IBM

International Technical Support Centers

PERSONAL SYSTEM/2 MODELS 95 XP 486, 90 XP 486, 55 LS AND P75 486 FUNDAMENTALS

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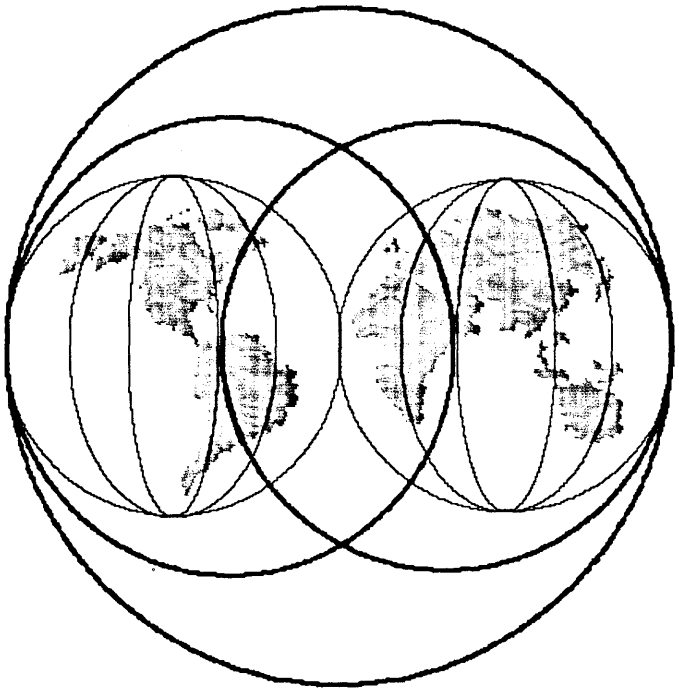
Personal System/2 Models 95 XP 486, 90 XP 486, 55 LS and P75 486 Fundamentals

Release 1.0



Take Note

Before using this information and the products it supports, be sure to read the general information under "Special Notices" on page xiii.

First Edition (October 1990)

This edition applies to IBM PS/2 Systems and PS/2 Options that were announced in the fourth quarter of 1990.

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Abstract

This document offers information on the PS/2 products announced in the fourth quarter of 1990. The following systems are covered:

- IBM Model 90 XP 486
- IBM Model 95 XP 486
- IBM Model 55 SX LS
- IBM Model P75 486

In addition, new features and options are discussed.

New Personal Systems/2 based on the Intel i486 are elaborated, as well as an installation scenario for the Model 55 LS system.

The contents of this document are designed as reference material for IBM customers and IBM systems engineers.

PSYS (176 pages)

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Special Notices

This publication is intended to help the customer to understand the internals of the PS/2 products announced by IBM in October 1990. It contains facts on the internals of the IBM Model 90 XP 486 system and IBM Model 95 XP 486 systems, as well as a description of the features and options necessary to successfully install and run these products.

The information in this publication is not intended as the specification of the programming interfaces that are provided by the Personal System/2 for use by customers in writing programs to request or receive its services. See the Publications Section of the IBM Programming Announcement for the IBM Personal System/2.

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Preface

The purpose of this document is to provide an overview and internal details of the IBM Personal System/2 announcements during the last quarter of 1990. It contains details on these systems from an architectural point of view and from the end-user standpoint.

Audience

This document is intended for persons requiring knowledge of the Personal System/2 products that IBM made available during the fourth quarter of 1990. It is targeted at IBM systems engineers and IBM customers who have a need to understand the internals of the new family of systems. The document has been written to give both a basic and an in-depth understanding, depending on the particular reader. The reader should be familiar with basic computer hardware concepts.

Structure

This document is divided into the following major sections:

- Chapter 1.0, "Introduction" on page 1 describes this document and how best to read it.
- Chapter 2.0, "Product Positioning" on page 3 tells where these products fit in today's marketplace.

The first section covers the IBM Model 95 XP 486 and IBM Model 90 XP 486 systems.

- Chapter 3.0, "General System Description" on page 7 takes you through a general description of the IBM Model 90 XP 486 system and IBM Model 95 XP 486 system.
- Chapter 4.0, "System Details and Planar Functions" on page 11 contains details of the planar boards.
- Chapter 5.0, "Processor Adapter" on page 25 describes the implementation of the processor adapters in the IBM Model 90 XP 486 system and IBM Model 95 XP 486 system.
- Chapter 6.0, "Memory Subsystem" on page 31 covers the memory subsystems.
- Chapter 7.0, "Initial Microcode Load" on page 43 looks at what is new in the Initial Microcode Load procedures.
- Chapter 8.0, "Direct Access Storage Devices (DASD)" on page 73 provides information about diskettes, disks, and tapes.
- Chapter 9.0, "IBM Extended Graphics Array Subsystems" on page 83 looks at the XGA and XGA Adapter/A video subsytems.

The second section deals with the IBM Model 55 LS.

- Chapter 10.0, "Model 55 LS Hardware" on page 101 describes the IBM Model 55 LAN station.

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- Chapter 11.0, "IBM PS/2 Model 55 LS Installation" on page 107 describes how to install the IBM PS/2 Model 55 LT0 and how to connect it to a Token-Ring LAN.

The third section covers the new IBM PS/2 Model P75 486.

- Chapter 12.0, "PS/2 Model P75 486" on page 119 describes the components of the new portable &kauai system and relates it to the already known PS/2 Model P70.

The appendixes discuss special details as an extension to some of the topics covered in previous chapters.

- Appendix A, "Micro Channel" on page 137 details some Micro Channel enhancements announced in November 1989.
- Appendix B, "Antialiased Fonts" on page 141 is all about the antialiased font support for Presentation Manager applications.
- Appendix C, "Programming the XGA" on page 149 gives some in depth details on programming the XGA and XGA Adapter/A.
- Appendix D, "List of IML Errors" on page 157 lists error messages that may occur at IML.
- Appendix E, "Announcement Summary - October/November 1990" on page 159 summarizes the announcements.
- Appendix F, "Remote IPL Reference Information" on page 163 lists error messages that may occur as the Model 55 LS connects to a remote IPL server.

Related Publications

The following publications are considered particularly suitable for a more detailed discussion of the topics covered in this document.

IBM PS/2 Model 90 XP 486 and Model 95 XP 486 Publications

Model 90 XP 486 Technical Reference Manual

Model 95 XP 486 Technical Reference Manual

Model 90 XP 486 Hardware Maintenance Library

Model 95 XP 486 Hardware Maintenance Library

IBM PS/2 XGA Technical Reference Manual

IBM 80 MB Fixed Disk Drive Technical Reference Manual

IBM 160 MB Fixed Disk Drive Technical Reference Manual

IBM 320 MB Fixed Disk Drive Technical Reference Manual

IBM Hardware Interface Technical Reference Manual

IBM BIOS Interface Technical Reference Manual

IBM PS/2 Model 55 LS Publications

Model 55 LS Technical Reference Manual

IBM DOS LAN Requester User's Guide

IBM Operating System/2 Local Area Network Server Version 1.2 Network Administrator's Guide

IBM Operating System/2 Version 1.2 Getting Started

IBM Personal System/2 Adapter/A for Ethernet Networks Technical Reference

IBM Personal System/2 Ethernet LAN Reference for Micro Channel Workstations

IBM Personal System/2 Token-Ring LAN Reference for Micro Channel Workstations

IBM Personal System/2 Fixed Disk Drive Installation Instructions

IBM Personal System/2 Diskette Drive Kit Installation Instructions

IBM Personal System/2 Model 55 LS Setup Instructions

IBM Personal System/2 Model 55 LS Quick Reference

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IBM PS/2 Model P75 486 Publications

IBM PS/2 P75 Technical Reference

IBM PS/2 P75 Quick Reference

IBM PS/2 P75 Hardware Maintenance Library

Additional Publications

IBM PS/2 Hardware Interface Technical Reference Manual

SCSI Architecture and Implementation G24-3507-00

Micro Channel Architecture Bus Master G24-3477-00

A Plain Man's View of the Micro Channel G24-3584-00

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1.0 Introduction

The IBM* announcements during the fourth quarter of 1990 include a number of new machines and peripherals. This document is divided into three sections to reflect the three environments that these systems are intended for.

The first section, "The IBM PS/2* IBM PS/2 Model 90 XP 486 and Model 95 XP 486", discusses two new high-performance workstations. This section also covers some new hard disks, diskette drives, and an external storage enclosure that can be used with these systems.

The second section, "The IBM PS/2 Model 55 LS", introduces a medialess workstation for use in a LAN environment.

The third section, "The IBM PS/2 Model P75 486" explains features of a new high performance portable PS/2 intended for business and professional use.

1.1 How to Read this Document

- To acquire in-depth knowledge of the systems, you can read this document in the order in which it is laid out. A general overview is provided for each of the sections, followed by details of the system components.
- If you are interested in a specific part of one of the systems, the "Contents" section at the beginning of the document lists the headings of each section and subsection, and where they can be found.
- Acronyms and abbreviations are plentiful in the computer industry. You will find that most acronyms are explained the first time they are used. There is also a handy list of abbreviations at the end of the document, under "Abbreviations" on page 165.
- You will also find many technical terms in this document. If these are not defined in the text, please refer to the "Glossary" on page 167.
- The index at the end covers all the systems, so that you can easily use the document as a reference. For additional information, see the "Related Publications" listing for other documents on this subject.

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2.0 Product Positioning

The IBM PS/2 Model 90 XP 486, Model 95 XP 486, and Model 55 LS systems expand the PS/2 product family, and provide new functions and features to bring you better solutions. The Model 90 XP 486 and Model 95 XP 486 are advanced computing systems, ideal for use in environments that require high performance and expandability.

The IBM Model 55 LS is a medialess system, providing access to central LAN data and peripherals, while maintaining security.

The IBM PS/2 Model P75 486 is a high-performance workstation with built-in display. It can be used as a quick-to-install backup unit as well as a professional workstation or as a LAN server. Due to its portability it will find many applications.

These systems are positioned separately below.

2.1 IBM PS/2 Model 90 XP 486 and Model 95 XP 486

The Model 90 XP 486 is now the highest performing desktop workstation in the PS/2 product family. It is ideal as a standalone system running high-performance applications such as Desktop Publishing, Financial Modeling, Design Graphics, and Multi-Media. In addition to its powerful processing, its expansion capabilities allow you to tailor the system to your requirements. You can enhance the system by increasing the amount of memory or storage, adding options like a CD-ROM or a LAN adapter, or upgrading the processor. The result is a system that works the way you want it to.

The Model 95 XP 486 is designed for the multi-user environment. With the appropriate operating system, it can support many LAN workstations as a server, or many dependent workstations as a host. Its floor-standing construction provides enough expandability to handle a large amount of additional storage, options, and peripherals. Combine this with the most powerful processing capability of the PS/2 family, and the Model 95 XP 486 becomes a machine that delivers what you need now, while continuing to satisfy your future requirements.

Both of these systems utilize several technical improvements to provide you with higher resolution, faster throughput, larger capacity, and greater reliability. When you put all of this together, you have systems that will deliver applications never previously envisaged on Personal System/2*:

- The new XGA Video Subsystem provides higher resolution and better graphics performance.
- The PS/2 external SCSI storage enclosure allows you to store up to 2.2 GB of hard disk information in each of its units. Database applications now have access to huge amounts of data, and you can expect to find high capacity files representing digitized audio and visual information residing on file servers.

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- These machines will protect your investment in advanced computing systems. The upgradeable design of the processor means that your system will always be in step with the latest advances in technology.
- Applications today provide more and more features and functions that are demanded in the marketplace. These systems can accommodate these applications, and future enhancements, by allowing up to 64 MB of memory to be installed.

In an ever-changing environment, the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 allow you to take advantage of today's technology, as well as the advances to come.

2.2 IBM PS/2 Model 55 LS

The Model 55 LS is ideal as a network workstation on a token-ring or Ethernet LAN. Because it is medialess, it restricts unauthorized entry and removal of software or data at the workstation. This protects the security and integrity of the LAN by allowing the server to be the single source for storage and maintenance. However, to protect your investment in LAN workstations, the Model 55 LS is also upgradeable. By adding a hard disk or diskette drive, or both, you can customize your system to meet changing requirements. The Model 55 LS provides the flexibility you need in the LAN environment.

2.3 IBM PS/2 Model P75 486

The IBM PS/2 Model P75 486 is a portable high-performance workstation that incorporates the functionality of the IBM PS/2 Model P70 with a lot of enhancements. It provides full XGA graphics and can have external SCSI devices attached. These make it compatible with the IBM Model 90 XP 486 system. Due to its universal capabilities, it can be suited as a LAN server as well as a high performance workstation. As it is portable, it can be taken to places where immediate high-perfomance computing power is needed. The IBM PS/2 Model P75 486 is intended for mobile professionals, engineers and business professionals that require high processing power, connectivity, large data bases and mobility.

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3.0 General System Description

This chapter gives a general overview of the Model 90 XP 486 and Model 95 XP 486 systems. The features of the systems are discussed, and the different models are outlined. Each of the following document sections provides more detailed information about the system elements.

3.1 System Overview

The systems are contained in two product groups. The first is the Model 90 XP 486, a desktop workstation, and the second is the Model 95 XP 486, a floor-standing workstation. Both systems have a number of models that differ in processor speed and hard disk size. The following section contains an overview of the IBM Model 90 XP 486 system. Its models are then outlined in Figure 1. After that is a description of the IBM Model 95 XP 486 system and its models in Figure 2 on page 8. Finally, Figure 3 on page 9 outlines the standard features of both the Model 90 XP 486 and Model 95 XP 486 systems.

3.1.1 IBM Model 90 XP 486 System

The Model 90 XP 486 systems are high-performance desktop personal computers designed for a single user, but also supporting multiple users in both shared-resource and shared-logic environments. Shared-resource refers to a machine, such as a local area network server, that provides common communications, file management, I/O device services and support functions for network-based PS/2s. Servers are specialized systems primarily dedicated to providing network services. A shared-logic machine allocates computing power to users via a centralized processing unit. That is, one machine acts as the host for many users.

The IBM Model 90 XP 486 system provides many expansion options, providing four bays for internal DASD devices, and four 32-bit Micro Channel* I/O expansion slots. One of these comes configured with a SCSI adapter with cache. The processor has been made upgradeable by implementing it on a separate adapter that plugs into the system board. The adapter houses an i486** microprocessor, and allows an optional second-level cache to be installed on it. Memory adapter cards are no longer required, as memory is expandable to 64 MB on riser cards, which are connected to the system board. In addition, each system comes standard with a fixed disk, a diskette drive, two serial ports, a parallel port, a mouse port, the XGA video subsystem, a power supply, a time and date clock, locking frames and covers, and a keyboard. (The keyboard is separate in Europe.)

Model 90 XP 486

The primary operating systems for the Model 90 XP 486 are OS/2* (standard and extended editions), DOS, and AIX/386* PS/2.

3.1.2 Model 90 XP 486 Models

All models of the IBM Model 90 XP 486 system include a common set of features. Specific models vary by processor speed and hard disk size. The different system models are shown in Figure 1. The model numbers vary from country to country. However, the models listed are the models available in the USA/Canada as well as those available in Europe and Asia/Pacific.

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Processor	Hard Disk	USA/Canada	Asia/Pacific	Europe
25 MHz i486	80 MB SCSI	8590 0J5	8590 5J5	8590 AJ5
25 MHz i486	160 MB SCSI	8590 0J9	8590 5J9	8590 AJ9
33 MHz i486	160 MB SCSI			8590 AK9
33 MHz i486	320 MB SCSI	8590 0KD	8590 5KD	8590 AKD

Figure 1. Model 90 XP 486 Models

IBM Model 95 XP 486 System

The Model 95 XP 486 systems, like the Model 90 XP 486 systems, are high-performance personal computers. The Model 95 XP 486 is a floor-standing workstation, designed for a multi-user environment, but also supporting the single user. The IBM Model 95 XP 486 system in a multi-user scenario could be either shared-resource or shared-logic (see 3.1.1, "IBM Model 90 XP 486 System" on page 7 for definitions of shared-resource and shared-logic).

Like the Model 90 XP 486, the Model 95 XP 486 has a very flexible design. Seven bays are provided for internal devices, and eight 32-bit Micro Channel I/O expansion slots are standard. Two of these slots come pre-configured, one with a SCSI adapter with cache and one with an XGA adapter/A. to provide video functions. Again, the processor is installed on a separate card that plugs into the system board. An optional second-level cache can be attached to this processor adapter. This design provides flexibility by allowing both a processor upgrade and the addition of cache. The system supports 64 MB of memory on the planar, eliminating the need for memory adapter cards. Finally, each system comes standard with a hard disk, a diskette drive, a serial port, a parallel port, a mouse port, a power supply, a time and date clock, locking frames and covers, and a keyboard (the keyboard is separate in Europe).

The primary operating systems for the Model 95 XP 486 are the same as those for the Model 90 XP 486: OS/2 (standard and extended editions), DOS, and AIX/386 PS/2.

3.1.3 Model 95 XP 486 Models

As with the Model 90 XP 486, all models of the IBM Model 95 XP 486 system include a common set of features. The different models of the Model 95 XP 486 system again vary only by processor speed and hard disk size. Each model of the IBM Model 95 XP 486 system is described in Figure 2. The model numbers vary from country to country. However, the models listed are the models available in USA/Canada as well as those available in Europe and Asia/Pacific.

Processor	Hard Disk	USA/Canada	Asia/Pacific	Europe
25 MHz i486	160 MB SCSI	8595 0J9	8595 5J9	8595 AJ9
25 MHz i486	320 MB SCSI	8595 0JD	8595 5JD	8595 AJD
33 MHz i486	160 MB SCSI			8595 AK9
33 MHz i486	320 MB SCSI	8595 0KD	8595 5KD	8595 AKD

Figure 2. Model 95 XP 486 Models

3.1.4 Model 90 XP 486 and Model 95 XP 486 Standard Feature Set

The Model 90 XP 486 and Model 95 XP 486 systems each have a number of different models that vary by processor speed and hard disk size. Each of these systems have a number of features that come standard with every model. Figure 3 outlines the standard features for both the Model 90 XP 486 and Model 95 XP 486 Systems.

	Model 90 XP 486	**Model 95 XP 486**
Memory (Standard)	4 MB (70 ns)	4 MB (70 ns)
Diskette Drive	3.5" 1.44 MB	3.5" 1.44 MB
Micro Channel Slots	4 (3 available)	8 (6 available)
Video Subsystem	XGA on planar	XGA on adapter
DASD Bays	4	7
Keyboard	Enhanced	Enhanced
LED Panel	No	Yes
Serial Port	One 25 pin, One 9 pin	One 25 pin
Parallel Port	Yes	Yes
Keyboard Port	Yes	Yes
Mouse Port	Yes	Yes
Processor Adapter Connector	Yes	Yes
Disk Interface	SCSI adapter with cache	SCSI adapter with cache
Note: The keyboard has to be ordered separately in Europe.		

Figure 3. Comparison of Model 90 XP 486 and Model 95 XP 486 Standard Feature Sets

4.0 System Details and Planar Functions

This chapter covers the functions of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems located on the planar board and other additional system features.

4.1 Overview

The following sections cover the physical specifications for both systems and the features integrated onto the planar board.

As many features on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are functionally equivalent, all of the following sections apply to both the IBM Model 90 XP 486 system and IBM Model 95 XP 486 system unless a difference is stated.

We will discuss:

- Physical specifications
- Micro Channel slot layouts
- Battery and CMOS RAM
- Keyboard and mouse ports
- Security
- Power supply
- LED display (PS/2 Model 95 Only)
- DMA parallel port
- DMA serial port
- Direct memory access (relating to the serial and parallel ports).

4.2 Physical Specifications

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems have a slightly different appearance from previous PS/2 systems. These differences are discussed in the following section. The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems' physical specifications are listed in Figure 4 on page 12 and Figure 5 on page 13, and they are compared with the PS/2 Model 70 and 80 respectively.

4.2.1 Model 90 XP 486 Physical Specifications

The IBM Model 90 XP 486 system is much like the PS/2 Model 70 in that both are desktop computers with the same basic appearance.

The IBM Model 90 XP 486 system is wider and slightly deeper than the Model 70. It is slightly heavier as well. The appearance of the system is basically identical to the Model 70, with a few changes.

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The on/off switch is now located on the front left of the machine, not on the front right like the Model 70. The switch is no longer a mechanical flip switch. It is now an electronic pushbutton switch. This change makes it easier for users with special needs to operate the machine, as only direct pressure is required on the switch, not a "flipping" action.

To the right of the on/off switch there is the green power-on LED. Above this is a yellow hard disk access LED. This LED is used by any and all hard disk devices and is not driven by the disk but is a system-driven indicator. In addition, the diskette drive has its own LED. Each additional removable media device comes with a kit that includes a drive cover called a "bezel". The bezel has a slot through which the medium is removed, and a bulb that the drive's LED shines through.

The cover of the system is designed to be easily removable without tools. A key lock is provided on the back of the system to provide physical security.

The IBM Model 90 XP 486 system must be operated in a horizontal position only.

	Model 90 XP 486	PS/2 Model 70
Height	140mm (5.5")	140mm (5.5")
Width	440mm (17.3")	360mm (14.2")
Depth	430mm (16.9")	420mm (16.5")
Weight (standard config.)	11.8 kg (26 pounds)	9.5 kg (21 pounds)

Figure 4. IBM Model 90 XP 486 System Size and Weight Specifications

4.2.2 Model 95 XP 486 Physical Specifications

The IBM Model 95 XP 486 system has a somewhat different appearance from the PS/2 Model 80. Both are floor-standing systems that save valuable desk space. The Model 95 XP 486 is shorter, but is slightly wider and deeper. The reduced height of the system allows it to fit more easily underneath a desk or table. The top right of the system has an electronic pushbutton switch rather than the physically operated switch found on previous PS/2 systems. The flip switch has been replaced with a pushbutton to allow disabled users to simply push the switch, rather than requiring a "flipping" action.

To the left of the power button is the green power-on LED. There is no hard disk access LED on the IBM Model 95 XP 486 system. On the top left of the machine is an information panel. This is an eight-character LED display that is used to indicate error conditions. When there is no monitor attached to the system, this information panel is the main means of communicating errors during the power-on self test.

In addition, the diskette drive has its own LED. Each additional removable media device comes with a kit that includes a drive cover called a "bezel". The bezel has a slot through which the medium is removed, and a bulb that the drive's LED shines through.

The system can be accessed internally by removing the front cover and then the system's left side panel. Both can be removed without tools.

A key lock is conveniently located on the lower front of the machine to provide internal security.

The IBM Model 95 XP 486 system must be operated in a vertical position only. There is also no external handle on the Model 95 XP 486 system.

	Model 95 XP 486	PS/2 Model 80
Height	501mm (19.75")	597mm (23.5")
Width	203.2mm (8.0")	166mm (6.5")
Depth	508mm (20.0")	482mm (19.0")
Weight (standard config.)	22.7kg (50 pounds)	20.6kg (45.3 pounds)

Figure 5. IBM Model 95 XP 486 System Size and Weight Specifications

4.3 Operating System Support

This section details the Operating Systems supported on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems and statements of direction that describe future plans.

4.3.1 Overall System Support

The following Operating Systems are supported on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems:

- DOS 3.3

  This operating system supports two hard disks.

- DOS 4.0

  With CSD UR29015 (or later) installed, DOS 4.0 will support up to seven hard disks and provide correct expanded memory support (EMS). With CSD UR 31300 installed, DOS 4.0 will correctly support three diskette drives in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

- OS/2 Standard Edition 1.2 and OS/2 Extended Edition 1.2

  This operating system supports up to seven hard disks.

- OS/2 Standard Edition 1.3 and OS/2 Extended Edition 1.3

  This operating system supports up to seven hard disks.

4.3.2 Total System Memory

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems both support up to 64 MB of memory.

All current version of DOS and OS/2 will NOT support more than 16 MB of memory installed in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. Please refer to chapter 6.0, "Memory Subsystem" on page 31 for more details on system memory support.

4.3.3 Statements of Direction

There are three main statements of direction for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems that relate to operating system support:

- IBM intends that OS/2 will support the full memory capability of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.
- IBM intends to support the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems with the Advanced Interactive Executive Personal System/2 (AIX PS/2).
- IBM intends to support the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems with the IBM 4680 Operating System Version 2 and Version 3.
- Support for up to 64 MB of memory installed on the planar of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

Confirmation

All of the items listed in here are **"Statements of Direction"**. In no way, they reflect currently available products or functions.

4.4 Micro Channel Slot Layout

- IBM Model 90 XP 486 System

  The IBM Model 90 XP 486 system has four 32-bit Micro Channel slots. Slot 1 is taken up by the SCSI adapter so there are three slots available for the user.

  Slot 3 has an Auxiliary Video Extension (AVE) for adapters that require it (the M-Motion adapter is an example). Figure 6 shows the Micro Channel slot layout in the IBM Model 90 XP 486 system.

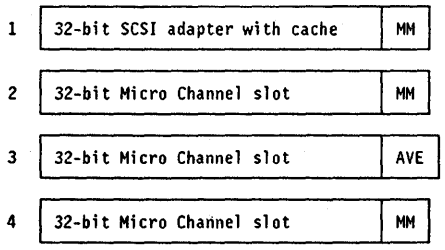

Figure 6. Micro Channel Slots in IBM Model 90 XP 486 System

- IBM Model 95 XP 486 System

  The IBM Model 95 XP 486 system has eight 32-bit Micro Channel slots. Slot 1 is taken up by the SCSI adapter, and slot 5 is taken up by the XGA adapter/A. This means that six slots are available for the user.

  Slot 7 has an "Auxiliary Video Extension" (AVE) for adapters that require it and slot 5 has a new "Base Video Extension" (BVE). This is covered is more detail in section 9.2.7, "Video Extension Support" on page 87.

  Figure 7 on page 15 shows the layout of the 32-bit slots in the IBM Model 95 XP 486 system.

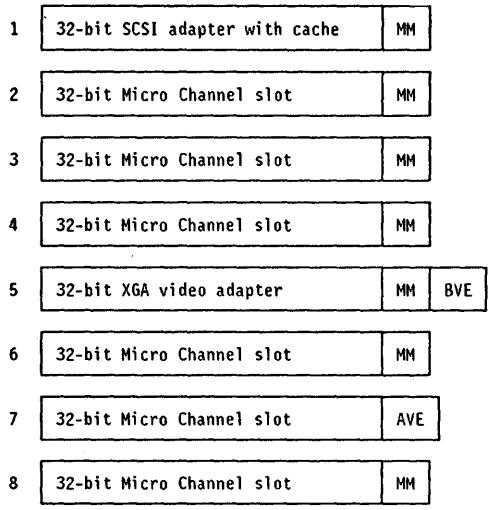

Figure 7. Micro Channel Slots in IBM Model 95 XP 486 System

4.4.1 Micro Channel Adapters - Special Considerations

The following IBM PS/2 Micro Channel adapters have some special installation requirements. All other IBM PS/2 adapters do not have the restrictions outlined below.

- IBM PS/2 Realtime Interface Co-Processor Multiport/2
- IBM PS/2 Realtime Interface Co-Processor Portmaster Adapter/A

These adapters *cannot* be installed in slot 4 on the IBM Model 90 XP 486 system system or slot 8 on the IBM Model 95 XP 486 system system.

4.4.2 Micro Channel Architecture - Features Supported

All of the 32-bit Micro Channel slots on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are full 32-bit implementations of the Micro Channel Architecture.

In addition to the basic Micro Channel features the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems support the following enhancements to the Micro Channel architecture that were announced in November 1989:

- Data parity

  This is supported on the Micro Channel for peer-to-peer transfers between supporting adapters.

- Address parity

  This is supported on the Micro Channel for peer to peer transfers between supporting adapters.

- Streaming data procedure

  This is supported up to 80 MBps using a 64 bit data path and a 100 ns cycle. It is supported on the Micro Channel for peer-to-peer transfers between supporting adapters.

These three new Micro Channel features are implemented on the planar boards of the Model 90 XP 486 and Model 95 XP 486 systems.

For more details on these Micro Channel features please refer to Appendix A, "Micro Channel" on page 137.

4.5 Battery and CMOS RAM

The real-time clock and CMOS RAM subsystem in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are functionally equivalent to those in previous PS/2 systems. However, the physical implementation is different.

A separate battery is used to support the two modules that are described below. It is a flat 3-V coin cell. The life expectancy of the battery is 7 to 10 years depending on system usage.

- Real-Time Clock

  The real-time clock provides a complete time-of-day clock and 100-year calendar. Also, it contains 64 bytes of nonvolatile RAM. This RAM is used to store system setup information such as the system password.

- 8 KB CMOS RAM

  This is an additional 8 KB of nonvolatile RAM used to store the system configuration and other system information.

4.6 Keyboard and Mouse Ports

The keyboard and mouse ports on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are functionally equivalent to those in previous PS/2 systems. They are designed to support the IBM enhanced keyboard and IBM mouse.

In addition, the new keyboard/mouse controller used on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 system provides additional functions for mouse support. These include the ability to separately receive and send data to the keyboard and mouse ports simultaneously. This is not possible on previous PS/2 systems as only one I/O port is used for both keyboard and mouse data. For details of these new functions please refer to the *Hardware Interface Technical Reference Manual*.

4.7 Security

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems provide both physical and password security. Password security is implemented with both a power-on password and a keyboard disable password. Both of these password securities are optional.

Power-On Password

The power-on password is set using the system program "Set Features" option. A combination of up to seven characters (A to Z and 0 to 9) are allowed for the password. Once set, the password must be typed when the password prompt appears during system power-up. If the password is entered correctly an OK message will be displayed. If it is entered incorrectly three times, you must power off the system for at least five seconds before attempting to start the system again.

Changing Power on Password: To change the power-on password you must power the system on and when you have entered the old password press the space bar and enter the new password.

Password Forgotten: If the user forgets the system password it is no longer necessary to remove the system battery.

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems have different methods of removing the old password:

- IBM Model 90 XP 486 System

  There is a three-pin connector on the planar board marked J10. This is located on the planar, beside the first memory riser. It has a jumper over two of the three pins. To remove the password simply toggle the jumper so that it covers the center pin and the other pin that is currently visible. You do not have to reposition it again.

- IBM Model 95 XP 486 System

  There is a three-pin connector on the planar board marked J16. This is located on the planar, above the memory SIMM sockets. It has a jumper over two of the three pins. To remove the password simply toggle the jumper so that it covers the center pin and the other pin that is currently visible. You do not have to reposition it again.

Keyboard Password

The keyboard password program is located on the reference diskette. It can only be used under DOS or in the DOS compatibility box under any version of OS/2. Details on how to set and use this program can be found in the *Guide to Operations* for the IBM Model 90 XP 486 system or IBM Model 95 XP 486 system.

Server Password

A server password can be set that allows the system to be accessed across the network while its keyboard is locked. This is particularly useful if the system is being used as a server. It is set using the system programs on the reference diskette or in the system partition.

Physical Security

Physical security differs slightly between the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems:

- IBM Model 90 XP 486 system

  The IBM Model 90 XP 486 system has the following physical security features:

  A mechanical lock on the back of the system, to allow the user to lock the system unit cover only.

  A bolt hole for securing the system unit to a desk.

- IBM Model 95 XP 486 System

  The IBM Model 95 XP 486 system system has the following physical security feature:

  A mechanical lock on the front of the system to allow the user to lock the system unit cover only.

4.7.1 SCSI Security

A security issue exists with the Small Computer Systems Interface (SCSI). This is because the SCSI adapter installed in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 has an external port to which external devices can be attached.

Please refer to the ITSC document *SCSI Architecture and Implementation* for full details of the SCSI system and why the security issue exists.

4.8 Power Supply

The power supplies on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are different so they will be covered in separate sections:

4.8.1 IBM 8590 XP 486

The IBM Model 90 XP 486 system comes with a 194 W auto sensing power supply. This provides power to the system and to the DASD storage devices that are installed in the system. Power is supplied to DASD devices in these storage bays via a three-connector power cable that is supplied with the system. This cable connects to the single power outlet on the power supply.

Power Supply Input: (Range is auto sensing)	
Low Range	90 (min) - 137 (max) Vac
High Range	180 (min) - 265 (max) Vac

Figure 8. Model 90 XP 486 power supply specifications

The power supply is actuated differently from previous PS/2 systems. The on/off switch is no longer a mechanical switch. It is electrical. It is located at the front of the system and is a push-lock/push-release type of switch. When the system is turned on, the switch will be indented by 4 mm to show that power is on.

Warning!

When removing a diskette from the diskette drive, please ensure that you do not depress the on/off switch by mistake as you may power the system off instead.

4.8.2 IBM 8595 XP 486

The IBM Model 95 XP 486 system comes with a 329 W power supply. It is a switched power supply. You have to ensure that the power supply has been switched to the correct range.

