and does not allow NetWare to use it.

- **PDA buffers are used to support Data Sentry operations, such as computing redundant data and recovering lost information. PDA buffers are *not* used to cache disk driver writes. All disk driver writes are completed only when all of the information is actually written to disk. This ensures data integrity in client/server applications.**

To change the buffer allocations from the default, use the PDA Buffer Size field in the reference disk's Feature Control Memory Allocation screen. Increasing the amount of memory available for PDA buffers can benefit performance on systems subjected to a lot of disk activity. A maximum of 32 MBytes of memory may be allocated for PDA buffers.

▲ **Do not use the "register memory" command to increase the amount of memory available to NetWare. This command has been disabled and is not supported on the PS/2 Server. Executing it can cause NetWare to start using memory that has been allocated for use as PDA buffers. As a result, the system may fail with possible loss of data.**

Performance considerations

Under heavy loads that have greater than two-to-one read/write ratios, overall performance of a Disk Array/2 exceeds that of an individual drive with the same capacity for most file servers and client/server applications.

Although a single read operation is not any faster on a Disk Array/2 than on an individual drive, concurrent reads benefit from the fact that multiple spindles are available. Instead of all reads being directed to a single

drive, the reads are spread out among multiple drives. On an N-drive Disk Array/2, the server can improve up to a factor of N in disk I/O operation.

Write performance improvements occur in the same way when the Disk Array/2 is configured without Data Sentry. On a Disk Array/2 configured with Data Sentry (a RAID–5 array), however, each write is broken down into two reads and two writes plus computational overhead. In this case, a write operation incurs four times the amount of I/O when writing to a Data Sentry Disk Array/2 than when writing to an individual drive. Since both reads and both writes can be overlapped, in most cases a Data Sentry Disk Array/2 write takes about twice as much time as a write to a single drive. This loss of performance is the cost of protecting data by increasing the amount of disk activity required for disk writes. In the case of FT pairs, the two reads are not necessary, because the same data is written to both drives.

Overall performance on a Data Sentry Disk Array/2 (that is, reads plus writes) benefits from high read/write ratios. In most cases, the improvements on reads have more impact on overall performance than the degradation caused by writes.

When a Data Sentry Disk Array/2 has lost one of its drives, read and write performance degrades in some cases. Each time a read is issued to the faulty drive, the data is recreated by reading the other drives. On an N-drive Disk Array/2, N-1 reads are required to satisfy each request directed to the faulty drive (1/N of the requests). Write performance is affected in the following way: N-1 reads are required instead of two, if the write involves information on the failed drive (N is the number of drives in the Disk Array/2). One write is required instead of two. The probability that the write involves information on the failed drive is 2/N. With FT pairs operating in reduced mode, a single read or write is sufficient to complete these I/O operations.

Orthogonal RAID–5 Disk Array/2 security

Server Disk Array/2 support includes logical security keys that must be attached to the computer when the first Disk Array/2 is installed. Any further Disk Array/2s installed use the same keys.

The security keys plug into the processor parallel port designated "Parallel_1," whether on the processor module or on a Micro Channel adapter. In Figure 5-6 on page 5-16, the keys are shown plugging in to the module parallel ports. The keys are passive, so that the processor module or adapter port can still be used by applications with a parallel connector plugged into the processor key.

▲ **For the PS/2 Server 295, if either key is removed or is installed on a port other than Parallel_1, the server does not function. For the single-processor PS/2 Server 195, only one key is necessary.**

Restrictions

The following restrictions apply to Disk Array/2s:

- Each Disk Array/2 must contain a minimum of two drives and a maximum of sixteen drives. A 2-drive PDA is referred to an an FT pair.
- All drives must be factory-qualified by IBM.
- Drive members of a PDA can have different capacities, however, drive members with larger capacities are going to be "wasted" because they will have the same useable space as the smallest drive member in that PDA.

▲ **Configuring drives into a Disk Array/2 causes the loss of all data on the drives. Changing PDA drive order, striping factor, any drive member (Data Sentry disabled), or any two or more drive members (Data Sentry enabled), causes the loss of all data on the drives.**

If Data Sentry has been enabled, you can replace any single Disk Array/2 drive member. The new drive is rewritten to contain exactly the same information as the replaced drive. The information is reconstructed from the Data Sentry redundant information on the other drives in the array. Drive replacement is described on page 5-43.

To change a Disk Array/2 drive topology—change the SCSI ID, controlling IDC, or channel connection for one or more drives—you logically remove and reinstall the Disk Array/2 using the reference disk and answering "No" to the prompt "Install as new PDA?" You cannot change the drive order of a Disk Array/2.

▲ **Answering Yes to the prompt "Install as new PDA?" during installation removes all current data from the member drives.**

Multiple simultaneous drive replacements are not allowed. You cannot logically remove an individual Disk Array/2 member, only replace it. You can remove the Disk Array/2 as a whole at any time, using the reference disk, and reinstall it in another server. Physical position after reinstallation does not matter, but drive order according to PDA order number must be preserved. In addition, you must remember to move any Disk Array/2 security device present in the server to the new server with the Disk Array/2, if it does not already have one.

You can reinstall individual drives from the Disk Array/2 or reinstall the Disk Array/2 with a different number of drives or striping factor. However, in such cases all data on the drives is lost. If you plan to use the member drives as individual drives, run FDISK to remove all partitions before dismantling the Disk Array/2.

Choosing a Drive ID number

Care is required when installing multiple fixed disk drives in the server, to avoid confusion in maintaining the drives. This applies to drives installed as individual units and to drives installed as part of a Disk Array/2. Refer to "Drive Identification" in Chapter 2 in the *PS/2 Server 195/295 Hardware Reference Manual* for the basic information you need

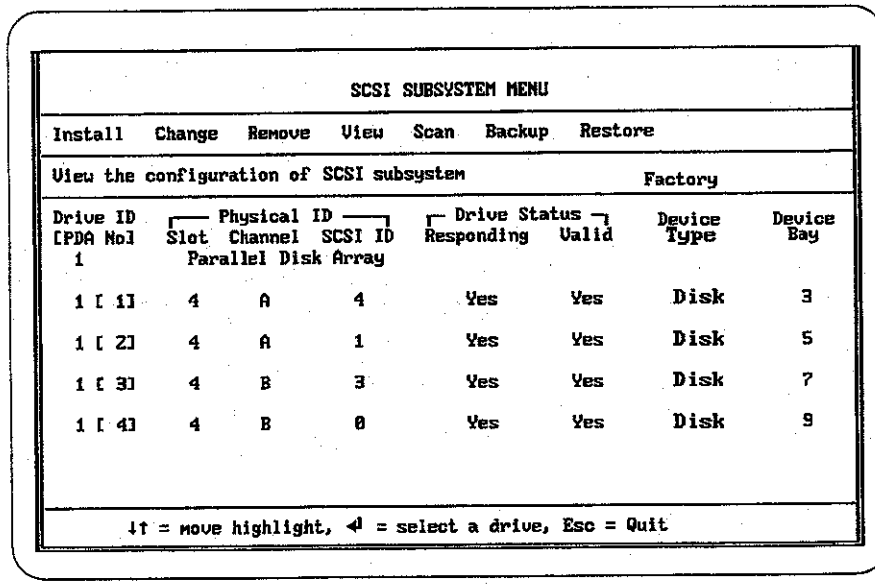


Figure 5-3
Viewing a PDA

to know before installing, moving, replacing, or removing a drive or Disk Array/2. This chapter assumes that you have read that section.

SCSI drive settings are defined by jumper settings on the drive and by information you provide using the reference disk. Information provided in Appendix E in the *PS/2 Server 195/295 Hardware Reference Manual* describes how to set the jumpers. This chapter and Appendix B in the *PS/2 Server 195/295 Hardware Reference Manual* explain how to use the reference disk.

When you use the Scan option, the reference disk displays a list of SCSI drives, ordered according to their physical location in the cabling topology or according to "Drive ID" and order number (when you use the View option) (Figure 5-3). You assign Drive IDs and specify PDA drive order when you install drives. The values for these parameters are not constrained by the physical location of the drives.

Installing a Disk Array/2

This section describes the procedures you follow to physically install a Disk Array/2 and to configure it into the server. Installation consists of:

- Planning the installation. This consists of deciding where the new drives will be added to the drive topology, which Drive ID is to be assigned to the Disk Array/2, and order of the drives in the PDA.
- Physcially installing the drives
- Setting up the Disk Array/2 using the reference disk
- Installing security devices
- Installing Disk Array/2 support software

The following sections describe how to accomplish these tasks.

Planning for installation

Perform installation tasks in this order:

✓ Install the physical drives.

✓ Set up the Disk Array/2 using the reference disk.

✓ Install DOS and NetWare onto the Disk Array/2 or on a single drive if necessary.

✓ Install Disk Array/2 software.

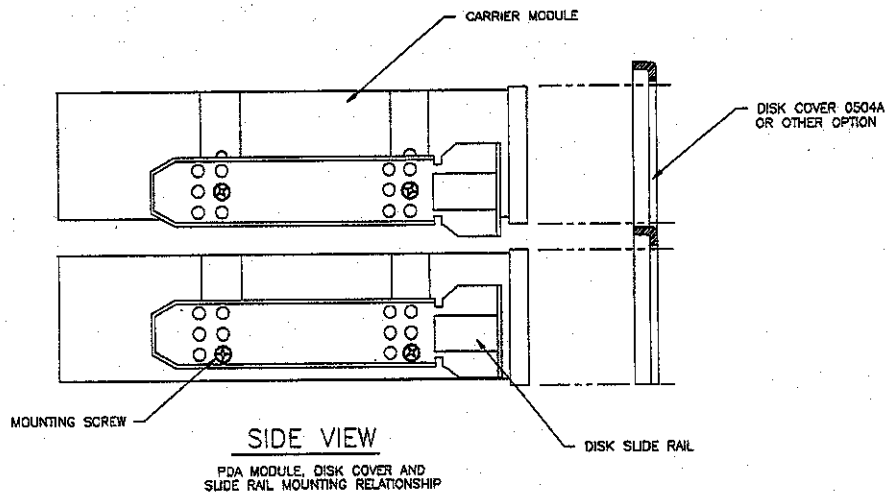


Figure 5-4
Attaching rails to a disk drive

Drive installation

Install drives for a Disk Array/2 as you would install any single drive in the server. The installation procedure for a drive is provided in Chapter 3 in the *PS/2 Server 195/295 Hardware Reference Manual.*

If you are installing drives that reside in the hot-extraction/insertion carriers provided by IBM, the following additional information applies:

- You attach mounting rails to the drive using one set of rail holes (middle/forward) for a drive to reside in the top half of a full-height device bay and a different set of rail holes (bottom/forward) for a drive to reside in the bottom half of the full-height bay (Figure 5-4).

- For hot-extraction/insertion drives installed in the lower device bays, you remove the pocket on the inside of the server cabinet door, since this pocket interferes with the extraction handles on the drives.

You can install spare drives in the server. These drives remain inactive unless a drive in a Data Sentry Disk Array/2 fails. One of the spare drives is then used to replace the defective PDA member.

You physically install a spare drive like any other, noting the slot number of the IDC module and the channel letter of the IDC channel to which it (or its hot-extraction/insertion carrier) is connected, its SCSI ID, and its bay number. Setting up (logically installing) the drive is described in "Setting up a spare drive" on page 5-24.

- **The spare drive must have the same manufacturer and model number as any failed drive that it is to replace.**

Leave the reference disk in drive A: to set up a Disk Array/2 (next section).

Setting up a new Disk Array/2

This section explains how to configure a new Disk Array/2 into the server using the reference disk. If you are *reinstalling* a Disk Array/2, refer to the section "Reinstalling a Disk Array/2" on page 5-32.

You set up Disk Array/2s in much the same way as single drives, except that all members of the Disk Array/2 have the same Drive ID. Your reference disk provides an option for Disk Array/2 installation. Only drives qualified at the factory are supported in Disk Array/2s. You can use the reference disk to add or remove a Disk Array/2, or to replace a drive in a Disk Array/2. You cannot add or remove a single drive to/from a Disk Array/2.

To configure a Disk Array/2 into server CMOS—to logically install the Disk Array/2 after physically installing the drives—do the following:

1. **Plug security keys into the processor parallel port designated "Parallel_1" (Figure 5-5).**

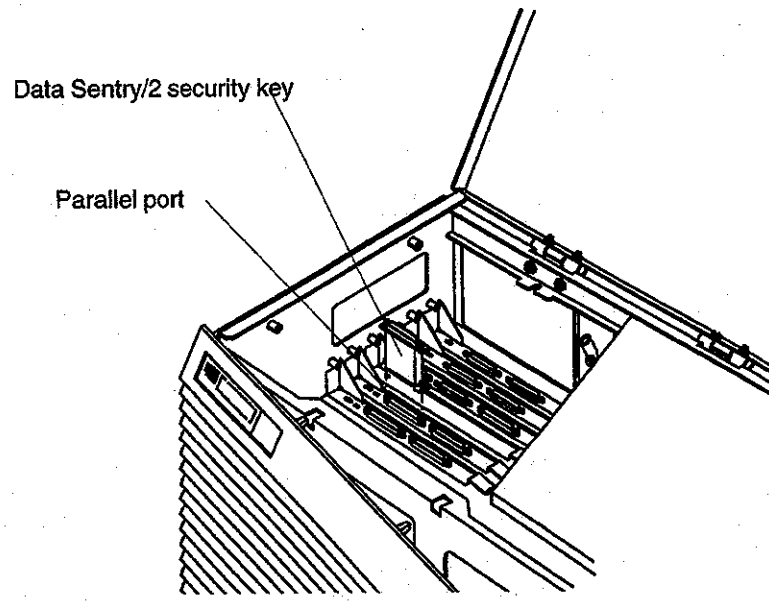


Figure 5-5
Installing a security key

Plug the side of the key with "computer" on it into the parallel port. These keys must always be present for the server to start up when a Disk Array/2 is present. If you have used the reference disk to designate a Micro Channel adapter port as Parallel_1, plug the key into that port.

The security keys are passive—that is, you can plug parallel connectors into it to use the processor parallel port. To prevent the parallel cable, attached to the security key, from interfering with the top cover, you can use a right-angle connector or plug the security key into the application end of the cable (Figure 5-6). IBM provides an extender/adapter for use between the key and a Centronix-type connector.

2. **Start the server with the reference disk inserted in drive A:.**

3. **From the main menu, select SCSI Subsystem.**

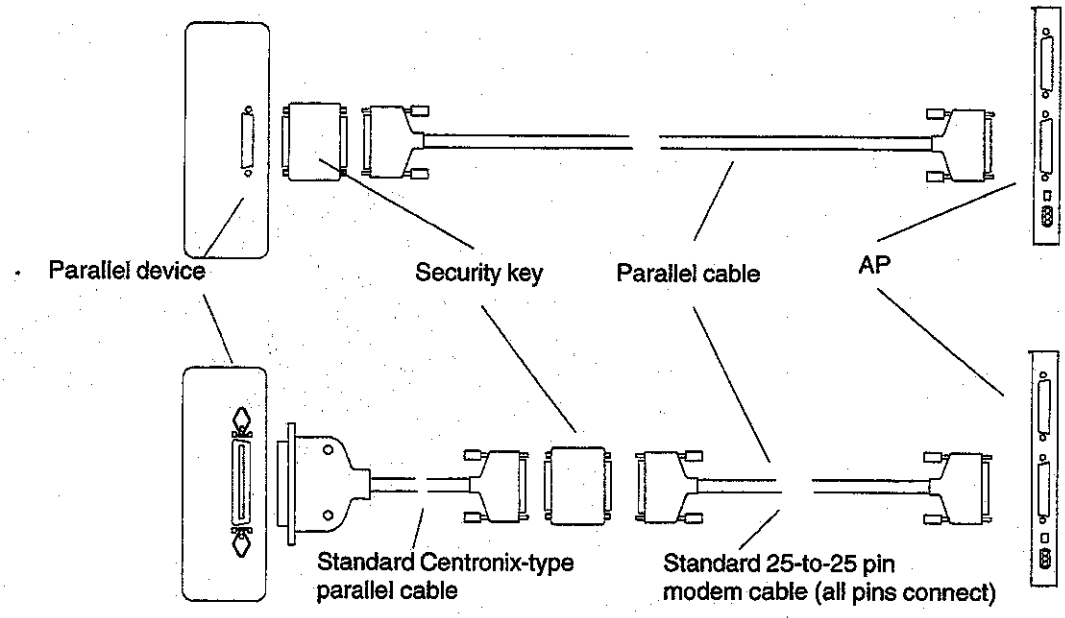


Figure 5-6
Cabling with security keys

4. **From the SCSI Subsystem screen, select Install.**

5. **From the Install menu, select PDA.**

   The Disk Array/2 Install screen is displayed (Figure 5-7) and the next available Drive ID is displayed as the default. In the figure, the the next available Drive ID is 2—that is, a boot disk with one partition is installed and the Disk Array/2 acts as the server's second disk.

❖ **NOTE: For a two-drive PDA, select "FT Pair". FT pairs (i.e., 2-drive PDAs) do not require the security key(s) to be plugged into the processor's parallel port.**

6. **Enter the number of drives that you intend to configure into this Disk Array/2 (this is not necessary in the case of FT pairs).**

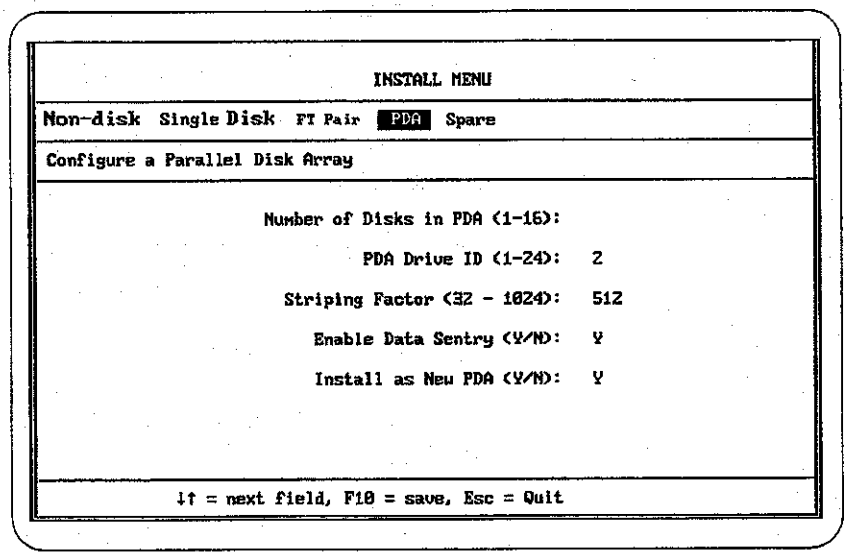


Figure 5-7
Installing a Disk Array/2 (screen #1)

7. **Decide which Drive ID number you want the reference disk to assign to the new Disk Array/2 (all drives in a Disk Array/2 are assigned the same Drive ID and, consequently, the same logical drive letter).**

   The Drive ID must be one of the IDs already in use or the next ID in sequence.

   If the Disk Array/2 is to be the boot drive, it requires the Drive ID 1.

8. **Enter a striping factor between 32 and 1024 for the array or accept default.**

   Once a striping factor is set up for the Disk Array/2, it cannot be changed without destroying the data on the disks. The setting affects performance. In most cases, you should set the striping factor to 256 or 512 (the default).

9. **If desired, keep Data Sentry enabled for the Disk Array/2.**

   Data Sentry must be enabled for the Disk Array/2 to provide fault-tolerant functionality. That is, with Data Sentry enabled, the Disk Array/2 can lose a drive without losing data or the ability to boot the server.

   Once Data Sentry is enabled or disabled for a Disk Array/2 and Disk Array/2 installation is complete, the setting cannot be changed.

   Data Sentry is always enabled with FT pairs.

10. **At the prompt "Install as New PDA (Y/N)? Y" press Enter to accept Y.**

    ▲ **All current data is removed from the drives.**

    You enter "N" and press Enter when you are *reinstalling* a PS/2 Server Disk Array/2. Reinstalling a Disk Array/2 preserves its data. However, the original Disk Array/2 parameters (drive order, striping factor, Data Sentry enable/disable) must be the same as when the drive was originally installed. This is explained in the section "Reinstalling a Disk Array/2" on page 5-32.

    You can press Escape to abort the process.

11. **Press F10 to confirm your entries.**

    The screen shown in Figure 5-8 is displayed.

12. **Enter the appropriate values for IDC slot, channel, SCSI ID, device bay number, and order number for the first member of the Disk Array/2.**

    You can enter the information for any one of the drives in the Disk Array/2. This drive is taken to be the first in the Disk Array/2's drive order, receiving data first as the data is distributed among the Disk Array/2 drives.

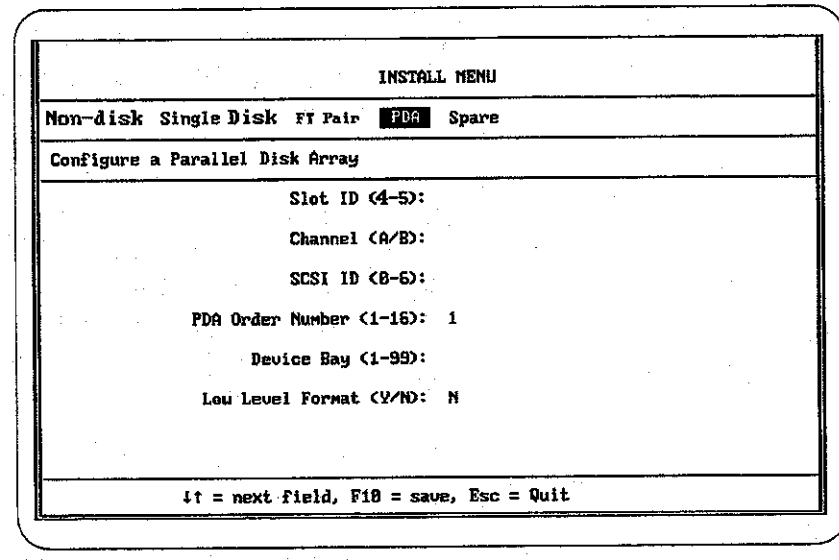


Figure 5-8
Installing a Disk Array/2 (screen #2)

Use the Enter key to move from field to field.

"PDA Order Number", which you enter for every drive, defines the order of the drives in the Disk Array/2. Disk space is allocated to the Disk Array/2 starting with the drive with the lowest PDA order number and ending with the drive with the highest order number. The first drive is number 1. As you add each drive, it is assigned the next number in sequence, but you can change drive order as you install each drive. To do so, simply change the order number of the drive you are installing to that of any previous number assigned so far.

Once Disk Array/2 installation is complete, you cannot change drive order.

- **If a drive in a Disk Array/2 fails and you want to replace it (this assumes that Data Sentry is enabled for the Disk Array/2), or you want to replace it for some other reason, the**

new drive is assigned the same order number. If you remove and replace the whole Disk Array/2, you must preserve drive order for the new Disk Array/2 to function. The reference disk and the PDAUTIL displays drive order.

- **If you attempt to reinstall a Disk Array/2 without knowing the drive order of the drives, you can use the "Recover SCSI" utility file called "RCVRSCSI" located on the Reference Diskette to determine the original drive order. This utility must be invoked at the DOS prompt (information on the RCVRSCSI utility is located on page 5-62).**

The "Drive ID" field is absent, since all drives in the array are assigned the same Drive ID.

If you do not know one or more of the values to be entered, check the server and determine the values by examining the labels on the drives (if labeled). Alternatively, press Escape and then select the Scan option. A list of all drives physically installed and responding is displayed. The drive you are configuring as part of a Disk Array/2 is included in the display, listed as "Not installed," with all the values you need to know for it to be included. However, any other uninstalled drives are listed as well, including the other drives to be members of the Disk Array/2. Therefore, if you use the Scan option to discover an unknown value for a drive, you must know enough about the drive to differentiate it from any other drives displayed. To display additional information about a drive, move the highlight bar to the drive on the Scan screen and press Enter.

When entering a value for "Bay number," note that bays are not labeled by the manufacturer. The bay-numbering scheme used for devices installed at the factory assumes that half-bays are numbered 1 through 10, starting at the top. The bay-location number you enter is a "comment-type" value. The server does not verify it. If you choose to use your own bay numbering scheme, ensure that the location value you enter is correct, according to your scheme.

13. **If desired, select the low-level format option.**

You might select the format option at this time for diagnostic purposes, if you have reason to doubt the integrity of the drive.

The formatting is done after you have entered all information about all drives to be in the Disk Array/2. The process takes from fifteen to twenty minutes for each 400 MB disk drive to be formatted, or thirty-five to fifty minutes for each 1 GB drive.

▲ **Warning: Formatting a drive permanently removes all data from it. However, if the drive was "factory-qualified," the reference disk still recognizes that fact after the format. (A drive must be factory-qualified to be in a Disk Array/2.)**

To cause the drive to be formatted during installation, type "y" at the prompt "Low-level format?"

If the drive is currently formatted, a warning screen is displayed before the formatting begins. In response to the warning message, you press any key other than Escape (<Esc>) to continue.

14. **After filling out the screen as desired, press F10.**

15. **Repeat steps 12 through 14 for the next drive to be included.**

After you have entered the desired information for the final drive in the array and pressed F10, a Disk Array/2 configuration summary screen is displayed.

Press any key but Escape and the Disk Array/2 is installed.

Any low-level formatting is performed at this time. One warning message is displayed, regardless of the number of drives to be formatted. A screen display indicates which drive is currently being formatted.

Installation of a Disk Array/2 with no Data Sentry and no formatting completes in several seconds. Installation of a RAID–5 compatible Disk Array/2 takes longer. A four-drive Disk Array/2 installation

using 400 MB drives takes between one-and-a-half and two hours without formatting.

Formatting adds twenty to thirty minutes per drive.

- **If the reference disk detects that the Disk Array/2 member drives have different characteristics than when originally configured, you are prompted to choose between low-level formatting all drives in the array or aborting the installation process (formatting may or may not correct the problem).**

16. **If desired, adjust the memory buffer size for the Disk Array/2.**

    Refer to page 5-28 for the procedure.

17. **To check the new configuration after the installation is complete, select View from the SCSI Subsystem screen.**

18. **Press Escape until you exit the program and the server restarts.**

Setting up a boot drive

Set up a Disk Array/2 as a boot disk just as you would a single drive. The Disk Array/2 should be set up with the Drive ID 1. Install DOS on the C: drive (primary DOS partition) and other desired system software in the usual way.

Installing Disk Array/2 Software

- **This procedure must be done after installing DOS on the C: partition.**

1. **Use the DISKCOPY function to make a duplicate copy of the NetWare SYSTEM-2 diskette.**

2. **Insert the IBM PS/2 Server Orthogonal RAID–5 Disk Array/2 diskette in drive A: and reboot the system.**

3. **Type "NWINST" to start the NetWare installation program.**

4. **When prompted, insert the NetWare SYSTEM –2 diskette copy (the one that was made in step 1).**

   NetWare starts and continues with the installation and configuration process. Refer to the NetWare Installation manual and Chapter 2 for more details.

When the installation procedure is complete, the following PS/2 Server NetWare support modules will be installed in C:\NETWARE:

- AS2DD.DSK - SCSI disk driver
- AS2EXTS.NLM - system interface software
- AS2SCSI.NLM - SCSI interface library
- PDAUTIL.NLM - PDA management utility

All other NetWare system software modules required to load NetWare are also installed in C:\NETWARE.

The following lines have been added to STARTUP.NCF (located in C:\NETWARE):

```
LOAD AS2DD.DSK
```

The following lines have been added to AUTOEXEC.NCF (located in SYS:SYSTEM):

```
LOAD C:\NETWARE\AS2EXTS
LOAD C:\NETWARE\AS2SCSI
LOAD C:\NETWARE\PDAUTIL
```

If installing Disk Array/2 software on a system where the NetWare Extensions have already been installed, use the "upgrade" function in NWINST instead of the "install" function. This procedure will copy the Disk Array/2 software modules to C:\NETWARE. It does not, however, make any changes to AUTOEXEC.NCF. Use INSTALL.NLM to edit AUTOEXEC.NCF. Add commands to load both AS2SCSI.NLM and

PDAUTIL.NLM. Place both of these commands after the command used to load AS2EXTS.NLM.

▲ **Warning: Always make sure that PDAUTIL.NLM is loaded if your system is configured with Disk Array/2. Although your system will appear to operate without PDAUTIL loaded, disk failures will not be handled correctly and may result in loss of data.**

Setting up a spare drive for a Data Sentry Disk Array/2

You can install and set up one or more spare drives in the server. These drives remain inactive until a Data Sentry Disk Array/2 drive fails. If such a drive fails, PDAUTIL can swap in a spare drive of the same make, model, and formatted capacity automatically. No data is lost.

If an individual drive or non-Data Sentry Disk Array/2 drive fails, you must remove a spare drive from the system and then reinstall it into the system to replace the failed drive using the reference disk. However, any data on the drive is lost.

For more information on the replacement of a failed drive, refer to the section "Replacing a drive in a Disk Array/2" on page 5-36.

You can set up a spare drive in the following ways:

- By running the reference disk. To do so, from the main menu select in order:
  - SCSI Subsystem
  - Install
  - Spare

  Fill out the display screen as desired. No Drive ID or PDA order number is required, since the spare drive will acquire the Drive ID and PDA order number of the Disk Array/2 member drive it replaces.

Press F10 to set up the drive.

- By using the PDAUTIL Configure menu. You use the "Add Spare" disk menu option to insert a spare drive into an empty hot-insertion carrier module already cabled in the server, *while the server is running*. Refer to the sections on the PDAUTIL menus starting on page 5-56.

▲ **Warnings: Use a spare only into a IBM half-height hot-insertion carrier module already cabled to the server.**

When adding a spare drive, PDAUTIL will inhibit disk I/O traffic to any drive located on the same SCSI channel as the drive that is being added. Do not use PDAUTIL to install a spare drive during the hours of peak server usage. Install the drive when the system is lightly loaded. Minimize the impact of this procedure on the system and avoid potential problems by freeing the SCSI channel as quickly as possible.

Backing up the current disk drive configuration

You can copy the CMOS drive-topology information to a reference diskette file. This is the information displayed by the View option. You do this to ease reconfiguration if CMOS is corrupted, or to restore your topological configuration after incorrectly installing, removing, or changing disk drive information using one or more Disk Subsystem options. Note that the Configuration Automatic, Backup, and Restore options do not operate on the SCSI subsystem.

To back up the current drive configuration, do the following:

1. **From the main menu, select SCSI Subsystem.**

2. **Select Backup.**

   You are prompted to insert the reference disk. Do so if the diskette is not already in place, and press Enter to continue. The current drive configuration is copied to the file DISKCONF.PTL.

Managing the Disk Array/2

You use the reference disk, NetWare, and PDAUTIL to manage the Disk Array/2s installed in PS/2 Server computers.

Use the reference disk for the following Disk Array/2 maintenance operations, which are described in this chapter:

- Change the PDA memory buffer allocation
- Remove a Disk Array/2
- Reinstall a Disk Array/2
- Replace or move an active or spare drive in a Disk Array/2
- Change a Disk Array/2 Drive ID
- Verify the consistency of Data Sentry information on Disk Array/2 drive members and optionally repair inconsistencies

Refer to Table 5-1 for a comparison of reference diskette functions when applied to single drives, Disk Array/2s, and Disk Array/2 drive members.

Use NetWare to configure the drives with NetWare 386 partitions and **use the PDAUTIL** to do the following while the server is running NetWare and application software:

- Add a spare drive to the server, for use by the PDAUTIL as a replacement if a drive fails
- Replace a failed PDA member drive and rebuild the Disk Array/2
- Verify the consistency of Data Sentry information on Disk Array/2 drive members and optionally repair inconsistencies
- Display spare drives and failed Disk Array/2 drive members

Table 5-1
Reference-disk SCSI Subsystem functions for individual drives, spares, and PDAs

SCSI Subsystem Option	Single drive	PDA	PDA drive member	PDA spare
Install	Yes	Yes	No. Install individual drives as part of PDA installation.	Yes
Remove	Yes	Yes	No	Yes
Change	Yes	No. Remove and reinstall the PDA, making required changes on the reinstallation.	Yes, if Data Sentry is enabled. Only one drive can be replaced at a time, and all other drives must be operational.	No
View	Displays single drive information	Displays PDA information: number of drives, Data Sentry, striping factor, capacity.	Displays single drive information, including drive order	Yes
Scan	Displays single drive information	No	Displays single drive information; no PDA information.	Yes

❖ **NOTE: Disk Array/2 drives as well as FT Pairs are identified as PDAs in all PDAUTIL messages and menu screens.**

You can display Disk Array/2 information via the PDAUTIL by selecting the PDA Disk window and cycling through the currently installed PDAs. Information about PDAUTIL is provided on page 5-46.

Changing the memory allocation

The server uses 2 MB of memory as buffer space for the first Disk Array/2 installed. The server assigns 1 MB buffer space to each additional Disk Array/2 installed. Refer to "Memory allocation" on page 5-7 for more information.