Power Supply Input: (Range is switch selectable)	
Low Range	90 (min) - 137 (max) Vac
High Range	180 (min) - 265 (max) Vac

Figure 9. Model 95 XP 486 power supply specifications

This provides power to the system and to the DASD storage devices that are installed in the system. Power is supplied to DASD devices in these storage

bays via a maximum of three power cables that are supplied with the system. These cables connect to three power outlets on the power supply and each will provide power to two DASD devices.

The power supply is actuated differently from previous PS/2 systems. The on/off switch is no longer a mechanical switch. It is electrical. It is located at the front of the system and is a push-lock/push-release type of switch. When the system is switched on, the switch will be indented by 4 mm to show that power is on.

Warning!

When removing a diskette from the diskette drive, please ensure that you do not depress the on/off switch by mistake, as you may power the system off instead.

Moving the Power Supply to Install Memory

The planar memory on the IBM Model 95 XP 486 system is located behind the power supply. When extra memory is being installed, you must move the power supply.

On the front of the power supply there is a spring-loaded power supply retaining knob. Rotate this about four times until it releases the power supply which you can then tilt out of the system. The power supply is not completely removed from the system unit.

Warning!

When moving the power supply ensure that the power cable has been removed from the back of the power supply.

4.9 LED Display (PS/2 Model 95 Only)

The IBM Model 95 XP 486 system has a new information panel located at the top of the system unit on the front. This LED panel is used to indicate errors to the user during POST. When an IBM Model 95 XP 486 system is being used without a display, the information panel will be the main means passing on error information to the user. Figure 10 shows how the error codes on the eight-character display can be interpreted.

RES	DEVICE #	ERROR #	DEVICE SPECIFIC	DEVICE SPECIFIC
X	XXX	XX	X	X

Figure 10. Error Code Structure - PS/2 Model 8595

Each of the sections in the error code structure in Figure 10 is explained below:

- Reserved

  This code is currently used to indicate only IML-related errors.

- Device

The three-character device number is a specific number assigned to each Field Replaceable Unit (FRU). It indicates the device that is being tested or is faulty.

- Error

  The two-character error code defines the specific error found in the device. Using two characters for each device enables the system to diagnose errors more efficiently.

- Device specific

  The first of the device-specific codes is used to determine the exact location of the device (slot or bay and so on).

- Device specific

  The second of the device-specific codes is used to determine the size of the particular device (size of hard disk or size of memory for example).

A full listing of all of the error codes can be found in the *Hardware Maintenance and Reference Manual* for each system. Although the error structure is different, the actual error codes seen on the previous PS/2 systems have the same meaning. A 165 error on a previous PS/2 system indicates a system configuration error and on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems it means exactly the same but will be displayed inside an eight-digit code.

For the IBM Model 90 XP 486 system all error codes are displayed on the primary display attached to the system. Some examples of error codes can be found in Appendix D, "List of IML Errors" on page 157.

4.10 Serial Ports

This section describes the serial ports on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

4.10.1 Serial Ports Overview

The IBM Model 90 XP 486 system comes with two standard DMA serial ports. One has a 9-pin external connector and one has a 25-pin external connector. Both of these serial ports are functionally equivalent. The only difference is the size of the external port.

The IBM Model 95 XP 486 system comes with one serial port as standard. This has the 25-pin external connector. This serial port is functionally equivalent to the IBM Model 90 XP 486 system serial ports.

4.10.2 Serial Port - Details

All of the information in this section refers to the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 25-pin serial ports, and the IBM Model 90 XP 486 system 9-pin serial port. For more detailed information on programming the new serial ports please refer to the *Hardware Interface Technical Reference Manual*.

The serial ports have many new features:

- New DMA modes for transmit and receive
- Received Data Status (RDS) available per character

- New transmit command
- Transfer speed from 300 bps to 345 Kbps.

We will cover each of these new functions in more detail.

New DMA modes: The serial ports can now use the DMA controller to transfer data into the system. When the system is first powered on, the serial ports function like the serial port on previous PS/2 systems. It is only when the serial port controller chip is programmed directly that the serial ports will operate in DMA mode.

To use the DMA mode, two DMA channels are required. One is for transmitting and one for receiving data. The arbitration levels for the DMA channels is set using the system programs located in the system partition or on the reference diskette. The DMA function allows for high-speed data transfer to and from the serial port.

Received Data Status: Received data status is an optional status byte used for each data byte that is received when the serial port is in DMA receive mode.

New Transmit Command: There are some new transmit commands to provide better software control for the user:

Start sending - starts or continues transmitting

Stop sending - stops transmitting.

These commands enable the user to insert characters into the data stream as it is being transmitted.

Transfer speeds: The serial ports now support speeds up to 345.6 Kbps (kilobits per second). To actually use the serial ports at this speed, a specially shielded cable is needed. For details on this cabling please refer to the *Technical Reference Manual* for the IBM Model 90 XP 486 system or IBM Model 95 XP 486 system.

4.10.3 Serial Port Connectors

Both the 9-pin and 25-pin serial ports use a male D-shell connector and pin assignments for the industry standard RS-232C protocol.

Figure 11 shows the pin assignments for the 25-pin connector found on both the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

Pin	I/O	Signal Names	Pin	I/O	Signal Names
1	N/A	Not connected	14	N/A	Not connected
2	O	Transmit data	15	N/A	Not connected
3	I	Receive data	16	N/A	Not connected
4	O	Request to send	17	N/A	Not connected
5	I	Clear to send	18	N/A	Not connected
6	I	Data set ready	19	N/A	Not connected
7	N/A	Signal ground	20	O	Data term ready
8	N/A	Data carrier detect	21	N/A	Not connected
9	N/A	Not connected	22	I	Ring indicator
10	N/A	Not connected	23	N/A	Not connected
11	N/A	Not connected	24	N/A	Not connected
12	I	Data rate RS232-C	25	N/A	Not connected
13	N/A	Not connected	-	-	-

Figure 11. 25-Pin D-shell Connector - Serial Port Pinouts

Figure 12 shows the pin assignments for the 9-pin connector found on the IBM Model 90 XP 486 system only.

Pin	I/O	Signal Names
1	I	Data carrier detect
2	I	Receive data
3	O	Serial data out
4	O	Data terminal ready
5	N/A	Ground
6	I	Data set ready
7	O	Request to send
8	I	Clear to send
9	N/A	Ring indicator

Figure 12. 9-Pin D-shell Connector - Serial Port Pinouts

4.10.4 Serial Port Numbering

When the IBM Model 90 XP 486 system is first powered on, the 25-pin serial port is assigned as COM1 and the 9-pin serial port is assigned as COM2. For the IBM Model 95 XP 486 system the 25-pin serial port is assigned COM1.

In both the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, the built in serial ports can be assigned to COM1 - COM8. This indicates that the maximum number of serial ports supported in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems is eight.

4.11 Parallel Port

The parallel ports on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems are functionally equivalent to the parallel ports on previous PS/2 systems, supporting bidirectional input and output. Also it can be used for DMA data transfers.

The DMA support for the parallel port allows high-speed data transfer between system memory and devices attached to the parallel port.

Operating system support for the DMA mode of the parallel port is provided by OS/2 SE V 1.2 and OS/2 EE V 1.2 or later versions. DOS applications can use the DMA capability through the BIOS interface only.

The arbitration levels for the DMA channels are set using the system programs located in the system partition or on the reference diskette.

4.12 Direct Memory Access (DMA)

This section will explain Direct Memory Access (DMA) and relate it to the DMA serial and DMA parallel ports on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

4.12.1 DMA Operation

The DMA controller is a device that performs data transfer between an I/O adapter and system memory. Unlike programmed I/O and other data transfer methods, DMA does not use the system processor in the actual data transfer operation.

The following section covers a normal DMA operation after a program has requested to receive or send data to an I/O device:

1. DMA initialization

   This is the only time that the system processor gets involved. The system processor initializes the DMA controller with the address and amount of data to be transferred. It then sends the commands necessary to make the I/O device start the actual I/O operation.

2. Getting control of the Micro Channel

   Once the I/O device is ready to send or receive data it arbitrates for the Micro Channel. The arbitration level corresponds to a particular set of registers in the DMA controller commonly known as the DMA channel (each I/O device that uses the DMA controller has its own DMA channel). When the Micro Channel arbitration controller raises the GRANT line on the bus, the DMA controller checks to see if the arbitration level is the same as one of its DMA channels. If it is the DMA controller takes control of the Micro Channel bus.

3. Data transfer from I/O device to DMA controller

   Once the DMA controller has control of the Micro Channel it issues an I/O read to the winning I/O device. The I/O device then places its data onto the data bus and the DMA controller reads the data into the data registers set aside for the I/O device (see transfer number 1 on Figure 13 on page 24).

4. Data transfer to memory

   The DMA controller then transfers the data from its own internal registers to the address in memory that it was previously given by the system processor (see transfer number 2 on Figure 13). If there is more data to transfer (the DMA controller knows how much it needs to transfer as it was told previously by the system processor), the DMA controller will perform further I/O reads to the I/O device.

The important point about DMA is that although it is not technically "direct", it does not use the system processor to perform the actual data transfer. This means that the system processor is free to handle other operations.

When running in normal mode (not DMA mode), the serial and parallel ports on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 use programmed I/O to perform data transfers. This method uses far more processor cycles then DMA mode. For this reason, when high-speed data transfers are being used on the serial or parallel ports, it is more efficient to use the DMA mode.

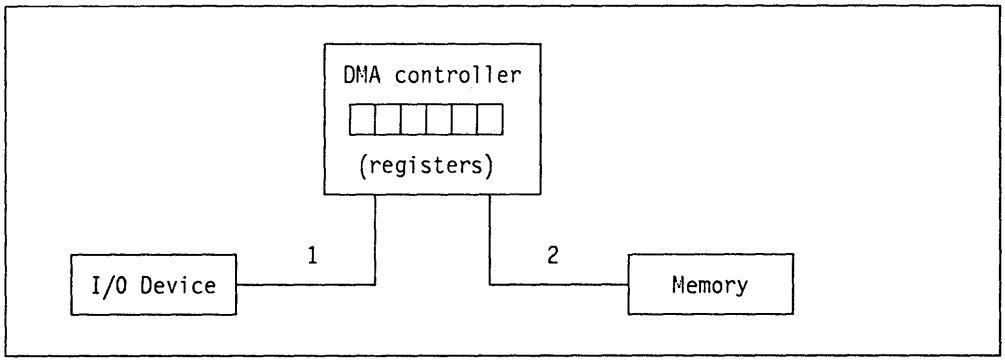

Figure 13. Basic DMA Two Stage Transfer

5.0 Processor Adapter

This chapter describes the implementation of the processor adapter in the Model 90 XP 486 and Model 95 XP 486 systems.

5.1 Processor Adapter General Description

The implementation of the processor in the Model 90 XP 486 and Model 95 XP 486 systems is quite different from that of previous PS/2 systems. The CPU complex is no longer on the planar board. Instead, all CPU-related functions are integrated onto one 11.5 x 4.3 inch adapter that attaches to the rest of the planar via a connector. The advantage of this configuration is that the processor and all its associated components are now easily upgradeable by simply replacing the processor adapter.

The processor adapter requires the connector, which is provided on the planar of the Model 90 XP 486 and Model 95 XP 486 systems. No card other than the processor adapter can be installed in this processor card connector, nor can the processor adapter be installed in any Micro Channel slot.

The processor adapter card comes in two variations.

- Processor Adapter 25 MHz
- Processor Adapter 33 MHz

Both the processor adapter 25 MHz and processor adapter 33 MHz house the i486** microprocessor, they simply run at different speeds. Aside from the speed of the processor, the adapters are functionally identical.

5.1.1 Connection to the Planar

The processor adapter attaches to the planar via two 164-pin, 82-position connectors called the "Processor Interface Connection". This connection is common to both the Model 90 XP 486 and Model 95 XP 486 systems. It is the only connection between the processor and the planar. Figure 14 on page 27 illustrates how the Processor Adapter connects to the rest of the system. The connection provides:

- A 32-bit interface to the Micro Channel
- The planar signals that connect the processor complex to the planar I/O functions
- Two 32-bit interfaces between the memory controller on the processor card and the memory SIMMS.

In more detail, the Micro Channel interface allows the processor adapter to access the cards plugged into the 32-bit I/O slots.

The planar signals provide an interface between the processor adapter and planar functions such as the parallel, serial, keyboard, and mouse ports.

The memory interfaces provide the only access to the planar memory. This means that all memory access must be done through the memory controller contained on the processor adapter.

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5.1.2 Processor Adapter Installation

The processor adapter simply plugs into the Processor Interface Connection. A blue lever called an extractor is provided at either end of the adapter. These levers hook into slots on the chassis of the system, and help to guide the adapter into position correctly, and to help remove it. They also provide additional insertion force, so that rather than using 17 pounds of force to insert the adapter, the use of the levers requires you to use only five pounds.

The type of processor adapter installed will be recognized by the system at startup. If the processor adapter is removed and another processor adapter installed, the system will prompt you to run auto configuration, and the new card will then be recognized. There are no device drivers or additional actions required. Usually this type of adapter replacement will be done when the system is being upgraded from a 25 MHz model to a 33 Mhz CPU speed by replacing the processor adapter.

5.1.3 Elements of the Processor Adapter

The processor adapter 25 MHz and the processor adapter 33 MHz are made up of a number of basic logic elements:

- Intel 25 or 33 MHz i486 microprocessor
- Data buffers
- Memory controller
- DMA (direct memory access) chip
- ROM subsystem
- Optional cache.

These elements, along with the processor card connector and its connection to the planar are illustrated in Figure 14 on page 27. The i486 microprocessor, data buffers, and optional cache are explained in the remainder of this chapter. A description of the memory controller can be found in section 6.3, "Memory Controller" on page 34. The DMA chip is described in section 6.5, "DMA Controller" on page 40. Finally, the ROM Subsystem is overviewed in section 7.3.1, "ROM Based Code" on page 46.

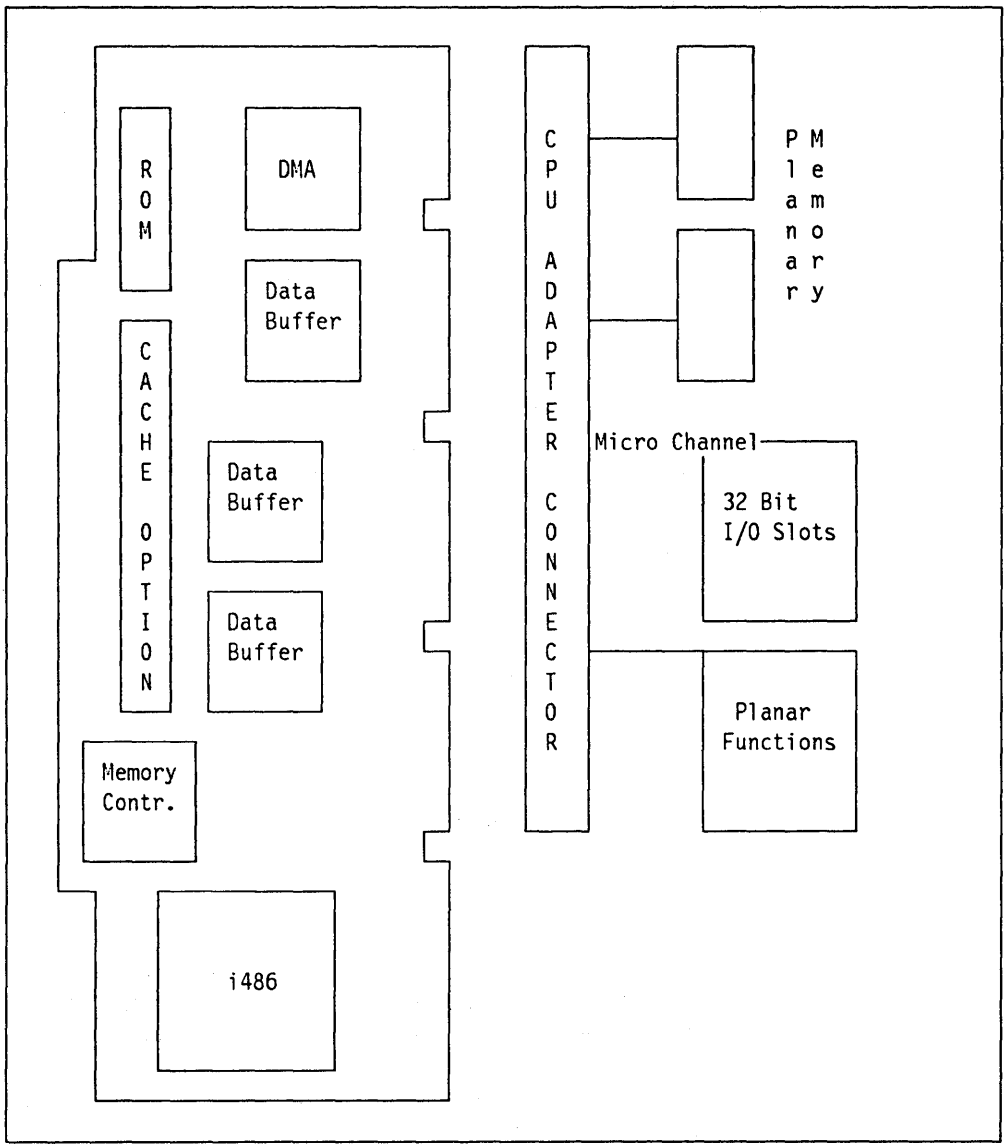

Figure 14. Processor Adapter Block Diagram

5.2 i486 Processor

The microprocessor used in the Model 90 XP 486 and Model 95 XP 486 systems is the i486, commonly known as the i486. It is a high-performance microprocessor that is available in two speeds, 25 MHz and 33 MHz. Both its data and address buses are a full 32-bit implementation, allowing it to address a 4 GB physical address space, and a 64 terabyte virtual address space. The processor is still fully compatible with 8 and 16-bit devices and adapter cards.

The chip itself provides memory management, a floating point unit, and a cache memory unit that are capable of supporting a multitasking operating system. The cache memory unit is a four-way set associative 8 KB code and data cache that decreases memory access time, and improves overall system performance. The i486 also provides for multiprocessor support, and allows an optional second level cache to be used (see section 5.4, "256 KB Cache Option" on page 28 for a discussion of cache).

The i486 improves overall system performance by including a pipelined architecture, paging, and dynamic data bus sizing. Frequently used instructions execute in one cycle, in the style of a RISC system. In fact, the performance of the i486 chip can be greater than twice that of the 80386. In addition, the chip includes an 80387 compatible math coprocessor to improve the performance of numerically intensive applications.

To protect software investments, the i486 is 100% code compatible with the Intel 8086, 80286, and 80386 microprocessors.[^] It can also run in three different modes:

- Real address mode runs programs written for the 8086** or 8088** processors, or for the real address mode of an 80286** or 80386** processor.
- Virtual 8086 mode allows not only for multiple 8086 programs to run, but for these multiple programs to run in multitasking mode with other i486 programs.
- Protected virtual address mode allows the running of programs written for the protected mode of the 80286 or 80386 processors.

Finally, the processor has a built-in self test that checks out the on-chip logic and cache memory at system startup.

5.3 Data Buffers

The processor adapter has three data buffers. Two of these are connected to the two memory banks on the planar, and one is connected to the Micro Channel. The main purpose of these buffers is to ensure that the processor receives its data on the correct lines. For example, the processor expects 32 bits of data. If a device on the Micro Channel sends 8 bits, the data buffer will make sure the bits arrive on the data lines that the processor will be expecting. The data buffers attached to the planar memory have an additional function. They allow 64 bits of data to be held at a time. This allows the processor to access the first 32 bits of data, and then very quickly access the second 32 bits, without refilling the buffers. This ability speeds up access to memory, and improves system performance.

5.4 256 KB Cache Option

The 256 KB cache is an add-on to the processor adapter. It is a 5.5 x 3.0 inch card that connects to either the processor adapter 25 MHz or the processor adapter 33 MHz. The connection is made up of 160 pins arranged in four columns and 40 rows. The processor adapter provides all the power required to drive the 256 KB cache.

[^] 8086,8088,80286,80386, and 80387 are trademarks of Intel Corporation

5.4.1 General Cache Operation

Cache memory increases system performance by satisfying a memory read request at full processor speed. This is faster than an access to memory on the planar. An access to memory on the planar requires a number of operations to take place. First, the address must be calculated. Then a 16 KB line of cache in either the i486 cache or in the optional cache must be filled using data from memory starting at the calculated address. (The reason this is done is because most memory accesses are sequential, so by filling a line of cache in this way we are more likely to find our data in the cache on our next access.) Filling the cache line requires a number of writes to the cache. All of this takes time. When an access is done from the cache, the data is simply addressed and accessed, with no additional overhead.

In addition, cache memory uses Static Random Access Memory (SRAM), as opposed to the Dynamic Random Access Memory (DRAM) used for system memory. Although SRAM is more expensive, and requires more power, it is much faster than DRAM.

All of this means that caching improves the performance of your system by reducing the amount of time it takes to access data.

5.4.2 Second Level Cache Operation

The Optional Cache Card provides an additional 256 KB of cache memory to hold instructions or data for the processor. This additional cache memory, also called "second-level cache", works together with the 8 KB of cache memory native to the i486 processor (see section 5.2, "i486 Processor" on page 27 for more information about the i486). If the processor cannot find what it needs in the i486 cache (a first-level "cache miss"), it then looks in the additional cache memory. If it finds the code or data there (a second-level "cache hit"), the processor will use it, and continue. If the data is in neither of the caches, an access to planar memory must be done.

5.4.3 Cache Performance

Both caches reduce the number of clock cycles required for a memory access. This is the way it works. When the CPU requires instructions or data, it always requests 128 bits at a time. This information is available in groups of 32 bits, so four memory accesses must be done. In previous PS/2 systems, this may require three clock cycles for each access, for a total of 12. In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, most of the calculation and setup is done when the first 32 bits are accessed, so that the next three 32-bit groups are accessed more quickly. The four accesses take 4, 1, 2, and 1 clock cycle, respectively, for a total of 8. When the information required is found in the second-level cache, the access time decreases. Now the four accesses take 2, 1, 1, and 1 clock cycle, respectively, for a total of 5. If the information is found in the first-level cache, the access time decreases even further. To translate these clock cycles into time, a clock cycle on the 33 MHz processor card requires 30 nanoseconds, while a cycle on the 25 MHz processor card requires 40 nanoseconds. What all this means is that by using the caches, applications can spend less time waiting for memory access, resulting in better performance.

Note: The example explained above describes a memory read on a page hit. The access times will be different in other situations.

5.4.4 Cache Card Components

The 256 KB cache is made up of three basic logic elements:

- 256 KB of SRAM
- 4 KB of TAG SRAM
- A cache controller.

The 256 KB of Static Random Access Memory makes up the cache itself. It is referred to here as "Data SRAM". This storage is two-way set associative, which allows each index location in the cache to store two pieces of information. This method improves the hit ratio, and decreases the number of times that cache items must be removed to make room for new items.

The 4 KB of "TAG SRAM" stores some of the cache item's address bits, used to store and locate the item, and some bits used for validity checking.

The "Cache Controller" coordinates access to the SRAM. On a cache-hit, the controller organizes the access of the data from the data SRAM using the TAG SRAM address. On a cache-miss, the controller places the new data into the cache, updating the TAG SRAM and data SRAM at the correct index location. The controller is also responsible for ensuring that the address being searched for is actually a cacheable address. If not, no cache search will be done. (See Figure 19 on page 35 for information about cacheable and non-cacheable addresses.)

5.4.5 Optional Cache Card Installation

The installation of the 256 KB cache is as easy as plugging it into the corresponding attachment on the processor adapter. One pin, called the "key", has been removed to provide a guide for inserting the card correctly. When installing the 256 KB cache, be aware that there is no need to reconfigure the system to have it recognize the additional cache. The processor will simply begin to use it. Therefore, the cache will not appear in the configuration of the system when viewed from the reference diskette.

6.0 Memory Subsystem

This chapter covers memory management in the Model 90 XP 486 and Model 95 XP 486 systems.

6.1 Overview

The memory subsystem in the Model 90 XP 486 and Model 95 XP 486 systems has some new functions, which have been implemented by a new memory controller:

- Dual bus memory

  Devices or bus masters on the Micro Channel can be accessing memory at the same time as the Intel i486 main processor is executing instructions held in local buffers, cache or memory.

- Memory interleaving

  Interleaved memory architecture allows memory to be accessed more quickly. In previous PS/2 systems, a separate memory access must be done for every 32 bits of information the processor requires. In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, 64 bits of information are available at a time. The first 32 bits are addressed, and the next 32 bits are immediately available.

- Planar Memory

  All system memory is installed on the planar board of the IBM Model 95 XP 486 system and in the IBM Model 90 XP 486 system the memory is installed on two "riser cards" that plug into the planar board.

- Cache

  There are two caches available:

  - The 8 KB cache within the i486
  - An optional 256 KB external cache.

  Both caches are arranged in lines of 16 bytes

  - 512 lines for the internal cache
  - 16384 lines for the optional cache

The cache memory is managed by the memory controller.

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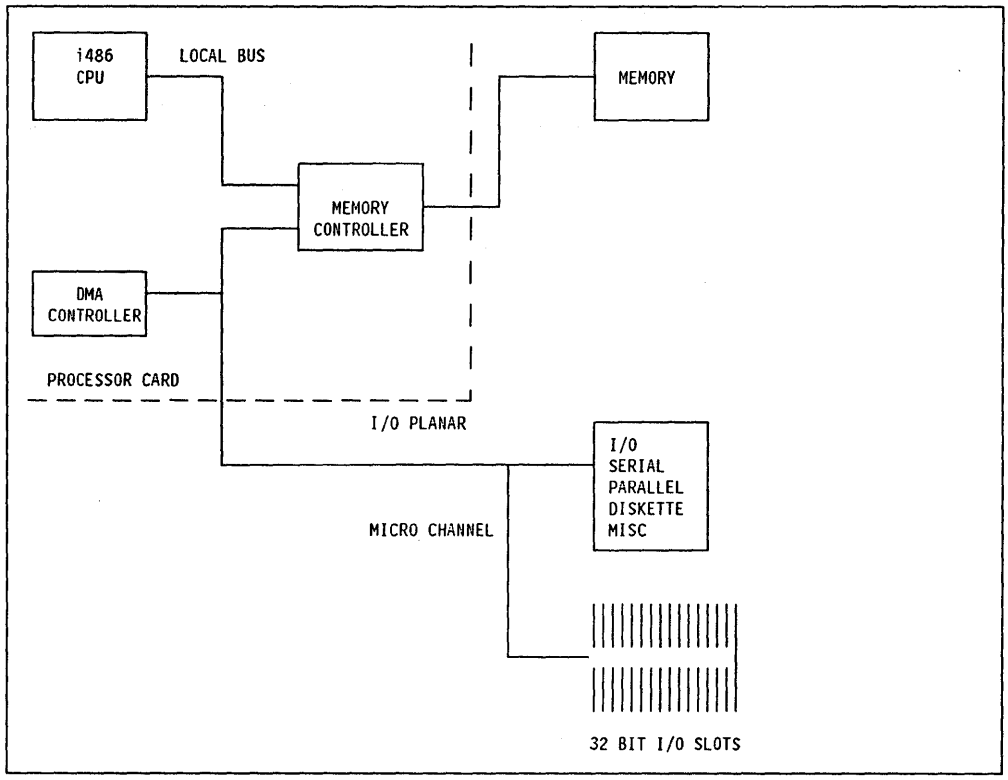


Figure 15. System Block Diagram

Figure 15 shows the general layout of the Model 90 XP 486 and Model 95 XP 486 systems. You can see that there are two paths to the memory through the memory controller:

- A path from the CPU
- A path from the Micro Channel.

6.2 Planar Memory Installation

The memory subsystem supports 1 MB, 2 MB and 4 MB 72-pin "Single Inline Memory Modules" (SIMMs). The SIMMs must be installed in matching pairs. This means that both SIMMs of a pair must be identical, but each pair may be of different speed and size from another pair. Existing memory from 80386 memory adapters may be used. The SIMMs must be installed in a pair of free memory positions A1/B1, A2/B2, and so on. This is shown on Figure 16 on page 33 and Figure 17 on page 33.

Note.

A pair of memory SIMMs is already installed in memory slots A1 and B1 when the system is supplied.

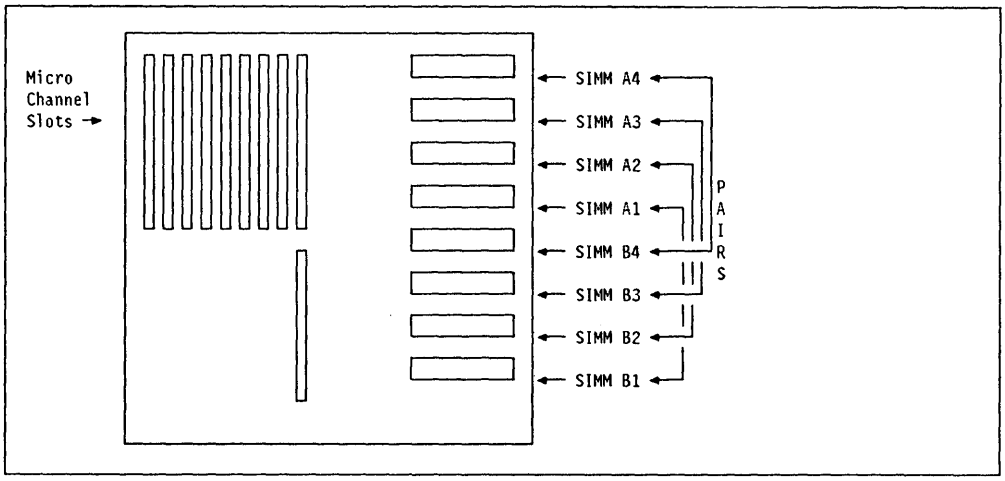


Figure 16. Model 95 XP 486 Planar SIMM Locations

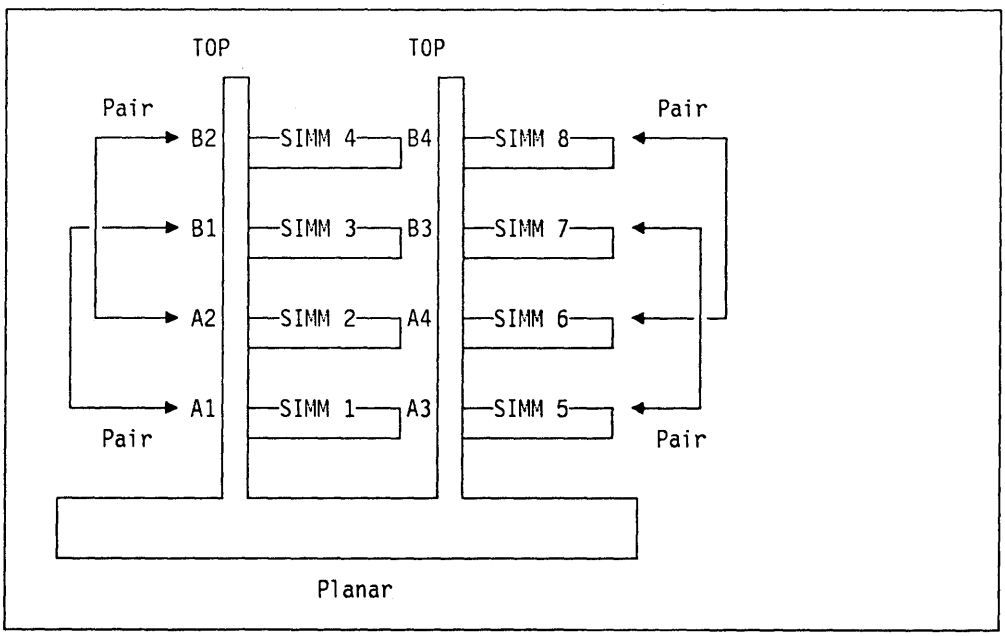


Figure 17. Model 90 XP 486 Planar SIMM Locations

Size	Speed
1 MB (256K x 36-bit)	85 ns
2 MB (512K x 36-bit)	85 ns
2 MB (512K x 36-bit)	80 ns
4 MB (1M x 36-bit)	80 ns
2 MB (512K x 36-bit)	70 ns
4 MB (1M x 36-bit)	70 ns

Figure 18. Memory Supported by the Processor Adapter 25 MHz and Processor Adapter 33 MHz

6.3 Memory Controller

The memory controller is a gate array designed to control the switching required to access the memory from the CPU, the I/O, and bus master adapters as efficiently as possible. (A gate array is an array or matrix of transistors that can be be wired or programmed as logic gates.)

The memory controller is configured according to the type of memory installed and the system's requirements. To accomplish this task, a set of registers are programmed by POST. This set of registers defines the size of the memory banks, the timings associated with the memory banks and the address mapping of the banks. This is performed for each bank separately. These registers are only programmable when the CPU controls the channel on the local bus.