You can use the reference disk to change PDA buffer size. You would change PDA buffer size to improve performance in the following areas:

- disk writes
- PDA recovery
- PDA verify and rebuild operations

▲ **Do not allocate less than 2 MB of PDA buffer for the first Disk Array/2, or 1 MB for subsequent Disk Array/2s, or disk performance may suffer.**

To change the PDA buffer size using the reference disk, do the following:

1. **From the reference diskette main menu, select Feature Control.**
2. **Select Memory Allocation.**
3. **Adjust the PDA Buffer Size field using the up and down arrow keys, and press F10 to save the new value.**
4. **To check the new configuration after the installation is complete, select View from the SCSI Subsystem screen.**

Removing a Disk Array/2

You can remove a Disk Array/2 from the server and then do any of the following:

- Reinstall the PDA drives as individual drives
- Reinstall the PDA in a different server with its current data intact
- Reinstall the drives as a new Disk Array/2

In each of these cases, you begin by logically removing the PDA from the server configuration using the reference disk. This section describes how to do so.

The procedure provided logically disconnects the Disk Array/2 from the server while leaving it physically installed. A logically-disconnected set of drives is invisible to the operating system. The reference diskette Scan option lists the drives; the View option does not.

If you want to convert a Disk Array/2 to a collection of individual drives, you logically remove the Disk Array/2 and then logically reinstall the drives using the reference disk. "Removing" a Disk Array/2 does not simply, of itself, convert the array into a collection of individual drives; instead, it logically removes all the array drives from CMOS.

- **To use the PDA members as individual drives, you need to remove any partitions set up while the drives are configured as part of a PDA. Use DOS FDISK to delete the partitions *before* you use the reference disk to remove the drives. Do not do this if you are planning to reinstall the Disk Array/2 at a later time, since FDISK destroys all data contained on the drives when the partition is deleted.**

- **You preserve the data on Disk Array/2 drives only when you logically remove and then reinstall the Disk Array/2 with the same striping factor and drive order. Converting an array to individual drives, enabling or disabling Data Sentry, changing**

drive order or the number of drives, or changing the striping factor results in the loss of all data on the drives.

You can change but cannot remove individual drives from a Disk Array/2. Note, however, that the reference diskette Change function is for use when you are replacing a faulty drive in a Disk Array/2 set up with Data Sentry enabled. All other drives in the Disk Array/2 must be fully operational. The contents of the drive being replaced are initialized according to the contents of the other Disk Array/2 members. This is a lengthy procedure, the duration of which depends upon the size of the drive and the number of drives in the Disk Array/2. It typically takes a little longer to replace a Disk Array/2 member and rebuild the Disk Array/2 than to install a new Disk Array/2. For example, rebuilding a 400 MB drive configured as part of a four-drive Disk Array/2 takes between one-and-a-half and two hours when using the reference disk.

- **To relocate a Disk Array/2 or individual drives within a PDA, do not use the Change function. Instead, logically remove and reinstall the PDA as an existing PDA.**

Installing, removing, or changing the Drive ID of a Disk Array/2 without calculating the effect of the change on logical drive letters may cause problems, since the server setup may no longer be valid. Refer to "Drive identification" in Chapter 2 in the *PS/2 Server 195/295 Hardware Reference Manual.*

To remove a Disk Array/2, do the following:

1. **From the reference disk main menu, select SCSI Subsystem.**

2. **From the SCSI Subsystem screen select Remove.**

   The current configuration of system fixed disk drives is displayed. The drives are listed as "Not responding" if you have physically removed them.

3. **Move the highlight bar to the PDA to be logically removed and press Enter.**

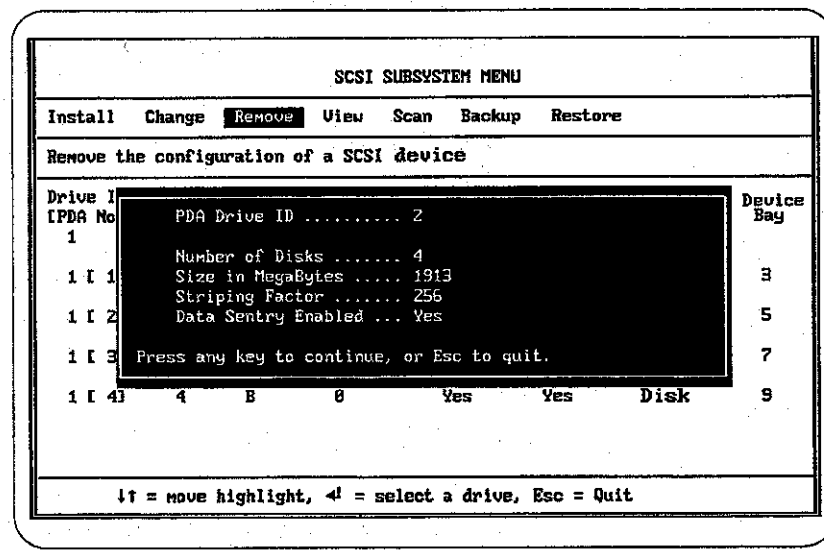


Figure 5-9
Removing a PDA

Highlight the PDA title line, not one of the PDA drives. You cannot remove a single member drive of a PDA, since data and Data Sentry information is spread evenly over all Disk Array/2 drives.

A screen of information about the PDA is displayed (Figure 5-9).

4. **Press any key except Escape to remove the PDA drives; press Escape if you decide to abort the procedure.**

5. **If desired, adjust the memory buffer size for the Disk Array/2.**

   Memory used for PDA buffers is returned to unused memory if the PDA is removed and is then available to NetWare once the server is restarted. Reassign this memory using the procedure provided in "Changing the memory allocation" on page 5-28.

6. **From the SCSI Subsystem screen, select View.**

Confirm that the Disk Array/2 has been removed as expected (it should not be listed in the display). Note the new assignment of drive IDs to the remaining drives and Disk Array/2s.

7. **Exit from the reference disk by pressing Escape until you reboot the system.**

8. **If desired, physically remove the Disk Array/2 drive members from the server according to the instructions in Chapter 3 in the *PS/2 Server 195/295 Hardware Reference Manual.***

Reinstalling a Disk Array/2

To reinstall a Disk Array/2, you physically install the Disk Array/2 drive members as desired in the server and use the reference disk to set up the Disk Array/2. The drives do not need to maintain the physical IDs (IDC, channel, and SCSI ID) that they had before, but they do need to maintain the same drive order. You specify the drive order when setting up the drives using the reference disk.

Reinstalling a Disk Array/2 using the reference disk is a "non-destructive process." The drives are not reformatted and no data is lost from them.

At the prompt "Install as New PDA (Y/N)?, enter "n" and press Enter. The Disk Array/2 is reinstalled with the original drive order, Data Sentry setting, striping factor, and data maintained. No low-level formatting or Data Sentry reinitialization takes place.

▲ **Entering "y" to the prompt causes the reference disk to remove all current data from the Disk Array/2 drive members.**

To configure a Disk Array/2 into server CMOS—to logically reinstall the Disk Array/2 after physically installing the drives, if necessary—do the following:

1. **Start the server with the reference disk inserted in drive A:.**

2. **From the main menu, select SCSI Subsystem.**

3. **From the SCSI Subsystem screen, select Install.**

4. **From Install, select PDA. If re-installing an FT pair, select "FT pair" instead of "PDA".**

   The Disk Array/2 Install screen is displayed (Figure 5-8 on page 5-19) and the next available Drive ID is displayed as the default. In the figure, the next available Drive ID is 3.

5. **Enter the number of drives that you intend to configure into this PDA (this is not necessary in the case of FT pairs).**

6. **Decide which Drive ID number you want the reference disk to assign to the new Disk Array/2 (all drives in a Disk Array/2 are assigned the same Drive ID.**

   The Drive ID must be one of the IDs already in use or the next ID in sequence.

   If the Disk Array/2 is to be the boot drive, it will require the Drive ID 1.

7. **Enter the array's original striping factor.**

8. **Enable Data Sentry for the Disk Array/2 if it was enabled for the original array (this is not necessary with FT pairs).**

9. **At the prompt "Install as New PDA (Y/N)? Y" type N.**

   ▲ **Warning: Selecting "Y" (the default) will cause all data on the Disk Array/2 to be removed.**

10. **Press F10 to confirm your entries.**

    The screen shown in Figure 5-9 is displayed.

11. **Enter the appropriate values for IDC slot, channel, SCSI ID, device bay number, and order number for the first member of the Disk Array/2.**

You can enter the information for any one of the drives in the Disk Array/2. IDC slot, channel, SCSI ID, device bay number can change from the values used for the original array. The drive order number for the drive cannot change—the drive order number for each drive must be the same as the original Disk Array/2.

Use the Enter key to move from field to field.

If you do not know one or more of the values to be entered, check the server and determine the values by examining the labels on the drives (if labeled). Alternatively, you can use the "Recover SCSI" (RCVRSCSI) program on the reference diskette to copy IDC-controlled disk device configuration(s) back to CMOS memory. The RCVRSCSI utility can be used to quickly examine the original disk drive configuration(s) if you lost track of PDA drive orders during installation (removal and replacing PDAs).

When entering a value for "Bay number," note that bays are not labeled by the manufacturer. The bay-numbering scheme used for devices installed at the factory assumes that half-bays are numbered 1 through 10, starting at the top. The bay-location number you enter is a "comment-type" value. The server does not verify it. If you choose to use your own bay numbering scheme, ensure that the location value you enter is correct, according to your scheme.

▲ **Do not select the low-level format option. Low-level formatting will destroy all existing information on your Diak Array/2.**

12. **After filling out the screen as desired, press F10 and confirm your desire to set up a Disk Array/2 on the screen displayed.**

13. **Repeat steps 11 and 12 for the next drive to be included.**

After you have entered the desired information for the final drive in the array and pressed F10, a Disk Array/2 configuration summary screen is displayed is displayed.

Press any key but Escape and the Disk Array/2 is installed.

14. **If desired, adjust the memory buffer size for the Disk Array/2.**

    Refer to page 5-28 for the procedure.

15. **To check the new configuration after the installation is complete, select View from the SCSI Subsystem screen.**

16. **Press Escape until you exit the program and the server restarts.**

Replacing a drive in a Disk Array/2

You can replace one, and only one, Data Sentry Disk Array/2 drive at a time. You would do this when a Disk Array/2 drive fails and no spare drive of the proper type is available.

You can replace a drive while the server continues to run (hot replacement) or when the server is powered down (cold replacement).

Spare drive replacement

If a Data Sentry Disk Array/2 drive member fails, and all other drive members are operational, and a suitable spare is set up in the server, you can replace the failed drive with no loss of data. The conversion of a spare drive to Disk Array/2 drive member and subsequent build of the Disk Array/2 is reflected on the PDAUTIL screen. The screen also displays the progress of the rebuild process (percent done).

The contents of the drive being replaced are initialized according to the contents of the other Disk Array/2 members. This is a lengthy procedure, the duration of which depends upon the size of the drive and the number of drives in the Disk Array/2. Twenty minutes is typical for a four-drive Disk Array/2 (400-MB drives) in a non-active or lightly loaded server.

Performance is initially degraded by the loss of the Disk Array/2 drive. As each new block of the replacement drive is initialized, it can be used by the system immediately, so that performance increases evenly until the Disk Array/2 is fully rebuilt.

Replacing a drive while the server is running

This section provides a procedure to do the following: with the server running, install a replacement drive, configure it into CMOS as the replacement drive for a failed Disk Array/2 drive, and rebuild the Disk Array/2. The procedure assumes that no spare drive of the same make, model, and formatted capacity as the failed drive is set up in the server, and that the failed drive resides in a hot-extraction/insertion carrier module. If a spare of the same formatted capacity was set up in the server when the drive failed, a replacement can occur via the PDAUTIL.

This procedure can apply to all Disk Array/2s—that is, if drives have failed in more than one Disk Array/2, this procedure can cause all Disk Array/2s to be checked and all failed drives to be replaced. Replacement is performed sequentially, not concurrently.

When you are replacing a faulty drive in a Disk Array/2 set up with Data Sentry enabled, all other drives in the Disk Array/2 must be fully operational. The contents of the drive being replaced are initialized according to the contents of the other Disk Array/2 members. This is a lengthy procedure, the duration of which depends upon the size of the drive and the number of drives in the Disk Array/2. Twenty minutes is typical for a four-drive Disk Array/2 (400-MB drives) in a quiet server.

When you are replacing a failed drive by removing it and inserting a drive in its place, the failed drive must reside in a hot-extraction/insertion carrier module. The server should be relatively quiet, since the SCSI bus servicing the drive will be shut down during the replacement operation.

1. **When switching drives, turn off the lock/power key on the carrier module of the failed drive (Figure 5-10).**

   The key should be turned to a horizontal position.

   ▲ **Warnings: Do not turn off the key on the wrong drive. Turning off the key on a drive on an active SCSI channel can damage the drive and cause data loss.**

   Never attempt to remove a drive that is not housed in a hot-extraction/insertion carrier module, when power is on in the server.

   PDAUTIL will inhibit disk I/O traffic to any drive located on the same SCSI channel as the drive that is being replaced. Do not replace a failed Disk Array/2 drive during peak hours. Install the drive when the system is lightly loaded. Minimize the impact of this procedure on the system and avoid potential problems by freeing the SCSI channel as quickly as possible.

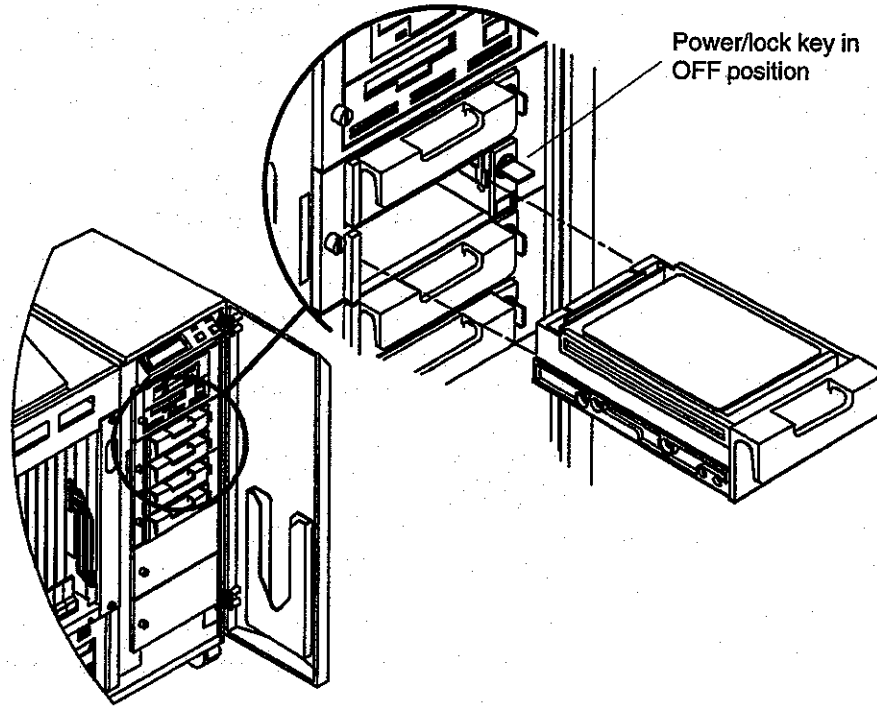


Figure 5-10
Removing a drive

2. **Swap in a new drive and turn on the lock/power key.**

   The drive must be at least as large as the failed drive (and all other drives in the Disk Array/2), and must be provided by IBM.

3. **Press the Enter key when the new drive is installed.**

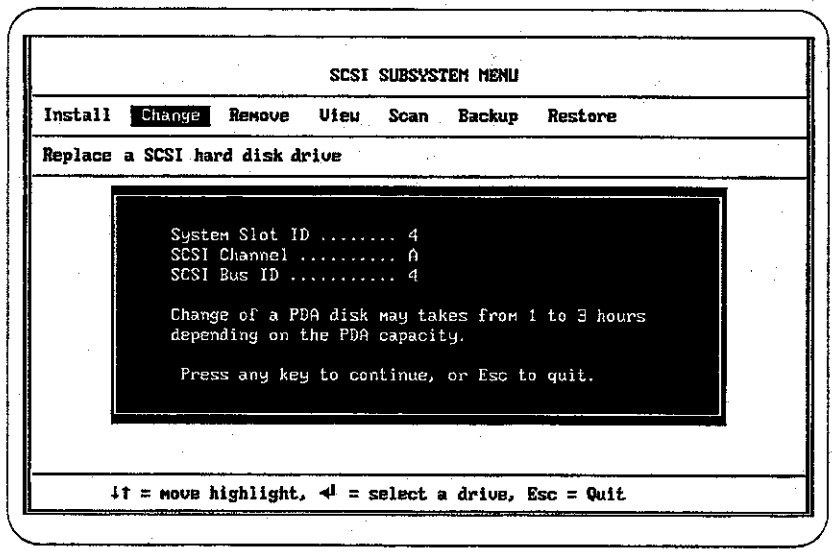


Figure 5-11
Replacing a Disk Array/2

Replacing a drive using the reference disk

To configure a replaced Disk Array/2 drive into CMOS using the reference disk instead of PDAUTIL, do the following:

1. **From the reference disk main menu, select SCSI Subsystem.**

2. **Select Change.**

   A warning message about the time it takes to make the change is displayed (Figure 5-11).

3. **Move the highlight bar to the drive to be replaced and press Enter.**

   A warning message is displayed. Press any key other than Escape to continue.

   A screen of information about the drive is displayed (Figure 5-12).

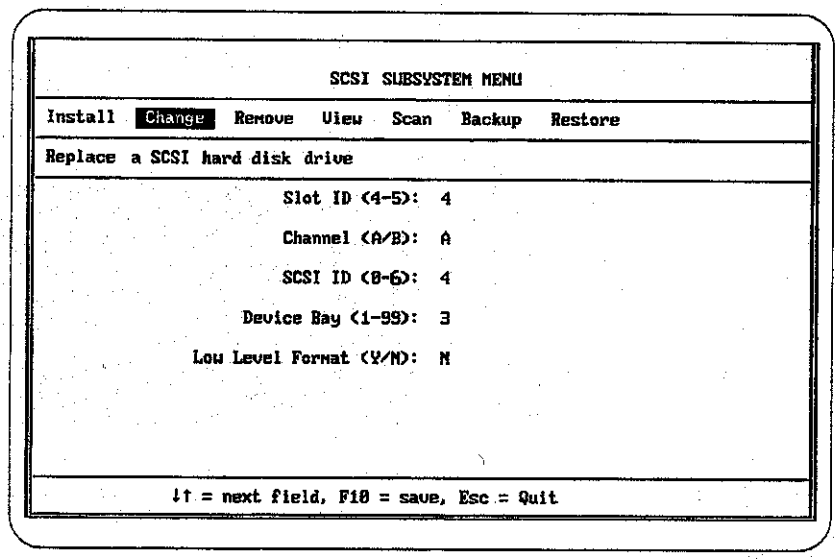


Figure 5-12
Replacing a PDA

For a replaced drive in the same physical location in the drive cabling topology, the values displayed should remain unchanged (with the exception of the bay number, which can change).

4. **Make any necessary changes to the values displayed for the replacement drive that is located at a different place in the cabling topology.**

5. **If desired, select the option to low-level format the drive.**

   You might use the format option at this time for diagnostic purposes, if you have reason to doubt the integrity of the drive.

   ▲ **Warning: Formatting a drive permanently removes any information on it. However, this will happen anyway as Disk Array/2 data and Data Sentry information is placed on the drive.**

To cause the drive to be formatted during the change process, type "y" at the prompt "Low-level format?"

- **The formatting process takes from fifteen to twenty minutes for a 400-MB disk drive.**

6. **Press F10 after filling out the screen as desired.**

   A screen of information about the drive is displayed, including any values you have just changed.

7. **Press any key but Escape to cause the change to proceed; press Escape to abort the process.**

   The new drive information is configured into CMOS and the replaced drive is configured into the Disk Array/2.

   This process takes longer than Disk Array/2 installation. For example, configuration can take close to three hours for a IBM 1 GByte drive in a four-drive Disk Array/2.

8. **To check the new configuration, select View from the SCSI Subsystem screen.**

9. **Exit from the reference disk by pressing Escape until you reach the DOS prompt.**

Moving a drive in a Disk Array/2

You can physically and logically move any of the current member drives of a Disk Array/2. You might do this to distribute drives over channels and IDCs to improve performance. The procedure to logically move a drive assumes that you have physically moved the drive according to the instructions in Chapter 3 *in the PS/2 Server 195/295 Hardware Reference Manual.*

To logically move a drive, deinstall and reinstall the Disk Array/2 as described in this chapter, entering the desired changes during reinstallation. When reinstalling drives, make sure that the same order is kept or information on your DiSk Arra/2 is going to be lost.

Removing a spare drive

If you want to change a spare drive in the server to an active individual drive, or remove the spare drive for use elsewhere, you must first logically remove the drive from the set of spares.

There are two ways to remove a spare drive:

- Use the PDAUTIL option to remove a spare while the server is operational, or
- Use the reference disk (this requires shutting down NetWare).

To remove a spare drive while the server is operational, use the PDAUTIL Configure menu and select Delete Spare Drive.

To remove the spare using the reference disk, follow this procedure:

1. **Issue the appropriate warnings to users, shut down the network and operating system, and reboot the server with the reference disk inserted in drive A:.**
2. **From the reference disk main menu, select SCSI Subsystem.**
3. **From the SCSI Subsystem screen select Remove.**

   The current configuration of system fixed disk drives is displayed. The configuration includes the fixed disk drive you want to remove.
4. **Select the disk drive to be logically removed and press Enter.**

   A screen of information about the disk drive is displayed.

5. **Press any key except Escape to remove the disk drive; press Escape if you decide to abort the procedure.**

6. **Exit the reference-disk program, power down the server, and physically remove the drive according to the instructions provided in Chapter 3 in the *PS/2 Server 195/295 Hardware Reference Manual.***

Replacing a spare drive

To replace a spare drive and rebuild a Disk Array/2, start the server using the reference disk. Use the SCSI Subsystem Remove option to remove the spare drive to be replaced. Use the SCSI subsystem's Install Spare option to set up the replacement drive.

You can use PDAUTIL to replace a spare drive by using the PDAUTIL Configure menu and "Add Spare Drive" option to add a spare drive after first deleting the existing one from the "Delete Spare Drive" option.

Changing a Disk Array/2 Drive ID

To change a Disk Array/2 Drive ID, you deinstall and then reinstall the Disk Array/2, making the change to the ID during the reinstallation. You might do this, for example, if you have installed a Disk Array/2 and want it to serve as your boot drive.

To change a Disk Array/2 Drive ID, you need to deinstall the Disk Array/2 from the current configuration using the reference disk's Remove option, and then add it again using the Install option.

▲ **When you reinstall a Disk Array/2 while changing its Drive ID, you must type "N" in response to the prompt "Install as New PDA (Y/N)? Y" or all Disk Array/2 data will be lost.**

The changes to the overall order of drive IDs and drive letters caused when you change a Disk Array/2 Drive ID are described in "Drive identification" in Chapter 2 in the *PS/2 Server 195/295 Hardware Reference Manual.*

Verifying data integrity

If a server configured with a Data Sentry Disk Array/2 is shut down abnormally, or if CMOS has been corrupted and repaired, the Disk Array/2 may develop inconsistencies between the data contained on the drives and the Data Sentry information used to maintain data integrity in the Disk Array/2. These inconsistencies may prevent the server from reconstructing the Disk Array/2 correctly should a drive in the Disk Array/2 fail. For this reason, the Disk Array/2 software automatically verifies Data Sentry consistency at startup following any abnormal server shutdown or incidence of corrupted CMOS, repairing any inconsistencies found. The process is carried out in the background at a lowered priority, so that the impact on server performance is minimized. You use PDAUTIL to check progress of the Verify operation. After the process is complete, the beginning and ending times are recorded in the event log.

If a Disk Array/2 that is being verified and repaired does in fact contain inconsistencies, and you should sustain an error in an area of inconsistency before it is repaired, the data affected would not be protected by Data Sentry.

You can also check a Data Sentry Disk Array/2 for consistency, in either of two ways:

- Select the PDAUTIL Verify menu, as shown in Figure 5-14, to check the integrity of data on the selected PDA or all PDAs. The results are displayed in a window located at the bottom right-hand portion of the screen shown in Figure 5 -14.

  On a quiet system, verifications requires about twenty minutes for a four-drive Disk Array/2 using 400-MB drives.

- On the reference disk's SCSI Subsystem View screen, select the Disk Array/2 to be verified and use the Verify Integrity or Correct Integrity function.

  When run on the reference disk, verification and optional correction takes about as long as the original Disk Array/2 installation.

❖ **Verification of Disk Array/2 integrity is a function of the PS/2 Server disk subsystem and not of the NetWare file system. The Disk Array/2 verify function fixes discrepancies between data on the drives and the redundant information maintained in Data Sentry blocks. Should the NetWare file system become inconsistent as a result of a server malfunction, the problem is with the data itself and not with Data Sentry. Consequently, it is still necessary to run VREPAIR to attempt to recover the file system information that was lost.**

Disk Array/2 Management Utility (PDAUTIL)

IBM's NetWare extensions software consists of the PDA Utility NetWare Loadable Module (NLM) which runs under NetWare. The PDAUTIL screen is shown in Figure 5-13.

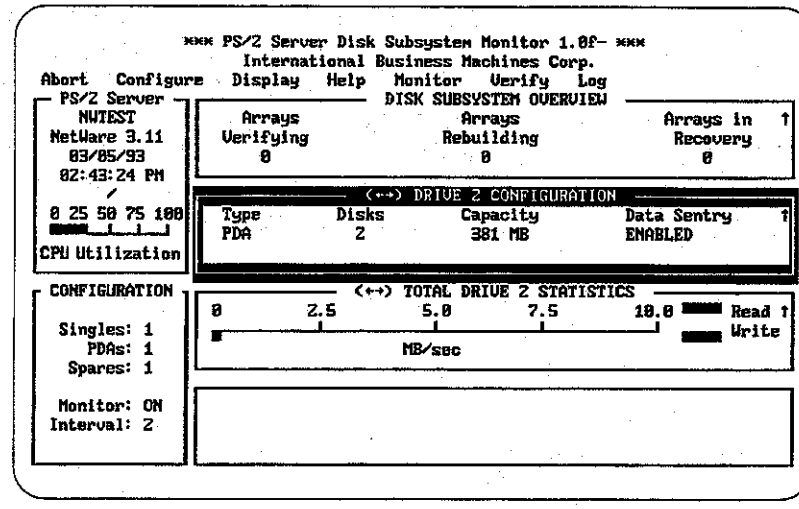


Figure 5-13
PDAUTIL screen

PDAUTIL is a utility provided with the NetWare Orthogonal RAID-5 Disk Array/2 software. PDAUTIL provides facilities that allow you to do the following:

- Add a spare drive to the server, for use as a replacement if a drive fails
- Replace a failed Disk Array/2 member and rebuild the Disk Array/2
- Display single, PDA, and spare drives. Report information on failed Disk Array/2 drive members

- Verify the consistency of Disk Array/2 Data Sentry information on Disk Array/2 drive members and optionally repair inconsistencies

The window screens for each mode is provided in this section. The complete procedures for accomplishing the tasks listed above are provided in the sections that follow.

Error and information messages are listed in Chapter 7.

❖ **PDAUTIL reports disk subsystem information only. If the NetWare file system is used to combine multiple drives to implement disk mirroring, disk duplexing, or a RAID-0 array, these drives are still reported as individual drives by PDAUTIL.**

The PDAUTIL screen has six (6) windows, two on the left side of the diplay and four (4) on the right. The two windows on the left side are used as follows:

- **PS/2 Server** – shows the server's name, NetWare version, date, time, a spinning system alive wheel (/), and a CPU utilization bar meter.

- **Configuration** – shows the number of single SCSI disk drives, PDAs, and spares configured in the disk subsystem. Additionally there are indicators for the PDAUTIL monitor status and the interval in seconds that a status update is performed.

The four windows on the right side are used as follows:

- **Disk Subsystem Overview** – shows the number of PDAs currently verified, rebuilt, or in recovery.

- **Drive *X* Configuration** – (where X is the selected drive or PDA) shows the type (single, PDA, or spare), the number of SCSI disks assigned, the total capacity in MBs, and the status of Data Sentry.

- **[Total] Drive *X* Statistics** – (where X is the selected drive or PDA) shows a bar meter indicating the total number of reads and writes to the disk in MB/second.

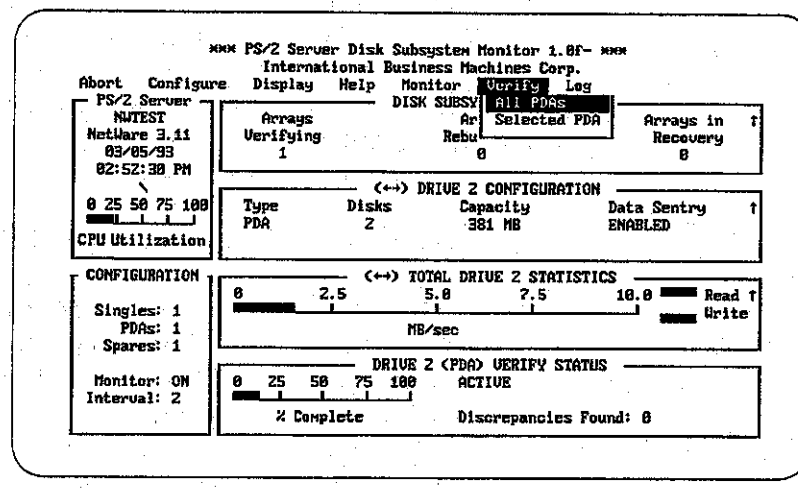


Figure 5-14
PDAUTIL screen indicating a verify in progress

- **Drive *X* (PDA) *Type* Verify (or Rebuild) Status** – (where X is the selected PDA) shows the status of the indicated operation on the PDA. If X is a single drive or if no status activities have been performed on the PDA, the window is blank. For example, in Figure 5-13, this window is blank because no Verify has been performed on drive 2.

In another example (Figure 5-14), all PDAs are being verified. The first 15% of the first (and only) array has completed with no discrepancies found. Note that the Disk Subsystem Overview window indicates a one (1) in the "arrays verifying" section. When the verify operation is complete, the Drive *X* (PDA) *Type* Verify Status window display updates and includes a COMPLETE message and a date and time stamp. This information is placed in an Event Log which may be examined at a later time (see Figure 5-29).

You may display statistics or configuration information for a different drive. Use the <Esc> key to toggle between the menu bar at the top of the PDAUTIL screen and the display windows. Pressing <Esc> does not exit

the program. If one of the display windows is highlighted, as shown in Figure 5-13, pressing the <Esc> key will switch focus to the menu bar. If, on the other hand, one of the menu options is highlighted (as shown in Figure 5-14), <Esc> will switch focus to one of the display windows. To select a different window, use the up and down arrow keys until the desired window is highlighted. Scroll indicators and exploded window indicators appear on windows when additional information is available.

Scroll Indicators - the scroll indicator (⇔) in the top left-hand corner of the Drive X Configuration and Drive X Statistics windows indicates additional information can be scrolled in the window. Use the right and left arrow keys to scroll the window. If the Drive Configuration window is highlighted, the left and right arrow keys select a different drive, PDA, or spare. Note that the Drive Statistics as well as the Drive Verify/Rebuild status scroll along with the Drive Configuration window. If the Drive Statistics window for a PDA is highlighted, the left and right arrow keys select Total PDA or individual member statistics.

Exploded Window Indicator - the up arrow (⇑) in the top right hand corner of the Disk Subsystem Overview, Drive X Configuration, and Total Drive X Statistics windows indicates that additional information can be viewed in an "exploded window". Use the Enter key to explode the window. The exploded window display can be collapsed by using the Enter or Escape keys.

Disk subsystem overview window

The disk subsystem overview window (Figure 5-15) reports current activity of verifies, rebuilds, and recoveries on all arrays. Note the up arrow in the top right hand corner indicates that additional information can be viewed in an exploded window.

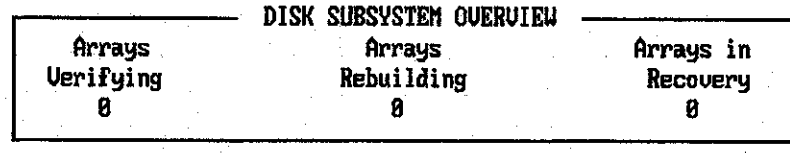


Figure 5-15
Disk subsystem overview window

- **Arrays verifying** - indicates how many PDAs are being checked for consistency of Disk Array/2 Data Sentry information.
- **Arrays rebuilding** - indicates how many PDAs are rebuilding. A PDA is rebuilding when a failed PDA drive member has been replaced with a new drive.
- **Arrays in recovery**- indicates how many PDAs are recovering data from other PDA drive member disk(s). A PDA is recovering if a read or write operation on a PDA drive member fails. In this case, the PDA starts to recover the data from the other PDA disk members.

Exploded disk subsystem overview window

The exploded disk window (Figure 5-16) shows all drives that are configured in the system. Information includes drive number, type, capacity, and status. The type field indicates three drive types: single, PDA, and spare. If your system includes a NetWare mirror pair it is viewed by PDAUTIL as two single drives. The values in the Capacity column indicate total drive capacity. Information in the Status column may indicate "OK", "In Recovery", "Rebuilding *nnn* with *nnn*", or "Verifying".