The SIMM Definition Registers, Bank Base Address Registers, and the Bank Enable Registers are used by the controller to map the memory addresses to the correct memory SIMM.

The memory controller provides the following functions on the Model 90 XP 486 and Model 95 XP 486 systems:

- Dual bus capability

  This allows bus master adapters to access memory on the planar board while the CPU operates out of internal cache (8 KB), the optional external cache (256 KB) or planar memory.

- Memory decode and bank selection

  This provides the capability to decode the addressing to the 2, 4, 6 or 8 interleaved SIMMs. The memory is split up into banks depending on the SIMMs that you have installed in the system. There are eight bank addresses. Each bank is mapped into the system memory address range by the controller. The banks are set to any 1 MB address ranging from 0 to 255 MB. Because of the requirement that the address is a multiple of the bank size, the largest SIMMs are set to the lowest addresses.

  The SIMMs supported are 1 MB, 2 MB, and 4 MB. They may be mixed in pairs of the same size and speed. The 1 MB and 2 MB SIMMs bank size is 1 MB; therefore if you have two 2 MB SIMMs installed, this will be four banks of 1 MB. The 4 MB SIMMs bank size is 4 MB; therefore if you have two 4 MB SIMMs installed, this will be two banks of 4 MB.

- Memory timing control

  The controller has the flexibility to support SIMMs with different speeds installed on the planar board.

  Note: Each pair of SIMMs *MUST* match in size and speed

- Cachable address range selection

  The controller controls the cachable system memory addresses for the CPU's internal cache and for the optional external cache on the CPU local bus. The cachable memory is shown in Figure 19 on page 35.

- Cache control

  The controller maintains cache validity.

- Bus bandwidth allocation.

The controller supports memory transfers of 8, 16 and 32 bits to and from the system memory by the CPU, bus master adapters or the DMA controller.

You can see the relationships of the various parts in the system block diagram in Figure 15 on page 32.

Cachable Address Map: The following map shows the memory controller's cachable address range. All system planar memory is capable of being mapped into the processor's internal cache and the optional external cache.

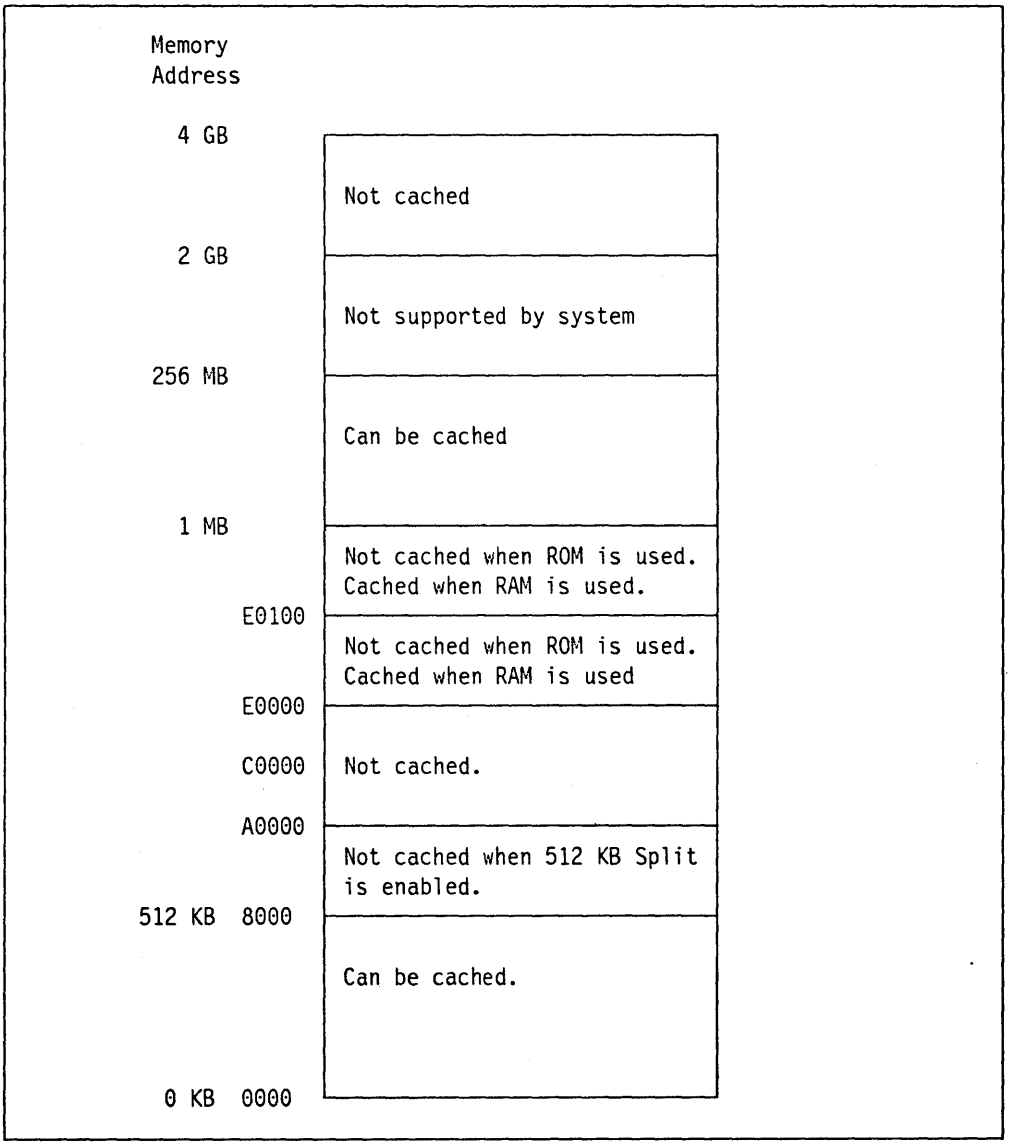


Figure 19. Cachable Address Range Map

6.3.1 Dual Bus Memory

Dual bus means that there are two separate buses, one from the CPU to the memory controller, and one from the Micro Channel to the memory controller.

The processor adapters 25 MHz and 33 MHz use a dual bus that improves the performance of the CPU when there are multiple bus masters active in the system.

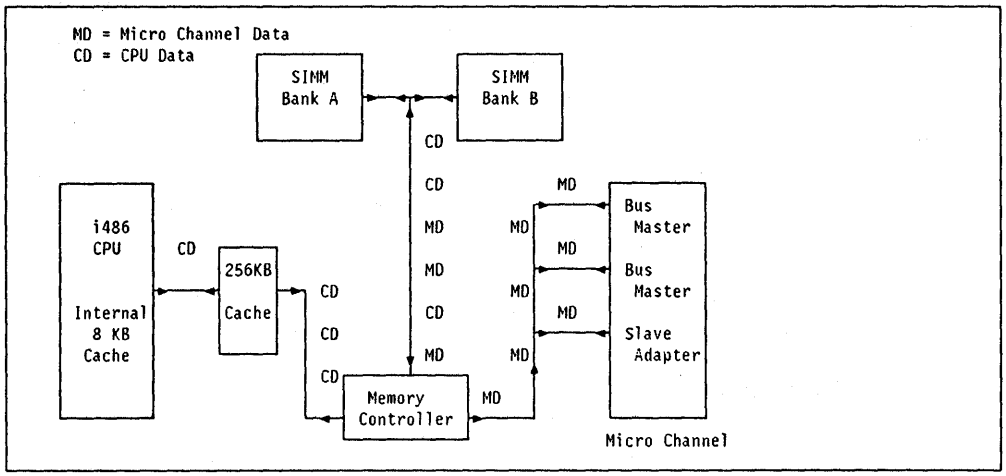


Figure 20. Dual Bus Operation

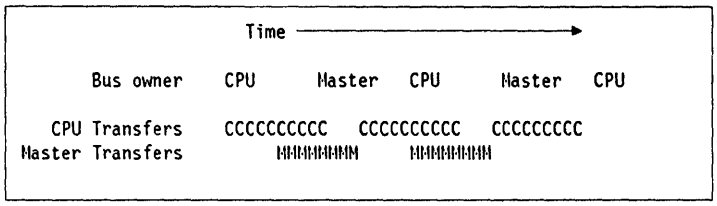
In previous PS/2 systems, when a bus master took control of the system bus, the processor had to wait for the bus master to release the bus, or had to arbitrate for control of the bus. This could take up to 7 microseconds.

In the Model 90 XP 486 and Model 95 XP 486 systems the memory controller alternates access to the system memory between the CPU and any bus master. This will happen even if the bus master is controlling the bus to the memory. This can be seen in Figure 20 in the interleaving of Micro Channel Data (MD) with CPU Data (CD) between the memory controller and the memory.

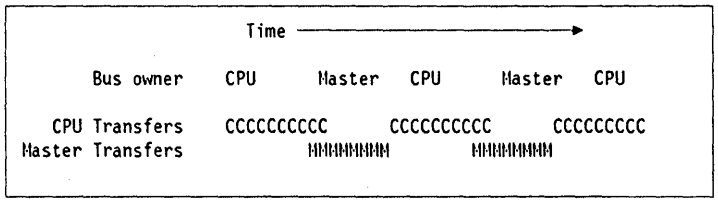
During the time that a bus master has control of the system, the CPU can access the system memory. If a transfer is in process at the same instant that the CPU wants to use the memory, the CPU will be held off until that one part of the transfer has finished. It does not have to wait for the total transfer to have finished as in previous PS/2 systems. The wait for the memory access is now approximately 300 - 500 nanoseconds compared with up to 7 microseconds in previous PS/2 systems.

Figure 21 on page 37 shows that the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems allow the CPU cycles to overlap bus master cycles more than in previous systems. The CPU executes cycles even after a bus master starts executing cycles, but the PS/2 8570 hits a cycle that locks the CPU out much sooner than the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

Note: The memory used in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems is dual bus *NOT* dual-ported so the CPU may be held off for the current bus master transfer to complete, but not the full transfer.



IBM PS/2 Model 90 XP 486 and Model 95 XP 486



PS/2 8570 System

M = Bus Master Transfers
C = CPU Transfers

Figure 21. Dual Bus Timing

Dual Bus Summary

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems the CPU does not have to arbitrate for the system bus to access the system memory. The CPU in previous PS/2 systems was treated as if it were a bus master. This could cause the CPU to have to wait for up to 7 microseconds (a long time in computer processing).

- Bus masters have exclusive access to the system memory when the CPU is running from the internal cache or the optional external cache
- Bus masters and CPU memory accesses are mixed when they both need to use the system memory
- The CPU has exclusive use of the system memory when a bus master is accessing I/O on the system board or an adapter on the Micro Channel.

6.3.2 Memory Interleave

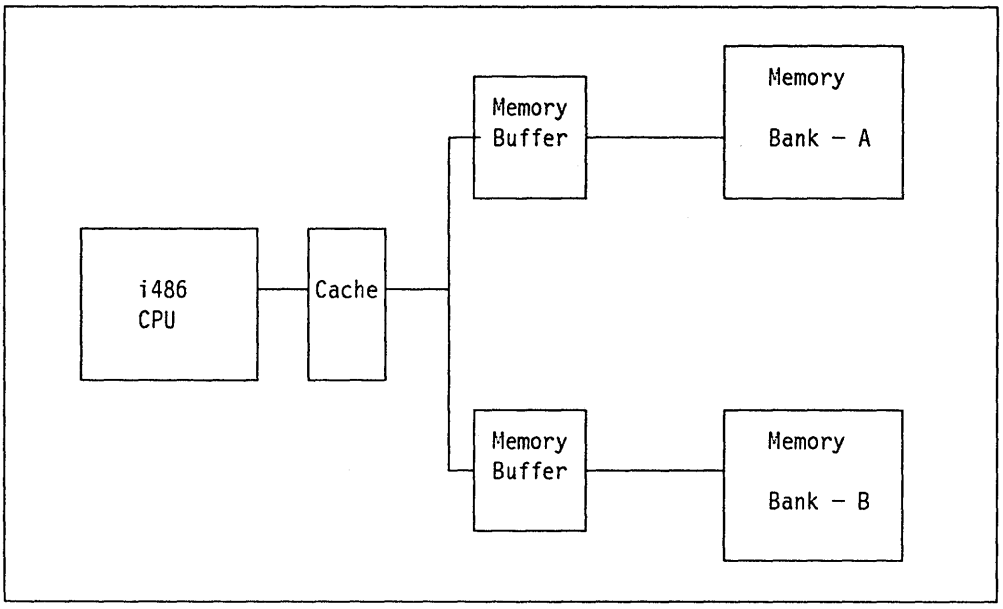


Figure 22. Memory Interleave

The RAM subsystem consists of two parallel 36 bit buses, each with 32 data bits and 4 parity bits. One parity bit is generated for each byte of data written. During a read operation from the CPU, the memory controller supplies 64 bits of data plus 8 parity bits. It immediately transfers 32 bits to the CPU, and holds the other 32 bits in the buffer. The CPU checks parity as it gets each of the two 32-bit data segments. Thus, parity error detection could occur several clock cycles after the transfer of data from memory to the data buffers. Non-CPU cycles perform only 32-bit data transfers and the parity detection is performed in the "Bus Interface Logic".

The CPU uses a 64-bit data path to the planar memory, which is accessed in interleaved 32-bit cycles. This will provide a general improvement over previous PS/2 machines for all system and application software.

This is how interleaved memory works. When the CPU reads from memory it would normally read 32 bits. With interleaved memory 64 bits are read: 32 bits from bank A and 32 bits from bank B. This means the CPU has to wait for only the first 32 bits. The second 32 bits are ready in the buffer when required. As most memory reads are sequential, there is a significant improvement in processing with this method.

6.4 Total System Memory Support

There are two factors that determine if a system can support more than 16 MB of memory. These are the physical hardware and the software that control the memory management.

For this reason the subject of how much memory the new IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems can support is covered in two parts, hardware and software.

6.4.1 Hardware Support

The hardware on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems allows more than 16 MB to be installed in the system.

- Planar Board

  The planar will support up to 32 MB. This would be in the form of eight 4 MB SIMMs.

- Micro Channel

  The Micro Channel has a 32-bit address bus. This allows the processor or a bus master to address above 16 MB on the Micro Channel.

- System Processor

  The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems both come with an Intel i486 processor installed. This has a 32-bit external address bus. This allows memory above 16 MB to be addressed by the processor.

- Memory Controller

  The memory controller on the processor adapter can support more than 16 MB of memory.

The only piece of hardware in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems that cannot address more than 16 MB of memory is the DMA controller. This is because it has only a 24-bit address bus.

The memory that is used for main system memory is known as "Dynamic Random Access Memory" (DRAM). By nature, in order for information stored in DRAM to stay there and not be lost, the actual DRAM chips must be recharged regularly. This is called memory refresh.

In previous PS/2 systems, the DMA controller initiates and performs all memory refresh operations.

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems it works differently.

The DMA controller initiates the refresh cycle. The memory controller sees these signals and refreshes the planar memory.

This means that although the DMA controller can only address 16 MB, the system hardware can support more than 16 MB of memory.

The only limitation in the system, from a hardware point of view, now lies with any I/O devices that use the DMA controller for performing data transfers.

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems there are three devices that use the DMA controller:

- Serial port in DMA mode
- Parallel port in DMA mode
- Diskette controller.

When these devices are used they will not be able to receive or send data above the 16 MB line. This is where software must come in and control the memory.

Warning!

Memory adapters on the Micro Channel are NOT supported, although they may work. However, it is strongly recommended not to use them as they will significantly degrade the overall performance of the system, as memory on the Micro Channel is not cached.

6.4.2 Software Support

As explained above, the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems support more than 16 MB of memory from a hardware point of view. The maximum that is currently supported is 32 MB on the planar board. The only limitation is with I/O devices that use the DMA controller to transfer data.

If an operating system wishes to use more than 16 MB of memory on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, it can. However, the operating system must ensure that any data that is to be written to the I/O devices that use the DMA controller is buffered so that it is addressable below the 16 MB limit.

Note: DOS Version 4.0 or previous versions will not support more than 16 MB in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

OS/2 Version 1.3 or previous versions will not support more than 16 MB in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

6.5 DMA Controller

The Direct Memory Access (DMA) controller allows I/O devices to transfer data directly to and from memory. DMA is a fast and efficient way to transfer blocks of data between I/O ports and memory. It can be used from diskette, serial port, or parallel port to transfer information to and from the device. DMA operates without involving the CPU in the transfer. This allows the CPU to continue with other processing during the transfer. For example, the keyboard can be used, and the time of day updated, without the DMA transfer being affected.

The DMA controller used in the processor adapters 25 MHz and 33 MHz is the same as previously used on the 8550 to 8580 PS/2 systems. This DMA controller has other functions in addition to the DMA function.

The DMA controller is implemented as a gate array with over 6000 circuits. It controls these functions:

- Bus arbitration control point
- Refresh controller logic
- 16 MB address capability (24-bit address)
- Eight independent DMA channels, each capable of transferring data between memory and I/O devices
  - Two channels are programmable to service any bus master adapter
- Serial DMA operation (separate read and write cycle for each transfer operation)

- Device support for byte or word transfer
- Auto-initialization of transferring parameter on each channel
- Sharing of the processor's system bus interface and control logic.

6.6 Comparison With Earlier PS/2 Systems

Comparisons are always difficult as no two systems are identical. This information will show you where the memory subsystem in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems has been improved.

6.6.1 Variable SIMM Support

In previous PS/2 systems if you install mixed-speed memory options on the system board, the memory will be used at the speed of the slowest memory module.

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems the memory controller sets the memory access speed for each pair of SIMMs. The speed can be different for each pair. This uses memory in the most efficient way, and allows you to get the most out of the system, and not have to worry about the speed of the memory.

6.6.2 Single Bus Memory

Figure 23 shows how the previous PS/2 systems worked with bus masters. The bus master can hold the system bus, and as there is only one bus, it does not matter to which part of the system the bus master is transferring data. The CPU will have to wait, and arbitrate for control of the system bus, so that it can get to the system memory. This was good for the bus masters, but not so good for the CPU.

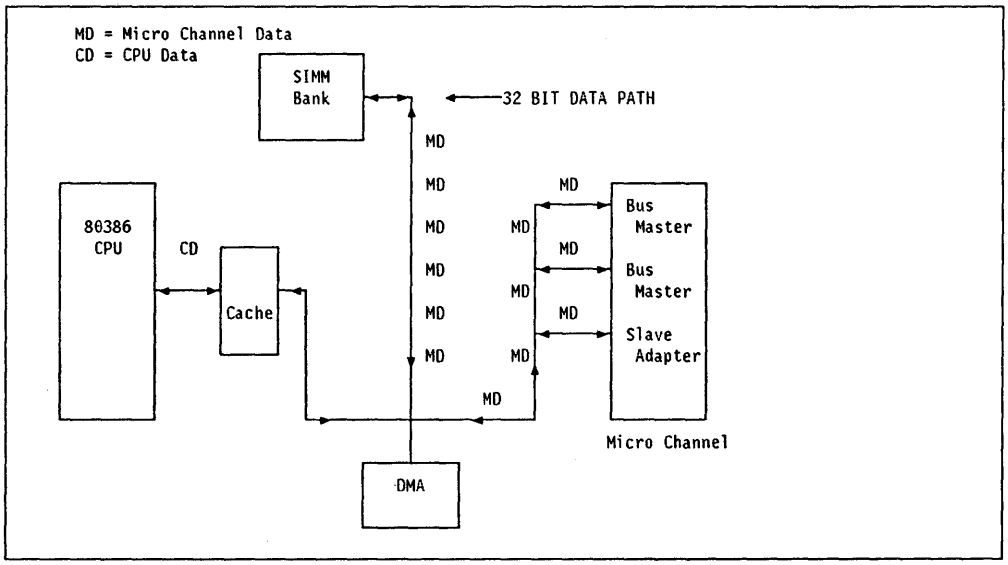


Figure 23. Single Bus Operation

Now in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 (see Figure 20 on page 36) we have a bus from the CPU to the memory controller, and a bus from the Micro Channel to the memory controller. This will allow the CPU to use the system memory, while at the same time a bus master can be using the Micro

Channel. The net result of this is a significant increase in processing power, but this will not be seen if you are using single tasking software, or running only one task in a multitasking environment.

6.6.3 Memory Interleave

When the CPU reads from the system memory, it wants to fill a 16 byte line in the internal cache or the external cache. To do this the CPU has to read 16 bytes (128 bits) from memory. In the PS/2 8570 this takes four cycles reading 4 bytes (32 bits) on each memory read cycle. The time it takes to read from memory depends on the memory speed and the CPU speed, but can be about 120 to 240 nanoseconds.

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems when the CPU reads from the memory, the memory controller reads 8 bytes (64 bits). The CPU still wants to read 16 bytes, and can still read only 4 bytes on one cycle, but the second 4 bytes are ready in the buffer, as shown in Figure 22 on page 38. There is no need to read memory for the next 4 bytes. So to read the 16 bytes the memory is now read only twice. This will give an improvement in processing speed under all operating conditions.

7.0 Initial Microcode Load

This chapter describes the features and process of "initial microcode load" which will be referred to as IML.

For the purposes of this chapter the IBM PS/2 Micro Channel Systems 8550, 8555, 8560, 8565, 8570, 8573 and 8580 will be referred to as the "previous PS/2 systems" to distinguish them from the IBM PS/2 Model 90 XP 486 and Model 95 XP 486.

7.1 Review of System Startup

Before going into detail about how the IML process works, the startup process for the previous PS/2 Micro Channel systems is reviewed.

7.1.1 POST/BIOS/BASIC

All IBM PS/2 systems come with a certain amount of Read Only Memory (ROM). This ROM contains system functions that are permanently recorded in the circuitry of these ROM chips. Their contents cannot be changed, erased or lost even when the system is switched off.

IBM's previous PS/2 systems come with 128 KB of ROM. This ROM contains three main sections. These are:

- Power on self test (POST)
- Basic Input Output System (BIOS)
- BASIC

POST

POST stands for power-on self test. The POST part of ROM contains the routines to test and initialize the system and I/O adapters. These tests are automatically initiated each time the system is powered on.

POST checks and initializes all of the system hardware and reports any errors to the user. If there are no errors, the operating system is loaded. The visual indication to the user that POST is running is the counting of memory on the screen. The POST routines occupy around 8 KB in ROM.

BIOS

BIOS stands for Basic Input Output System. BIOS is the firmware that isolates the operating system from the low-level system hardware. The operating system makes functional requests to BIOS rather than directly manipulating the hardware. This makes it possible to change hardware details below the BIOS level without the operating system being aware of the change. BIOS comes in two forms:

- Compatibility BIOS (CBIOS)

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CBIOS is a single-tasking component that can only address up to 1 MB of memory and will only work in the 8088** compatibility mode of the processor. If an application wants to use a routine in CBIOS, it accesses the routine by issuing a software interrupt with a routine specific number. Each routine in CBIOS has its own interrupt number.

CBIOS provides support for all of the basic system components as well as other services such as the system timers and memory size determination.

- Advanced BIOS (ABIOS)

  ABIOS provides support for the protect mode of the processor. It can address more than 1 MB of memory and operate in both the real and protected mode of the processor. Requests to ABIOS are made using special parameter blocks called "Request Blocks".

The BIOS is the main part of the system and takes up about 80 KB in ROM.

BASIC

This is a copy of cassette BASIC to maintain compatibility with older systems. The BASIC program occupies about 32 KB of ROM.

7.1.2 The POST Process

In the previous PS/2 systems all POST/BIOS/BASIC routines reside in 128 KB of ROM on the planar board. Figure 24 shows the memory map for a PS/2 Model 80 and the approximate amount of memory that each part of the ROM takes up.

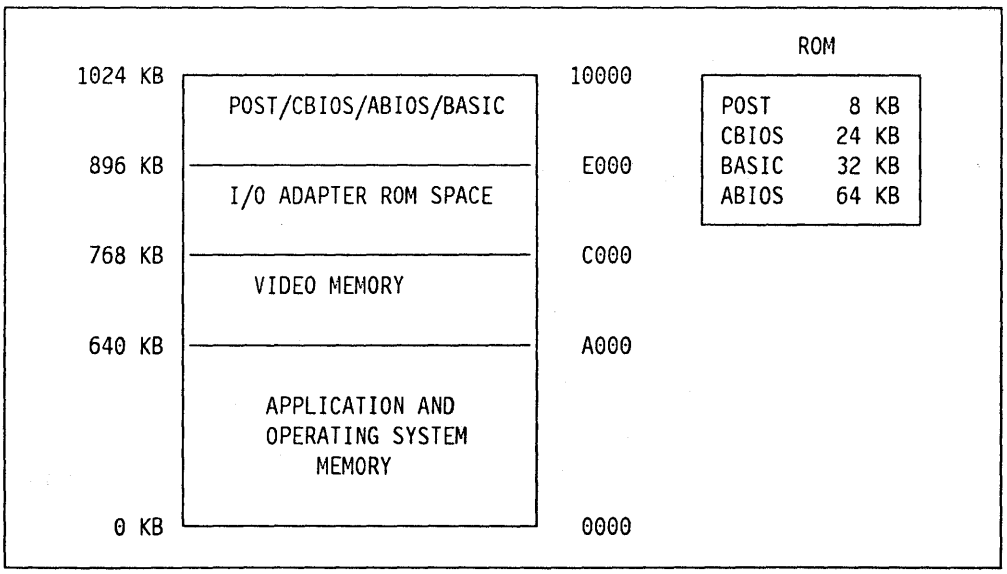


Figure 24. PS/2 Model 80 Memory Map and Approximate ROM Split

When the PS/2 Models 50, 55, 60 and 80 (with a 16 MHz processor) are powered on two things happen. Firstly, the 128 KB of ROM is mapped to the two address segments starting at E000 and F000. Secondly the processor loads its first instruction from memory location FFFF:0000. This is valid for all Intel 80X86 processors used in the PS/2 systems. This location is where the ROM initialization code starts. The various POST routines now test and initialize the system.

** Intel 8088 is a trademark of Intel Corp.

When completed, the operating system is loaded and has access to the BIOS routines located at segments E000 and F000.

Shadow RAM

In PS/2 Models 65, 70 and 80 (with a processor speed of more than 16 MHz) the 128 KB of ROM is copied into normal system RAM. The RAM that the ROM routines are copied to is known as "shadow RAM". Once the ROM is copied to the shadow RAM, the ROM is disabled and the 128 KB ROM image in RAM occupies the two address segments starting at E000 and F000. This method is used because access to RAM is quicker than access to ROM.

You can see that shadow RAM is being used because the memory count will only show the actual memory size minus 128 KB.

7.2 Initial Microcode Load Overview

Initial microcode load is a process by which the POST/BIOS/BASIC routines can be loaded into the system memory from a media source (such as a disk or diskette). This means that the system functions that are otherwise held in ROM on the planar board will actually be held on another media - such as a diskette or a hard disk.

7.2.1 POST/BIOS/BASIC Locations

In systems that have IML implemented, the location of the POST/BIOS/BASIC routines change, but their actual functions remain the same.

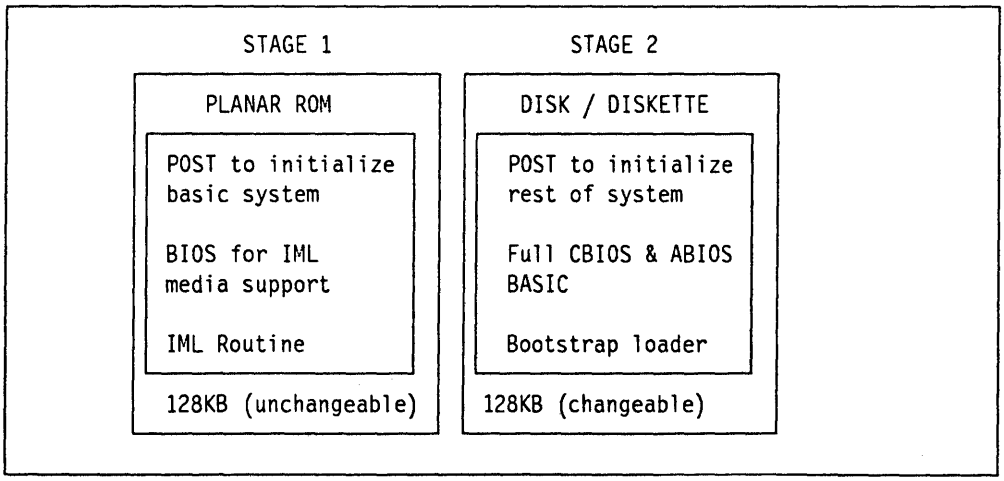


Figure 25. Location of Startup Code in an IML-Based System

In a system where IML is implemented, the startup process is in two distinct stages. The first is ROM based and executes code located in ROM on the planar board. The second stage executes code loaded into system RAM from a media source such as a hard disk or diskette.

- IML Process - Stage 1

  This stage of the IML process resides in ROM. When the system is first powered on, POST code in ROM initializes all parts of the system that are required by the IML process. Control is then passed to the IML routine, which searches a media source for a "Master IML Boot Record". Once it has found and loaded this boot record, it passes control to it. This passing

of control from the IML routine to the master IML boot record indicates the move to stage 2 of the IML process.

- IML Process - Stage 2

  This stage is loadable from a media source. The master IML boot record verifies that the boot record is for the correct system and then loads in the 128 KB image of **POST/BIOS/BASIC** from the selected media. The image is placed in "shadow RAM" starting at segment address E000:0000. Once loaded, the ROM is disabled and control is passed to Stage 2 POST routines and eventually to the bootstrap loader that attempts to IPL an operating system.

7.3 IML implementation - IBM PS/2 Model 90 and Model 95

On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486, IML has been implemented, so that the media source will be either the primary hard disk (SCSI ID=6) or a diskette (only a diskette that also has the systems programs on it, such as the reference diskette). If IML is not successful from the hard disk then the diskette in drive A: becomes the media source.

The IML process needs code stored in two places in the system to run. These two places are planar ROM and a media source.

7.3.1 ROM Based Code

The ROM on the planar board of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 is 128 KB. It contains 16 KB of POST routines, some CBIOS and the IML routine. It is *not* the same as the ROM on the previous PS/2 systems. There is no ABIOS and no BASIC code stored here.

The POST routines in ROM are sufficient to get the system to a point where the IML process can run. The CBIOS routines contained in ROM are enough to initialize the hard disk and diskette for use as the IML media source.

7.3.2 Media Source Based Code

The media-based IML code consists of two files:

- 128KB IML Image of the POST/BIOS/BASIC routines
- Master IML boot record.

Both the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 will be shipped with this IML code loaded on the hard disk and on the reference diskette. The IML code on the hard disk or diskette is in addition to the code permanently stored in system ROM.

The two IML code files are stored on the hard disk in the "system partition". This is a protected area at the end of the hard disk that cannot be seen by any operating system.

Note: In all IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, there must be a SCSI hard disk with a SCSI ID set to 6, with a system partition installed for the system to run. If there is no SCSI hard disk with an ID of 6 installed, an error message will be displayed, and the system will halt unless an IML diskette is located in the first diskette drive.

The system partition is covered in more detail in section 7.7, "System Partition Overview" on page 49.

7.4 The POST Process

Figure 26 shows the overall POST procedure for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. This section will describe the different stages in detail.