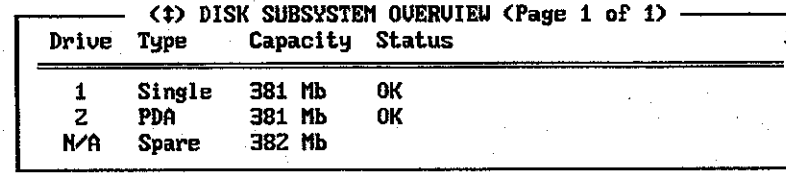


Figure 5-16
Exploded disk subsystem overview window

Drive configuration window

The drive configuration window selects a drive for viewing. In this example, Drive 2 (Figure 5-17) is a two disk PDA, each disk is 381 MB, and Data Sentry is enabled. Note the up arrow in the top right hand corner indicates additional information for the display is contained in an exploded window by pressing the Enter key. Also, note that the scroll indicator (⇔) indicates that more information can be displayed for other drives configured in the server (PDAs, Singles, or Spares) when the left and right arrow keys are pressed. Note that the Drive Statistics as well as the Drive Verify/Rebuild status scroll along with the Drive Configuration window.

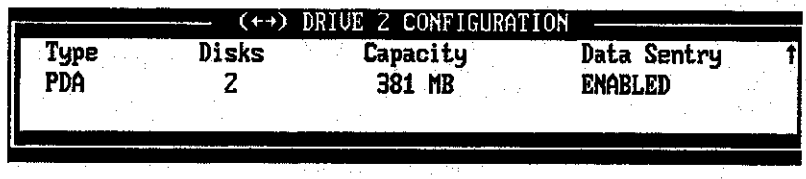


Figure 5-17
Drive configuration window

Exploded drive configuration window

The exploded drive configuration window is used to view the drive members in the selected PDA. In this example Drive 2 (Figure 5-18) shows that it is a two disk PDA, Data Sentry is enabled, and the striping factor is 512. Also, the member disks are connected to the IDC in slot 4, on channel A, and SCSI ID 2 physically located in (drive) bay 2 is the first disk in the array and that disk 5B1 in bay 8 is the second disk. Note that both disks in the array are the same types (capacity, vendor, and model).

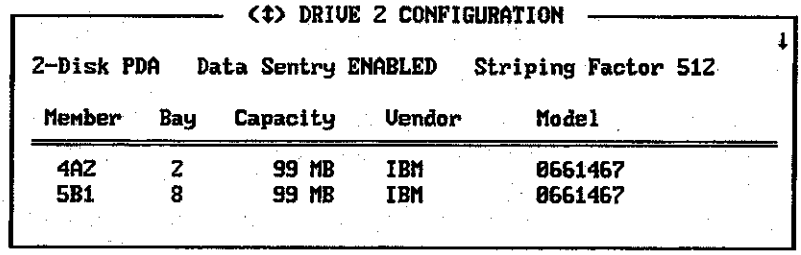


Figure 5-18
Exploded drive configuration window

Total drive statistics window

The total drive statisitics window (Figure 5-19) graphically displays the total drive activity (reads and writes) on the selected drive. The throughput value used in the graph can be changed by setting the value in the "adjust throughput graph" selection in the Display menu (see page 57). Note the up arrow in the top right hand corner indicates additional information on the selected drive is contained in an exploded window. Also, note that the scroll indicator (⇔) indicates that you can cycle through each disk in the array by pressing the left and right arrow keys.

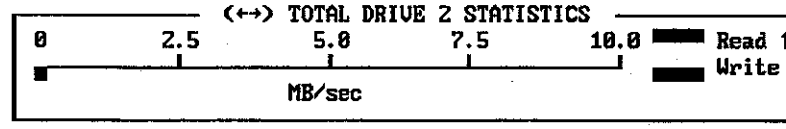


Figure 5-19
Total drive statistics window

Exploded total drive statistics window

The exploded total drive statistics window (Figure 5-20) shows the drive statistical data. This data includes requests, subrequests, blocks read and written, the average block size, and a histogram of blocks per transaction.

- **Requests** - indicates the total number of requests (reads and writes) issued to the drive.
- **Subrequests** - on PDAs, certain disk I/O requests will span more than one drive. If this is the case, each of these requests will be divided up into subrequests. This entry indicates the total number of subrequests as well as the percentage of requests that had to be divided up into subrequests.
- **Blocks Read** - indicates the total number of 512 byte disk blocks that have been read from this device (or PDA).

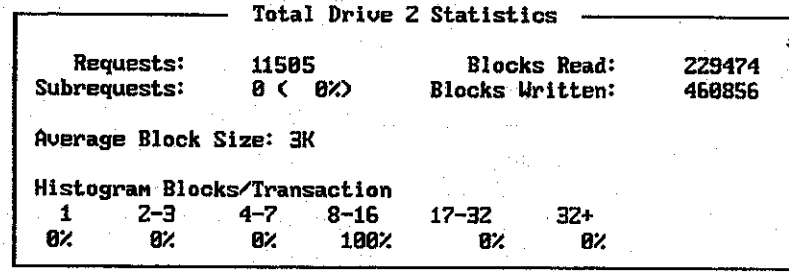


Figure 5-20
Exploded total drive statistics window

- **Blocks Written** - indicates the total number of 512 byte disk blocks that have been written to this device (or PDA).

- **Average Block Size** - indicates the average size of each disk I/O request.

- **Histogram Blocks/Transaction** - contains a breakdown of all disk I/O requests based on the number of 512 byte disk blocks transferred as part of the request. In most cases, the volume block size(s) selected for volumes located on the drive will affect a significant percentage of data transfer requests. A large number of 1-block requests may indicate a lot of directory searches or updates. A lot of large requests (32+ blocks) on a Disk Array/2 typically indicates that a verify or rebuild has taken place.

The PDAUTIL utility menus

The PDAUTIL has seven (7) menus used to control the PDAs and the PDAUTIL. These menu selections are listed across the top of the PDAUTIL main screen (see Figure 5-13) as:

- ✓ Abort
- ✓ Configure
- ✓ Display
- ✓ Help
- ✓ Monitor
- ✓ Verify
- ✓ Log

You may use the left and right arrow keys to highlight a different menu. Once the desired menu has been highlighted, type <Enter> to select it. You may then use the up and down arrow keys to highlight menu options. <Enter> indicates the desired action; <Esc> returns to the main menu.

Abort menu

Select the abort menu (Figure 5-21) when you need to stop verify activity on a selected PDA or on all PDAs.

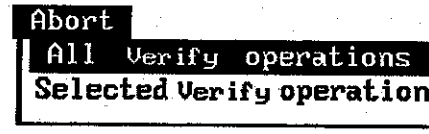


Figure 5-21
Abort menu

Configure menu

Select the configure menu (Figure 5-22) when you wish to activate a configured spare disk, add a disk to the spare list, or delete a disk from the spare list.

Figure 5-22
Configure menu

Add spare disk mode

When invoked, the add spare disk mode causes the utility to set up a new spare drive in the server. Spare drives may be used as a replacement if a Data Sentry Disk Array/2 drive fails.

Delete spare disk mode

When invoked, the delete spare disk mode causes the utility to remove a spare drive.

Replace mode

When invoked, the Replace mode causes the utility to replace a failed Data Sentry Disk Array/2 drive member with a spare drive with same SCSI ID.

Display menu

Select the display menu (Figure 5-23) when you wish to adjust the drive throughput graph (Figure 5-24) to change the settings for the PDAUTIL screen colors, reset to the default colors, or after changing the color to save them as the new program settings.

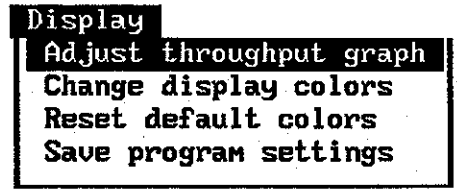


Figure 5-23
Display menu

Adjust throughput graph mode

The adjust throughput graph mode (Figure 5-24) is used to select the range in MB/sec that is used in the "total drive statistics" window display (Figure 5-19). The maximum graph throughput range is from 1 to 5 MBytes/sec.

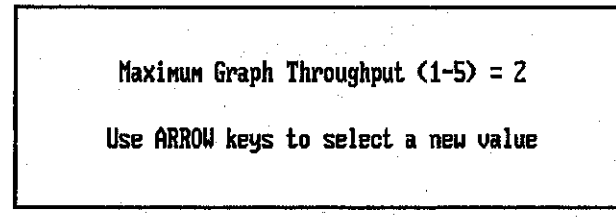


Figure 5-24
Adjust throughput graph window

Help menu

Select the help menu (Figure 5-25) to display help information about keyboard commands and the PDAUTIL program operation. Additional help is available by highlighting the menu or selection window and pressing <F1>.

Figure 5-25
Keyboard command help window

Keyboard commands

Select the keyboard commands option for a help screen of the keyboard commands supported by the PDAUTIL.

Program operation

Select the program operation option for a help screen of the program operations supported by the PDAUTIL.

Monitor menu

Select the monitor menu (Figure 5-26) to change the PDAUTIL monitor setting. Supported functions are to change the monitor interval (how often in seconds that the monitor queries the PDAs), enable and disable PDA monitoring, and save the program settings.

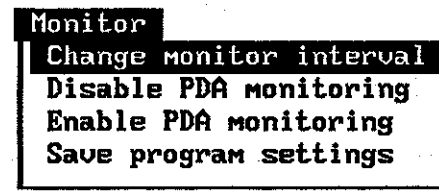


Figure 5-26
Monitor menu

If PDA monitoring is disabled, no action will be taken by PDAUTIL to rebuild the Disk Array/2, even if spares are configured in the system. Select the "Replace Disk" option form the "Configure" menu to start rebuilding the PDA using a new disk.

▲ **Warning: Disabling PDA monitoring will adversely effect the ability of the server to recover from drive failures. If you have installed spares in your system, never disable PDA monitoring for extended periods of time or if you plan to leave the system unattended.**

Verify menu

Select the verify menu (Figure 5-27) to check the integrity of data in the selected PDA or all PDAs. When a PDA is being verified, the bottom right-hand window on the PDAUTIL screen will display the verification progress. During verification selection, you can also select to repair or not to repair parity errors at a pop-up window. Use the left and right arrow keys to select between Yes or No.

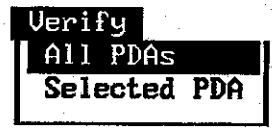


Figure 5-27
Verify menu

Log menu

The log menu (Figure 5-28) is used to display, backup, or clear the server's PDAUTIL event log file.

Figure 5-28
Log menu

Event Log

The event log (Figure 5-29) holds an historical record of disk subsystem events, in chronological order from the time that the server was started or from the last time that the log was cleared. The event log will contain a history of disk drive verification, rebuild and error status.

The log can be scrolled vertically, a page at a time (PgUp and PgDn keys) or one line at a time (by pressing the up and down arrow keys). The Home key will scroll the event log to the beginning of the log. The End key will scroll the log to the end of the log.

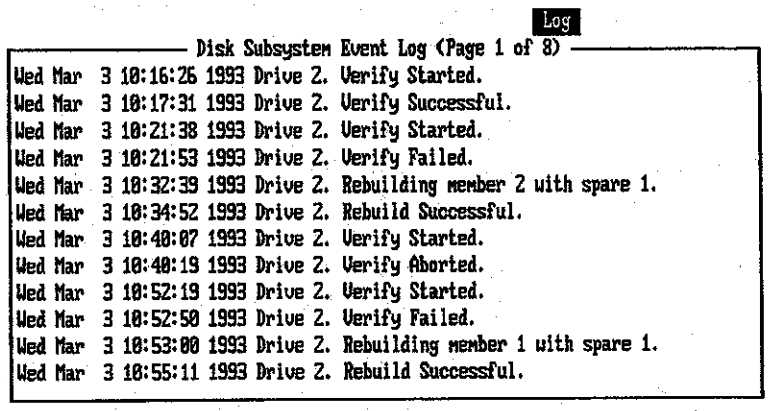


Figure 5-29
Event log example

The event log file is called "pdautil.log" and is located in SYS:SYSTEM. The pdautil.log file is an ASCII file that can be printed and read with most text editors.

- **Backup event log** - this option copies the event log file "pdautil.log" to "pdautil.bak" in SYS:SYSTEM.

- **Clear event log** - this option deletes the "pdautil.log" file.

As a system administrator, you may want certain users (i.e., SUPERVISOR) to automatically be notified, at their workstations, when a PS/2 Server PDA verification or rebuild is/or has taken place. You can do this by creating an ASCII text file called "notify.txt" in SYS:SYSTEM. When created, place all of the usernames (one line at a time) in this file of those users that you wish to be notified. When an event is reported in the event log file, a broadcast message will also be sent to the users listed in this file.

- **SCSI error messages placed in the event log will NOT be broadcasted.**

RCVRSCSI Utility

If the SCSI disk drive configuration stored in CMOS memory is lost or damaged, you use the the "Recover SCSI" (RCVRSCSI) program on the reference diskette to copy IDC-controlled disk device configuration(s) back to CMOS memory. The RCVRSCSI utility can also be used to quickly examine the original disk drive configuration(s) if you lost track of PDA drive orders during reinstallation (removal and replacing PDAs).

- **The RCVRSCI utility function is similar to the Restore utility from the SCSI Subsystem Menu. However, the Restore utility relies on the fact that you have initially backed-up disk drive configuration(s) by invoking the Backup utility.**

  If CMOS memory has become corrupted, use the Restore utility (from the SCSI Subsystem Menu) to regenerate disk drive configuration(s) to CMOS memory provided that you have backed up drive configurations with the Backup utility. Use the RCVRSCSI utility if you have *not* backed-up disk drive configuration(s) and CMOS becomes corrupted. The RCVRSCI utility can only be invoked from the DOS prompt (see the following section for RCVRSCSI program operation).

  The RCVRSCSI utility can only write to CMOS memory. It will not write to the IDC-controlled disk devices.

Using the RCVRSCSI utility

1. **Start the PS/2 Server with the Reference Diskette in the A: drive.**

2. **At the initial start-up screen, press the <ESC> key, once.**

3. **The server should exit to the DOS (A:) prompt.**

4. **At the prompt, type RCVRSCSI and press <ENTER>.**

   The initial RCVRSCSI utility start-up screen is composed of a copyright message and a message indicating that the program is searching for a disk. The program will read each disk device configuration information starting from the first disk device that it finds and will display a table summarizing all disk device configuration information that is retrieved.

   As each drive's configuration is retrieved, a consistency check is made to determine that the configuration parameters agree with what is stored in CMOS memory. This is followed by a prompt that asks if you want to reset CMOS disk configuration using the displayed disk device configuration. Answering (N) No, will cause the program to analyze another disk device. Answering (Y) Yes, will cause the program to write the disk device configuration into CMOS memory. This process will continue until all disk devices have reported.

   At the completion of the process, the program will return to the DOS prompt.

5. **Restart the PS/2 Server with the Reference Diskette in the A: drive.**

   - **Since the RCVRSCI utility does not write to the disk devices, if during startup, disk device configuration errors occur, the server may be assuming that a drive has been replaced or moved to a drive location formerly occupied by a different drive. Such a drive must be configured into the server using the Replace or Change option.**

Chapter 6: Troubleshooting

Troubleshooting

IBM PS/2 Server computers are designed for fault-tolerant operation. However, as with all high-performance systems, you may occasionally encounter problems with your server. This chapter lists the most common trouble symptoms and the problems most likely to cause them. The chapter describes the problems and explains the corrective actions that you take to remedy them. In addition, this chapter lists and describes the server's troubleshooting resources.

- **A description of troubleshooting at the board level is beyond the scope of this guide. Module and adapter problems are solved in this guide by swapping out the module or adapter. Contact your authorized service representative when confronting such a problem.**

Table 6-1 lists problems discussed elsewhere in this manual set.

Table 6-1
Problems discussed elsewhere

Problem or Procedure	Refer to
Lost password	Chapter 4 of this guide
Lost key	Your technical-support representative
Problems with server assembly	Chapter 2, *IBM PS/2 Server 195/295 Installation Guide*
Problems with server setup	Chapter 3, *IBM PS/2 Server 195/295 Installation Guide*
Problems with software installation	Chapter 4, *IBM PS/2 Server 195/295 Installation Guide*
Maintaining and tuning the server	Chapters 3 and 4 of this guide
Option installation and reconfiguration problems	*IBM PS/2 Server 195/295 Hardware Reference Manual*
Server response to error conditions	Chapter 7 of this guide
Lost PDA configuration	SCSI recover utility, Appendix B, *PS/2 Server 195/295 Hardware Reference Manual*

Correcting problems

In general, you become aware of a server problem in one of the following ways:

- Server halts, resets, or won't start.
- Server performance is degraded.
- Software on the server issues an alert to users or the system administrator, or displays and logs an error message. DOS, NetWare Extension/2, NetWare, and application programs can all issue such messages.

When multiple startup errors occur, you might find it most convenient to use the reference diskette and set the system recovery level to "Stop on all errors," allowing you to note errors one-by-one as they are encountered.

Server problem groups

This guide groups server problems in the following way:

1. Software halts system (applications or operating system) (page 6-6)
2. Performance problems (server slows down) (page 6-6)
3. Cabling and seating problems (page 6-6)
4. Startup or reboot failure (page 6-7)
5. Network failure, high network error rate (page 6-7)
6. Power outage (page 6-7)
7. Disk failure or disk full (page 6-8)

8. Internal power failure (page 6-9)
9. Heat-related problems (page 6-10)
10. CMOS failure (page 6-11)
11. Mismatch errors (CMOS configuration does not match physical startup configuration) (page 6-11)
12. System-memory failure (page 6-12)
13. Processor failure (page 6-12)
14. IDC failure (page 6-13)
15. Micro Channel adapter or backplane failure (page 6-13)
16. System-backplane failure (page 6-14)
17. LCD failure (page 6-14)

Table 6-2 lists specific symptoms you might encounter and which problems in the list above might cause them.

For optimum error detection and recovery, the server should be configured with DOS v5.0, IBM NetWare Extensions, and NetWare v3.11. The server can then detect developing error conditions; issue warnings; power down, power cycle, or reset as necessary; and work around problems at startup and restart. The server then maintains service, perhaps in a reduced configuration, until the problem is corrected.

Table 6-2
Symptoms

Symptom	Cause
System will not start or reboot	POST error (6-7)
Server halts operation	Software crash (page 6-6) Power outage (page 6-7) Power-supply failure (page 6-9) Heat-related problems (page 6-10) Processor failure (page 6-12) System backplane failure (page 6-14)
Performance problems	Server slows down (page 6-6) Network failure (page 6-7) Disk failure (page 6-8)
Errors and alerts	Refer to Chapter 7.
Component problem	Disk failure or disk full (page 6-8) CMOS failure (page 6-11) CMOS mismatch errors (page 6-11) Memory failure (page 6-13) Processor failure (page 6-14) IDC failure (page 6-15) Micro Channel adapter or Backplane failure (page 6-13 System backplane (page 6-16) LCD failure (page 6-16)

Software halts system

Both application software and operation software can halt the system. When this occurs, the processor may be rendered inactive. NetWare tries to carries out an orderly shutdown of the file system, if NetWare is active and logs the error to the system administrator mail box.

Performance problems

PS/2 Server computers are performance-sensitive to configuration in the following areas:

- NetWare software parameter settings
- Type of network adapter and adapter drivers
- Memory allocation
- Distribution of fixed disk drives over available channels

Slow adapters, badly written adapter drivers, incorrect allocation of memory, overloaded SCSI channels, network problems, and network parameters set for a network of the wrong size can all cause performance problems.

For further information refer to the section on tuning in Chapter 4.

Cabling and seating problems

Whenever an error condition points to a particular system module, begin the troubleshooting process by reseating the board in the system card cage, according to the instructions provided in Chapter 3 of the *PS/2 Server 195/295 Hardware Reference Manual.*

In the case of equipment that contains multiple modules and adapters with multiple ports and connections, cable connections are immediately suspect when erratic communication, degraded network performance, or other such problems occur. Check all connections.

In the case of data problems and transient or irregular disk performance, confirm that fixed-disk cables do not exceed allowed lengths and are

properly terminated. For further information, refer to Chapter 2 of the *IBM PS/2 Server 195/295 Hardware Reference Manual.*

Startup or reboot failure

The server at startup performs a comprehensive series of system tests ("power-on self tests" or "POST"). Server subsystems are tested, and the actual system configuration is compared with the expected configuration stored in CMOS. If an error condition is encountered, an error message is generated, as described in Chapter 7.

The server BIOS attempts to work around many problems that can cause error conditions at startup, such as bad memory that can be mapped out. If the error is sufficiently severe (corrupted CMOS, for example) the server prompts for authorization to reconfigure the system (using BIOS) to reboot.

If the server will not start up and displays no error message on the console monitor or LCD, note and record the beep code it produces, refer to the beep-code table in Chapter 7, and contact your service representative.

Network failure

Network traffic and network errors are tracked by NetWare. The NetWare MONITOR.NLM screen provides network information.

All network errors that occur are logged in the NetWare error log.

To recover from network errors, check network cabling and connections and otherwise troubleshoot the network. Refer to NetWare documentation for information on how to detect and correct the causes of particular network errors.

Power outage

Power failure can be caused by power-line blackout or brownout, improper cabling or cable failure, power-supply failure, UPS failure, or thermal problems that cause the power supply to shut down.

As documented in the NetWare manuals (when UPS is supported), when UPS is present, the server alerts users of any power failure via NetWare's

alerter service. If the situation is not corrected, UPS and NetWare shut down the server in an orderly way, if possible.

If the problem is not caused by a blackout or brownout, refer to "Internal power failure," "Cabling problems," and "Thermal problems" for corrective actions.

Disk failure or disk full

A system with multiple fixed disks may exhibit a number of confusing trouble symptoms when a SCSI problem occurs. The following paragraphs list the most common problems.

Refer to Chapter 7 for a list of SCSI error keys and error codes.

❖ **You can replace a drive that has failed in a Disk Array/2 that has Data Sentry enabled, without loss of data.**

Run-time disk errors, typically caused by bad spots on a disk, are reported by the SCSI disk driver to the file system, which alerts the user. The errors are recorded by NetWare fault-tolerant facilities.

Full-disk errors are reported to users via Netware facilities.

POST disk errors at startup usually indicate that a disk is unusable. If this is the case and the drive is not mirrored, system services may be affected (for example, data or applications may be inaccessible because the current network configuration applies to the wrong drives). PDAUTIL logs such errors and alerts users. The server supports Disk Array/2s with Data Sentry, which allow loss of a drive with no loss of data. The server also supports NetWare disk mirroring and duplexing, when present.

The following can cause drive failures to be reported :

- An IDC has been moved to a different slot.
- A SCSI cable has been moved to a different channel on the same or a different IDC.

- A fixed disk drive is not configured correctly into CMOS. It has been added to or removed from the server, cabled incorrectly in the server, or replaced without using the reference diskette.
- A fixed disk drive does not pass POST and is listed as invalid by CMOS.

If a drive or PDA is removed or has failed but not been configured out of CMOS using the reference diskette, the reference diskette lists the drive or PDA as invalid and does not remove its drive ID. However, DOS ignores it.

Use the reference-diskette SCSI Subsystem Scan option to display all devices physically present and responding in the server, whether configured or not.

Internal power failure

An internal power failure can be caused by a power-supply failure, overheating, incorrect cabling, or a bad fuse.

Do the following to correct the problem:

1. **Confirm that power is available from the power receptacle and that the server is plugged in.**
2. **If the server starts up but fails soon after, confirm that the fans are working.**
3. **If power is available and the server is correctly cabled, contact your service representative.**

Heat-related problems

If the server's internal temperature (as measured in the system card cage) rises into a warning range (between 45° C and 55° C), this threatens damage to server hardware. If the temperature rises higher, into a fatal range (above 55° C), shut down NetWare and turn off the server.

The server's cabinet fan and power-supply fan must be operational to control the server's internal temperature. Although the fans are rated for seven years of continual performance (Mean Time Between Failures), you

may want to have them replaced on a scheduled basis as part of your server maintenance program.

If the server issues a thermal alert, do the following:

1. **Confirm that the server is located in an adequately ventilated room that is no warmer than 100° F (30° C).**
2. **Confirm that all server vents have at least 5" free space ; if necessary, the intake vents on the server's right side function adequately with only 3" clearance.**
3. **Confirm that the server filters are clean.**
4. **Allow the server to cool down, then restart it.**
5. **Confirm that both server fans (power-supply fan and fan located behind the power supply) are working.**

If the server shuts down unexpectedly without issuing an alert and with no UPS intervention, the power supply may have failed or shut down due to overheating.

CMOS failure

The processor module contains battery-backed CMOS memory, which holds the server's configuration information. The information in a CMOS can be lost or corrupted if a processor-module battery loses its charge or is disconnected, or if the CMOS fails.

Errors in CMOS are detected during the POST procedure.

If the battery fails, use the reference diskette to attempt to restore the CMOS settings using the Automatic Configuration, Configuration Restore, and Disk Subsystem Restore options.

Contact your service representative to replace the battery or CMOS causing the problem.

If CMOS memory fail, restart the server using the reference diskette, and reconstruct CMOS contents using the Automatic Configuration and Restore options.

If two processors are present in the system, the server recovers automatically from most CMOS failures on a CPU.

Mismatch errors

At startup, POST compares the actual system configuration with the expected configuration as recorded in CMOS. Differences cause error messages, and in addition may either halt the startup process or cause the server to reconfigure itself in an unexpected way. Performance may be affected.

For example, if both AP/FP switches are set to AP or FP, the server will start up with the processor module in slot 0 treated as AP and the processor module in slot 1 treated as FP. If you have configured the network adapters and other Micro Channel options to expect the opposite, the server will not function properly.

Other examples of mismatches: available memory is less than that expected (memory has failed); fixed disk drives have been moved, removed, or replaced without using the reference diskette to update the system; an unexpected Micro Channel adapter is present, or a Micro Channel adapter has been removed or has failed.

Memory failure

System memory problems can be transient or permanent, and can occur at startup or during server operation.

At startup, the POST routine tests system memory and records any errors. These errors are displayed on the LCD, or console monitor, or both, at startup.

If the POST routine encounters bad memory at startup, it records the area of bad memory. If the bad memory occurs in any but the last bank of memory, and all banks of memory hold 32 MB, the BIOS maps out that bank, but keeps the banks above and below it. If the bad memory occurs in the last

bank, the BIOS keeps all memory in the banks below it and in the bank itself up to the area of bad memory, ignoring the rest.

For example, if four banks of memory are present, with 32 MB in each, and the bad memory occurs in the middle of the second bank, 96 MB (3 x 32 MB) of memory would be available. If the bad memory occurs in the middle of the fourth bank, approximately 112 MB (3 x 32 MB plus 16 MB) of memory would be available.

Only one bank with bad memory is mapped out. If two banks hold bad memory, the lowest is mapped out and replaced by the highest bank with good memory. Memory is used up to the area of bad memory in the second bank.

To change the allocation to an allocation of your own choosing until the bad memory can be replaced, run the reference diskette, and reallocate memory as desired. Then restart the server.

Refer to Chapter 8 for a list of error types and codes.

Processor failure

A processor failure during server operation looks very much like a software error condition that halts the server. When this occurs, MASS/2 (if installed) attempts an orderly shutdown of the operating system, logs the event, alerts users and the system administrator.

For software errors that halt the system, rebooting with no reconfiguration eliminates the problem. In the case of a faulty processor module, rebooting does not offer a workaround until the problem can be rectified.

The problem can be an improperly seated module, faulty processor module, or faulty system backplane. Contact your service representative.

IDC failure

Data errors occurring in multiple disks attached to the same IDC indicate that the IDC has failed, or that a daisy chain cable is improperly attached or terminated. Check the cabling.

If an IDC or IDC channel is suspect, use the reference diskette Scan option and compare the display of responding drives with those actually present in the server. Look for a pattern, such as all drives on one channel not displayed.

To check a suspect channel, you might connect the affected drives to a different IDC or channel. This requires reconfiguration using the reference diskette, however, and may cause added confusion. Refer to the *IBM PS/2 Server 195/295 Hardware Reference Manual* for information on moving drives. Contact your service representative for a new IDC.

Micro Channel adapter or backplane failure

Micro Channel adapters are tested during the startup POST procedure and an adapter that fails this procedure can halt the system.

An adapter failure can be caused by an improperly seated adapter, a faulty adapter, or a faulty Micro Channel backplane. Multiple adapter failures implicate the backplane. Replacing an adapter is described in Chapter 3 of the *IBM PS/2 Server 195/295 Hardware Reference Manual.* Contact your service representative if the backplane is suspect.

An adapter may appear to have failed because the reference diskette has disabled it. Start up using the reference diskette to check the adapter's status before removing or replacing it; you may only need to adjust a setting such as that for the adapter's interrupt level.

System backplane failure

A failure in the system backplane causes fatal hardware errors or otherwise halts the system. Details of the backplane failure may then be available via POST error messages at startup. Contact you service representative for a backplane replacement.

LCD failure

If the LCD, front-panel LEDs, or front-panel buttons will not work, but the system is otherwise normal, the LCD bracket assembly should be replaced. Contact your service representative.

Troubleshooting Resources

The following resources are available to you for troubleshooting:

- Error indicators (page 6-14)
- Reference diskette (page 6-15)
- Diagnostic monitor (page 6-15)
- Remote diagnostics (page 6-16)
- Customer support (page 6-21)

Error indicators

The server uses the following to display or otherwise indicate that an error condition has been encountered:

- Server speaker and yellow error LED on front panel
- Processor-module LEDs
- Front-panel LCD
- Server monitor
- Broadcasts and dial-outs
- NetWare error and event logs
- PDAUTIL event log

Error messages, their meaning, and the means of their display are listed and described in Chapter 7.

The reference diskette

You can use the reference diskette to display extended POST error messages and to eliminate some problems by reconfiguring the system. You can also run the server's onboard diagnostic monitor from the reference diskette (refer to the following section).

For some startup errors, the reference diskette performs a mandatory autoreconfiguration of the system. For other errors, it recommends an autoreconfiguration. Such a reconfiguration eliminates some error conditions caused by inconsistencies between the system's actual configuration and the expected configuration, as recorded in CMOS.

Once the mandatory reconfiguration is complete, you can restore a configuration of your own that you have previously backed up on the reference diskette, assuming that your server hardware configuration is the same.

Diagnostic test diskettes

Supplied with the server are diagnostic test programs located on two diskettes:

- ✓ IBM PS/2 Server Diagnostic Monitor Tests diskette
- ✓ IBM PS/2 Server Field Maintenance System Tests diskette

These programs can be executed on the PS/2 Server for fault analysis. Your technical support representative may want to apply this diagnostic software to your problem. Additional information on these diagnostics and how to use them on your server is found in the *IBM PS/2 Server Diagnostics Manual.*

Remote diagnostics

Your technical support representative may want to apply remote disgnostic software to your problem, and may suggest that a connection be established (by the representative, via modem) between the representative's remote terminal and your server.

Your server supports the following types of dial-in serial connection via modem:

- Connection to a processor-module diagnostic monitor when the server will not boot, via a module communications port.

Your service representative will provide instructions should a diagnostic connection need to be made.

Customer support

Prior to shipment, PS/2 Server computers are thoroughly tested and exercised at the component level and system level. However, since it is not possible to simulate every possible situation that might exist on your network, occasionally you might encounter problems with the server. In such cases, IBM provides prompt technical-service assistance.

After hearing from you, our support personnel will discuss the problem with you over the telephone. The problem is often a simple one and can be resolved during a discussion. In some cases, a service representative may want to dial in to your server and perform remote diagnostics. At other times, a service representative may need to swap in new parts, or you may need to ship the server to the factory for repair or replacement.

If you encounter any problem with your server and you or your system administrator cannot resolve it, please contact IBM at the toll-free number provided on page ii.

For prompt assistance, Customer Service will require the following information. Please have available:

- Your company name
- Name of technical contact
- Company address
- Company telephone number
- IBM product name, serial number, and part name
- Customer purchase order number or service contract number

The customer service staff will then discuss your problem with you. They will assist you in isolating the fault and fixing it if possible.

If the problem cannot be solved through this discussion or subsequent service calls, the service staff may provide you with a Return Material Authorization (RMA) number. At this point, depending upon whether or not the unit is under warranty or service contract, the service staff will also advise you of any applicable charges for the service.

You should then securely pack the unit in its original packing, as described in "Relocating the server" in Chapter 4, and return it to IBM or your authorized service provider.

Chapter 7: Error Messages

Error Messages

You may encounter error conditions while using the server. The server returns error codes and messages when an error occurs. You can use these codes and messages to isolate and identify system problems.

For convenience in presentation, this chapter divides errors into startup (POST) errors and operational errors. Additionally, for native NetWare errors refer to Novell manuals.

A discussion of error causes, server recovery mechanisms, administrative actions to recover, and general troubleshooting, is provided in Chapter 6.