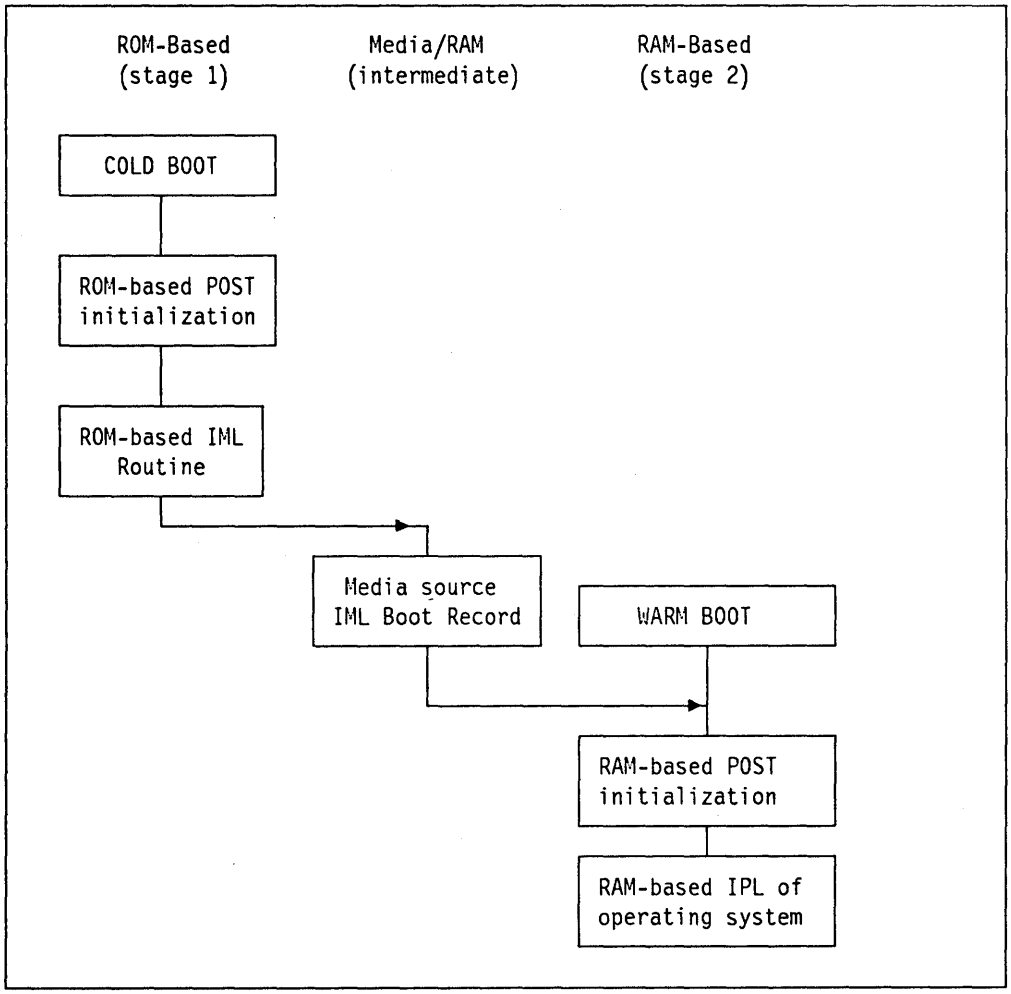


Figure 26. Overall POST Procedure

7.5 Stage 1

7.5.1 ROM-Based Process

When you power on your system (commonly known as a "cold" boot), the processor loads its first instruction from memory location FFFF:0000. As ROM in all PS/2 systems resides in the memory map at memory segments starting at E000 and F000, the first instruction executed will be part of the ROM-based code.

In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 this is the start of stage 1 POST, which is located in ROM. This stage 1 POST initializes enough of the system so that an attempt to load the IML image from the hard disk can be made.

A small part of CBIOS is also loaded during this stage so that the IML routine can access the hard disk or diskette drive to load the IML image.

Once POST has initialized the system, it passes control to a ROM-based routine called the IML routine. The first thing the IML routine does is to initialize the hard disk. It then searches for a master IML boot record in the system partition. If it finds a record it validates it and loads it into system RAM.

If the IML routine does not find a valid boot record on the hard disk it will automatically initialize the first diskette drive, the A: drive, and search for a valid IML boot record on the diskette.

If it finds no record on the diskette either, the system will NOT search other media sources. It will halt with an error message.

7.6 Stage 2

7.6.1 RAM-Based IML Load

When the IML routine in ROM has passed control to the master IML boot record the system is in Stage 2.

The master IML boot record contains both data and code. The code is what the IML routine passes control to. This code then verifies data within the boot record to check that the IML image loaded is for the correct system.

Once the master IML boot record has validated the system it will load the 128 KB IML image from the media source into "shadow RAM" at location E000:0000. When it has loaded this image into RAM, it will pass control to stage 2 RAM-based POST and disable the ROM.

7.6.2 RAM-Based POST

When you see the memory counted up on the screen it is an indication that IML has been successful and the Stage 2 POST is now operating.

This stage 2 POST initializes the rest of the system. It also builds the interrupt vector table and does a ROM scan for any additional BIOS modules for installed adapters that may need to be initialized.

It is worth noting here that if you do a CTRL-ALT-DEL key sequence (commonly known as a "warm boot") the system will start with stage 2 POST. This means that a warm boot will not invoke any IML procedures.

Once stage 2 POST is complete, it will attempt to load an operating system using the standard IPL procedure.

7.6.3 IML Error Conditions

Figure 27 shows how the IML process works overall and what happens when errors are found during the IML process.

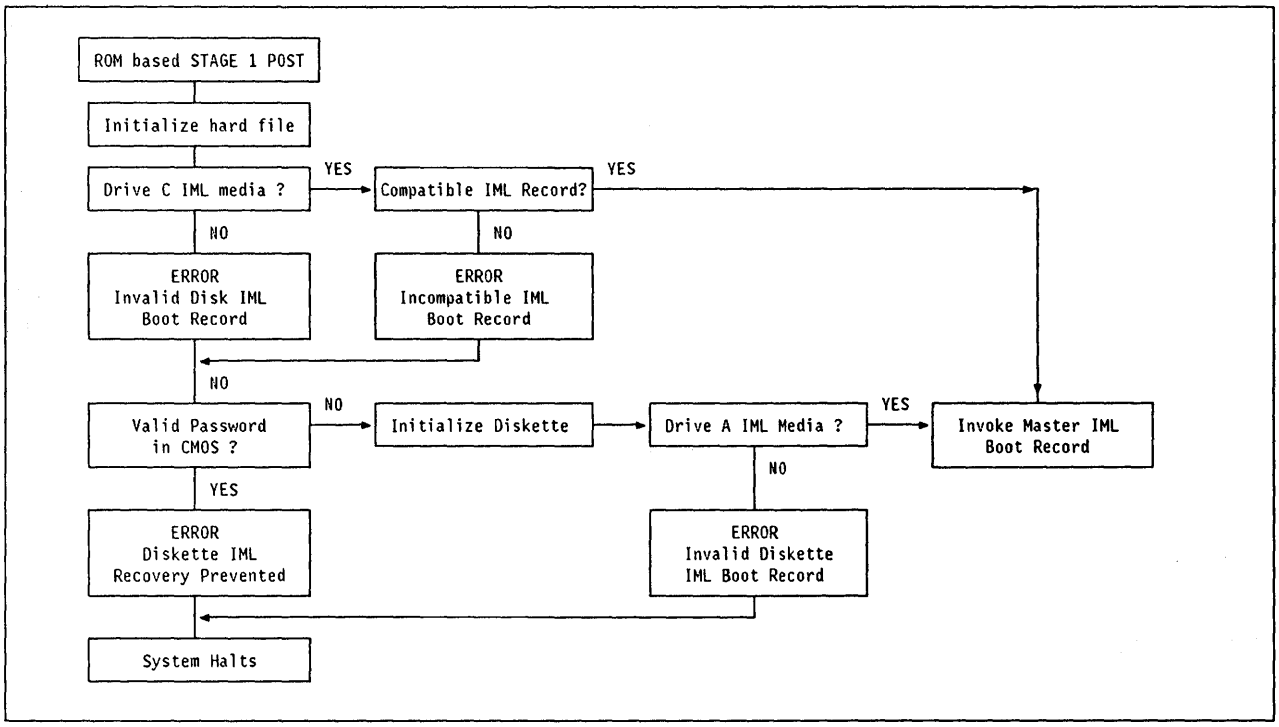


Figure 27. Initial Microcode Load (IML) Routine Overview

Due to the nature of the IML startup routine there are some new error codes that reflect the errors shown in Figure 27.

Most IML errors start with *I999*. Appendix D, "List of IML Errors" on page 157 lists all of the error messages associated with IML and should be referred to if you have any problems with IML.

7.7 System Partition Overview

The system partition is the name given to a special section of the hard disk on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. The system partition is used to store:

- A copy of the system programs

  This is a copy of the programs that are stored on the reference diskette. They include such options as Set Configuration and Set Features.

- The IML code.

  The master IML boot record

  The IML POST/BIOS/BASIC image.

The system partition has enabled the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 to be the first systems to implement IML and have the system programs resident on the hard disk.

7.7.1 The System Partition Layout

The system partition is built onto the hard disk during manufacturing. It is located on the last 3 megabytes of the primary fixed disk. This means that each Model 90 XP 486 or Model 95 XP 486 system shipped will have a hard disk with the 3 MB system partition installed. Any SCSI hard disks that are ordered as a field replaceable unit (FRU) or as an add-on option, will *not* have the system partition installed (see "Backup/Restore System Programs" on page 52 for more details).

Figure 28 shows the layout of the system partition. It will always be 3 MB in length (unchangeable) and located at the end of the hard disk. It is totally invisible to an operating system and to any BIOS calls made to the hard disk once the operating system has completed IPL.

Figure 28. System Partition Layout

Location	Size in KB	Content	Description
Last sector on disk less 3 MB	0.5	Partition Boot Record	Loads IBMBIO.COM, IBMDOS.COM to boot partition
	4.5	FAT	File Allocation Table (First Copy)
	4.5	FAT	File Allocation Table (Second Copy duplicate of first copy)
	7	Root Directory	Directory of the Data Area (224 Entries available)
	2877.5	Data Area	Location of system programs
	128	IML Image	Memory image of POST/BIOS
Last sector on disk	49.5	IML MBR	IML master boot record. (48 KB reserved to account for defective sectors). This boot record will load the IML image. The actual boot record is three sectors in length.

The partition boot record, two FAT sections and the root directory are all used to make the system partition "bootable".

7.8 System Partition - Details

This section explains some important facts about the system partition:

- Hard disk size

  The hard disk installed in any IBM PS/2 Model 90 XP 486 and Model 95 XP 486 will only show its total capacity minus 6 MB. This is because the system partition takes up 3 MB and the master partition table takes up 3 MB.

- Master partition table

  The master partition table is present on all hard disks that have been formatted by an operating system. It contains all of the information about the hard disk such as partitions, partition sizes, active partition and so on (please refer to the system *Technical Reference Manual* for more details). The master partition is always located at the start of the hard disk.

As the system partition is located at the end of the hard disk, it has no affect on the master partition table.

- Operating system view.

  The system partition is totally invisible to an operating system. By the time the operating system is loaded, POST and BIOS have hidden the partition.

7.8.1 Using the System Partition System Programs

When an error occurs during POST on an IBM PS/2 Model 90 XP 486 and Model 95 XP 486 the system partition will be booted automatically and the system program's main menu will appear.

To allow you to boot the system programs in the system partition, a new key sequence has been introduced. When you perform a "warm boot", CTRL-ALT-DEL, the cursor will move immediately to the top right hand corner of the screen and stay there for three to ten seconds. While the cursor is in this position you have the option to press the key sequence CTRL-ALT-INS. This key sequence will boot the system partition on the hard disk and bring up the system programs.

You will not get the option to boot the system partition during a power-on of the system.

7.8.2 Multiple Drive Environment

When you have more than one hard disk installed in a system, the system partition must be resident on the SCSI hard disk with the highest SCSI ID. This ID has to be SCSI ID 6.

When multiple SCSI adapters are installed in the system, the SCSI hard disk with the SCSI ID of 6, attached to the SCSI adapter installed in the lowest numbered slot, must contain the system partition.

7.8.3 Deleting the System Partition

There may be circumstances when you want to delete the system partition. An operating system format will *not* erase the system partition. The only way to erase the system partition is to perform an advanced diagnostics low-level format.

7.9 The System Programs Overview

The system programs are all of the programs located on the reference diskette for the previous PS/2s. Examples of these programs are:

- Set configuration
- Copy an option diskette
- Set features.

The system programs for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 can be found on either the hard disk drive (in the system partition) or on the reference diskette.

To use the system programs on the reference diskette, boot the system with this diskette in the A: drive.

To use the system programs on the hard disk you must follow this procedure:

1. Power on the system.
2. When POST has completed, hold down the CTRL and ALT keys, and press the DEL key (warm boot).
3. When the cursor moves to the top righthand corner of the screen, hold down the CTRL and ALT keys and press the INS key. This key sequence boots the system partition.
4. The system program's main menu will appear.

Both of these methods will give you access to the system programs.

7.9.1 Changes to the System Programs

This section describes the additional system programs that are provided with the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 and changed from previous versions on other PS/2 systems:

- Start operating system
- Backup/restore system programs
- Backup/restore configuration
- Set console
- Set startup device
- Update the system program
- IBMCACHE
- Keyboard password program.

All of the other system programs that are available on the previous PS/2 reference diskettes are still available on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 reference diskettes. The function and use of these has not changed, so they are not covered here.

Start Operating System

On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 any errors in POST force a boot of the system programs from the hard disk.

Choosing the "Start Operating System" option from the system program's menu will ignore any POST errors and IPL the operating system.

However, it is not recommended to IPL the operating system when POST errors occur.

Backup/Restore System Programs

These two options are used to perform housekeeping on the system partition.

- Backup System Programs

This option copies all files in the system partition to a diskette in the A: drive. The diskette must be a 2 MB diskette. The diskette is automatically formatted to 1.44 MB capacity by the backup program.

The diskette created is bootable and holds the configuration for the system whose system partition has been backed up. The diskette is exactly the same as the backup copy of your reference diskette.

This option should be used every time that you make a change to the system configuration. It can also be used to create a reference diskette in case your original or backup copy has been lost or is corrupted in some way.

In some cases you may store more than 1.44 MB of information in the system partition. This may be due to a requirement to hold all possible "Adapter Description File" (ADFs) and diagnostic files with the system programs. This can cause problems with the backup option. Please refer to 7.9.2, "Adapter Description Files" on page 54 for more information.

- Restore System Programs

  This option is used for two main reasons:

  To rebuild a damaged system partition

  To create a system partition on a new hard disk.

  If your primary hard disk is damaged, you can select this option from either your reference diskette or your diskette created using "Backup System Programs". This will build a system partition on the hard disk and copy all of the system programs, the IML image, the master IML boot record and the hidden files necessary to make the partition bootable. It is only possible to restore the system partition to the primary hard disk drive (the SCSI hard disk with ID = 6). You cannot restore to any other hard disk in the system.

  You should assume that the use of this option will permanently erase all of the information on the hard disk. In some circumstances the data may still be present after you have performed the restore, but this is *not* a reliable assumption to make.

Backup/Restore Configuration

This option is not new for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486. It enables you to back up the configuration in the system to a file on either the reference disk or the system partition. This should be performed every time a change is made to the configuration so that if, for example, the battery fails and the system configuration is lost, you can simply restore the system to its previous configuration.

Set Console

This option is for the IBM Model 95 XP 486 system only. It is *not* available in the IBM Model 90 XP 486 system. This option enables you to select which display the system uses. There are three options to choose from:

1. Display and keyboard
2. ASCII terminal
3. No console.

These options are covered in more detail in sections 7.10, "Set Console Option" on page 56 and 7.10.2, "No Console Support" on page 58.

Set Startup Option

This option enables you to define a boot sequence. It gives you the option to boot from any diskette drive or hard disk.

This option is covered in more detail in section 7.11, "Selectable Boot Overview" on page 58.

IBMCACHE.SYS

IBMCACHE.SYS provides a caching program that can be used in the DOS environment. On previous PS/2s the program files were hidden on the reference diskette. On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 reference diskette these files are not hidden and can simply be copied across to the hard disk using DOS copy commands. Although these files are also stored in the system partition on the fixed disk they cannot be seen or copied from there.

7.9.2 Adapter Description Files

A common problem with all PS/2s has been the amount of adapter description files (ADFs) and diagnostic (DGS) files that you can store on the reference diskette. This is due to the maximum space available on a single high-capacity diskette being 1.44 MB when formatted.

On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 the same restriction still applies to the reference diskette but not for the system partition. Due to the size of the system partition (3 MB) it is possible to store far more ADF and DGS files than a single diskette can hold.

However, this can cause a problem with the "backup system partition" option. Backup system partition will back up only to a single diskette. All system programs as well as ADF and DGS files are copied to this diskette. If you have a system partition that has more than 1.44 MB of information, an error message will be generated during the backup of the system partition. This is purely a warning to state that not all of the system partition has been backed up. The backup program will always back up the system programs and the planar ADF and DGS files first. The diskette will still be as described above, but will not have all of the ADF and DGS files that were on the system partition.

Deleting Files From the System Partition

It is possible to look at the system partition, and add or delete files just like a normal hard disk.

It is not recommended that this method be used unless the situation described in 7.9.2, "Adapter Description Files" occurs.

The procedure to look at the system partition is as follows:

1. Use a diskette that contains a backup of the system partition.
2. Under DOS, perform a **DEL *.*** on the diskette (do not erase hidden files)
3. Copy a DOS 4 "COMMAND.COM" file to the diskette.
4. Copy FDISK and any other utilities you wish to use to look at the system partition, to the diskette.
5. Boot from this diskette.
6. The C: drive will now be your system partition. It will be only 3 MB in size.

It will now be possible to delete files from the system partition, to make it possible to perform a backup to a 1.44 MB diskette.

7.9.3 Installing an Adapter in an IML Environment

When you install an adapter in a PS/2 Micro Channel system, you are instructed to copy an ADF to the reference diskette using the "copy an option diskette" option.

On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 system you should copy the option diskette to the system partition first and then back up the system partition to a diskette. To copy an option diskette to the system partition you must first boot the system partition and then use the "copy an option diskette" option from the system program's main menu.

7.9.4 View Configuration - PS/2 Model 8590

On the IBM Model 90 XP 486 system when you look at the configuration using the "view configuration" option, there will be an entry for the second serial port which will be called a "planar device".

The following section explains what a planar device is.

Planar devices

When a PS/2 system is powered on, the adapter cards and various devices located on the planar do not have the information they need to operate correctly in the system. This is because there are no longer switches in the system. Instead a method called "Programmable Option Select" (POS) is used, which stores this setup information in registers on the various adapters or devices.

The information that POS uses to set up the various parts of the system is now stored in an area called CMOS RAM. This is nonvolatile storage that keeps its contents even when the system is powered off, due to a long-life battery.

The POST process takes the data stored in the CMOS RAM and writes it to the POS registers of the particular adapter or device, during the power-on sequence.

Because the planar has a lot of built-in devices, these are all set up using a single I/O port address. Setup information is sent via this port to the various planar devices.

The adapters are set up using a different port. Information is sent by POST to the port stating which adapter is to be set up and then that particular adapter is configured.

On the IBM Model 90 XP 486 system the setup program can recognize eight adapter slots. However, the IBM Model 90 XP 486 system only has four adapter slots on the planar. This leaves room for some additional features to be set up using the adapter setup port. These additional features are called "planar devices".

```
Built in features
   Serial Port ............................ Serial_1
   Serial transmission arbitration level ... Shared 7
   Serial receive arbitration level ........ Shared 7
   etc.....

Slot1 - SCSI adapter with cache
Slot2 - Empty
Slot3 - Empty
Slot4 - Empty

Planar device5 - Empty
Planar device6 - Serial port No. 2
   Serial Port ............................ Serial_2
   Serial transmission arbitration level ... Shared 7
   Serial receive arbitration level ........ Shared 7
Planar device7 - Empty
Planar device8 - Empty
```

Figure 29. View Configuration Showing Planar Devices (8590 Only)

Figure 29 shows the reference to planar devices on the "view configuration" menu. These planar devices are set up using the adapter setup port even though they are attached directly to the planar board. The IBM Model 90 XP 486 system supports up to four of these planar devices. Currently, only one of these planar devices is used:

This is planar device 6, which is used by the second serial port on the IBM Model 90 XP 486 system (the 9-pin serial port). Planar devices 5, 7, and 8 are currently reserved and there is no facility for you to use these device options.

7.10 Set Console Option

The "set console" option is available on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 system only. It enables you to set one of the following options:

- Display and keyboard
- ASCII terminal
- No console

The default is "display and keyboard" which is the normal operation of the system using a standard display and keyboard. The other two options will be covered in the next section.

7.10.1 ASCII Terminal

You can use the Model 95 XP 486 with an ASCII terminal in place of the usual keyboard and display screen.

The ASCII terminal must be attached directly to the serial port. When attached, you will be able to run the system programs from the ASCII terminal when a display and keyboard are not attached to the main system unit.

Note: IBM does not support the use of DOS and OS/2 on this ASCII terminal.

Supported IBM ASCII Terminals

The Model 95 XP 486 supports the IBM 3151, 3161, 3162, 3163 and 3164 ASCII Display Stations.

ASCII Terminal Setup

You must ensure that the communications parameters you define at the terminal exactly match those you define on the Model 95 XP 486. For example, for best performance, set the communications values on the ASCII terminal as:

Line Speed (bps)	9600
Word Length (bits)	8
Parity	No
Stop Bits	1

Figure 30. Optimum Communications Values for ASCII Console

ASCII Console Setup

Having set the ASCII terminal to communicate at 9600 bps, 8 data bits, no parity, one stop bit, you must now ensure that you configure the Model 95 XP 486 to match those parameters.

To do this, you should reboot the system and use the Ctrl-Alt-Ins keystroke combination as described in section 7.8.1, "Using the System Partition System Programs" on page 51. This will bring up the system programs main menu. Make the following selections:

1. Select **Set Features** on the main menu.
2. Select **Set Console** on the set features menu.
3. Select **ASCII terminal** on the set console menu.

Make sure you set the communication parameters as shown:

Baud rate	9600
Bits per character	8
Parity	None
Stop bits	1

Figure 31. Communications Values to Match ASCII Terminal

Note: These settings assume that you have set up the ASCII screen as shown in Figure 30. If you change a parameter in the ASCII terminal setup, you must make the same change in the ASCII console setup. Although speeds below 9600 bps are supported, they result in slower screen writing times.

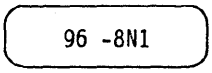
Note: When you have set up for an ASCII screen, the configuration program will prompt you with:

```
Do you want to remove the video
adapter from the computer?
```

If you reply "Y", you should remove any XGA Adapter/A before restarting. A reply of "N" means that you wish to retain the XGA Adapter/A support.

Operational Considerations

When you have defined your console to be an ASCII terminal, you will notice during IML that the communication parameters will appear in the LED information panel, like this:



This is to confirm the setup - you should not regard it as an error message.

7.10.2 No Console Support

The **"No console"** option allows you to run the Model 95 XP 486 without an attached keyboard or display.

If you make this selection from the set console menu, you may then remove the keyboard and display screen or ASCII terminal after turning off the computer. Now you can power it up without keyboard, display or ASCII terminal.

The next time you need to communicate with the computer, you may install and use either a keyboard and display or an ASCII terminal.

During an IML, the Model 95 XP 486 will test to see if there is a video adapter. If there is one, it will use the display and keyboard as the console. If not, it will assume that you are using an ASCII terminal.

Note: DOS and OS/2 do not support a keyboardless and displayless environment.

7.11 Selectable Boot Overview

Selectable boot is a new option available on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. It enables you to designate which drive (diskette or hard disk) an operating system will be loaded from during system power-up or after a CTRL-ALT-DEL (warm boot).

Selectable boot enables you to boot from any diskette or hard disk installed in the system by establishing your own "boot sequence". It is totally transparent to the operating system as it is implemented at a BIOS level for hard disks and a BIOS/hardware level for diskette drives.

It is only available on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486. Previous PS/2 systems *do not* support selectable boot.

7.11.1 BIOS Drive Notation

Throughout the following sections references will be made to the way that drives installed in the system are recognized by BIOS.

BIOS numbers the installed drives using the following notation:

Diskette drives are numbered 00, 01, 02 etc. where diskette drive 00 is the first physical diskette drive installed, diskette drive 1 is the second physical diskette drive installed and so on.

Hard disks use the same approach but the number sequence starts at 80. This means that the first physical hard disk drive is hard disk drive 80. In the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems this will be the SCSI hard disk with SCSI ID 6. In the case where multiple SCSI adapters are installed, it will be the SCSI hard disk with SCSI ID 6, attached to the SCSI adapter in the lowest numbered slot.

7.11.2 Previous POST Startup Procedure

On all previous PS/2s once POST has completed its testing it will attempt to load an operating system from a diskette in the first physical diskette drive. If there is a diskette present that has an operating system installed, POST will transfer control to that operating system. If there is a diskette without an operating system installed the message "non-system diskette" will appear and the user asked to insert a valid diskette.

If there is no diskette present in the first diskette drive, POST attempts to load an operating system from the first hard disk. If an operating system is present it will pass control to it. If there is no operating system present control will be passed to BASIC.

There are some other situations that should be noted:

- POST errors

  If there are any POST errors, POST will always attempt to load the system programs from a reference diskette in the A: drive.

- Diskette in another drive

  If there is a diskette in your second diskette drive, POST will not attempt to load an operating system from it.

- Second hard disk.

  POST will not attempt to load an operating system from a second hard disk.

7.11.3 Operating System Support

Both DOS and OS/2 use information stored by POST/BIOS to determine the number and characteristics of hard disks and diskettes installed in the system. This information that the operating system uses is stored in the BIOS notation for drives.

- Operating system startup sequence

  Both DOS and OS/2 are designed to start *only* from a diskette in the first physical diskette drive (BIOS drive 00) or the first hard disk drive (BIOS drive 80).

- Operating system load

  Both DOS and OS/2 operating system code is designed to invoke drive 00 and drive 80 calls during its boot process. This is why both operating systems will load only from BIOS drives 00 or 80.

- Drive lettering

  Both DOS and OS/2 assign drive letters in the following sequence.

  A: = BIOS diskette drive 00

B: = BIOS diskette drive 01

C: = BIOS hard disk 80

D: = BIOS hard disk 81

7.12 Setting up Selectable Boot

The "Set Start-up Sequence" option is part of the "Set Features" main menu option. When selected, you will get a screen display as shown in Figure 32.

```
                        Set Boot Sequence

Sequence Number                                  Device

      1 . . . . . . . . . . . . . . . . 1.44Mb Floppy Device 0

      2 . . . . . . . . . . . . . . . . SCSI Hard Disk ID 6,0

      3 . . . . . . . . . . . . . . . . Not assigned

      4 . . . . . . . . . . . . . . . . Not Assigned



  F1=Help   F3=Exit   F5=Prev Choice   F6=Next Choice   F10=Save
```

Figure 32. Screen Layout for Selectable Boot Option

The panel will display the current "boot sequence". If you are using the startup utility for the first time, the screen display will be as shown in Figure 32. This is an indication that the default sequence (BIOS diskette 00 followed by hard disk 80) is in operation.

To change the boot sequence you must move the cursor to the device box and use the F5 and F6 keys to toggle the options. The devices that you can choose will be determined by the number of devices that you have installed. Only the following installed options will be selectable:

- 1.44 MB 3.5" diskette drives
- 1.2 MB 5.25" diskette drives
- SCSI hard disk drives.

There is no support for selecting a Token-Ring adapter with the RIPL chip installed (see section 7.17, "Remote Initial Program Load (RIPL) Support" on page 62). The maximum number of devices that can be in the boot sequence is four. These devices can be both internal and external.

Each of the installed devices will have a description plus the physical number for the device.

7.13 Selectable Boot Sequence Operation

Figure 33 shows a boot sequence defined by a user.

```
                        Set Boot Sequence

Sequence Number                              Device

      1 . . . . . . . . . . . . . . . . 1.44 MB Floppy Device       0

      2 . . . . . . . . . . . . . . . . 1.2 MB Floppy Device        1

      3 . . . . . . . . . . . . . . . . 360 KB external diskette    2

      4 . . . . . . . . . . . . . . . . SCSI Hard Disk ID        6,0


  F1=Help   F3=Exit   F5=Prev Choice   F6=Next Choice   F10=Save
```

Figure 33. Example Boot Sequence

In all PS/2s, the default boot sequence for POST is to start first from a diskette in the first diskette drive (BIOS diskette 00) and then (if no diskette is present) from the first hard disk (BIOS hard disk 80). If there is a diskette in BIOS diskette 01, or a bootable partition on BIOS hard disk 81, no attempt would be made to boot from these devices.

On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 with a boot sequence as defined in Figure 33, POST would attempt to load an operating system from each device in the sequence. In the example above, if there is no diskette in the 1.44 MB diskette drive, POST would try to boot a diskette from the 1.2 MB diskette drive and so on.

7.14 Selectable Boot - Operating System Support

The section 7.11.3, " Operating System Support" on page 59 explains how both DOS and OS/2 work in a selectable boot environment.

To maintain compatibility with these operating systems, BIOS will remap the BIOS drive assignments, so that the operating system always thinks that it has booted from either BIOS drive 00 or 80.

For example, in Figure 33, if no diskette is present in the 1.44 MB diskette drive and there is a bootable diskette in the 1.2 MB diskette drive, POST would attempt to load the operating system from this drive. This drive is known by BIOS as drive 01, the second physical diskette drive.

However, DOS and OS/2 will not load from this diskette as it is not drive 00. This is where new BIOS/hardware comes in and remaps the drive BIOS numbers. In this example POST and BIOS would remap the drives so that the actual diskette drive the operating system is loaded from becomes drive 00, even though it is the second physical diskette drive.

This remapping makes the operating system think it is booting from the first physical diskette drive (which is all that it supports), when it has actually booted from the second physical diskette drive.

7.15 When the Boot Sequence Will be Used

If the selectable boot sequence utility has not been used, POST will default to the boot sequence - drive 00 followed by drive 80.

If you have set up a boot sequence, it will *not* be used in the following cases and POST will default to a boot sequence of drive 00, drive 80:

- When errors occur during POST

  When errors occur during POST (other than errors that occur when an attempt is made to IPL an operating system) the default boot sequence will be used. An attempt will be made to boot the system partition or a reference diskette.

- When a CTRL-ALT-INS key sequence occurs

  This is so that the system partition can be booted.

- When a reference diskette is in the first physical diskette drive

  Even if the first physical diskette drive is *not* in the boot sequence, POST will check to see if a reference diskette is installed in the drive. If a reference diskette is present it will boot from it.

7.16 IML Considerations

The loading of the IML code from the media source (refer to section 7.3, "IML implementation - IBM PS/2 Model 90 and Model 95" on page 46) takes place before POST attempts to load an operating system. This also means that POST will not recognize a user-defined boot sequence before IML is loaded.

This implies that the system partition that contains the IML code must be located on the first physical hard disk even if you have defined the operating system to load from a second hard disk.

Note: The complete IML process takes place before any selectable boot sequence is recognized.

7.17 Remote Initial Program Load (RIPL) Support

Selectable boot will not allow a token-ring adapter with a RIPL chip installed to be a selectable item.

However, there are two ways in which the remote IPL function on the token-ring adapter can be initiated.

The first is to use the special program that is shipped with the RIPL chip. This simply stops POST trying to load from any hard disk and to attempt a remote IPL instead.

The second is to set up your system so that a remote IPL is attempted as a default instead of BASIC. The following section explains how this works:

The RIPL function on the token-ring adapter hooks into the BIOS interrupt that calls the BASIC program. On the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 if there is no bootable device in the boot sequence or a fixed disk failure, the error condition calls BASIC. If the RIPL chip is installed, a remote IPL will be attempted instead.

For example if you had a hard disk installed that was working perfectly but wanted to remote IPL, you could do the following:

- Set the selectable boot sequence to include only your diskettes.
- Remove all diskettes from the drives.
- Reboot the system.
- When the system asks for a diskette to be inserted in a drive press F1.
- The system will then invoke the RIPL process.

7.18 IPL Process Overview

Figure 34 on page 64 shows the IPL process in a system that is using selectable boot to check for diskettes in more than one diskette drive. The flowchart shows the error situations for the boot sequence.

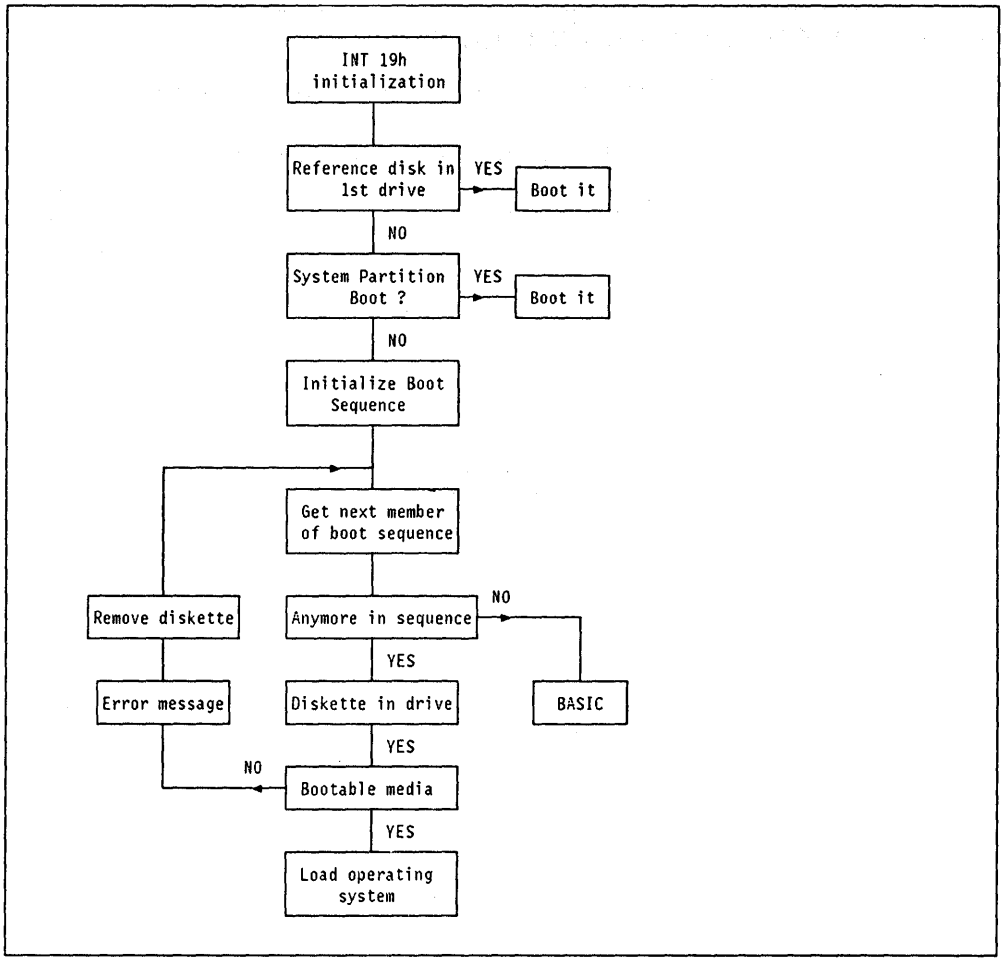


Figure 34. IPL Routine Overview for Diskettes With Selectable Boot Active

There are a few important points to note in Figure 34:

- Reference Diskette in First Physical Diskette Drive

  POST will, regardless of the boot sequence, always check for a reference diskette in the first physical drive. This is true even if the first physical drive is not in the boot sequence. If it finds a reference diskette in this drive it will boot from it and the selectable boot sequence will be ignored.

- Invalid Diskette in Drive

  When there is a diskette in one of the diskette drives that is not a system diskette the error message *non-system diskette* will be displayed. Depressing the Enter key will make POST ignore the diskette and move on to the next drive in the sequence. However, if the diskette is a system diskette, but with some of the files required to load the operating system missing, the system will halt.

7.19 Selectable Boot Examples

The examples show how selectable boot works.

Each table has four columns as defined below:

1. Physical Location

   This is the physical location of the drive. Figure 35 shows these locations.

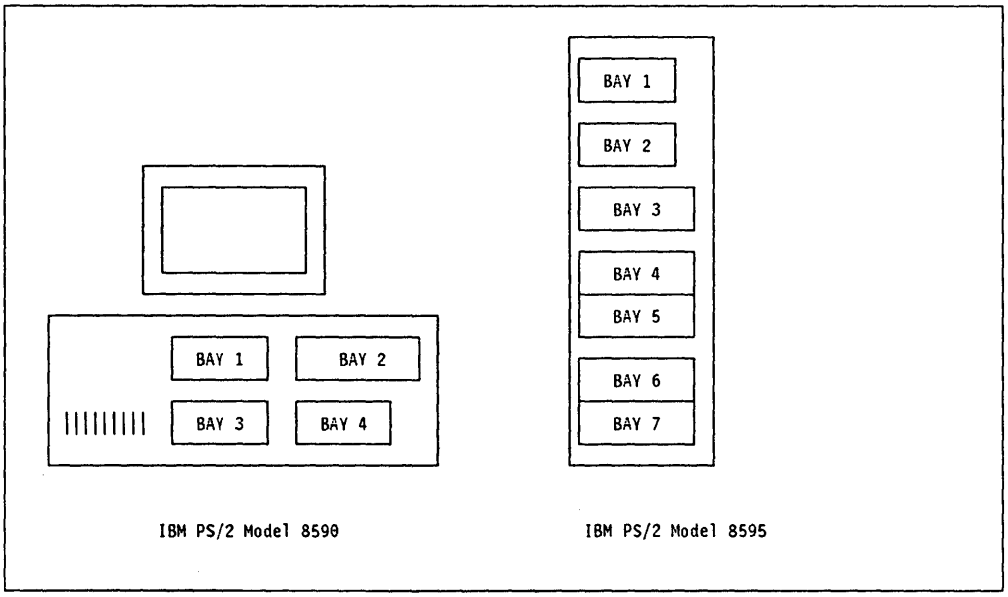


Figure 35. Physical Locations - PS/2 Model 90 and PS/2 Model 95

2. Boot sequence

   This is the boot sequence that you have defined using the selectable boot sequence.

3. BIOS Number

   This shows how the BIOS numbers are altered according to the boot sequence. The operating system assigns letters to the drives according to this number.

4. Drive Letter

   This is the letter assigned to the drive by the operating system.

7.19.1 Single Hard Disk Partitions

Example 1

Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
3.5" Diskette	1	1	00	A:
1.2 MB Diskette	2	-	01	B:
SCSI Hard Disk (6,0)	3	2	80	C:
SCSI Hard Disk (5,0)	4	-	81	D:

Figure 36. Selectable Boot - Example 1

Figure 36 shows the default startup sequence.

If a diskette is placed in any diskette drive that is not in the boot sequence POST will not attempt to load an operating system from it. In all systems where no boot sequence has been defined, Figure 36 on page 65 applies.

Example 2

Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
3.5 Diskette	1	2	01	B:
1.2 MB Diskette	2	1	00	A:
SCSI Hard Disk (6,0)	3	3	80	C:
SCSI Hard Disk (5,0)	4	4	81	D:

Figure 37. Selectable Boot - Example 2

In Figure 37 the user wants POST to check for an operating system in the 1.2 MB 5.25-inch diskette, then the 1.44 MB diskette and then, if none is found, to start the operating system on the first hard disk.

If the operating system booted from the 1.2 MB diskette drive or the hard disk the drive assignments would be as shown in Figure 37.

However, if the operating system boots from the 1.44 MB diskette drive which is number 2 in the sequence, the drive assignments would be different. They would be exactly the same as in Figure 36 on page 65.

This is because selectable boot makes the assumption that whatever diskette drive the operating system boots from will be the diskette drive that you will use most. For this reason it gives the diskette drive that the operating system loaded from the BIOS drive number 00, hence the operating system sees it as the A: drive.

In normal circumstances, you will see the drive assignments in Figure 37 unless the operating system loads from a diskette in a diskette drive which is:

1. In the boot sequence
2. *And not* the first diskette drive in the sequence.

This assumption does not happen for hard disks. The first hard disk in the sequence will always be assigned as the first drive. Selectable boot will not move on to a second hard disk if an operating system cannot be loaded from the first hard disk in the sequence.

Example 3

Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
3.5 Diskette	1	4	00	B:
1.2 MB Diskette	2	3	01	A:
SCSI Hard Disk (6,0)	3	2	81	D:
SCSI Hard Disk (5,0)	4	1	80	C:

Figure 38. Selectable Boot - Example 3

In Figure 38 on page 66 the boot sequence has been selected so that POST does not attempt to load an operating system from any of the diskette drives. Instead, POST will boot from the second hard disk.

However, the diskette drives have still been placed in the boot sequence. This is because they will keep the assignments relating to the order of the boot sequence.

The hard disk assignments will also change. The hard disk that the operating system loads from will always be the C: drive. The second hard disk will always be assigned as the D: drive.

7.19.2 Multiple Hard Disk Partition Support

Example 4

Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter	Extended Partitions
3.5 Diskette	1	1	00	A:	-
1.2 MB Diskette	2	2	01	B:	-
SCSI Hard Disk (6,0)	3	3	80	C:	F:
SCSI Hard Disk (5,0)	4	4	81	D:	G: H:
SCSI Hard Disk (4,0)	5	-	82	E:	I: J:

Figure 39. Selectable Boot - Extended Partitions - Default Sequence

Figure 39 shows a system with multiple hard disks installed, each with extended partitions. The lettering of the hard disk partition always follows these rules:

1. Letter primary partitions on all hard disks; *then...*
2. Letter all extended partitions on the first hard disk; *then...*
3. Letter all extended partitions on the second hard disk and so on.

Example 5

Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter	Extended Partitions
3.5 Diskette	1	1	00	A:	-
1.2 MB Diskette	2	2	01	B:	-
SCSI Hard Disk (6,0)	3	4	81	D:	H:
SCSI Hard Disk (5,0)	4	3	80	C:	F: G:
SCSI Hard Disk (4,0)	5	-	82	E:	I: J:

Figure 40. Selectable Boot - Extended Partitions - New Boot Sequence

Figure 40 shows how changing the boot sequence affects the lettering of the hard disk partitions. The same rules apply as explained above, but the first drive is no longer the same, so the drive assignments will change.

Warning!

This example shows that all path statements defined within the system will be incorrect if the boot sequence has changed. Malfunction of some applications may occur as a result of these changes.

7.19.3 Multiple Operating Systems

The selectable boot option allows you to boot from different hard disks. This assists you in the following cases:

- Multiple operating systems in one system
- Operating system upgrades.

Each of these will be covered in more detail.

Multiple Operating Systems in one System: Figure 41 shows three SCSI hard disks, each formatted with a different operating system.

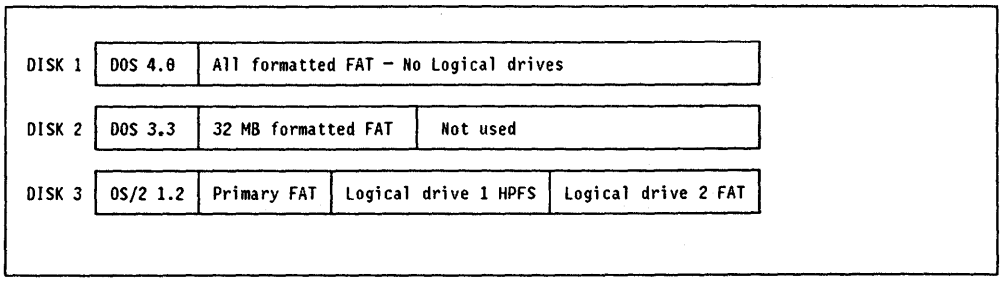


Figure 41. Hard Disk Example Layout

Selectable boot will enable you to select which hard disk and hence which operating system you wish to boot. There are some issues that you should be aware of in this environment:

- OS/2 1.2 High Performance File System (HPFS)

  Assume that logical drive 1 on the OS/2 1.2 hard disk has been formatted using the HPFS.

When you boot on the DOS 3.3 hard disk, it will not see the HPFS logical drive, or logical drive 2 in Figure 41, even if the logical drives are only 32 MB in size.

When you boot on the DOS 4.0 hard disk (with CSD 33003 applied), it will see the HPFS partition but not be able to copy or write files to it. However, provided logical drive 2 is a FAT drive, you will be able to see and use it.

- DOS Version 3.3

  DOS 3.3 will only be able to see partitions less than 32 MB in size.

- Drive letter assignments

  When you boot from the different drives the drive letter assignments will change. Please refer to section 7.19.2, "Multiple Hard Disk Partition Support" on page 67 for more details.

Operating System Upgrades: There will be occasions when you want to test out a new operating system, or an upgrade to a newer version. Examples of these would be the application of new CSDs to OS/2 or an upgrade from DOS 3.3 to DOS 4.0. In these cases you may want to ensure that the new level of operating system does not affect your current environment.

Selectable boot will allow you to keep a copy of the previous software level on one disk and load the newer version to a second disk. This will provide a clean environment for testing out new software levels.

If it is your intention to use this method to upgrade, it is advisable to allocate the first partition of each hard disk purely for the storage of the operating system code.

7.19.4 Three Diskette Drive Support

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems both have three diskette drive connectors. They are supported by two cables connected directly to the planar board. The diskette cables support any combination of the following devices:

- 1.44 MB diskette drive
- 1.2 MB internal diskette drive
- Internal tape backup unit.

The connector that the device attaches to determines which physical drive your device will be. Please refer to section 8.1.1, "Diskette Drive Connectors" on page 73 for more details.

Operating System Support: When three diskette drives are installed internally, the drive lettering performed by the operating system is important. To maintain compatibility it must letter the third diskette drive AFTER all hard disk drives have been assigned their letters. This ensures that the C: drive will always be the first hard disk.

OS/2 1.2 fully supports the three diskette drives in any combination.

DOS 4.0 with CSD 30030 supports three diskette drives.

Note: To install three diskette drives in a DOS system, you must first install DOS on the system when only one or two diskettes are installed. Then the CSD 30030 must be applied. When the CSD has been applied you can then reconfigure the system with the third diskette drive installed.

Three Diskette Drive Environment Examples: Figure 42 shows a three-diskette drive environment.

Example 6

Physical Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
Diskette 0	1	1 **1**	00	A:
Diskette 1	2	2	01	B:
Diskette 2	3	3	02	D:
SCSI Hard Disk (6,0)	4	4	80	C:
Note: **1** indicates the drive that the operating system loaded from				

Figure 42. 3 Diskette Environment - Example 6

In Figure 42 BIOS drive 02 does not become the C: drive. It is assigned a letter after all hard disk partitions have been assigned (in our example the D: drive).

Example 7

Physical Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
Diskette 0	1	1	00	A:
Diskette 1	2	3	01	B:
Diskette 2	3	2	02	D:
SCSI Hard Disk (6,0)	4	4 **1**	80	C:
Note: **1** indicates the drive that the operating system loaded from				

Figure 43. 3 Diskette Environment - Example 7

In a three diskette drive environment, POST/BIOS make the assumption that the diskette 2 (BIOS diskette drive 02) will not be used as much as the other two diskette drives. BIOS drive 02 will have its BIOS number remapped only if an operating system actually loads from it. If an operating system does not load from it, regardless of its position in the boot sequence, it will always be BIOS drive 02. This is why, in Figure 43, although diskette 2 is second in the boot sequence it will not be mapped as BIOS drive 01. It will remain as BIOS diskette 02. However, in Figure 44 on page 71, the operating system actually loaded from diskette 3 and it has been remapped to BIOS drive 00.

Example 8

Physical Device	Physical Location	Boot Sequence	BIOS Number	Drive Letter
Diskette 0	1	1	01	B:
Diskette 1	2	3	02	D:
Diskette 2	3	2 **1**	00	A:
SCSI Hard Disk (6,0)	4	4	80	C:
Note: **1** indicates the drive that the operating system loaded from				

Figure 44. 3 Diskette Environment - Example 8

In Figure 44, the operating system actually loaded from diskette 3. Unlike Figure 43 on page 70 it is now mapped to BIOS drive 00 and becomes the A: drive. This ensures that you can always assume that the diskette drive you load the operating system from will be the A: drive.

Warning!

Please be aware that changing the boot sequence may change the way that some applications behave due to incorrect paths and location of programs or data.

8.0 Direct Access Storage Devices (DASD)

This chapter describes the various disks and diskette storage devices that come standard or as options on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

8.1 Diskette Controller

The diskette controller on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems is a type 2 controller. It is compatible with the type 1 controller used on current PS/2 systems. The type 2 diskette controller supports the following devices:

- 1.44 MB 3.5″ diskette drives
- Internal tape backup unit
- 1.2 MB 5.25″ 1 inch high diskette drive.

The 1.2 MB 5.25″ 1 inch high diskette drive is supported only by the type 2 controller.

8.1.1 Diskette Drive Connectors

Both the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems support three diskette drives through the type 2 diskette controller. A cable with three diskette drive connectors (pin format not berg or edge connector) attaches directly to the planar. In an environment with two or three diskette drives installed, the specific connector that the diskette drive connects to determines its physical drive number. This is important in a selectable boot environment. All connectors support all diskette devices listed above, in any combination. The connector layout is different in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems:

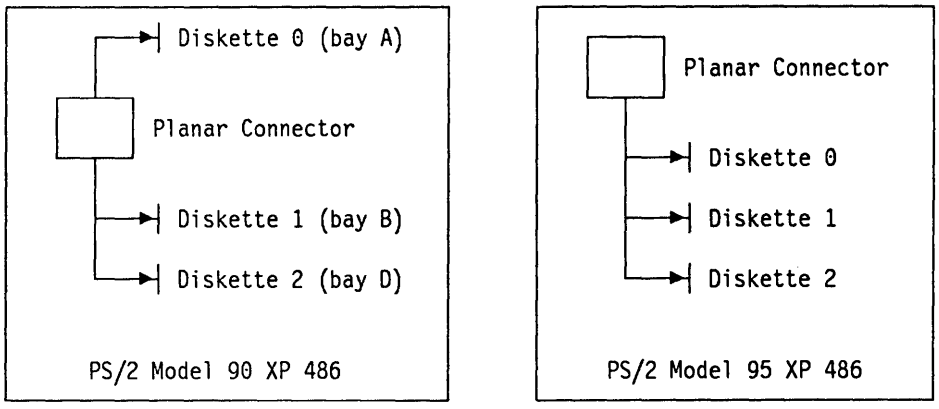


Figure 45. Diskette Controller Connectors

Please refer to Figure 35 on page 65 for the layout of the system bays.

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8.2 1.44 MB Diskette Drives

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems use a new 1.44 MB diskette drive. It uses a pin connector rather than a berg connector. However, this diskette drive is *not* the same as the 1.44 MB diskette drive with a pin connector being used on some of the current PS/2 systems.

Warning!

If you install any 1.44 MB diskette drive other than those specifically available for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems you may cause damage to the planar board.

8.3 1.2 MB 5.25" 1 Inch High Slim Diskette Drive

The 1.2 MB 5.25" slim diskette drive is a new diskette drive that is supported only in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

The 1.2 MB 5.25" slim diskette drive has many advantages over the current 1.2 MB 5.25" internal diskette drive:

- Slimmer physical size
- No device driver required
- No adapter required
- Electronic eject
- Bootable device.

The drive is installed by direct attachment to the diskette drive connector cable (see Figure 45 on page 73). Unlike the 1.44 MB diskette drive and the internal tape backup unit, it requires a separate power cable, which is shipped with both systems. After installing the drive and reconfiguring the system, it is displayed as one of the diskette drives in the "built-in devices" section of the system configuration.

The 1.2 MB 5.25" slim diskette drive can be installed only in bay B on the IBM Model 90 XP 486 system as shown in Figure 35 on page 65 and either bay D or bay F on the IBM Model 95 XP 486 system as shown in Figure 49 on page 79.

The 1.2 MB 5.25" slim diskette drive will format, read and write to both 360 KB and 1.2 MB diskettes. However, 360 KB diskettes formatted on this drive may not be readable on 360 KB diskette drives.

8.4 Internal Tape Backup Unit

To install the internal tape backup unit in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems you need the "Internal Tape Backup Unit Installation Kit B". This kit consists of a small cable with a berg connector on one end and a 34 pin connector on the other end.

Once installed the internal tape unit will be shown in the installed devices menu when you view the system configuration using the system programs.

8.5 IBM 6157 Streaming Tape Device

Both models of the IBM 6157 tape streaming device are supported on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. The 6157-001 gives a tape capacity of 60 MB and the 6157-002 gives 150 MB tape capacity. Both tape units use the same IBM 6157 Tape Streaming Adapter.

8.6 IBM PS/2 2.3 GB Full High SCSI Tape Drive

The IBM PS/2 2.3 GB Full High SCSI Tape Drive is a full height SCSI tape unit that supports the backup of 2.3 GB of data onto a single tape cartridge.

The highlights of the drive are as follows:

- SCSI interface attachment
- 2.3 GB formatted capacity on tape
- 245 KB per second data transfer rate (sustained)
- 248 KB data buffer
- ANSI standard 8mm cartridges

The IBM PS/2 2.3 GB Full High SCSI Tape Drive is only supported when installed in the IBM Model 95 XP 486 system or the PS/2 external SCSI storage enclosure. The IBM PS/2 2.3 GB Full High SCSI Tape Drive will not fit internally in any desktop PS/2 system, including the IBM Model 90 XP 486 system. This is because it is a full height 5.25" wide device.

Tape

The IBM PS/2 2.3 GB Full High SCSI Tape Drive uses 8 mm tape cartridges

Program Support

The IBM PS/2 2.3 GB Full High SCSI Tape Drive is supported by Sytos Plus**. Sytos Plus is supported under the following operating systems:

- Operating System/2 Standard Edition 1.2 and 1.3
- Operating System/2 Extended Edition 1.2 and 1.3

There is no support for the IBM PS/2 2.3 GB Full High SCSI Tape Drive under DOS.

8.7 SCSI Hard Disk Drives

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems come with one of the following SCSI hard disk drives installed as standard:

- 80 MB SCSI hard disk
- 160 MB SCSI hard disk
- 320 MB SCSI hard disk

Each of these SCSI drives can also be used as options for all SCSI based systems. The 320 MB SCSI hard disk drive is a new version of the previous 320 MB SCSI hard disk drive. To install the 80 MB or 160 MB SCSI hard disk drives in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems or the PS/2

external SCSI storage enclosure you need the "SCSI Hard Disk Drive Kit D". This kit consists of special trays and slides plus installation intructions.

Warning!

Only the new version of the 320 MB SCSI hard disk drive can be installed in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. The old version is *not* supported.

Figure 46 shows the specifications for each of the SCSI fixed disk drives.

Figure 46. Hard Disk Drive Specifications

	80 MB Disk	160 MB Disk	320 MB Disk
Formatted Capacity	80 MB	160 MB	320 MB
Average Seek Time	16 ms	16 ms	12.5 ms
Sector Interleave	1:1	1:1	1:1
Look Ahead Buffer	32 KB	32 KB	64 KB
SCSI Synchronous Support	Yes	Yes	Yes

All of the SCSI hard disk drives are 3.5" drives. They are for internal installation in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems or in the PS/2 external SCSI storage enclosure. More details on the drives can be found in the *Technical Reference Manual* for the particular drives.

8.8 PS/2 SCSI Adapter With Cache

The "IBM Micro Channel SCSI Adapter with Cache" is a 32-bit SCSI bus master adapter. (For a full description of both SCSI and the PS/2 SCSI adapter with cache please refer to ITSC document *SCSI Architecture and Implementation*). It comes as a standard feature on both the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems and is installed in slot 1 on both systems.

A maximum of four SCSI adapters (16 bit SCSI adapter or 32 bit SCSI adapter with cache) can be installed in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

8.8.1 512 KB Cache

The PS/2 SCSI adapter with cache comes with 512 KB of cache as standard installed. This cache memory cannot be upgraded or removed and used on other adapters. It is *not* supported on the SCSI adapter.

This on-board cache will improve system performance as memory will not have to be set aside for system caches. If you also install a system cache this will improve performance of the PS/2 SCSI adapter with cache rather than cause double caching.

8.8.2 External Terminator

The terminator for the PS/2 SCSI adapter with cache is in the form of a 60-pin external plug. This must be installed when no external SCSI devices are attached to the system.

> **Warning!**
>
> Do not use the external SCSI terminator as a handle to lift the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. This will break and damage the PS/2 SCSI adapter with cache.

8.8.3 SCSI Device Driver

The IBM PS/2 Model 90 XP 486 and Model 95 XP 486 reference diskettes contain an update program and an installation program. The update program is called *DISK386.SYS*. This program maintains compatability between SCSI devices, IBM DOS, and some of the following types of programs that assume the hard disk drive will utilize the system DMA controller. The following programs are affected:

- Multitasking DOS programs
- Programs written for the 80386 processor only
- Programs that use the virtual 8086 mode of the 80386 processor
- Programs that emulate expanded memory specification (EMS) in extended memory.

The update program should *only* be installed when applications providing DOS and/or memory extensions fail to work properly. For example, an application may fail to load and return the DOS prompt or when attempting to access a SCSI device, the system may hang or the screen go blank.

With the update program installed, a buffer is provided in the first megabyte of system memory that serves as an intermediate location for data being transferred between the SCSI adapter and the requesting programs buffer. While this update program allows applications that utilize the system DMA controller to run, some performance degradation in file access time may be experienced. Only after problems have been experienced, and the performance implications considered, should the update program be used.

8.9 DASD Storage Bays

All of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems can be upgraded using any of the IBM SCSI options:

- 60, 80, 120, 160, 320 MB SCSI hard disks
- IBM PS/2 2.3 GB Full High SCSI Tape Drive
- Internal and External SCSI CD-ROM Drives

However, the actual location in which the devices can be installed in the system unit is very important. The following sections explain what can be installed and where for the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

8.9.1 IBM 8590 XP 486 System

The IBM Model 90 XP 486 system is a desktop system that has four DASD storage bays. Every IBM Model 90 XP 486 system comes standard with the following:

- 1.44 MB diskette drive
- 3.5″ SCSI hard disk (size dependent on model).

The other bays are free for expansion.

Figure 47 shows the bay locations and Figure 48 explains what options can be installed in each particular bay.

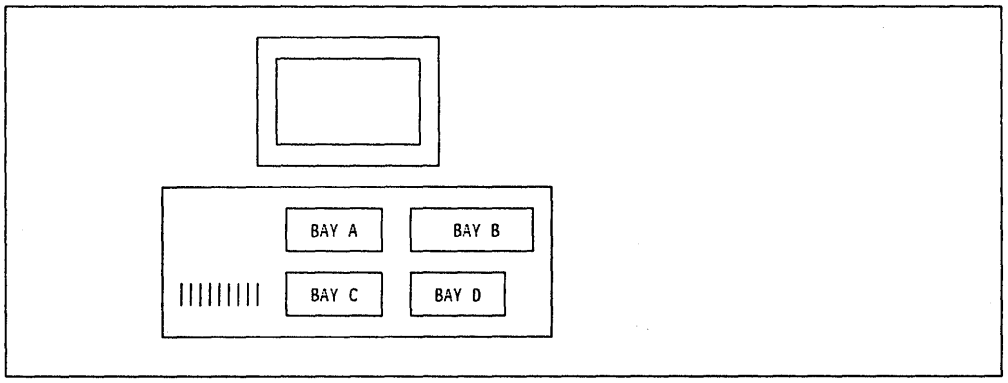

Figure 47. DASD Storage Bays on the PS/2 Model 90

Bay	Standard	Options (only one of)
A	1.44 MB Diskette	NONE
B	EMPTY	1.2 MB 5.25″ Diskette 1.44 MB 3.5″ Diskette Internal tape backup unit 3.5″ SCSI hard disk Internal CD-ROM
C	3.5″ SCSI hard disk	NONE
D	EMPTY	1.44 MB 3.5″ Diskette Internal tape backup unit 3.5″ SCSI hard disk

Figure 48. DASD Storage Matrix - PS/2 Model 90

8.9.2 IBM 8595 XP 486 System

The IBM Model 95 XP 486 system is a floor-standing system that has seven DASD storage bays. Every IBM Model 95 XP 486 system comes standard with the following:

- 1.44 MB diskette drive
- 3.5″ SCSI hard disk (size dependent on model).

The other five bays are free for expansion. Figure 49 on page 79 shows the bay locations and Figure 50 on page 79 explains what options can be installed in each particular bay.

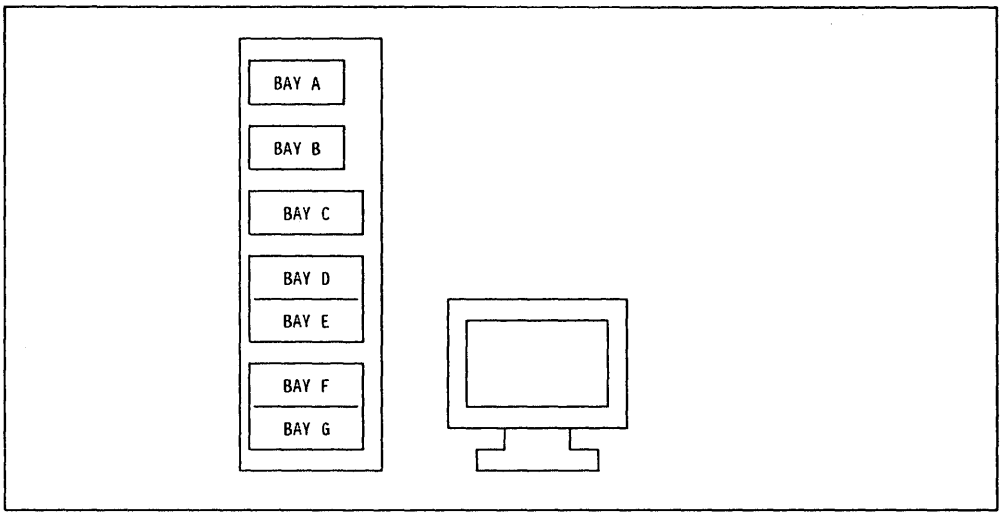

Figure 49. DASD Storage Bays for PS/2 Model 95

Bay	Standard	Options (only one of)
A	1.44 MB Diskette	NONE
B	EMPTY	1.44 MB 3.5" Diskette Internal tape backup unit
C	EMPTY	1.2 MB 5.25" Diskette Internal tape backup unit 3.5" SCSI hard disk Internal CD-ROM
D	EMPTY	1.2 MB 5.25" Diskette Internal tape backup unit 3.5" SCSI hard disk
E	EMPTY	1.2 MB 5.25" Diskette 3.5" SCSI hard disk Internal CD-ROM
D & E	EMPTY	IBM PS/2 2.3 GB Full High SCSI Tape Drive
F	EMPTY	3.5" SCSI hard disk
G	3.5" SCSI hard disk	NONE
Note: Although it is possible to install the IBM PS/2 2.3 GB Full High SCSI Tape Drive in bays F and G (if the SCSI hard disk was moved to a bay other than F or G), IBM does not support this configuration.		

Figure 50. DASD Storage Matrix - PS/2 Model 95

8.9.3 Installation Kits

When installing any of the DASD devices in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems you will not need to purchase an additional installation kit unless it is listed below.

- 80 MB and 160 MB SCSI Hard Disk Drives

  To install either of these drives you will need the *SCSI Hard Disk Installation Kit D*. This kit consists of mounting material and installation instaructions.

- Internal Tape Backup Unit

  To install this option you will need the *Internal Tape Backup Installation Kit*. This kit consists of a cable and installation instructions.

8.10 PS/2 External SCSI Storage Enclosure

This section covers the new PS/2 external SCSI storage enclosure that enables you to expand the storage capacity of a PS/2 system externally with up to 2.2 GB per PS/2 external SCSI storage enclosure.

8.10.1 PS/2 External SCSI Storage Enclosure Overview

The PS/2 external SCSI storage enclosure is a floor-standing expansion unit, similar in appearance to the IBM Model 95 XP 486 system. It can be attached to any PS/2 system with an installed SCSI adapter or SCSI adapter with cache. The attachment is made using the external SCSI cable. The PS/2 external SCSI storage enclosure comes standard with a 320 MB SCSI hard disk drive installed. It can be populated with a maximum of seven SCSI devices. This means that an additional 2.2 GB of storage can be attached to a system. This is extremely valuable in a server environment.

The PS/2 external SCSI storage enclosure supports only SCSI devices and can be attached to only one SCSI adapter at a time. It is important to remember that one SCSI adapter can support a total of seven SCSI devices. This number is a total of all of the devices attached both internally and externally.

PS/2 External SCSI Storage Enclosure Configuration

The PS/2 external SCSI storage enclosure has the following components:

- 329 W power supply
- 320 MB SCSI hard disk drive
- SCSI cable with seven connectors.

Figure 51 shows the bay locations and Figure 52 explains what options can be installed in each particular bay.

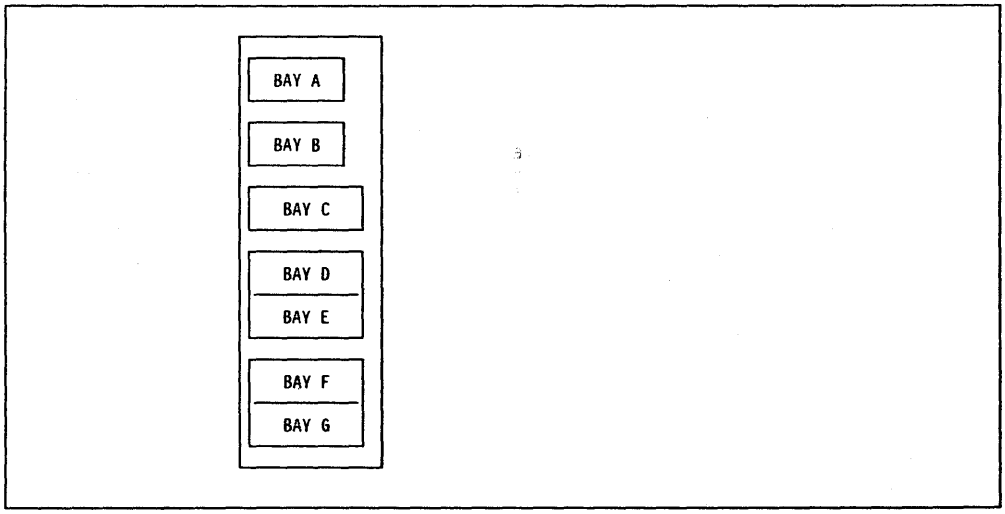

Figure 51. DASD Storage Bays - PS/2 External SCSI Storage Enclosure

CD-ROM Drive	2.3 GB Tape	60 MB disk 120 MB disk	80 MB disk 160 MB disk	320 MB disk
Half height	Full height	Half height	Half height	Half height
Bay D Bay F	Bay D and E	All bays except A and B	All bays	All bays

Figure 52. DASD Storage Matrix - PS/2 External SCSI Storage Enclosure

Power Considerations

Unlike the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems, the PS/2 external SCSI storage enclosure has some power restrictions that will not allow certain combinations of devices to be installed in the unit.