Startup errors

The server uses various combinations of the following to report errors:

- Beep codes
- Front-panel yellow error LED
- Front-panel LCD
- Diagnostic LEDs on the system modules and system backplane
- Server and terminal monitors
- Reference diskette
- PDAUTIL display screen

The server performs a power-on self-test (POST) at startup, returning an error if a component fails to respond properly or if the server configuration encountered is not the same as that recorded in CMOS.

DOS and NetWare software start up following POST, returning errors if problems are encountered.

The server's initial response to startup errors is determined by the current CMOS setting for "Recovery level," as set using the reference diskette:

- The "Stop on all errors" option, when set using the reference diskette, pauses the server during startup if any error is encountered. You press F1 on the console keyboard to continue. The server then works around problems using its BIOS facilities. When a major reconfiguration is required, you are prompted to reboot or continue with the reconfiguration.

- The "Console optional" option, when set using the reference diskette, causes the server to continue startup if a console or diskette error is encountered (the error is displayed and logged). Any other error pauses the server until the F1 key is pressed. The server then works around problems using its BIOS facilities. When a major reconfiguration is required, you are prompted to reboot or continue with the reconfiguration.

As the server starts up, each processor module passes through eight states, with a change in LED code for each state (Table 7-1).

If the POST encounters an error in the initial startup process before the console monitor is initialized, the server issues a three-digit error code as three sets of beeps, sometimes preceded by a long beep of lower pitch. In most cases, an LCD message is also issued. Table 7-2 lists the beep codes and their meanings.

▲ **Warning: "Beep-code" errors are always fatal and indicate a hardware problem that probably requires assistance from your service representative.**

If the POST encounters an error after the processor module has been initialized, the server turns on the front-panel yellow LED, and displays an LCD message. Table 7-3 lists these errors.

If the POST encounters an error after the server monitor has been initialized, the server displays the error on the monitor. Beep codes are not

issued for these errors. Up to five such errors are recorded in memory. The reference diskette can display an extended description of the error.

Errors caused by processor module problems are displayed before the monitor message "Processor POST complete."

After POST completes, DOS starts up. DOS startup errors are displayed on the monitor. All NetWare operating system errors are recorded in the NetWare error logs. Page 7-19 lists these messages for PDAUTIL only.

In the case of beep-only errors, which are all fatal, you have only one option: repair hardware components and restart. In the case of multiple nonfatal errors, you have several choices:

- Press F1 and ignore the error.
- Restart with the reference disk. In some cases, the reference diskette can rectify the error condition by reconfiguring the system.
- Start up with the Autorecovery option enabled and operate in a reduced mode while you troubleshoot the problem.

For more about errors and troubleshooting, refer to Chapter 6, "Troubleshooting."

Table 7-1
Processor-module LED codes

Code[1]	LEDs[2]			Description
0	off	off	off	Processor-module is operational.
1	on	off	off	Not used.
2	off	on	off	Not used.
3	on	on	off	Second processor to boot only. Second processor has completed POST and is idle. This is the normal state for reference-diskette, DOS, and uniprocessor mode operation.
4	off	off	on	POST is running on the module. Any errors encountered are displayed at the server console.
5	on	off	on	Indicates that POST is starting.
6	off	on	on	Output by EBIOS as soon as the processor module resets. The first processor to boot shows this code only briefly. The second shows this code while waiting for the first to complete POST.
7	on	on	on	The processor-module CPU is being held in reset. This can be caused by the RMP, the user pressing the CPU reset button, or the other module's CPU EBIOS detecting an error in this module. A power-cycle may release the reset. Otherwise, problems with the processor module are indicated.

1 The processor module starts up, displaying these codes, in the order seven through zero.

2 The LEDs are listed as seen from the front of the server. The low-order LED is on the left, toward the side panel. The high-order LED is on the right, toward the system backpanel.

Table 7-2
Beep codes

Beep code	Description of test or failure
1-1-3	CMOS write/read test failure
1-1-4	BIOS ROM checksum failure
1-2-1	Programmable Interval Timer test failure
1-2-2	DMA initialization failure
1-2-3	DMA page register write/read test failure
1-3-3	1st 64K RAM chip or data line failure - multi-bit
1-3-4	1st 64K RAM odd/even logic failure
1-4-1	1st 64K RAM address line failure
1-4-2	1st 64K RAM parity test failure
2-1-1	1st 64K RAM chip or data line failure - bit 0
2-1-2	1st 64K RAM chip or data line failure - bit 1
2-1-3	1st 64K RAM chip or data line failure - bit 2
2-1-4	1st 64K RAM chip or data line failure - bit 3
2-2-1	1st 64K RAM chip or data line failure - bit 4
2-2-2	1st 64K RAM chip or data line failure - bit 5
2-2-3	1st 64K RAM chip or data line failure - bit 6
2-2-4	1st 64K RAM chip or data line failure - bit 7
2-3-1	1st 64K RAM chip or data line failure - bit 8
2-3-2	1st 64K RAM chip or data line failure - bit 9
2-3-3	1st 64K RAM chip or data line failure - bit A
2-3-4	1st 64K RAM chip or data line failure - bit B
2-4-1	1st 64K RAM chip or data line failure - bit C
2-4-2	1st 64K RAM chip or data line failure - bit D

Table 7-2 (Continued)
Beep codes

Beep code	Description of test or failure
2-4-3	1st 64K RAM chip or data line failure - bit E
2-4-4	1st 64K RAM chip or data line failure - bit F
3-1-1	Slave DMA register test failure
3-1-2	Master DMA register test failure
3-1-3	Master interrupt mask register test fail
3-1-4	Slave interrupt mask register test fail
3-2-4	Keyboard controller test failure
3-3-4	Screen memory test failure
3-4-1	Screen initialization failure
3-4-2	Screen retrace test failure
4-2-1	Timer tick interrupt test failure
4-2-2	Shutdown test failure
4-2-3	Gate A20 failure
4-2-4	Unexpected interrupt in protected mode
4-3-3	Interval timer channel 2 test failure
4-3-4	Time-of-day clock test failure
4-4-1	Serial port test failure
4-4-2	Parallel port test failure
4-4-3	Math Coprocessor test failure
low-1-1-2	Processor module select failure
low-1-1-3	Extended CMOS RAM failure
low-2-1-1	No IP-bus RAM detected in system
low-2-1-2	Bad server shutdown byte (no LCD message)

Table 7-2 (Continued)
Beep codes

Beep code	Description of test or failure
low-2-1-3	IP-bus failure: DSTO or BGTO
low-2-1-4	ABIOS image RAM ECC check
low-2-2-1	Bad mailbox register(s) (no LCD message)
low-2-2-3	Bad diagnostic monitor entry vector - missing or misprogrammed diagmon ROM
low-2-2-4	RAM Image write protection failure
low-2-3-1	FP/AP parameter transfer area mismatch - ensure that BIOSs are same on each CPU (dual CPU error only)
low 2-3-2	Not enough memory for AP to operate (MB usable)
low 2-3-3	Bad processor module IMR or IRQ level CSRs
low 2-3-4	Bad processor module offset, offstsz or Mem.sz memory-mover CSRs
low 2-4-1	Bad 486 internal cache RAM
low 2-4-2	Bad 486 "487" internal coprocessor
low 2-4-3	Bad server memory mapper

Table 7-3
POST errors

Code	Server console message	Reference diskette message
103	Processor module failure	The timer interrupt failed while testing timer 0 during POST. The processor module should be replaced.
104	Processor module failure	An unexpected interrupt occurred while the processor was in protected mode. The processor module should be replaced.
108	Processor module failure	Timer 2 failed during POST. The processor module should be replaced.
110	Memory parity error at *address*	A fatal memory error has occurred. Restart the server. If the error recurs, server hardware is at fault. Refer to Chapter 6. (This is a monitor message; no reference diskette display for this error.)
111	I/O adapter parity error at *address*	A Micro Channel error has occurred. Restart the server. If the error recurs, server hardware is at fault. Refer to Chapter 6. (This is a monitor message; no reference diskette display for this error.)
112	Watchdog timeout	A processor module has failed. If the problem recurs, replace the module. (This is a monitor message; no reference diskette display for this error.)
113	DMA bus timeout	A processor module has failed. If the problem recurs, replace the module. (This is a monitor message; no reference diskette display for this error.)
114	Option ROM checksum failure	The checksum calculated for an option ROM installed in the system does not match the checksum stored in the option ROM. The failing option ROM or adapter containing the option ROM should be replaced.
130	Processor module failure	A shutdown failure has occurred during POST. The processor module should be replaced.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
131	Processor module failure	Gating of the A20 address line failed when entering or leaving protected mode. The processor module should be replaced.
161	Real time clock failure (battery)	The real time clock's bad battery flag bit is set. The battery should be replaced. If the problem persists, the processor module should be replaced. The reference diskette performs a mandatory autoconfiguration.
162	Real time clock failure (CRC)	The checksum for a CMOS is incorrect. Correct information will be copied into the CMOS from the other processor-module CMOS at startup. If both CMOS memories are bad, start up using the reference diskette, which will performs a mandatory autoreconfiguration. Autoreconfiguration rebuilds both CMOS memories. If desired, use the Configuration and Disk Subsystem Restore options to restore backed-up CMOS information. Otherwise reconfigure the CMOS as necessary. If the problem occurs after running automatic configuration, the module battery should be replaced. If the problem occurs after replacing the battery, the processor module should be replaced.
163	Time and date not set	The time and date in the real time clock have not been set or have been corrupted. When the main menu appears on the reference diskette, select "Feature Control" then "Date and Time." Enter the correct date and time at the prompts.
164	Invalid configuration information (memory)	The amount of memory found in the system does not match the amount of memory specified in CMOS. Automatic reconfiguration should be run to correctly configure the system. If the problem persists after running automatic configuration, the processor module should be replaced. The reference diskette prompts you for optional autoconfiguration.
165	Invalid configuration information (Micro Channel adapter)	An adapter configured by the reference diskette does not exist in the correct slot in the system. The reference diskette prompts you for optional autoconfiguration.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
166	Invalid configuration information (Micro Channel adapter)	An adapter configured by reference diskette does not exist in the slot specified in the system or the adapter is not responding. The reference diskette prompts you for optional autoconfiguration. If the problem persists, the adapter should be replaced.
167	Invalid configuration information (diskette)	A diskette drive has been found when CMOS information indicated there was none, or CMOS indicated there was a diskette drive but none was found. Use the reference-diskette Configuration option to manually configure CMOS to agree with the current server setup.
168	Invalid configuration information (processor module)	A math coprocessor has been found onboard the CPU when CMOS information indicated there was none; or CMOS indicated there was a math coprocessor but none was found. Use the reference-diskette Configuration option to manually configure CMOS to agree with the current server setup.
201	General memory failure	A read/write error has occurred in memory. The memory in the system should be replaced. If the problem persists, the processor module should be replaced.
202	General memory failure	A memory parity has occurred in memory. The memory in the system should be replaced. If the problem persists, the processor module should be replaced.
203	General memory failure	An address line failure has occurred in memory. The memory in the system should be replaced. If the problem persists, the processor module should be replaced.
301	Keyboard failure	The keyboard controller has failed during POST. The keyboard should be checked to make sure it is functioning correctly and is installed correctly. If the problem persists, the processor module should be replaced.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
304	Keyboard failure	The clock line on the keyboard controller has failed during POST. The keyboard should be checked to make sure it is functioning correctly and is installed correctly. If the problem persists, the processor module should be replaced.
306	Keyboard failure	The data line on the keyboard controller has failed during POST. The keyboard should be checked to make sure it is functioning correctly and is installed correctly. If the problem persists, the processor module should be replaced.
307	Stuck key failure	A stuck key has been detected on the keyboard. The keyboard should be checked to make sure it is functioning correctly and is installed correctly. If the problem persists, the processor module should be replaced.
601	Diskette subsystem failure	The reset function has failed on a diskette subsystem. The diskette controller on the system backplane has failed and should be replaced.
602	Diskette drive *x* failure	The seek function has failed on the diskette drive. The drive is malfunctioning and should be replaced. *x* indicates the drive that failed. 0 for drive A:, 1 for drive B:.
1101	Serial port failure	The serial port on the processor module has failed. The processor module should be replaced or an alternate serial port used.
1780	Fixed disk drive 0 failure	Fixed disk drive 0 is either not ready or the recalibration function failed during initialization. The fixed disk controller should be checked for proper functioning. Check all connections.
1781	Fixed disk drive 1 failure	Fixed disk drive 1 is either not ready or the recalibration function failed during initialization. Check the fixed disk controller. Check all connections.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
1782	Fixed disk reset failure	The controller reset function failed during initialization. The fixed disk controller should be checked for proper functioning. Check all connections.
1790	Fixed disk drive 0 failure	The verify function has failed on fixed disk drive 0.
1791	Fixed disk drive 1 failure	The verify function has failed on fixed disk drive 1.
2401	Video failure	The processor module video controller has failed during POST. The processor module should be replaced.
8602	Auxiliary device failure	The auxiliary device (mouse) was detected in the system but an interface error occurred while testing. The auxiliary device should be checked for proper operation and possibly replaced. If the problem persists, replace the processor module.
9901	Memory mover failure	The memory mover has failed during POST. This will cause degraded system performance. The system memory module should be replaced.
9902	CPU FP/AP switches have same setting	The CPU boards' FP/AP switches are set identically. Change the setting of one CPU's FP/AP switch, and then turn system power off and back on.
9903	System configuration mismatch	The amount of memory found in the system is less than the amount of memory specified in CMOS. The reference diskette's Automatic configuration should be run to correctly configure the system. The reference diskette prompts you for optional autoconfiguration.
9904	AP error during POST. AP not usable	The AP CPU has failed during POST. The system is continuing operation with one CPU. The AP CPU module should be replaced.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
9906	Invalid system memory configuration	The FP/AP memory bases specified in CMOS are both non-zero. The reference diskette performs a mandatory autoconfiguration.
9907	CPU/disk interrupt conflict	The CPU's interrupt level settings conflict with those of an adaptor attached to its Microchannel. If the problem persists, use manual configuration to check interrupt levels.
9910	Disk controller board failure (slot *n*)	The IDC in slot *n* failed during POST. The IDC, whose LED should now be steadily illuminated, should be replaced.
9911	Hard disk drive failure (slot *n* channel *n* SCSI ID *n*, in bay *n*)	The indicated SCSI drive failed during initialization. Check the drive's IDC. Check drive cabling. If the disk has been physically removed, causing the error message, select "SCSI Subsystem," and then "Remove" to remove the drive from the CMOS record.
9912	Hard disk configuration error (slot *n* channel *n* SCSI ID *n*, in bay *n*)	The indicated SCSI drive contains configuration data which does not match that stored in CMOS. When the main menu appears on the reference diskette select "SCSI Subsystem," and then "Replace." Enter the correct configuration information at the prompts. If the system has only one SCSI disk, "Remove" the disk configuration and "Install" it again.
9913	Security key(s) not installed	One or more IBM Disk Arrays are configured but the required security keys are not present. Ensure that a Disk Array/2 security key is attached to the parallel port of each CPU module in the server, then exit from the reference disk to reboot the server.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
9914	Disk device address mismatch	POST has detected an error in the SCSI disk configuration sequence. The slot, channel, and SCSI Id for a disk does not match the embedded configuration record. That disk (or the disk array it belongs to) will be disabled to prevent any damage that could occur from writing to it while it is out of sequence. When the Main Menu appears on the Reference Diskette, select 'SCSI Subsystem'. 'Remove' the disk or disk array that contains the errant drive, and 'Install' it using the correct parameters. If it is a disk array, answer 'N' to the prompt 'Install as New PDA (y/n)'.
9915	Non-Disk device off line or not present (slot*n*, channel*n*, SCSI ID*n*, bay*n*)	This is a warning and is not reported to the reference disk
9916	Non-Disk device configuration error (slot*n*, channel*n*, SCSI ID*n*, bay*n*)	A Non-disk SCSI device is not configured correctly. When the Main Menu appears on the Reference Diskette, select 'SCSI Subsystem', then 'Non-disk' from the "Install" menu to correct the problem.
9920	IP slot configuration mismatch	A system bus adapter configured by the reference diskette does not exist in the slot specified, or a bus adapter has been added to the system. Automatic configuration should be run to correctly configure the system. If the problem persists, the adapter should be replaced. The reference diskette prompts you for optional autoconfiguration.
9921	IP slot configuration mismatch	A system bus adapter configured by the reference diskette has reported an old revision value. Automatic configuration should be run to correctly configure the system. If the problem persists, the adapter should be replaced. The reference diskette prompts you for optional autoconfiguration.
9922	Invalid IP slot configuration data	An unsupported system bus configuration has been found in CMOS during POST. Either the CMOS is corrupted or you are using a reference diskette with a version number different than that of the system software (e.g., a processor module board revision level does not match that listed in CMOS). The reference diskette performs a mandatory autoconfiguration.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
9923	RMP in IP slot *n* is not usable	The RMP module in the identified IP bus slot failed to communicate with the BIOS during POST. Check the RMP to be certain it is configured for normal system operation. If the problem persists, replace the RMP.
9925	Cache subsystem is not usable	The external/internal cache memory on the processor module has been disabled. Restart. If the problem persists, replace the module.
9926	Memory error detection is not usable	ECC has been disabled. Restart. If the problem persists, replace the memory module.
9927	FP/AP Module Parameter Discrepancy	Parameters stored in the FP module's CMOS do not agree with those in the AP module's CMOS. Automatic configuration should be run to correctly configure the system. This might occur when, for example, a processor module from another server is swapped in. Neither CMOS appears to be corrupted, but they do not agree. In this case, the BIOS cannot mirror the good CMOS into the incorrect CMOS; instead, it simply issues this error message and logs the error. Rebuild both CMOS memories using the reference diskette.
9928	FP/AP Module Memory Parameter Discrepancy	Memory allocation parameters stored in the FP module's CMOS do not agree with those in the AP module's CMOS. Automatic configuration should be run to correctly configure the system. This might occur when, for example, a processor module from another server is swapped in. Neither CMOS appears to be corrupted, but they do not agree. In this case, the BIOS cannot mirror the good CMOS into the incorrect CMOS; instead, it issues this error message, logs the error, allocates all but 1 MB of memory to FP, and restarts in uniprocessor mode. Rebuild both CMOS memories using the reference diskette; return to multiprocessor mode using MPINST.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
9929	Boot CPU Handoff Failed	Control transfer from the FP to the AP (boot) processor failed. The AP processor is left quiescent and SCSI devices are not usable. The reference diskette can be run and CMOS updated. Do not alter the SCSI configuration. Verify that both CPUs are using the same EBIOS version. If the problem persists, replace one or both CPUs.
9930	Boot CPU Configured for Non-Zero Base	The CMOS memory configuration specifies a non-zero base for the boot processor. Run the reference-diskette Configuration Automatic option to correct the memory configuration.
9931	CMOS Configuration Revision Mismatch	The current CMOS configuration applies to a different BIOS software version than that currently installed in the server. Use the reference diskette's Automatic Configuration option to update CMOS. All but 2 MB of server memory is allocated to the default initial boot processor. The remaining 2 MB is assigned to the other processor.
9950	External cache disabled	(Warning) The external cache is disabled. The internal cache is still enabled. This message is a warning only. System performance is degraded somewhat. You can correct the condition by running Autoconfigure from the reference diskette Configuration menu, or by manually enabling the cache for the CPU board using the reference diskette Configuration Change option for the processor module. This warning is not reported to the error log/reference diskette.
9951	Internal and external caches disabled	(Warning) The external and internal (486) cache on a processor module are disabled. System performance may be severely degraded. You can correct the condition by running Autoconfigure from the reference diskette Configuration menu, or by manually enabling the cache for the CPU board using the reference diskette Configuration Change option for the processor module. This warning is not reported to the error log/reference diskette.
9952	Total IP RAM limited by 16 MB compatibility flag	(Warning) The server's 16 MB compatibility mode is enabled. The server will recognize and use only the first 16 MB of installed memory.