It is possible to damage the power supply or shutdown the system if the total amount of nominal operating current required for the installed devices exceeds the current made available by the storage enclosure.

The total amount of current that the PS/2 external SCSI storage enclosure can make available is as follows:

- 4.6 A on the + 5V line
- 7.5 A on the + 12V line

To determine if the combination of SCSI devices that you wish to install in the PS/2 external SCSI storage enclosure exceeds these system maximums, simply add up the +5 V line and +12 V line requirements. If they exceed the maximum on either of the lines, this device combination must not be used. Figure 53 shows the nominal power requirements for all of the IBM SCSI devices currently available.

Device	Nominal current	
	+5V line	+12V line
CD-ROM drive	0.9 A	1.7 A
60/120/320 MB hard disk drives	0.66 A	1.0 A
80/160 MB hard disk drives	0.5 A	0.8 A
2.3 GB tape drive	2.0 A	0.4 A

Figure 53. Power Requirements

9.0 IBM Extended Graphics Array Subsystems

This chapter describes the XGA and XGA Adapter/A video subsytems. The XGA comes standard on the Model 90 XP 486. The XGA Adapter/A comes standard on the Model 95 XP 486.

9.1 Introduction

The IBM Extended Graphics Array (XGA) is the video subsystem that is integrated onto the planar board of the Model 90 XP 486. It is not resident on the planar of the Model 95 XP 486.

The XGA Adapter/A is the video subsystem, packaged as an adapter card, which plugs into a Micro Channel slot. It comes as standard with the Model 95 XP 486.

Both systems consist of a video subsystem similar to the VGA, but with the addition of a coprocessor, which provides high-speed display update functions.

Both systems are bus masters designed to support high-resolution screens with a maximum resolution of 1024 x 768 pels with 256 colors. Both systems have 512 KB of video display buffer or video random access memory (VRAM), which can be upgraded to 1 MB by installing the IBM PS/2 Video Memory Expansion Option.

Note: In some countries, these systems will be supplied with 1 MB of VRAM installed as standard.

In this chapter, we treat both the XGA and the XGA Adapter/A as the same. Where there are differences, they are pointed out.

9.2 New Features

This section summarizes some of the new features in the XGA and XGA Adapter/A that distinguish them from the Video Graphics Array (VGA). These are:

- VGA mode
- 132-column text mode
- Extended graphics mode
- Direct color mode
- 8514/A compatibility
- Multiple XGA Adapter/A support
- Video extension support.

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9.2.1 VGA Mode

Both the XGA and XGA Adapter/A offer general compatibility with the VGA at the register level, but with improved performance. There are several reasons for this performance improvement.

For example, both the XGA and XGA Adapter/A will exploit a 32-bit physical bus width for all of their system memory and I/O addresses when fully configured to 1 MB. (The only exception is the Programmable Option Select registers, which have an 8-bit port width, but these are infrequently accessed.)

The XGA and XGA Adapter/A will access a 512 KB video display buffer with a 16-bit data path width. They will access the 1 MB video display buffer with a 32-bit data path width.

The XGA Adapter/A will also exploit a 32-bit Micro Channel slot. This requires that you install it in a 32-bit Micro Channel slot to exploit that larger bus width.

Further performance gains are achieved because VGA mode uses some "extended graphics mode" registers, and implements several registers directly in I/O space for rapid access.

Note: Improved VGA performance may impact applications that are time dependent, such as any applications where the developer assumed that graphics I/O would take a certain time to perform, and coded logic to depend on that assumption.

9.2.2 132-Column Text Mode

The VGA has a maximum text resolution of 720 x 400 pels. 132-column text mode provides for screen sizes larger than VGA screens, specifically a 132-character per line text mode. Characters are defined in an 8-pixel-wide character box. With either the XGA or the XGA Adapter/A installed, you can use this mode to view 132 characters on any attached PS/2 screen that has a video rate over 41.539 MHz. Therefore you cannot use 132-column text mode on the IBM 8503, 8512 or 8513 displays, which have a video rate slower than that.

Software support for this new mode is limited to applications coded at the register level. There is no BIOS level support provided. If you need to code to the register level, please refer to the *IBM PS/2 XGA Technical Reference Manual*.

Note: Although 132-column text mode uses some of the extended graphics mode registers, it is different from extended graphics mode.

9.2.3 Extended Graphics Mode

This is designed to support screens at a resolution of 1024 x 768 with simultaneous display of up to 256 colors from a palette of 256 K (262,144) colors. (Please refer to Figure 58 on page 91 for the prerequisites.) This mode also supports a hardware-driven cursor sprite, and hardware assist functions to speed up graphics operations. It is in extended graphics mode that the full power of the XGA and XGA Adapter/A come into play. It is also in extended graphics mode that maximum screen resolutions are achieved. It would be safe to say that extended graphics mode may well become the new video graphics standard.

Extended graphics mode supports both real and virtual memory addressing.

This mode was designed to readily support multiple video adapters.

9.2.4 Direct Color Mode

Finally, there is another mode that the XGA or XGA Adapter/A can run in. It's called Direct Color mode, sometimes known as palette bypass mode. With 1 MB of Video Memory RAM installed, direct color mode allows you to work with a screen resolution of 640 x 480 pixels, using 64 K (65,536) colors. That means that there is an opportunity for software developers to meet the demand for color applications that can not be met with the previous 256-color limitation of earlier graphics adapters. Here, a new kind of application program would create the data that makes up a picture as a series of 16-bit pel values, which it stores into the video memory. The usual technique of looking up a color in the palette (as described in "Palette" on page 91) can then be bypassed, resulting in a faster operation with a wider color range. It's like having a huge color range to choose from, and having all these colors pre-mixed ready to use.

Strictly speaking, direct color mode is a subset of extended graphics mode operations.

Software support for this new mode is limited to applications coded at the register level. There is no BIOS level support provided. If you need to code to the register level, refer to the *IBM PS/2 XGA Technical Reference Manual*.

Display	Description	Maximum Supported Content		VRAM
8503	12-inch Mono	640 x 480	64 Gray Shades	512 KB
8507 [1]	19-inch Mono	1024 x 768 1024 x 768 640 x 480	64 Gray Shades 16 Gray Shades 64 Gray Shades	1 MB 512 KB 512 KB
8512	14-inch Color	640 x 480 640 x 480	256 Colors 65536 Colors	512 KB 1 MB
8513	12-inch Color	640 x 480 640 x 480	256 Colors 65536 Colors	512 KB 1 MB
8514 [2]	16-inch Color	1024 x 768 1024 x 768 640 x 480 640 x 480	256 Colors 16 Colors 256 Colors 65536 Colors	1 MB 512 KB 512 KB 1 MB
8515 [2]	14-inch Color	1024 x 768 1024 x 768 640 x 480 640 x 480	256 Colors 16 Colors 256 Colors 65536 Colors	1 MB 512 KB 512 KB 1 MB
8604 [1]	15-inch Mono	1024 x 768	64 Gray Shades	1 MB

Note:

[1] These displays can show 16 gray shades with 512 KB of VRAM at 1024 x 768 or 64 gray shades at 640 x 480.

[2] These displays can show 16 colors with 512 KB of VRAM at 1024 x 768 or 256 colors at 640 x 480. These displays are also capable of displaying 132 column text at 1056 x 400 pels with 1 MB of VRAM.

Figure 54. XGA Display Support

9.2.5 8514/A Compatibility

The 8514/A is Unsupported

The 8514/A adapter that supports the 8514 and 8515 displays is *not* supported in the Model 95 XP 486 and Model 90 XP 486.

Having made that warning, let's now consider the compatibility of applications written for the 8514/A. There is compatibility with the 8514/A applications at the adapter interface level and above. Be aware that the XGA and XGA Adapter/A are not stated to be compatible with the 8514/A at the register level. For an explanation, we need to look at the history of the 8514 support.

Originally, IBM announced an application programming interface for software developers to use on the 8514/A, called the Adapter Interface. Another high-level interface provided was the Virtual Device Interface (VDI). In each case, the offering was a high-level programming interface designed to minimize device dependence and ensure an easy migration to future video graphics architectures.

Unfortunately, some software developers were not satisfied with high-level interfaces. In response to their requests, IBM disclosed the specifications of the register-level interface. Although developers could code to this interface level, they risked having to invest in a larger migration effort if this interface should change in the future.

This is the case with the XGA and XGA Adapter/A implementation. As a result, some independent software vendors who have coded to the register-level interface will need to perform a migration of their applications to take advantage of the new video subsystem. IBM has encouraged software vendors to adopt the new architecture by providing early specifications. Please refer to the *IBM PS/2 XGA Technical Reference Manual* for more in-depth technical information.

9.2.6 Multiple XGA Adapter/A Support

You can have up to six adapters installed, each driving a different display simultaneously and individually. On machines which have a built-in VGA or XGA, you can have a maximum of five XGA Adapter/A adapters if there are enough available slots. This is a major departure from previous video capabilities in the PS/2 family, which was limited to a maximum of two independent displays. As a result, software developers can now satisfy the demand for multiple independent display applications. For example, standard configurations and software will now be able to handle such multiple display applications as airport arrival and departure display systems, or financial dealing room information displays.

Note: Only one real VGA, VGA mode or 132-column text mode can be *enabled* at any one time. This is because all of these modes have only one set of addresses allocated - the VGA addresses. But that does not mean that multiple screens attached to multiple adapters cannot be *displaying* in VGA or 132-column text mode at once. You can enable and disable the address decoding mechanism independently for each adapter. That means that you can write to a screen, disable its address decoding mechanism, enable another adapter's decoding mechanism, and write to it in turn.

9.2.7 Video Extension Support

The purpose of the Video Extension support is to provide the functions of the Auxiliary Video Extension, found in previous PS/2 models, to these new machines. The implementations differ between the XGA and the XGA Adapter/A, so they are covered separately.

Model 90 XP 486 Video Extension

The Model 90 XP 486 has the XGA video subsystem on its planar board. When running in VGA mode, it drives an attached screen in much the same way as the VGA on previous IBM PS/2 machines. Just as these previous machines could drive a secondary screen through the connection between the VGA and Auxiliary Video Extension, so the XGA can drive a secondary screen through its connection to the Auxiliary Video Extension. There is no Base Video Extension in the Model 90 XP 486. You will find the Auxiliary Video Extension in Micro Channel slot 3. This is shown in Figure 6 on page 14.

Note: The Auxiliary Video Extension is disabled when the XGA is in extended graphics mode.

Model 95 XP 486 Video Extension

The Model 95 XP 486 has the video subsystem on the XGA Adapter/A, not on the planar board. When running in VGA mode, it drives an attached screen in much the same way as the VGA on previous IBM PS/2 machines. As explained below, there is both a Base Video Extension and an Auxiliary Video Extension in the Model 95 XP 486. The Base Video Extension's signals drive through to the Auxiliary Video Extension's signals. Just as the previous machines could drive a secondary screen through the connection between the VGA and Auxiliary Video Extension, so the XGA Adapter/A can drive a secondary screen through its connection between the Base Video Extension and the Auxiliary Video Extension. The Base Video Extension is the driver; the Auxiliary Video Extension is driven.

On the Model 95 XP 486, you will normally find that the XGA Adapter/A is already fitted in the Base Video Extension in Micro Channel slot 5. This is shown in Figure 7 on page 15. The Auxiliary Video Extension is in slot 7. The signals coming from a VGA mode application being generated on the XGA Adapter/A which is plugged into the Base Video Extension in slot 5, will "drive through" to the Auxiliary Video Extension in slot 7. This is not true when the application is running in extended mode.

The BVE to AVE connection is shown in Figure 55 on page 88.

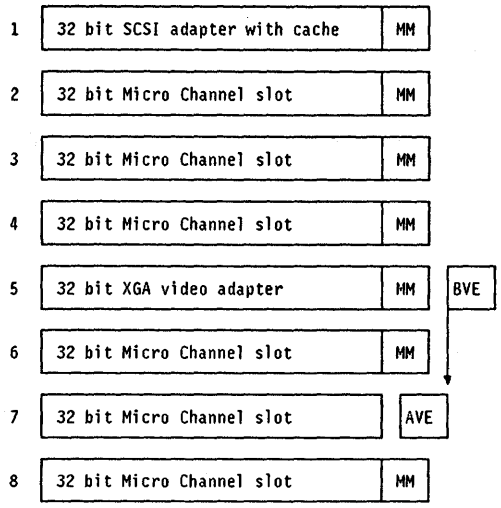

Figure 55. Micro Channel Slots in Model 95 XP 486 showing BVE to AVE connection

You will find more details about this in section 9.4, "XGA Adapter/A Installation" on page 93.

Note: The Base Video Extension is disabled when the XGA Adapter/A is in extended graphics mode.

9.3 Components

Figure 56 on page 89 shows the block diagram of the XGA Adapter/A hardware. This is identical to the XGA planar implementation, except that the Adapter POST Programmable Read-Only Memory (PROM) PROM and Base Video Extension (BVE) would not be included. The block diagram shows the relationship between the various components of the XGA Adapter/A. It depicts the flow of control and addressing signals, and the data flows from the external interfaces (PS/2 interface and Base Video Extension) through the components to the display.

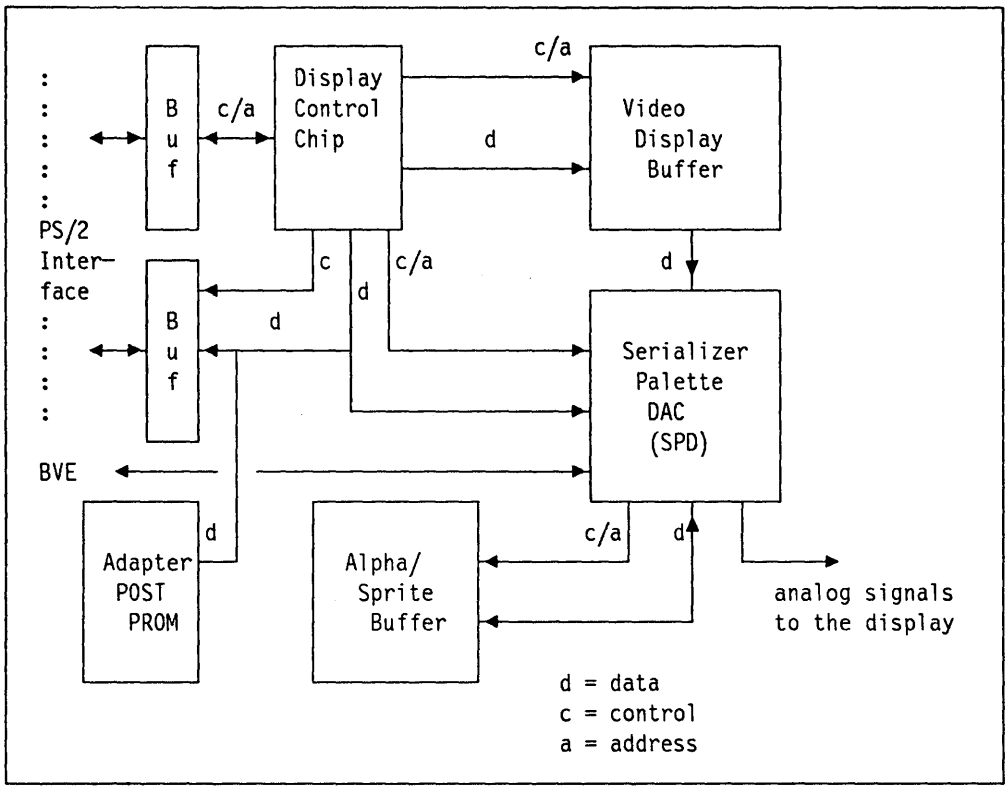

Figure 56. XGA Adapter/A Block Diagram with Data, Control and Address Flows

Over the next few pages, we will take a brief look at each of the video subsystem components. The purpose is to understand what each component does in sequence.

The XGA and XGA Adapter/A have these components:

Component	XGA	XGA Adapter/A
Display Controller Chip	Yes	Yes
Video Display Buffer	Yes	Yes
Serializer/Palette/Digital-Analog Converter	Yes	Yes
Sprite/Attribute Controller	Yes	Yes
Alpha/Sprite Buffer	Yes	Yes
Power-On Self Test PROM	No	Yes
Video Extension Support	AVE	BVE to AVE

Figure 57. Comparison of Video Graphics Subsystems

As you can see, apart from the power-on self test PROM and video extensions, the subsystems are identical. (The XGA has its power-on self test in the system ROM.) Remember also that the XGA interfaces to the Auxiliary Video Extension, whereas the XGA Adapter/A interfaces to the Base Video Extension, which in turn drives the Auxiliary Video Extension.

Let's take a quick look at each of these in turn.

Display Controller Chip

The display controller chip has three major parts:

1. PS/2 interface controller
2. Memory and cathode ray tube controller
3. Coprocessor.

The PS/2 interface controller comprises a bank of control registers, a pixel interface, a bus master and video RAM controller, and a state save/restore module. The bank of control registers are available to the main processor to set up. The pixel interface performs a wide range of pixel manipulations that are common to graphics applications. The bus master and video RAM controller handle accesses to the Micro Channel bus or video RAM on behalf of the pixel interface. The state save/restore module provides the rapid task switching required in a multitasking system.

Thus the interface controller performs several functions. Its primary task is to act as the video interface to the system bus of the PS/2. One of its jobs is to determine whether the XGA Adapter/A has been plugged into a 16- or 32-bit slot, and set itself up to transfer data according to the the available bus width. It also handles decoding the addresses for all I/O registers, the programmable ROM, the coprocessor's memory mapped registers, and the video display buffer. Perhaps its most interesting function is to support the video subsystem when it is in Micro Channel bus master mode. That's when it will generate all the Micro Channel bus signals as it "blits" data between the video display buffer and PS/2 memory. (Blit refers to a block data transfer, which is covered in appendix C.1.5, "Real-Life Application" on page 153).

The memory and cathode ray tube controller provides all the VGA functions. It allows the main system processor to access the video display buffer, and it controls the serializer/palette/DAC described below.

The coprocessor is the key component responsible for the enhanced performance of this new video subsystem:

- It provides hardware drawing functions that can draw graphics in both the video display buffer, and the system memory.
- It can update memory independently of the main processor, which can continue executing other code while the coprocessor is drawing those graphics.
- It is a Micro Channel 32-bit bus master. As a bus master, the coprocessor directly accesses system memory when in extended graphics mode. That's another reason why it has such improved performance. Here it has a programmable bus master arbitration level and a programmable fairness feature, just like any other bus master.
- It is even capable of acting as a bus master to other devices on the channel in extended graphics mode, such as another XGA for example. In fact, it is also capable of performing burst mode data transfers at up to 16.6 megabytes per second. This opens up new performance capabilities for high-speed video applications.
- It has support for virtual memory addressing.
- It provides for rapid suspending and resuming of tasks. Such a capability in a coprocessor is important in a multitasking environment.

Video Display Buffer

Also called a video RAM or VRAM, the video display buffer is a fast access dual-ported local memory buffer for storing screen data. It supports higher resolution video screens than VGA, and allows faster screen updating. Because it is dual-ported, it allows simultaneous display buffer updates and screen refresh. The video display buffer in its current implementations has either 512 KB or 1 MB of memory.

In extended graphics mode, the amount of memory installed determines what resolutions and how many colors are supported. These are summarized in Figure 58.

Video Memory Installed	Resolution	Colors
512 KB	640 x 480	256 out of 256 K
512 KB	1024 x 768	16 out of 256 K
1 MB	640 x 480	64 K [1]
1 MB	1024 x 768	256 out of 256 K
Note: [1] 64 K (65,536) colors assumes direct color mode, where the palette is bypassed, and 16-bit pixel data drives the digital-analog converter.		

Figure 58. Relationship of Memory to Resolution and Colors

One immediate advantage of the larger memory size is faster performance in all video modes for both the XGA and XGA Adapter/A. They perform faster because at 1 MB the data path width into the video display buffer memory is 32-bits wide. At 512 KB the data path width is only 16-bits wide. Further advantages of the larger memory size and the effect on fonts are explained in more detail in section B.2, "Guidance for Users of Antialiased Text" on page 142.

Serializer/Palette/Digital-Analog Converter

The serializer/palette/digital-analog converter is usually abbreviated to SPD. Assume we have some data representing a picture sitting in the video display buffer. This is the video RAM, which has a serial port, or access path. The **serializer** gets the picture data out of the video display buffer and converts it into a serial bit stream with a width equal to the number of bits per pixel. The data will be in the form of a number of bits (1, 2, 4, 8 or 16). If it is not 16, then it is treated as a binary number, which is used to index into a table of colors.

Palette

The table of colors is the palette. It's similar in concept to mixing up colors before painting each section of a painting. Basically, the palette has 256 memory locations, where each location has 18 bits. If the data used to index into the palette consists of 1, 2, 4, or 8 bits, then it can be used to look up a color value in the palette, since 8 bits can be used to represent any number up to 256. The 18 bits at each palette location are divided into three 6-bit values. These values represent the intensity of each primary color for each pixel that will make up the picture. Also, 6 bits is the size of input that the digital-analog converter works on.

Digital-Analog Converter

The digital-analog converter (DAC) takes the three 6-bit values, treats them as binary numbers, and converts them to analog values. That's because the screens for the PS/2 family use analog signals to drive them. The more colors you want on a screen, the more economical it is to drive them with analog values versus the digital signals used on the earlier PC screens.

The DAC places these analog values onto the signal lines to the display, and you see a colored dot on the screen.

The palette and DAC are no different from the VGA in this respect.

The exception to the rule is when the number of bits that the serializer picks up is 16. In this case, it is not used as an index into the palette. It means that the video subsystem is running in direct color mode. The 16 bits are treated as three color intensities for the red, green and blue primary colors. The SPD interprets these as 5 bits of red, 6 bits of green and 5 bits of blue, and passes them over to the DAC, which carries on as described above. By skipping the palette, we can use a range of 65,536 different colors!

Sprite/Attribute Controller

The sprite on the XGA is a small picture, measuring anything up to 64 pixels across and 64 pixels down. It is stored in the XGA or XGA Adapter/A sprite buffer, described below. You will see it as a pointer icon, the picture that moves around the screen as you move your mouse. It overlays the other information on the screen, without modifying it. Sometimes you will see the sprite called a graphical cursor, or the mouse icon, or simply the pointer.

The sprite/attribute controller works with the SPD described above. It functions differently depending on what mode you are running in. In VGA mode, it handles color selection and character generation. In extended graphics mode, it handles the cursor sprite.

Alpha/Sprite Buffer

The alpha/sprite buffer is a 32 KB static RAM module. It stores alphanumeric character fonts when you are running in VGA text modes or 132-column text mode. It stores the sprite image when in extended graphics mode. All points addressable modes of VGA and extended graphics mode provide for more flexible fonts than the hardware character generator used in text modes.

Each pixel of the sprite consists of two bits. These specify four colors for the pixel, but in fact there are only two actual colors. The other two are really attributes rather than colors. They are called *"complement"* and *"transparent"*. They dictate how this pixel of the sprite should behave in relation to the background image on the screen as the sprite is superimposed over it.

Power-On Self Test PROM

The power-on self test PROM (programmable read-only memory) holds the XGA Adapter/A self-test code that is invoked during system POST. This code occupies only about 7 KB.

The memory location to which this PROM will be mapped will be selected using the system setup program. Such mapped areas occupy 8 KB. Setup will relocate the 8 KB location for the POST PROM to one of 16 possible locations to avoid conflict with other devices.

You will find a description of the power-on self test procedure of the XGA in the description of the BIOS in section 7.4, "The POST Process" on page 47.

9.4 XGA Adapter/A Installation

In this section, the term "connector" refers to that part of an adapter that plugs into the Micro Channel. The term "slot" refers to that part of the Micro Channel into which the connector plugs.

The XGA Adapter/A plugs into most standard Micro Channel 16-bit or 32-bit slots. It will perform faster in a 32-bit slot, but if you have only 16-bit slots left, it will still run there. However, for 32-bit operations, it will require two bus cycles instead of one, and memory addressability will be limited to 16 MB.

On the Model 95 XP 486 machine, there is a slot especially designed for the XGA Adapter/A. This is called the Base Video Extension (BVE) slot.

If you have ever fitted an 8514/A adapter into a PS/2, you will have noticed that there is an extra set of connectors at the bottom. These can fit into a matching slot on the Micro Channel bus. This extra part of the slot is called the Auxiliary Video Extension (AVE). This is mentioned here to ensure that you don't confuse the two. The XGA Adapter/A has the new Base Video Extension connector; the 8514/A has the Auxiliary Video Extension connector.

Note: The one slot that the new XGA Adapter/A can not physically plug into is the one designed for the 8514/A adapter. That's because the 8514/A was designed to fit into a 16-bit slot with an AVE connection. The XGA Adapter/A is designed to exploit a 32-bit slot. But the 32-bit slot has some connectors, used for matched memory, which would conflict with the position of the AVE. That explains why the location of the BVE has moved forward. It is not in the same relative position as the AVE. So when you are about to put your first XGA Adapter/A into a PS/2, here are your options.

- If the system has an available Base Video Extension slot, as in the Model 95 XP 486, use that. In VGA mode, it will support the Auxiliary Video Extension slot, and give optimum performance.
- Otherwise, use a 32-bit Micro Channel slot for optimum performance.
- If neither of these are available, use a 16-bit Micro Channel slot.

Note: You will find AVE slots in both the Model 90 XP 486 and Model 95 XP 486. You will also find a BVE slot in the Model 95 XP 486 but not in the Model 90 XP 486. This is shown in Figure 6 on page 14 and Figure 7 on page 15.

9.4.1 Eligible PS/2 Machines

The XGA is located on the planar of the Model 90 XP 486.

The XGA Adapter/A can be used in all Micro Channel PS/2 machines with a 80386, 80386SX or i486 processor. It is not supported in systems with 80286 or earlier processors. That's because the XGA Adapter/A drivers make use of 32 bit registers and segment registers, which are not available on the 80286 machines.

The XGA Adapter/A is also not supported on the Portable Model 70.

IBM supplies drivers for DOS, Windows*&asterisk, OS/2 Presentation Manager, and for the AutoCAD** The drivers are supplied with the Model 90 XP 486, Model 95 XP 486, and the XGA Adapter/A. There are two diskettes, one for DOS environments and one for OS/2 environments.

9.5 DOS Software Considerations

This section looks at the software considerations for the DOS user with special emphasis on the subsystems that contain their own screen device drivers.

DOS users will find four compatibility options available to them with the XGA or XGA Adapter/A video subsystems. These four options are:

- DOS device driver for the adapter interface
- Device driver for Microsoft** Windows/286 2.1
- Device driver for Microsoft Windows 3.0
- ADI device driver for AutoCAD Version 10.

9.5.1 DOS Device Driver for the Adapter Interface

The DOS adapter interface consists of a set of entry points callable by an application, providing access to the adapter's display hardware capability. You would use it to provide compatibility with applications that have been written to use the 8514/A adapter interface.

Supported LIMulators

There are some programs that emulate expanded memory by using extended memory or hard disk. These are sometimes called "LIMulators". The XGA Adapter Interface is compatible with LIMulators that use physical address services. The following LIMulators have been tested:

- EMM386**
- 386Max** 5.0
- QEMM**

To enable 386Max to run with the IBM XGA Adapter the following line should be added to your CONFIG.SYS file:

DEVICE=386MAX.SYS /NOXBIOS

To enable QEMM to recognize the IBM XGA Adapter you need to modify the QEMM file MCA.ADL.

Find out how to do this by reading the READ.ME files on the *XGA Device Drivers Diskette 1 DOS Support* diskette.

Limitation

The XGA DOS adapter interface is not compatible with Windows 3.0. If you wish to run Windows 3.0 you must not install the XGA DOS adapter interface. If you have already done so, remove the following line from your CONFIG.SYS file:

DEVICE=C:\XGAPCDOS\XGAAIDOS.SYS

and reboot your system.

New Fonts

There are four new standard fonts supplied with this driver:

STAN1220.IMG - 12 x 20 size standard font optimized for the XGA adapter
STAN0814.IMG - 8 x 14 size standard font optimized for the XGA adapter
STAN0715.IMG - 7 x 15 size standard font optimized for the XGA adapter
STAN1223.IMG - 12 x 23 size standard font optimized for the XGA adapter

For full compatibility with the 8514/A, the previous fonts are also there:

STAN1220.SSV - 12 x 20 size standard font 8514/A compatible
STAN0814.SSV - 8 x 14 size standard font 8514/A compatible
STAN0715.SSV - 7 x 15 size standard font 8514/A compatible
STAN1223.SSV - 12 x 23 size standard font 8514/A compatible

Refer to the *IBM PS/2 XGA Technical Reference Manual* for further details.

9.5.2 Device Driver for Microsoft Windows/286 2.1

This display driver will provide a better-defined picture area (high resolution) at the expense of the number of colors it provides. It is possible to override this decision and request the driver to operate at a lower resolution but with more colors.

For example an adapter with 512 KB of video memory connected to an 8514 or 8515 display defaults to a resolution of 1024 x 768 with 16 colors. A resolution of 640 x 480 with 256 colors can be selected by editing the file named WIN.INI (in the directory in which you installed Windows). This procedure is documented in the READ.ME file that comes with this driver.

9.5.3 Device Driver for Microsoft Windows 3.0

If you have an adapter with 512 KB of video memory connected to a 1024 x 768 display you may wish to run the driver in low resolution giving you 256 system colors and palette manager support at the expense of resolution.

Limitation

Windows 3.0 is not compatible with the XGA DOS adapter interface. If you wish to run Windows 3.0 you must not install the XGA DOS Adapter Interface. If you have already done so, remove the following line from your CONFIG.SYS file:

DEVICE=C:\XGAPCDOS\XGAAIDOS.SYS

and reboot your system.

Note: This device driver will not function if Windows is run in the DOS compatibility box of OS/2.

9.5.4 ADI Device Driver for AutoCAD Version 10

This driver is designed to take advantage of the facilities provided by AutoCAD Version 10. The AutoCAD device interface (ADI) allows support for large screens (1024x768) and multiple viewports.

Before installing the AutoCAD XGA device driver, you must install AutoCAD Release 10, and the XGA DOS adapter interface.

AutoCAD 386

Installation is as for DOS AutoCAD. The ACAD386 VDISK switch needs to be set before running ACAD for the first time:

CFIG386 ACAD -VDISK

Coexistence Limitation

The ADI driver will not work with OS/2.

9.6 OS/2 Software Considerations

This section looks at the software considerations for the OS/2 user with special emphasis on the device driver.

9.6.1 Installing OS/2 1.2 Device Support

The OS/2 XGA display device driver diskette supports OS/2 Standard Edition Version 1.2 and OS/2 Extended Edition Version 1.2. It contains instructions to assist you to perform two tasks:

1. Installing the device driver
2. Selecting antialiased fonts

The installation procedure for the device driver allows options for:

- Installing with or without a VGA driver
- Installing with initial OS/2 installation or subsequently
- Installing with one display attached or more than one.

When you have completed the installation of the device driver, there may be configuration options for you to select depending on the amount of video memory your system has, as follows:

- If your system has 1 MB of video memory no options are needed. Your system will run at high resolution (displaying 1024 x 768 pixels on the screen) and can also display up to 256 different colors.
- If your system has 512 KB of video memory installed, you can choose to operate at either:
  - High resolution (1024 x 768 pixels) with the ability to display up to 16 colors simultaneously, but without the ability to use antialiased text

    or
  - Medium resolution (640 x 480 pixels) with the ability to display up to 256 colors simultaneously, and the ability to use antialiased text.

If your system has 512 KB of video memory, the first time you start OS/2, high resolution (1024 x 768 pixels) with 16 colors is selected. You can change to medium resolution (640 x 480 pixels) with 256 colors by running the supplied XGASETUP program, as follows:

In the OS/2 Desktop Manager, select *screen setup*. In the screen setup group, run *screen configuration*, which lets you change screen resolution options.

9.6.2 XGA Device Support under OS/2 V 1.3

OS/2 SE and EE V 1.3 include the XGA support in the system. It is not necessary to install the device drivers separately.

9.6.3 Selection of Antialiased Text

For instructions on how to install and select antialiased fonts, please refer to appendix B.4.1, "System Fonts" on page 145.

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10.0 Model 55 LS Hardware

This chapter describes the hardware and capabilities of the IBM Personal System/2 Model 55 LS.

10.1 Description

The IBM Personal System/2 Model 55 LS is a medialess desktop system that uses the Intel** 80386SX** processor.

It is designed for connection to a LAN by the inclusion of either an IBM 16/4 Token-Ring Network Adapter/A or an IBM Ethernet Adapter/A. The Model 55 LS comes standard without a diskette drive or hard disk. However, a diskette drive and/or hard disk may be added at any time. The Model 55 LS is supported as a DOS workstation with PC LAN Program or OS/2 LAN Server on a token-ring network. It is supported under DOS and Novell** NetWare** on an Ethernet network.

10.2 Models

The IBM Model 55 LS comes in two models:

Machine	Model	Network Adapter
8555	LT0	Token-Ring 16/4 Adapter/A
8555	LE0	Ethernet Adapter/A

Figure 59. IBM PS/2 Model 55 LS Models

Apart from the different network adapters, the two models are identical.

10.3 Highlights

The IBM PS/2 Model 55 LS:

- Is a cost-effective LAN station provided without diskette or fixed disk drive
- Is a compatible member of the IBM PS/2 family
- Has a 32-bit 16 MHz 80386SX microprocessor
- Has 2 MB standard memory expandable up to 8 MB on the system board
- Is ready for attachment to a 4 MB or 16 MB Token-Ring or Ethernet LAN
- Has Micro Channel architecture with two available 16-bit slots
- Can have an optional 16MHz 80387SX coprocessor installed for improved performance
- Is expandable with an optional 1.44 MB diskette drive and a 30 MB or 60 MB hard disk for growth.

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10.4 Product Positioning

The IBM PS/2 Model 55 LS is intended for use as a network workstation in a token-ring or Ethernet LAN environment. Network workstations share operating systems, application programs, and data on the server. The server provides a single source for software and data file storage and maintenance. It also restricts unauthorized entry and removal of software or data at the workstation. It may also provide other services to the network, such as the sharing of peripherals like printers and plotters, or providing a communications gateway.

10.5 System Unit Externals

Externally, the Model 55 LS system unit is identical to the previous IBM PS/2 Model 55SX. It can be distinguished from these systems only by the lack of a diskette and hard disk drive, and by the label on the front of the system unit.

10.6 Power Supply

The Model 55 LS 90-watt power supply is equipped with a voltage-selector that can be switched between 115V (90 to 137 VAC) and 230V (180 to 265 VAC).

Note: Watch for the correct voltage setting, as it is not an automatic voltage-sensing power supply.

10.7 Microprocessor

The Model 55 LS uses an Intel 80386SX processor clocked at 16 MHz. Optionally, an Intel 80387SX mathematical coprocessor can be installed.

10.8 Memory

The Model 55 LS has two memory connectors on the planar board and is shipped with a 2 MB SIMM already installed in connector 1. The planar board memory can be expanded to 3 MB, 4 MB or 6 MB by adding a 1 MB, 2 MB or 4 MB memory module kit in connector 2. If the originally supplied 2 MB SIMM is removed and replaced by a 4 MB memory module kit, a total of 8 MB can be installed on the planar.

Figure 60 shows the different planar board memory configurations.

SIMM Connector 1	SIMM Connector 2	Total Memory
2 MB	----	2 MB
2 MB	1 MB	3 MB
2 MB	2 MB	4 MB
2 MB	4 MB	6 MB
4 MB	4 MB	8 MB

Figure 60. Model 55 LS Planar Board Memory

The system memory can be further expanded up to 16 MB by the addition of a memory expansion adapter card.

10.9 Riser Card

The Model 55 LS is equipped with a riser card. This Micro Channel interface card allows feature cards to be attached horizontally instead of vertically.

The following connectors are located on the riser card:

- Two 16-bit Micro Channel connectors

  One of these two connectors (slot 3) comes pre-configured with the token-ring or Ethernet adapter

- One 16-bit Micro Channel connector with an auxiliary video extension
- One card edge connector for the hard disk drive

  Note: The optional hard disk drive is connected via a cable attached to this connector.

- The speaker connector, which is also used to override the security password.

10.10 Graphics

The Model 55 LS includes full VGA function on the planar board. The 8514/A adapter can be installed in slot 1, which has the auxiliary video extension.

10.11 Token-Ring Adapter

The IBM PS/2 Model 55 LTO contains the IBM Token-Ring Network 16/4 Adapter/A with the Remote Initial Program Load (RIPL) feature.

This adapter is installed in I/O-slot 3 initially but it can be moved to any other slot.

10.12 Ethernet Adapter

The IBM PS/2 Model 55 LEO contains the IBM Ethernet Adapter/A. This adapter conforms to the ANSI/IEEE standard 802.3. Link layer support for ANSI/IEEE standard 802.3 is provided through software device drivers supplied with the adapter.

The IBM Ethernet Adapter/A connects to the network through:

- 50-ohm double-shielded (0.4-inch diameter) coaxial cable (ANSI/IEEE standard 802.3 10BASE5)
- 50-ohm RG58-A/U (0.2-inch diameter) coaxial cable (ANSI/IEEE standard 802.3 10BASE2).
- A twisted pair Ethernet network (uses an external connector).

The option diskette shipped with this adapter contains device drivers for DOS, OS/2 and Novell. This adapter is installed in I/O slot 3 initially but it can be moved to any other slot.

For further information see *IBM Personal System/2 Adapter/A for Ethernet Networks Technical Reference.*

10.13 Security

The Model 55 LS is equipped with the following security features:

- The bolt-down feature allows you to attach the system unit to a table or desk. The bolt-down hole is located on the righthand side of the base plate.
- The cabling feature allows you to attach a U-bolt to the rear of the system unit so that it can be cabled to a table or desk. The two holes are located above the keyboard and mouse connectors and are protected by plastic inserts. To install a U-bolt, use a screwdriver to remove these inserts.
- A mechanical lock prevents the system unit cover from being removed.
- An optional power-on password can be installed using the reference diskette.

  If the user forgets the password, it can be removed by unplugging the speaker connecter from the riser card, turning it by 180 degrees and replugging it in the opposite position. Of course, this can only be done after the mechanical lock has been opened to allow access to the planar board.

10.14 Reference Diskette

The Model 55 LS comes with a reference diskette, even though it is not equipped with a diskette drive. The diskette is Version 1.04 or later of the IBM PS/2 Model 55/65 reference diskette and contains some modifications compared to the one provided with other IBM PS/2 Model 55SX systems. However, it will work also on all existing IBM PS/2 Model 55SX and 65SX systems. Versions 1.00 to 1.03 of this reference diskette will not work on the Model 55 LS.

Refer to 11.2.2, "Update the Reference Diskette" on page 108 for instructions on using the reference diskette.

10.15 DASD

Figure 61 shows the hard disk and diskette drives that can be optionally installed in the Model 55 LS.

Description	Feature	Part #
1.44 MB Diskette Kit B	1035	6451035
30 MB Hard Disk Drive	1086	6451086
60 MB Hard Disk Drive	1084	6451084

Figure 61. DASD

With these DASD devices the Model 55 LS can be upgraded in several stages to accomplish different requirements. Starting with the medialess system it can be expanded up to a standard IBM PS/2 Model 55SX.

Figure 62 gives a short overview of the upgrade path.

	Base model	Diskette drive upgrade	Hard disk upgrade	Diskette drive and hard disk upgrade
IPL from	• Server	• Diskette • Server	• Hard disk • Server	• Diskette • Hard disk • Server
Main advantage	Enhanced security	Inexpensive removable storage	Non-removable local storage	Full function IBM PS/2 Model 55SX

Figure 62. IBM PS/2 Model 55 LS Upgrade Path

11.0 IBM PS/2 Model 55 LS Installation

This chapter describes how to install the IBM PS/2 Model 55 LT0 and how to connect it to a token-ring LAN.

The installation of a IBM PS/2 Model 55 LE0 to an Ethernet LAN is similar (see the *IBM Personal System/2 Ethernet LAN Reference for Micro Channel Workstations*).

11.1 What You Need

To get the IBM PS/2 Model 55 LT0 running you need the following:

1. IBM PS/2 Model 55 LT0
   - System unit
   - Keyboard
   - Display
   - Token-ring attachment cable
   - IBM Model 55 LT0 reference diskette
   - Token-ring option diskette.

     Note: These diskettes are shipped with the IBM PS/2 Model 55 LT0 system unit.
2. File server
   - Hardware:
     - System unit with the appropriate Token-Ring adapter installed (a remote program load module is not required at the file server)
     - Hard disk drive
     - Keyboard
     - Display
     - Diskette drive (3.5-inch 1.44 MB).
   - Software:
     - An operating system such as the IBM OS/2 Extended Edition, Version 1.2, or the IBM PC DOS, Version 3.3 or 4.0
     - A network program such as the IBM OS/2 LAN Server Program, Version 1.2 or the IBM PC LAN Program with Extended Services, Version 1.3
     - A remote IPL support program such as the IBM Local Area Network Support Program, Version 1.1

       Note: The IBM LAN Support Program, Version 1.1 comes with the IBM OS/2 LAN Server, Version 1.2, but is also available for separate purchase.

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– An image of the IBM PS/2 Model 55 LT0 reference diskette. Refer to 11.2.3, "Create an Image of the Updated Reference Diskette" on page 109 for instructions.

Note: The file server should be fully configured and operational prior to connecting the workstation.

11.2 First Time Installation

The example installation is made in the following environment:

- An IBM PS/2 Model 55 LT0 is to be connected to a Token-Ring LAN.
- The file server uses IBM OS/2 Extended Edition Version 1.2 and the IBM OS/2 LAN Server Version 1.2.
- The Model 55 LT0 uses IBM PC DOS Version 3.30.

The installation of a IBM PS/2 Model 55 LE0 to an Ethernet LAN is similar (see the *IBM Personal System/2 Ethernet LAN Reference for Micro Channel Workstations*).

11.2.1 File Server Requirements

Ensure that the file server contains all the hardware and software needed to support RIPL of the Model 55 LS workstation. Refer to section 11.1, "What You Need" on page 107 to check for completeness.

If DOS image support is not yet installed on your LAN server, install it now. The installation procedure will prompt you for the OS/2 LAN server program diskette as well as for the LAN Support Program, the DOS LAN requester and the DOS operating system diskettes. For instructions, see the *IBM Operating System/2 Version 1.2 Getting Started*.

Note: Make sure that you apply the latest corrective services diskette (CSD) for OS/2 after you have installed DOS Image Support. The CSD may contain updates for the LAN Support Program and the DOS LAN requester program.

11.2.2 Update the Reference Diskette

1. Make a backup copy of the Model 55 LT0 reference diskette.

   Use the DOS or OS/2 BACKUP command to copy the diskette using any IBM PS/2 equipped with a 1.44 MB diskette drive, for example the LAN server. Store the original diskette in a safe place and use the backup copy as your working diskette.

2. Copy configuration programs and test programs from your token-ring option diskette to the backup copy of your reference diskette.

   Use the following information to determine the types of files on an option diskette:

   - Configuration programs have an extension of .ADF
   - Test programs have an extension of .DGS and .PEP
   - Device drivers have an extension of .COM and .SYS.

   Thus, insert the token-ring option diskette into your drive A and issue the following commands:

```
COPY A:*.ADF B:
COPY A:*.DGS B:
```

Note: There are no files with the extension .PEP on this option diskette. Other option diskettes shipped with Micro Channel adapters may contain such files.

The backup copy of your reference diskette is now ready to use.

11.2.3 Create an Image of the Updated Reference Diskette

You need to create an image of the updated Model 55 LT0 reference diskette on the file server. This gives you the ability to boot Model 55 LT0 with the reference diskette over the LAN whenever you need to change the system configuration or to test the system.

1. Create an image profile:
   a. On the OS/2 LAN server main panel, select **Definitions** from the action bar.
   b. Select **IPL Images** from the Definitions pull-down.
   c. Select **--New--**.
   d. Select **Actions** from the action bar.
   e. Select **Create** from the Actions pull-down.
   f. Complete the "Create Image Profile" panel by filling in the Image ID (for example "REF") and the Description (for example "Reference Diskette for Model 55 LT0"). Select **No** in the Definition File field, as you will create the image from a diskette.

      After completing this panel, you will come back to the Manage Images panel.
2. Create the image on the server:
   a. Select the image profile you just created ("REF").
   b. Select **Make**.
   c. Select **To server**.
   d. Enter "A" in the **Source drive** field and select the destination server from the **Servers** list.

For detailed information on installing and managing IPL images refer to the *IBM Operating System/2 Local Area Network Server Version 1.2 Network Administrator's Guide*.

11.2.4 Install the Model 55 LT0 Workstation

Unpack the workstation, keyboard, display and Token-Ring attachment cable. Connect all the cables according to the documentation packaged with the workstation (see *IBM Personal System/2 Model 55 LS Setup Instructions* and *IBM Personal System/2 Model 55 LS Quick Reference*).

11.2.5 Identify the Token-Ring Adapter Address

Each token-ring adapter has a unique 12-digit hexadecimal address. You have to identify the address of the token-ring adapter in your workstation in order to connect it to the LAN server.

1. Power-on the Model 55 LTO and the display.

   You will see a screen like this:

```
ET-00:00:06
ID-166

BU-0000
AA-10005A6BFECA
AL-00 0008 A78064
BL-A33861C
MM-DA00 02
SR-DC00 16
OP-0000 04
```

Figure 63. Remote IPL Startup Screen (Normal Startup)

   The number next to **AA-** is the unique network adapter address and the number next to **AL-** is the code level of the program contained in the adapter.

   For a description of all the fields on this screen refer to Appendix F.1, "Remote IPL Startup Screen" on page 163.

2. Record the numbers next to **AA-** and **AL-**.

   Note: This screen is just an example. You will find different numbers on your screen, but the **AA-** and **AL-** fields should appear. If your screen looks substantially different, refer to the *IBM Personal System/2 Token-Ring LAN Reference for Micro Channel Workstations*. This document contains detailed information about setting up your Model 55 LTO and connecting it to the LAN.

3. Power-off the workstation.

11.2.6 Create a Remote IPL Requester Definition

You now have to define your Model 55 LTO remote IPL requester workstation to the LAN server.

1. In the OS/2 LAN server main panel, select **Definitions** from the action bar.
2. Select **Machine parameters** from the Definitions pull-down.
3. Select **--New--**.
4. Select **Actions** from the action bar.
5. Select **Create** from the Actions pull-down. The "Machine Type" panel is displayed.
6. Select **Remote IPL workstation**. The "Create a Remote IPL Workstation Definition" panel is displayed.
7. Complete the panel by filling in all the fields. The **Network adapter number** must match the unique adapter number of your workstation (that is the

number next to the **AA-** field in Figure 63). Type the name of your reference diskette image ("REF") in the **Default IPL Image** field.

You are now ready to connect your Model 55 LT0 workstation to the LAN server.

11.2.7 Start the Model 55 LT0 Reference Diskette Image

1. Power-on the Model 55 LT0.

   You will either see a screen similar to Figure 63 on page 110 or a screen like this:

```
ET-00:00:06
ID-166

BU-0000
AA-10005A6BFECA
AL-00 0008 A78064
BL-A33861C
MM-DA00 02
SR-DC00 16
OP-002E 16      DR:  "F4-04"  "F6-16"
```

Figure 64. Remote IPL Startup Screen (Wrong Token-Ring Adapter Speed)

   The blinking **OP-002E** field followed by the number **16** shows you that the Token-Ring Network 16/4 Adaper/A is currently set to a speed of 16 Mbps while the LAN your Model 55 LT0 is connected to operates at a speed of 4 Mbps. If your workstation is set to 4 Mbps while the network operates at 16 Mbps, the blinking **OP-002E** field will be followed by the number **04**.

   In either case, you can override the current token-ring adapter setting by pressing the **F4** key to select 4 Mbps or **F6** to select 16 Mbps respectively. However, this procedure will override the pre-set speed only for the very next startup. You will have to change the token-ring adapter speed later using the image of your updated reference diskette on the server as described in step 3.

2. As we defined the reference diskette image ("REF) as the remote IPL image for your workstation in section 11.2.6, "Create a Remote IPL Requester Definition" on page 110, the Model 55 LT0 will load the reference diskette.

3. You can now use the reference diskette to set the correct token-ring adapter speed if a screen like Figure 64 appeared during startup. The reference diskette can also be used to test your workstation. Consult the *IBM Personal System/2 Model 55 LS Quick Reference* for instructions.

Your workstation should be correctly configured and operational on the LAN by now.

11.3 Start the LAN Requester Program

This section describes the steps needed to start the IBM Local Area Network Requester Program on your workstation.

11.3.1 Create an Image Profile

1. In the OS/2 LAN server main panel, select **Definitions** from the action bar.
2. Select **IPL Images** from the definitions pull-down.
3. Select **STD3H330** from the image ID list.

   If you have installed DOS 4.0 instead of DOS 3.3 during the DOS Image Support installation, choose **STD3H400** instead.
4. Select **Actions** from the action bar.
5. Select **Create** from the Actions pull-down.
6. Complete the "Create Image Profile" panel by filling in the image ID (for example "LANREQ") and the description (for example "DOS LAN Requester"). Select **YES** in the definition file field, so you will use the existing definition file for the **DOS3H330** image.

   After completing this panel, you will be back in the manage images panel.

11.3.2 Change the Remote IPL Requester Definition

Now you have to change the default IPL image for your workstation.

1. In the OS/2 LAN server main panel, select **Definitions** from the action bar.
2. Select **Machine Parameters** from the Definitions pull-down.
3. Select **LANREQ**.
4. Select **Actions** from the action bar.
5. Select **Update**. The "Update a Remote IPL Workstation Definition" panel is displayed.
6. Change the Default IPL Image from **REF** to **LANREQ**.

The next time you start up your Model 55 LTO workstation, the "DOS LAN Requester Logon Panel" will appear and allow you to access the LAN services.

11.4 Use of Alternate IPL Images

From the DOS LAN requester logon panel you can choose an alternate IPL image by pressing the ESC key.

For example, if you need to start the reference diskette image ("REF") on a LAN workstation that normally starts the LAN requester services, you don't have to change **Default IPL image** in the "Remote IPL Workstation Definition" panel on your server. You simply choose the "REF" Image from the menu and the workstation reboots and starts up the reference diskette image.

Note: This option overrides the default IPL image definition only for the very next IPL.

11.5 Upgrade the IBM PS/2 Model 55 LT0

This section describes the installation of a diskette drive and/or a hard disk as well as the additional capabilities provided by such an upgrade.

11.5.1 Security Considerations

The IBM PS/2 Model 55 LS can be converted into a stand-alone computer by installing a diskette drive, a hard disk drive, or both.

When installing these options, the workstation can be started using the diskette drive, the hard disk, or the remote IPL image from the server. Because of this, you must consider the security of the data and software on your LAN.

In addition to the physical hardware locks, passwords and authorizations, the Model 55 LS reference diskette contains a hidden file. This file enables you to restrict the use of a hard disk and force the workstation to use an IPL image from the server.

11.5.2 Model 55 LS with Diskette Drive

When you install a diskette drive in the workstation, IPL images may no longer be needed. However, you can still start from an IPL image and just use the diskette drive to copy files to or from the LAN server or to run programs on the requester workstation.

11.5.3 Model 55 LS with Diskette and Hard Disk Drive

The reference diskette contains a hidden file, **RIPL**, and an installation program for it. This hidden file enables the workstation to bypass the hard disk drive and to continue to start from a remote IPL image on the server. To run the RIPL program, perform the following steps:

Insert the backup copy of the reference diskette into the diskette drive of the Model 55 LS and type:

```
A:RIPL /1
```

Note: If you have a hard disk but no diskette drive, see section 11.5.4, "Model 55 LS with Hard Disk Drive Only" on page 114. The RIPL program changes the bit in CMOS (the RIPL FLAG) that controls the power-on startup sequence of the workstation. When the bit is set to 1, the hard disk drive is ignored during startup and the workstation will start from the Default IPL Image defined on the server. Once the workstation has started, the access to the hard disk is by no means restricted. When the bit is reset to 0 by issuing the command:

```
A:RIPL /0
```

the workstation will attempt to start from the hard disk, provided an operating system is correctly installed. Refer to Figure 65 on page 114 for a complete description of the Model 55 LS startup sequence.

If you want to provide the operator of the LAN workstation with the ability to control the power-on sequence of the workstation, you must install the RIPL program on the hard disk of the workstation with the command:

```
A:RIPL /I
```

You are now able to set or reset the CMOS bit directly from the Model 55 LS hard disk.

11.5.4 Model 55 LS with Hard Disk Drive Only

When you install a hard disk drive in a workstation that does not contain a diskette drive, you must run the RIPL program before you can partition and format the hard disk. Otherwise, the workstation will attempt to boot from the hard disk and stop with an error message because there is no valid boot sector on the disk. You would then not have access to a remote IPL image on the server that gives you access to the DOS files needed to partition and format the hard disk.

To do this, you have to share the A: drive of the server containing the backup copy of the Model 55 LS reference diskette. By doing this, the reference diskette can be accessed from the requester workstation using the NET USE command.

Refer to the *IBM Operating System/2 Local Area Network Server Version 1.2 Network Administrator's Guide* and the *IBM DOS LAN Requester User's Guide* for instructions on sharing and using files.

11.5.5 Remote IPL Flow Control

Figure 65 shows how the Model 55 LS workstation decides which device is used for initial program load (IPL).

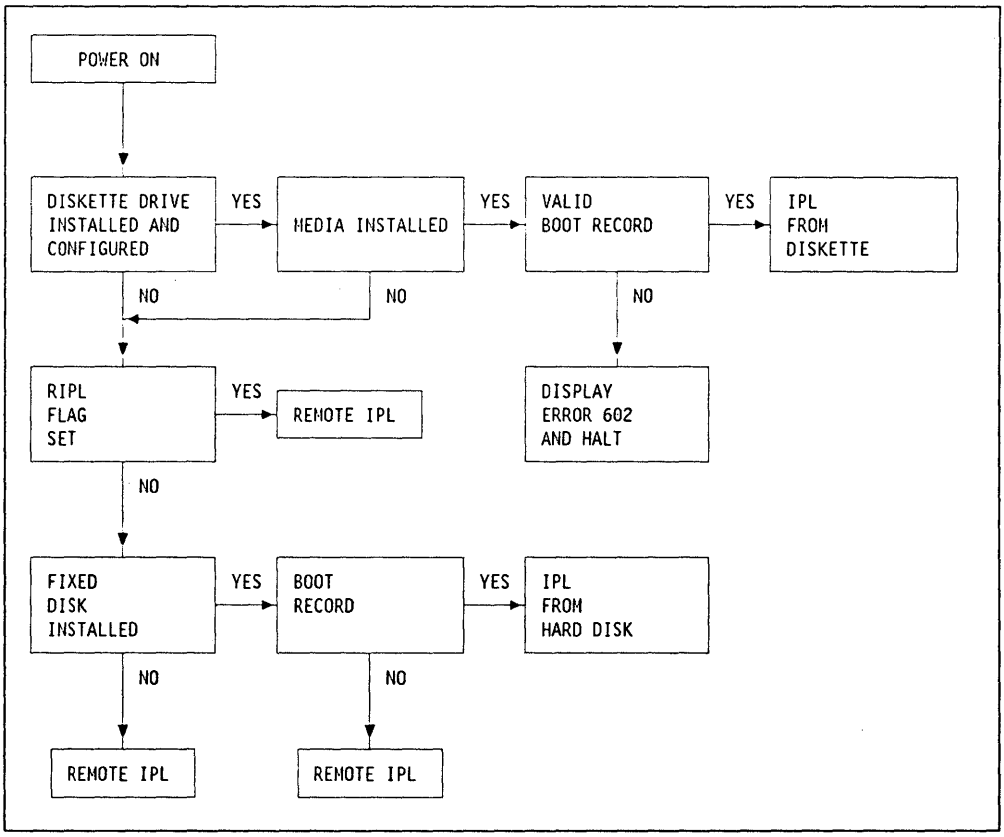

Figure 65. Remote IPL Flow Control

Note: To set or reset the RIPL FLAG, refer to section 11.5.3, "Model 55 LS with Diskette and Hard Disk Drive" on page 113 for instructions on the usage of the RIPL program.

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12.0 PS/2 Model P75 486

This section provides information on the PS/2 Model P75 486 system. It describes similarities and differences to the IBM PS/2 Model P70, which was announced in May 1989.

12.1 System Overview

The PS/2 Model P75 486 system is a transportable unit intended for professional and business use worldwide. The PS/2 Model P75 486 system is a self-contained fully portable PS/2 Micro Channel system. Although portable, it does require main power at all times. It comes with a built-in keyboard and plasma display. It is equipped with one SCSI hard disk drive and one diskette drive. It can support external SCSI devices as well as one additional external storage device like the PS/2 Model P70. Support is also provided for attachment of a PS/2 screen with either VGA resolution (like 8503, 8512 or 8513) or XGA resolution (like 8514 or 8515). The PS/2 Model P75 486 system has a lot of features that also can be found in the IBM PS/2 Model P70. Other features are unique to the PS/2 Model P75 486 system.

Highlights:

- INTEL i486 - 33 MHz processor
- 8 MB (70 ns) memory standard expandable to 16 MB
- Plasma display adapter with XGA graphic capabilities to external displays
- 640 x 480 sixteen gray scale plasma display
- Universal power supply
- 1.44 MB 3.5-inch Diskette Drive
- Integrated SCSI adapter with one of the following:
  - 3.5-inch 160 MB SCSI hard disk drive
  - 3.5-inch 400 MB SCSI hard disk drive
- External SCSI port
- Full-size keyboard (101/102 keys)
- Four option card slots
- Rear cover keylock.

12.2 PS/2 Model P75 486 Models

Type/Model	Processor	Disk Size
8573-161	Intel i486 33MHz	160 MB
8573-401	Intel i486 33MHz	400 MB

Figure 66. PS/2 Model P75 486 Models

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12.3 Physical Specifications

- Size
  - Width 465.0 mm (18.3 in)
  - Depth 156.0 mm (6.1 in)
  - Height 306.3 mm (12.1 in)
- Weight 10.0 kg (22 lb)
- Cables
  - Power Cable (for U.S.) 1.8 m (6.0 ft)
  - Power Cable (for W/T) 2.8 m (9.3 ft)
  - Keyboard Cable 0.4 m (1.3 ft)
  - Keyboard Extension Cable 2.4 m (8.0 ft)
- Air Temperature
  - System On 10.0 to 40.6 deg.C (50 to 105 deg.F)
  - System Off 10.0 to 50.0 deg.C (50 to 125 deg.F)
- Humidity
  - System On 8% to 80%
  - System Off 20% to 80%

12.4 System Block Diagram

The system configuration is shown in Figure 67.

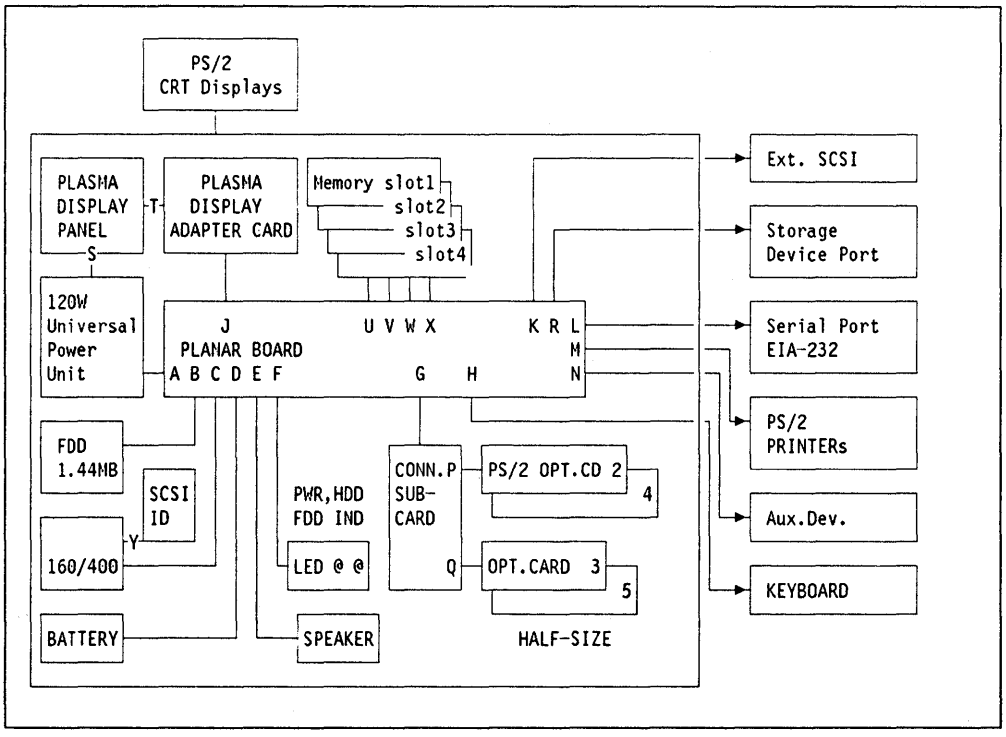

Figure 67. PS/2 Model P75 486 Block Diagram

A Power supply cable
B Diskette drive cable
C Hard disk cable
D Battery cable
E Speaker cable
F Power, diskette and hard disk access indicator cable
G Micro Channel interposer connector
H Keyboard connector and cable
J Display adapter card connector
K External SCSI connector (60 pin)
L Serial port connector
M Parallel port connector
N Auxiliary device connector (mouse)
P Micro Channel slot 2 and 4 (32 bit, one with an auxiliary video extension)
Q Micro Channel slot 3 and 5 (16 bit for short adapters)
R External storage device connector
S Power supply cable for plasma display
T Plasma display signal cable
U SIMM Memory slot #1
V SIMM Memory slot #2
W SIMM Memory slot #3
X SIMM Memory slot #4
Y SCSI ID Switch cable

Note: Micro Channel slot 1 is physically not implemented as a slot. It is built onto the planar board in the form of the integrated SCSI adapter.

12.5 Memory Subsystem

This section describes the memory subsystem of the PS/2 Model P75 486.

12.5.1 Memory

PS/2 Model P75 486 systems use the following types of memory:

- Read-only memory (ROM)
- Random access memory (RAM)
- Real-time clock and CMOS RAM.

12.5.2 Read-Only Memory Subsystem

The ROM subsystem consists of 128 KB. At power-on, ROM is active in two address spaces: Hex 000E0000 to 000FFFFF and Hex FFFE0000 to FFFFFFFF. After POST ensures the proper operation of system memory, the ROM code is copied to RAM. Usually, this RAM is called "Shadow RAM". ROM is then disabled, and the RAM responds to ROM requests. This RAM is write protected.

A snoop address protocol is built into ROM to keep the 486 microprocessor's cache contents consistent with the RAM subsystem. Cache holds a copy of memory locations. If those are being changed (by I/O operations for example), the copy in the cache has to be updated. This is performed through so called "Snoop Cycles".

12.5.3 Random Access Memory Subsystem

The PS/2 Model P75 486 system supports 70 ns 2 MB SIMMs as well as 70 ns 4 MB SIMMs on the planar board. The system does not support any other SIMM configuration. The maximum amount of memory that can be installed on the planar board is 16 MB (4 x 4 MB SIMMs).

Memory on the planar board should be installed in groups of 2 SIMMs (either two 2 MB SIMMs or two 4 MB SIMMs per pair). If matched SIMM pairs are installed, the CPU will access memory in interleaved mode (64 bits at any one time will be transferred into the buffer). If non matched SIMMs are installed or if one SIMM has been detected to be defective during POST, the CPU will access memory in non-interleaved mode, resulting in only transferring 32 bits from memory to the buffer. The result may be a performance degradation in any application that runs on the system. The PS/2 Model P75 486 also supports any 32 bit memory adapter on the Micro Channel up to a maximum of 16 MB within the system. The RAM subsystem on the system board starts at address Hex 00000000 of the address space. The RAM subsystem is 36 bits wide; it has 32 data bits and 4 parity bits. One parity bit is generated for each byte of data written. During a read operation, one parity bit is checked for each byte of data read by the device controlling the bus.

The PS/2 Model P75 486 enables and disables memory in 2 MB blocks. Each 2 MB block must start on a 2 MB boundary.

System and Nonsystem Memory

Two basic types of memory can be assigned addresses within the memory address space:

- System memory
- Nonsystem memory.

System memory is memory that is managed and allocated by the primary operating system. It remains assigned to and fixed in the 4 GB physical address space, and its contents can be accessed or modified only by an independent master (bus master, system microprocessor, or DMA controller).

Note: Nonsystem memory is memory that is not managed or allocated by the primary operating system. It is made up of memory-mapped I/O devices, memory on an adapter that can be directly modified by the adapter, or memory that can be relocated within the address space, such as bank switched and EMS (expanded memory specifications) memory.

Memory Caching

Figure 68 on page 123 shows the memory map for the first 16 MB of address space on the system board and lists which addresses can be used with the cache. The third and fourth GB are not mapped into cache, but can be used, especially for nonsystem memory (for example: memory mapped I/O).

Within the first 16 MB of address space, all system memory above 1 MB must be contiguous and starting at the 1 MB boundary. If nonsystem memory is present, it should be assigned addresses starting at 16 MB and allocated downwards.

Nonsystem memory must not be assigned addresses below 8 MB.