Table 7-3 (Continued)
POST errors

Code	Server console message	Reference diskette message
9980	2-bit ECC error @ *address* (fast burst or not burst)	A fatal error has occurred in system memory. Restart. If the error persists, replace the appropriate bank of memory. (This error is not reported to the reference diskette.)
9981	IP bus grant timeout error	A fatal system error has been encountered. Restart. If the error persists, a system module is bad. (This error is not reported to the reference diskette.)
9982	IP bus data strobe timeout	Software tried to access a non-existent device, or a system module is bad. Replace the module or reinstall the software. (This error is not reported to the reference diskette.)
9983	IP bus parity error (responder report)	Retry. If the error persists, it indicates a serious hardware problem. Contact your service representative. (This error is not reported to the reference diskette.)
9984	IP bus parity error (local report)	Retry. If the error persists, it indicates a serious hardware problem. Contact your service representative. (This error is not reported to the reference diskette.)
9985	Intermittent NMI occurred	An untraceable fatal error has occurred. Restart the system. If the problem recurs, contact your authorized service representative.
9990	Mixed memory sizes in Banks 0-2. System halted	System halts. This error is not reported to the reference disk.
104xx	(Code only is displayed)	An error has occurred on the Micro Channel ESDI fixed disk controller. Check the controller cables and connections. The reference diskette performs a mandatory autoconfiguration.

Errors during operation

The server displays operating errors on the LCD.

The server returns the following types of messages during operation:

- Informational (status)
- Non-fatal
- Fatal

Informational messages provide the user with status information. They do not turn on the front-panel error LED. A new message will overwrite and replace the previous message.

Non-fatal errors cause the error LED to flash until reset or until the system is rebooted or a fatal error occurs. They do not halt server operations. You reset the LED by pressing both buttons on the front panel.

The server can store up to eight non-fatal errors at one time in memory, for LCD display. You can use the front-panel buttons to scroll through the messages and display any current status message on the front-panel LCD. Pressing the left button displays the previous error message; pressing the right button displays the next error message. Pressing both buttons displays the status message and turns off the flashing amber error LED. Scrolling past the end of the list of error messages displays any status message and then begins the error list again.

A Fatal error turns the error LED on and halts the system. The LED does not blink; it stays on until the system is restarted. You cannot scroll through LCD messages after the server has encountered a fatal error.

Errors are displayed or recorded on the LCD.

This section lists operational messages and errors according to where they are displayed or recorded, and according to the following categories:

- Informational messages

- Memory errors
- SCSI errors
- PDAUTIL errors and information
- IP-bus errors and NMI errors
- DOS errors

During server operation, most operating errors are returned by NetWare. You handle these according to the instructions provided with NetWare. IBM NetWare Extensions errors (PDAUTIL) and error codes are listed end for this chapter. The informational, non-fatal, and fatal error messages listed in Tables 7-1, through 7-7 are returned by IBM software, and relate to system hardware.

NetWare allows you to inspect the NetWare error logs, which contains both network and environmental errors.

IBM NetWare Extensions error messages

The NetWare Extension software (PDAUTIL) provides the following error messages:

- "Event Log File %d%% Full. Use Backup and Clear to reset file."

  Warning that the event file is filling up. Message starts being sent at 75 percent of file capacity. This message is sent to the system console and notify list.

- "Event Log File full. Event not logged."

  The event log file is full and subsequent messages are sent to the system console and notify list.

- "Drive X. Verify Started/Failed/Successful."

The message is sent to the system console, notify list, and event log.

- "Drive X. Rebuild Started/Failed/Successful."

  The message is sent to the system console, notify list, and event log.

- "SCSI Error on Device 4A0."

  This message appears only in the event log. Followed by SCSI error information, including Sense Key, Sense Code, Logical Block Address (LBA), and 32-bytes of sense data. All data execpt device address are displayed in hexadecimal format.

PDAUTIL event log

With the IBM Orthogonal RAID-5 DiskArray/2 option installed, an event log can be displayed using the PDAUTIL program which provides informational and error mesages on the server's SCSI drive subsystem operation. Refer to Chapter 5 for more information on this event log.

Table 7-4
Operating errors (LCD)

LCD	Description
Informational messages	
System running Single processor	Single processor boot complete. The MASS/2 software will overwrite this message with date and time.
System running Dual Processor	Dual processor boot complete. The MASS/2 software will overwrite this message with date and time.
System error messages	
Fatal error: NMI - -str-pcawblxdgm	PS/2 generic sources p - parity check (61h, bit 7) c - channel check (61h, bit 6) a - bus timeout (90h, bit 5) w - watchdog timer (92h, bit 4) b - DMA SCB timeout (1Fh, bit 4) Server-specific sources l - IP bus parity (internal) x - IP bus parity (external) d - data strobe timeout g - bus grant timeout m - double (or multiple) bit ECC memory r - undetermined source t - address parity (internal) s - data parity (internal) Error sources are listed in the second display line; other sources are listed as dashes. (IP-Bus NMIs are reported in the Field Service diagnostic error log or RMP log
Boot failure error(s) in POST	Errors detected during POST. Check the RMP event log.

Table 7-4 (Continued)
Operating errors (LCD)

Memory error messages	
ECC memory error read failure	Transient error in the read path.
Memory error messages (Continued)	
ECC memory error soft failure	Memory error corrected via "scrubbing." Scrubbing is a term for clearing or removing an error by writing correct data back to memory over the error.
ECC memory error hard failure	Memory error not corrected via scrubbing.
ECC memory error tracking stopped	Memory error tracking stopped to reduce overhead (at least five errors within two seconds).

Table 7-5
SCSI error keys

Error key	Description
SCSI Error *error code, sense code* Board *IDC slot number*, Channel *letter*, Id *SCSI ID number*	
00	No sense. There is no sense key information to be reported. This code occurs for a successfully completed command.
01	Recovered Error. The last command was completed successfully, but with some recovery action performed by the disk drive.
02	Not ready. The disk drive cannot be accessed. Operator intervention may be required.
03	Medium Error. The command terminated with a nonrecoverable error condition which was probably caused by a flaw in the media or by an error in the recorded data.
04	Hardware Error. A nonrecoverable hardware error (e.g. disk drive failure, parity error, etc.) was detected while the disk drive was performing the command.
05	Illegal Request. There was an illegal parameter in the command or in the additional required parameters supplied as data for some related commands. If the error is detected in the CDB, the disk drive does not alter the media.
06	Unit Attention. The disk drive has been reset. This error is reported the first time any command is issued after the condition is detected and the requested command is not performed. This condition is cleared when the next command that is not an INQUIRY command is issued by the same initiator. UNIT ATTENTION is reported to all SCSI devices that subsequently issue a command to the disk drive.
07	Data Protect. A write operation was attempted on a write protected device.

Table 7-5 (Continued)
SCSI error keys

Error key	Description
08	Reserved. This key is reserved.
09	Vendor Unique. A vendor unique error condition occurred. This key is currently not returned by the disk drive.
0A	Copy/Compare Aborted. A COPY or COMPARE command was aborted because an error condition was detected on the source and/or destination device. This code is not returned by the disk drive.
0B	Aborted Command. The disk drive aborted the command. The initiator may recover by trying to execute the command again.
0C	Reserved. This key is reserved.
0D	Reserved. This key is reserved.
0E	Miscompare. Used by the VERIFY and READ DATA BUFFER commands to indicate that the source data did not match the data read from the disk.
0F	Reserved. This key is reserved.
FF	Specific errors based on the following codes: 01 = Parity error 02 = Select time out 03 = Drive not supporting disconnect/reconnect 04 = Drive not ready 05 = Driver repaired bad block on disk

Table 7-5
SCSI error codes

Error code	Description
SCSI Error *error code, sense code* Board *IDC slot number*, Channel *letter*, Id *SCSI ID number*	
00	NO ADDITIONAL SENSE INFORMATION. The disk drive has no additional sense available for the previous command.
01	RESERVED. This code is reserved.
02	NO SEEK. The disk drive could not complete a seek operation.
03	DRIVE VIOLATED SCSI BUS TIMING. The drive has been placed in a lower peformance mode.
04	DRIVE NOT READY. The disk drive is not ready.
05	DRIVE NOT SELECTED.
06	NO TRACK ZERO. The disk drive could not rezero the positioner.
07-0F	RESERVED. These codes are reserved.
10	ID FIELD CRC ERROR. The sector ID field could not be read after without a CRC error.
11	UNRECOVERED DATA ERROR. A block could not be read after the number of retry attempts specified in the MODE SELECT command.
12	ID FIELD ADDRESS MARK NOT FOUND. The disk drive could not locate the address mark for a sector header.

Table 7-5 (Continued)
SCSI error codes

Error code	Description
13	DATA ADDRESS MARK NOT FOUND. The disk drive could not locate the address mark for the sector data area.
14	RECORD NOT FOUND. The block sequence is improper, a block is missing, or the block cannot read.
15	SEEK ERROR. A miscompare occurred between the cylinder address of the data header and the address specified in the CDB of the command.
16	RESERVED. This code is reserved.
17	RECOVERED READ ERROR (WITH RETRIES). The disk drive encountered an error which was recovered using retries, not including ECC, while reading the media.
18	RECOVERED READ ERROR (WITH ECC). The disk drive encountered an error which was recovered using ECC correction, while reading the media.
19	DEFECT LIST ERROR. The disk drive encountered an error while accessing one of the defect lists.
1A	PARAMETER OVERRUN. The parameter list length specified in the CDB by the initiator is too large for the disk drive.
1B	SYNCHRONOUS TRANSFER ERROR.
1C	PRIMARY DEFECT LIST NOT FOUND. The disk drive could not locate the primary defect list (P list).

Table 7-5 (Continued)
SCSI error codes

Error code	Description
1D	COMPARE ERROR. One or more bytes did not compare when the VERIFY or WRITE AND VERIFY command was issued.
1E-1F	RESERVED. These codes are reserved.
20	INVALID COMMAND. The initiator issued a command that cannot be executed or is not applicable.
21	INVALID BLOCK ADDRESS. The addressed block is not valid.
22	ILLEGAL FUNCTION FOR DEVICE TYPE. The disk drive is unable to perform the requested function.
23	RESERVED. This code is reserved.
24	ILLEGAL FILED IN CDB. A field in the CDB is reserved and contains a value other than zero, or the value in the field is incorrect.
25	INVALID LUN. The LUN specified in the CDB or the SCSI IDENTIFY message is not zero.
26	ILLEGAL FIELD IN PARAMETER LIST. A field in the parameter list is reserved and contains a value other than zero, or the value in the field is incorrect.
27	WRITE PROTECTED. The disk drive is write protected. The outstanding WRITE command is aborted.
28	MEDIUM CHANGED. The drive has detected a NOT READY condition followed by a READY condition.

Table 7-6
IP bus error codes

IP bus error
address ap datahi32 datalo32 dp be ep br bg dwb tselydmr ncs84adb

address	IP bus error address
ap	Address parity
datahi32	Upper 32-bit data
datalo32	Lower 32-bit data
dp	Data parity
be	Byte enable
ep	Byte-enable parity
br	Bus request
bg	Bus grant
dwb	Data-strobe write-strobe burst
t	IP-bus timeout
s	IP-bus memory single bit error
e	IP-bus error signal
l	IP-bus lock
y	IP-bus retry
d	IP-bus ready
m	IP-bus multiple bus grant
r	IP-bus reset
n	IP-bus Non-Maskable-Interrupt
c	IP-bus common bus request
s	IP-bus stall signal
8	8-slot Micro Channel channel check signal
4	4-slot Micro Channel channel check signal
a	IP-address parity error
d	IP-bus data parity error
b	IP-bus byte enabled parity error

Table 7-7
Memory error syndrome code[1]

n1 \ n2	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
00	--	64	65	DB	66	DB	DB	MB	67	DB	DB	17	DB	MB	16	DB
10	68	DB	DB	18	DB	19	20	DB	DB	21	22	DB	23	DB	DB	MB
20	69	DB	DB	08	DB	09	10	DB	DB	11	12	DB	13	DB	DB	MB
30	DB	14	MB	DB	15	DB	DB	MB	MB	DB	DB	MB	DB	MB	MB	DB
40	70	DB	DB	MB	DB	MB	MB	DB	DB	MB	33	DB	MB	DB	DB	32
50	DB	MB	34	DB	35	DB	DB	36	37	DB	DB	38	DB	39	MB	DB
60	DB	MB	56	DB	57	DB	DB	58	59	DB	DB	60	DB	61	MB	DB
70	62	DB	DB	MB	DB	63	MB	DB	DB	MB	MB	DB	MB	DB	DB	MB
80	71	DB	DB	MB	DB	MB	MB	DB	DB	MB	49	DB	MB	DB	DB	48
90	DB	MB	50	DB	51	DB	DB	52	53	DB	DB	54	DB	55	MB	DB
A0	DB	MB	40	DB	41	DB	DB	42	43	DB	DB	44	DB	45	MB	DB
B0	46	DB	DB	MB	DB	47	MB	DB	DB	MB	MB	DB	MB	DB	DB	MB
C0	DB	MB	MB	DB	MB	DB	DB	MB	MB	DB	DB	01	DB	MB	00	DB
D0	MB	DB	DB	02	MB	03	04	DB	DB	05	06	DB	07	DB	DB	MB
E0	MB	DB	DB	24	DB	25	26	DB	DB	27	28	DB	29	DB	DB	MB
F0	DB	30	MB	DB	31	DB	DB	MB	MB	DB	DB	MB	DB	MB	MB	DB

1 Syndrome n_1n_2 where - - = no error, *nn* = single bit error in error bit *nn* (0 through 63, data; 64 through 71, ECC 0 through 7), DB = double bit error, MB = multiple-bit error.