In the 8 MB to 16 MB address space, there are three types of cacheable areas: 8 MB to 12 MB, 8 MB to 14 MB and 8 MB to 16 MB. The system memory configurations are selected by POST. When the CPU write operations occur in the system ROM space, E0000 to FFFFF, the cache line that is accessed is invalidated by the memory subsystem.

In the 16 MB to 4 GB address space, system memory can be contiguously placed from 16 MB up to 32 MB and can be cached. If nonsystem memory is located within the 16 MB to 4 GB address space, it should be assigned addresses starting at 4 GB and allocated downwards, allowing space for system ROM.

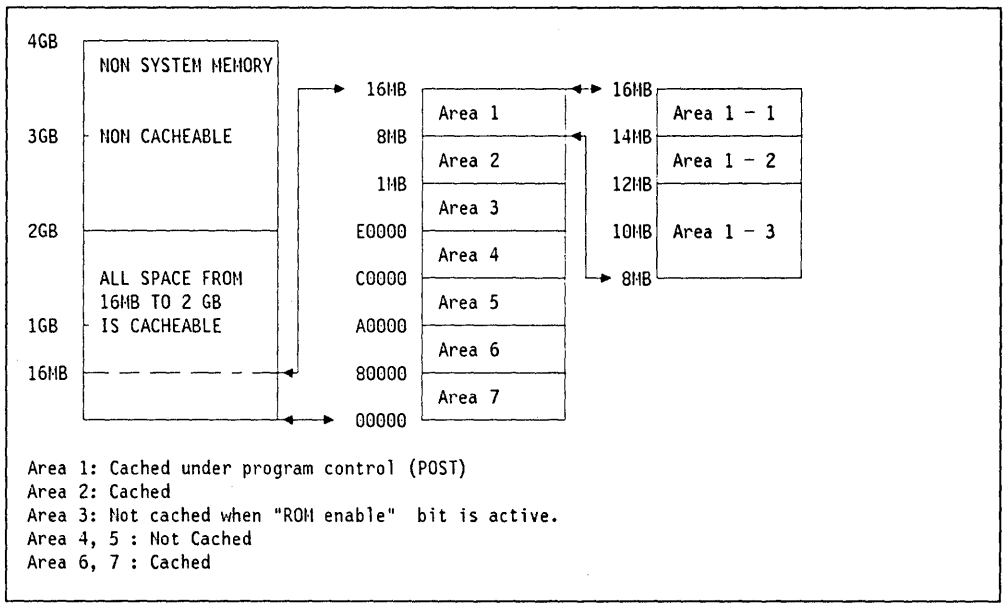

Figure 68. Memory Setup

Matched-Memory Cycles

Each 32-bit channel connector has a matched-memory extension. The system microprocessor activates the "matched memory cycle" signal when it does a memory access to Micro Channel memory. This allows the PS/2 Model P75 486 system to support the same memory adapters as the PS/2 Model 80 system board.

12.5.4 Real-time Clock and CMOS RAM

CMOS RAM is compatible to the implementation on other PS/2 systems. It consists of 64 Byte for system information and a realtime clock/calendar. There is also a 2 KB CMOS RAM extension for additional system configuration information. CMOS RAM is implemented with battery backup, to keep it valid even if the system is powered down for a longer period.

12.6 Micro Channel and SCSI

Subsystem Control Block (SCB) architecture is a description of a set of facilities which are designed to raise the functional level of the interface between device drivers running in a main processor, and I/O processors, which are capable of independent operation. The SCB architecture provides the ability to program an intelligent I/O subsystem and its attached devices in a uniform way. Complex

commands are delivered to devices from processor storage areas using Subsystem Control Blocks (SCBs). The ability for a device to execute a string of SCB I/O operations without interrupting the main processor between I/O commands is provided. For a detailed description of Subsystem Control Block architecture, refer to the *Hardware Interface Technical Reference* manual.

The following PS/2 Model P75 486 sub-system supports this architecture:

- Small Computer System Interface (SCSI).

The SCSI functions are implemented on the planar board of the PS/2 Model P75 486 system. The functions are equivalent to the implementation of the IBM SCSI Adapter. SCSI allows the attachment of additional SCSI devices externally. It is possible to connect the PS/2 external SCSI storage enclosure to the external SCSI port and to additionally install six SCSI devices there. Also the attachment of an external CD-ROM is possible.

When external SCSI devices are attached to the PS/2 Model P75 486 system, the SCSI terminators must be removed from the system board. The SCSI terminators are located in the lower half of the planar board and can be recognized by three paper tags. In order to remove the terminator, all three resistors have to be removed by pulling the paper tags. Removal of only one or two of the resistors may produce errors on the SCSI bus and data may be lost.

You may find more details on SCSI in the ITSC publication *SCSI Architecture and Implementation*.

12.7 Plasma Display Subsystem

This section describes functional specifications of the plasma display and the plasma display adapter used in the PS/2 Model P75 486 system. The PS/2 Model P75 486 portable video subsystem uses an enhanced plasma display adapter that includes IBM PS/2 Enhanced Performance XGA Display Adapter/A graphic, the Plasma Display Controller (PDC), and 1 MB of Video RAM.

The PDC has two display interface logics. One is an interface to the Plasma Display Panel (PDP). The other is an interface to an external PS/2 CRT display.

The PDC supports both the plasma display and an external monitor simultaneously. This function is not available on the IBM PS/2 Model P 70.

Highlights of the plasma display subsystem are:

- Plasma display:
  - 640 x 480 dot matrix flat plasma display panel (PDP)
  - 8.31″ x 6.24″ viewable screen area (WxH)
  - 16 gray scale, one color capability
  - CRT-like dot serial signal interface
  - CRT-range clock.
- VGA emulation:
  - 64 to 16 distinctive gray mapping

- Dithering (halftoning), to provide 61 out of 64 shades.
- Software selectable vertical screen centering.

- Auto-DIM (0 to 120 minutes, can be set via the reference diskette)
- Color to gray scale in color mode
- CRT interface:
  - External monitor support, fully compatible with IBM PS/2 Enhanced Performance XGA Display Adapter/A graphics.

12.8 Display Capability

The PDP Display Adapter Card supports the following three configurations.

1. Using the PDP only - all VGA modes are supported
2. Using an external CRT only - all VGA and XGA modes are supported
3. Using the PDP and a CRT at the same time - all VGA modes are supported. XGA modes are supported on the external display and will be mapped to the PDP.

Sections 12.8.1, "Configuration 1 - Using the PDP Only" to 12.8.3, "Configuration 3 - Using Both the PDP and a CRT" on page 126 show examples of these cases.

12.8.1 Configuration 1 - Using the PDP Only

In the alphanumeric (A/N) mode, all modes with an 8 x n dot font are supported.

In this case, the PDP is regarded as a monochrome CRT (like an IBM PS/2 8503 Monochrome Display) by default.

The user can change this default with the reference diskette. Then, the PDP is regarded as a color CRT, in order to use applications which require a color CRT. When the PDP is regarded as the color CRT, the color to gray scaling is used (see section 12.8.9, "Color to Gray Mapping (Color Emulation)" on page 130).

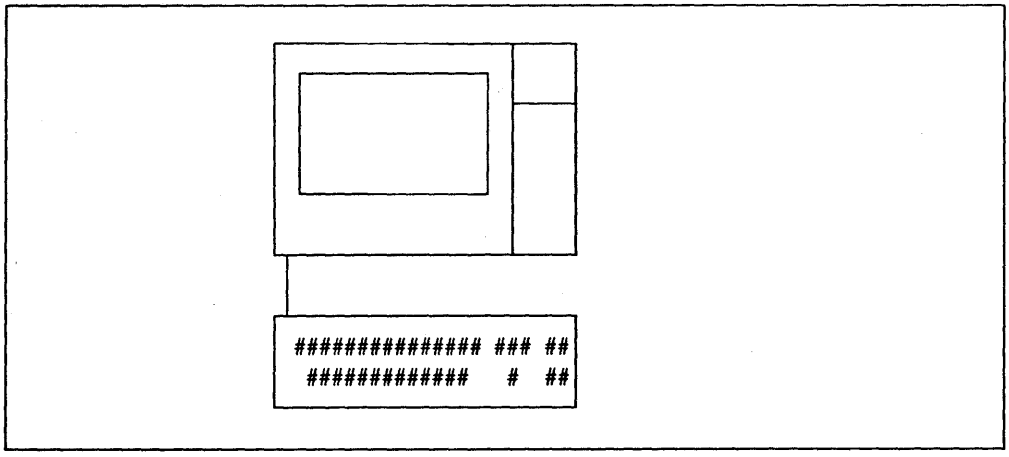

Figure 69. Plasma Display Only

12.8.2 Configuration 2 - Using an External CRT Only

This case is fully compatible with IBM PS/2 Enhanced Performance XGA Display Adapter/A CRT systems. Here, the PDP is disabled by POST.

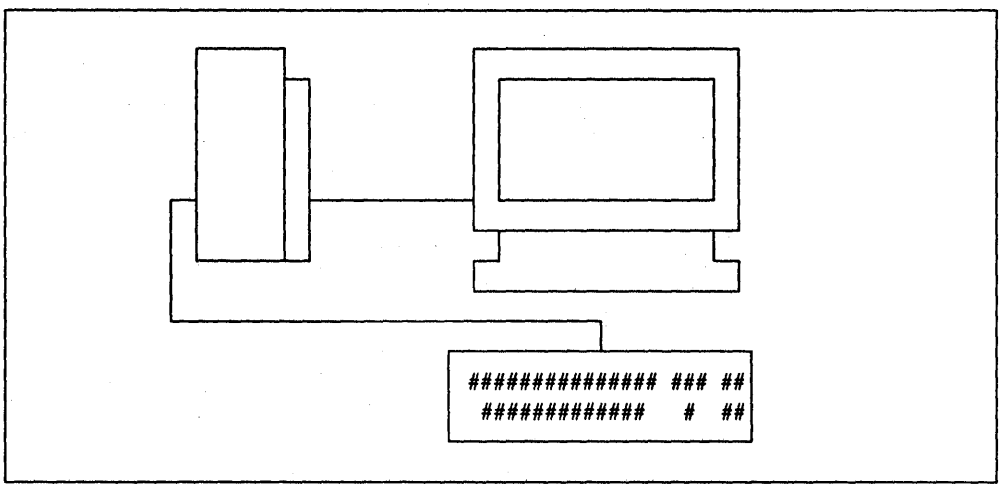

Figure 70. External Display (CRT) Only

12.8.3 Configuration 3 - Using Both the PDP and a CRT

The PDP display adapter operates both display units with an 8 dot font, as in the first case. This configuration can be set from the reference diskette (see 12.9, "Reference Diskette" on page 132).

If a monochrome CRT is connected to the system, the PDP emulates a monochrome CRT.

If a color CRT is connected to the system, the plasma display controller converts color data into monochrome data by a method defined by NTSC (National Television Standard Committee). For more details on this conversion, refer to section 12.8.9, "Color to Gray Mapping (Color Emulation)" on page 130.

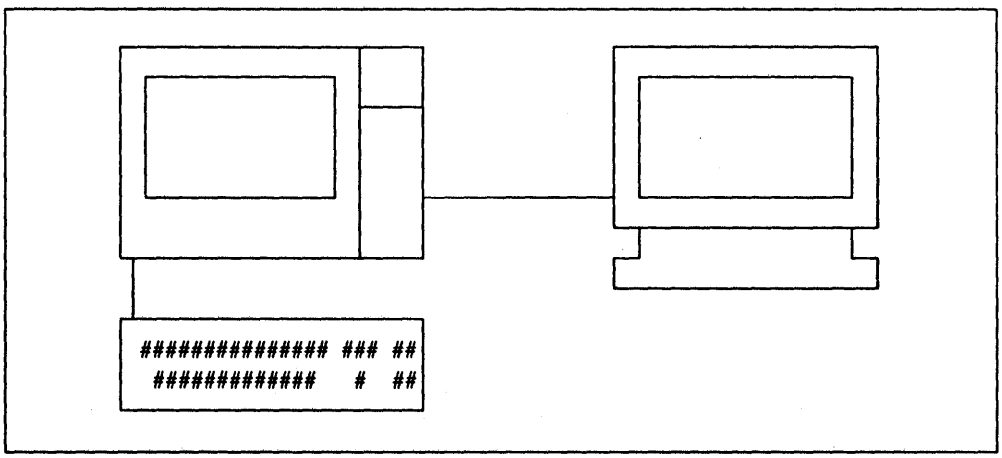

Figure 71. Plasma Display and External Display (CRT)

This configuration is new and is not supported on the IBM PS/2 Mdl. P70 system. In the IBM PS/2 Mdl. P70, BIOS disables the PDP if a CRT is connected.

12.8.4 Summary of the Three Cases

Plasma Display	External Display	Parameter Setting	Functions
on	no	POST sets parameters	**H** 640, 320 **V** 480, 400, 350, 200 **C** fix **B** no
off	mono/color	POST sets parameters (default)	**H** All modes **V** All modes **C** Variable **B** yes
on	mono	POST enable via SETUP Option	**V** 480, 400, 350, 200 **C** BIOS **B** CRT only
on	color	POST enable via SETUP Option	**H** 640, 320 **V** 480, 400, 350, 200 **C** BIOS **B** CRT only

Figure 72. Summary of the Three Cases

H Horizontal lines

V Vertical lines

C CRT parameter set

B Border support

For details on the setup refer to section 12.9, "Reference Diskette" on page 132. Figure 73 shows the screen modes supported by the plasma display adapter.

Type	Colors	Alpha Format	Font Box	Resol-ution	Resolution on PDP	CRT Con-nected	PDP Enabled
A/N	B&W	40x25	8x8	320x200	640x400	Y	Y
A/N	16	40x25	8x8	320x200	640x400	Y	Y
A/N	16/64	40x25	8x14	320x350	640x350	Y	Y
A/N	16/256K	40x25	9x16	360x400	-	Y	N
A/N	16/256K	40x25	8x16	320x400	640x400	N	Y
A/N	B&W	80x25	8x8	640x200	640x400	Y	Y
A/N	16	80x25	8x8	640x200	640x400	Y	Y
A/N	16/64	80x25	8x14	640x350	640x350	Y	Y
A/N	16/256K	80x25	9x16	720x400	-	Y	N
A/N	16/256K	80x25	8x16	640x400	640x400	N	Y
APA	4/256K		8x16	320x200	640x400	Y	Y
APA	4/256K		8x16	320x200	640x400	Y	Y
APA	2/256K		8x16	640x200	640x400	Y	Y
A/N	B&W	80x25	9x14	720x350	-	Y	N
A/N	B&W	80x25	8x14	640x350	640x350	N	Y
A/N	B&W	80x25	9x16	720x400	-	Y	N
A/N	B&W	80x25	8x16	640x400	640x400	N	Y
APA	16/256K		8x8	320x200	640x400	Y	Y
APA	16/256K		8x8	640x200	640x400	Y	Y
APA	2/256K		8x14	640x350	640x350	Y	Y
APA	16/256K		8x14	640x350	640x350	Y	Y
APA	2/256K		8x16	640x480	640x480	Y	Y
APA	16/256K		8x16	640x480	640x480	Y	Y
APA	256/256K		8x8	320x200	640x400 [1]	Y [2]	Y [3]
APA	256/256K			640x480	640x480	Y [2]	N [4]
APA	16/256K			1024x768	-	Y [5]	N [6]
APA	256/256K			1024x768	-	Y [5]	N [6]

Note: [1] 4 dots are used per 1 pixel [2] On monochrome display, only 64 gray scales can be displayed [3] Same as monochrome display. Only 64 gray scales can be displayed on plasma display using dither pattern. [4] The plasma display will display only 16 gray scales, and the image may not be legible. [5] High resolution monitor is needed [6] Plasma display automatically disabled

Y Supported screen mode
N Not supported screen mode

Figure 73. Some of the Screen Modes

12.8.5 Screen Modes on the Plasma Display

The PDP that is used in the PS/2 Model P75 486, has the capability of handling 16 gray scales on each pixel.

This is different from an external CRT display, which can deal with 64 gray scales on each pixel.

In a special new mode, the CRT displays the 64 gray scales; the plasma display on the other hand uses halftoning patterns instead.

Also, the plasma display does not support screen modes that require a 9-dot font. When these modes are used, BIOS sets the screen mode with an 8- dot font transparent to the application.

12.8.6 Screen Modes on a CRT

CRT screen modes are fully compatible with PS/2 CRT XGA systems. Some more screen modes are added. BIOS supports only VGA compatible modes. Added modes can be supported through interface programs, which may be implemented as device drivers from different software suppliers.

To use all modes (including high-resolution 1024 x 768), it is necessary to attach a CRT (IBM 8514 or 8515) which supports a 44.9 MHz dot clock.

12.8.7 Display Turned-on

There are two choices:

1. Primary plasma display. This is the default.
2. Plasma and external displays.

The plasma display of the PS/2 Model P75 486 will display distorted images when an external PS/2 display is connected to it and both displays are forced to display a 9-dot font by an application program. In this case, change the turned-on display to "external display only". This function can be set via the reference diskette and will force the plasma screen blank.

12.8.8 Emulating the VGA Mode

The plasma display controller is able to map VGA to sixteen gray values to be displayed on the plasma display. We have to distinguish between two cases:

- 64 gray values to 16 gray values mapping
- Color to gray mapping.

64 Gray to 16 Gray Values Mapping

An IBM PS/2 8503 monochrome displays can deal with 64 gray scales.

The PDP only has a capability of 16 gray scales, therefore a function that can remap 16 gray scales from 64 gray scales is required. The display adapter supports two kind of mapping functions. One is "distinctive mapping" and the other is "natural mapping". The selecting is done by a control register setting. The default mode is "distinctive mapping".

Distinctive Mapping: The distinctive mapping can translate 64 gray scales into sixteen gray scale, by means of determining which 16 shades are currently used by the application.

This compression method operates with no change in brightness.

Natural Mapping: Natural mapping puts priority on the original 64 gray scale relations, therefore this function translates 64 gray scales into sixteen gray scales in the same step width.

Because this function gets 4-bit of dot data, it can not determine the small difference caused by the two least significant bits (LSB) on the PDP. This mapping is also called "MSB 4-bit Mapping".

Half-Toning (Dithering): The PS/2 8503 Monochrome Display Unit can display 64 gray scales at the same time. As the plasma display can only display 16 gray shades, it uses half-toning patterns instead.

The resolution of this mode is 320 x 200 dots, therefore one pixel can be displayed with 2 x 2 dots on the PDP. As the PDP itself provides 16 halftones, the PDP can display 2 x 2 x 16 = 64 halftoning combinations. As some of these combinations look alike, the maximum number of different combinations is 61.

12.8.9 Color to Gray Mapping (Color Emulation)

There are two choices to map color to gray values:

1. RGB mixed signal (color emulation). This is the default.
2. Green signal only (monochrome emulation).

This function can be changed from the reference diskette (see section 12.9, "Reference Diskette" on page 132). There are some applications that are developed for color displays but can be used on monochrome displays. When using such applications, "color to gray mapping" should be reset to "green signal only". Setting "RGB mixed signals" may result in an unpredictable display image.

When the PDP is in 8503 monochrome emulation mode, RGB signal to gray scaling is implemented by BIOS according to an NTSC (National Television Standards Committee) standard. This is the same as in the PS/2 Model P70. When the P70 is forced to the color mode, the portion of the picture that contains no green element would not appear on the PDP. PS/2 Model P75 486 has added a color emulation mode that implements the color to gray scale summing algorithm in hardware, when it is forced into the color display mode. This mode also supports enabling of the PDP and an external CRT simultaneously.

When the PDP emulates the 8503 monochrome CRT the PDC only uses the green CRT signal. Therefore, when applications change the PDC to the color emulation mode, they must set a new bit that enables the PDC to implement the color to gray scale summing reduction in hardware.

Users who want to use such applications without attaching the color CRT can select another mode by using the reference diskette.

In this mode, the PDP is regarded as the color CRT. All of values of RGB signals are added using the equation shown in Figure 74 on page 131. This technique and the equation are defined by the NTSC.

```
F = 0.30 x R + 0.59 x G + 0.11 x B

F: Result.
R: The value of the red signal.
G: The value of the green signal.
B: The value of the blue signal.
```

Figure 74. Color to Gray Conversion

Using this function, the user can see the color data on the PDP as gray scales similar to color TV programs on a monochrome TV.

12.8.10 Auto-DIM

The PDP display card has a function to turn off the PDP automatically. This operation is controlled by keyboard and mouse access.

The user sets the time value (0 to 120 min) by the reference diskette. A counter is reset and started after power on, when a key is depressed on the keyboard or when the mouse is moved. If the counter reaches the preset value, the PDP is blanked. Moving the mouse or depressing a key on the keyboard will turn on the PDP again.

12.8.11 Display Start Position

The number of horizontal lines of the PDP is 480 lines. In the 350-lines display mode, 130 lines are non-data display lines. In the 400-lines display mode, 80 lines are non-data display lines. The PDP display card is able to change the display start position in the 350- and 400-lines modes. For example, in the 400-lines mode, if the top margin value is set to 30, data is displayed from line 31 to line 430. The display start position is 31, and the bottom margin is 50. The lines up to the top and below the bottom margins, are non-displayed (blank) lines.

Figure 75 shows the value of the vertical display position of any mode.

Number of Lines	Top + Bottom Margin	Start Position
350	130	1 to 131
400	80	1 to 81
450	0	1

Figure 75. Display Start Position

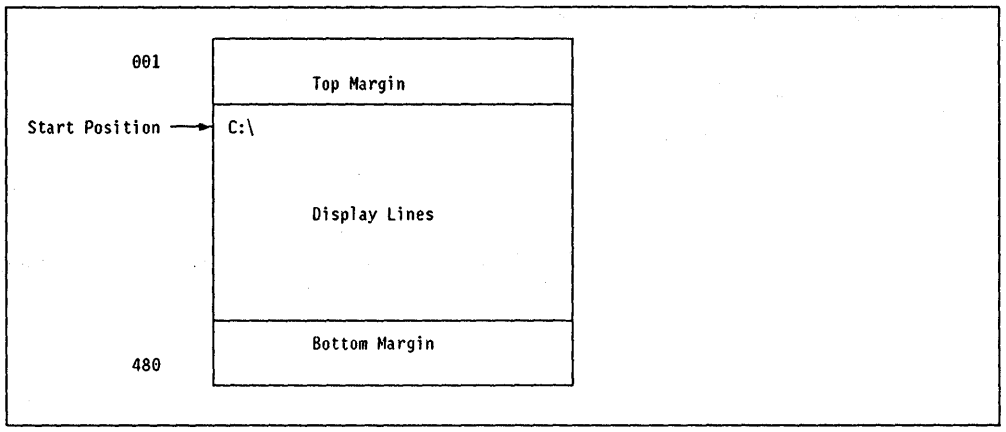

Figure 76. Display Area

12.9 Reference Diskette

The PS/2 Model P75 486 system reference diskette has some new functions added to support the PDP. When "Change Configuration" from the "Set Configuration" menu is selected, the following can be chosen in addition to functions already available on the IBM PS/2 Mdl P70:

Function	To be set to
Auto Dim Time	1, 5, 10, 30, 60 or 120 mins.
Auto Dim Reset	Keyboard only or keyboard and auxiliary device (mouse)
Background brightness	Low or high
Color to gray mapping	Green signal only or RGB mixed signal
Turned-on display	Plasma and external display or external display only

12.10 PS/2 Model P75 486 Expansion Capabilities

The PS/2 Model P75 486 has two full-length 32-bit PS/2 Micro Channel adapter slots. One of them has the auxiliary video extension bus implemented. For a detailed list of which PS/2 Micro Channel adapters are supported, please refer to the IBM Product Announcement for PS/2 Model P75 486. These adapters include 8-, 16- and 32-bit implementations. There are also two halflength 16-bit PS/2 adapter slots, intended primarily for the halflength 300/1200/2400 bps Modem Adapter Card (available only in US and Canada), Token-Ring Network Adapter/A, 5250 Emulation Adapter/A and 3270 Connection.

12.10.1 Common Options

PS/2 Model P75 486 will support PS/2 common options with the exception of those requiring more than two slots, or those that require internal space such as hard disks, diskette drives and backup devices. However, SCSI devices can be attached externally through the SCSI interface. A SCSI interface cable can connect to a PS/2 external SCSI storage enclosure unit, which may have up to six additional SCSI devices installed.

12.10.2 PS/2 Model P75 486 Unique Features

The PS/2 Model P75 486 has the following features that are also available for the IBM PS/2 P70:

1. IBM traveling case

   The traveling case is a hard-cover plastic case with rolling wheels and an integrated telescope handle for easy pulling. The interior is padded and able to hold a P75 or P70, cables and a mouse. It is designed according to aircraft (FAA) luggage regulations, thus allowing the case to be carried on board of an aircraft and stored under the seat.

Measures	Width	Depth	Height	Weight
Metric	390 mm	216 mm	584 mm	4.1 kg
US	15.4 inches	8.5 inches	23.0 inches	9.0 lbs

Figure 77. IBM Traveling Case Physical Specifications

2. External storage device cable

   This is identical to the already available cable for the P70.

3. Keyboard extension cable

   The keyboard extension cable is designed to allow the user to have the flexibility to place the keyboard and the system unit to suit his requirements.

12.11 Power Supply

The power supply is an "auto-sensing" power supply, which works within the range of 100 - 240 V at 50/60 Hz.

12.12 Homologation

The PS/2 Model P75 486 system has UL, CSA, TUV, GOP, FCC Class-B and Nordic Safety approvals.

Electromagnetic compatibility is according to FCC Class B, VCCI Class 2 and GOP standards.

12.13 Keyboard

The keyboard is the same as on the IBM PS/2 Mdl. P70. It is has the same layout as the enhanced keyboard on the IBM PS/2 systems, but is built into a smaller frame that enables it to be attached to the PS/2 Model P75 486 system unit. An optional keyboard extension cable is available. The keyboard has 101/102 keys. The 101 key models are for US-English and Hebrew languages, the 102 key model is for all other languages.

The keyboard cable connects to the keyboard with a 6-position connector, and the other end connects to the system with a 4-pin connector. In some countries, the keyboard is not part of the ordered system and has to be ordered separately.

Note: Please be aware that due to the different connectors, a PS/2 Enhanced Keyboard is not supported.

12.14 Power Switch, Indicators and Identification

Figure 78 shows the enlarged indicator plate. The access indicators are marked with a hard disk and a diskette symbol.

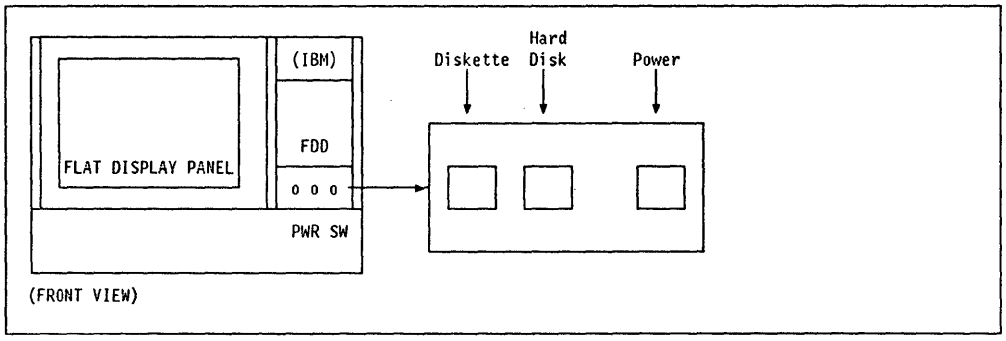

Figure 78. Indicator Plate

12.14.1 Power Switch and Indicator

The white key top power switch is located in front of the diskette unit and the green power indicator is on the front cover under the diskette drive unit bezel.

12.14.2 Hard Disk Access Indicator

The yellow hard disk access indicator is located next to the power indicator.

12.14.3 3.5"Diskette Drive Access Indicator

The yellow diskette drive access indicator is located next to the hard disk access indicator. The eject button is on the top bezel on the right side of the diskette unit. A mark is located on the right side of the diskette unit front bezel as a tilt lock indicator.

12.14.4 System IDs

Figure 79 shows the system ID bytes, system board types, and system clock speeds.

Figure 79. Model/Submodel Bytes

Model Byte	Submodel Byte	Processor	System Clock
F8	52	i486	33 MHz

Refer to the *IBM Personal System/2 Technical Reference* of other systems, and check the supplement sections for updates to that listing.

12.15 Operating Systems

The PS/2 Model P75 486 is supported by the following operating systems:

1. IBM DOS 3.3
2. IBM DOS 4.0
3. IBM OS/2 SE V 1.2
4. IBM OS/2 EE V 1.2
5. IBM OS/2 SE V 1.3
6. IBM OS/2 EE V 1.3

Appendix A. Micro Channel

This appendix details three of the Micro Channel enhancements announced in November 1989. These are:

- Data parity
- Address parity
- Streaming data mode.

A.1.1 Data and Address Parity

When data is stored in memory or on any external device, the integrity of the data is ensured by having some form of check information stored together with the data. This extra information ensures that any lost or extra bits of data can be detected and in certain cases corrected without having to retransmit the data.

The various buses (data, address, etc.) that make up the Micro Channel are usually regarded as very safe conduits of information and are therefore not checked.

Although this is a very safe assumption to make, there is always the chance that some electromagnetic interference or a power disruption could cause some extra or missing bits. This is especially important for adapters that use the Micro Channel at higher transfer rates.

Parity is now implemented on the Micro Channel in two forms:

- Data parity

  Data parity is implemented on the Micro Channel with a new line on the control bus. This line is called DPAREN. This line provides a method for verifying that correct data has been sent across the Micro Channel. The data parity line will become more important as more adapters start to use the new data streaming modes with faster data transfers.

  Data parity only works between two adapters that have the data parity signal connected. It works as follows:

  1. A bus master adapter enables the DPAREN line during a write operation to a slave.
  2. The slave then checks the parity of the data.
  3. If the data has bad parity, the slave indicates this to the master by activating the CHCK signal.

  Adapters that support data parity will not be able to use this function unless the data parity line DPAREN is wired onto the planar board.

- Address Parity

  Address parity is implemented on the Micro Channel with a new line on the control bus. This line is called APAREN. It provides a method for verifying that a device has been correctly addressed across the Micro Channel. The address parity line ensures the reliability of the system, which is especially important in a server environment.

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Address parity works only between two adapters that have the address parity signal connected. It works as follows:

1. A bus master adapter addresses a slave device with the APAREN line enabled.
2. The slave then responds if the parity is good.
3. If the parity is bad, the slave will not respond and the bus master can assume that the address is incorrect.

Adapters that support address parity will not be able to use this function unless the address parity line APAREN is wired onto the planar board.

A.1.2 Streaming Data Mode

This is a new method of data transfer on the Micro Channel. To fully understand streaming data mode it is necessary to look at the current data transfer procedure on the Micro Channel.

The actual speed of data transfer between two participants on the Micro Channel is dependent on many factors:

- Time to gain control of the channel (arbitration)
- Time taken for each data transfer
- Number of transfers performed (burst mode)
- Width of the data path (8, 16, 32 or more bits)
- Type of transfer cycle used

The arbitration cycle to gain control over the channel takes a minimum of 300ns. Once a device has control of the channel it can use it until it has finished its data transfer or until the PREEMPT line on the channel is raised (PREEMPT is a line on the bus used by all of the attached devices to indicate to the Micro Channel logic that they want to use the channel).

Once a device has control of the channel it can move data on the channel by putting an address on the address bus (memory or I/O) and data on the data bus. The basic transfer cycle on the Micro Channel is 200ns: 100ns to set up the address part and 100ns for the data part. This means that 5,000,000 basic transfer cycles per second are possible for a device running in burst mode (continuous transfers).

With this figure in mind, the actual data transfer rate across the Micro Channel will depend on the width of data being transferred. If the data path is 1, 2 or 4 bytes (8, 16 or 32 bit) the instantaneous data transfer rate across the channel would be 5, 10 or 20 MBps respectively.

If the data to be transferred was all stored sequentially it should not be necessary to specify the address for each separate data transfer. This is how the streaming data mode works. Streaming data mode provides a faster rate of data transfer across the Micro Channel than the basic transfer cycle.

In the basic transfer cycle, an address and data are transferred every 200ns. In streaming data mode the address and first data transfer occur in 200ns (just like a basic transfer cycle). However, all following data transfers occur in 100ns. This transfer works as follows:

- An address is specified by the bus master.
- When the first data has been transferred to this address a new address is needed for the next set of data.
- This new address is worked out by the adapters by simply adding the length (1, 2 or 4 bytes) of the data just sent to the last used address.

This is a very simple idea, but one that enables each transfer cycle to take only 100ns. The result is a doubling of the transfer rate. Instead of 5, 10 or 20 MBps transfers of 1, 2 or 4 bytes, the same number of bytes is transferred at 10, 20 or 40 MBps respectively.

Figure 80 shows the possible transfer cycles.

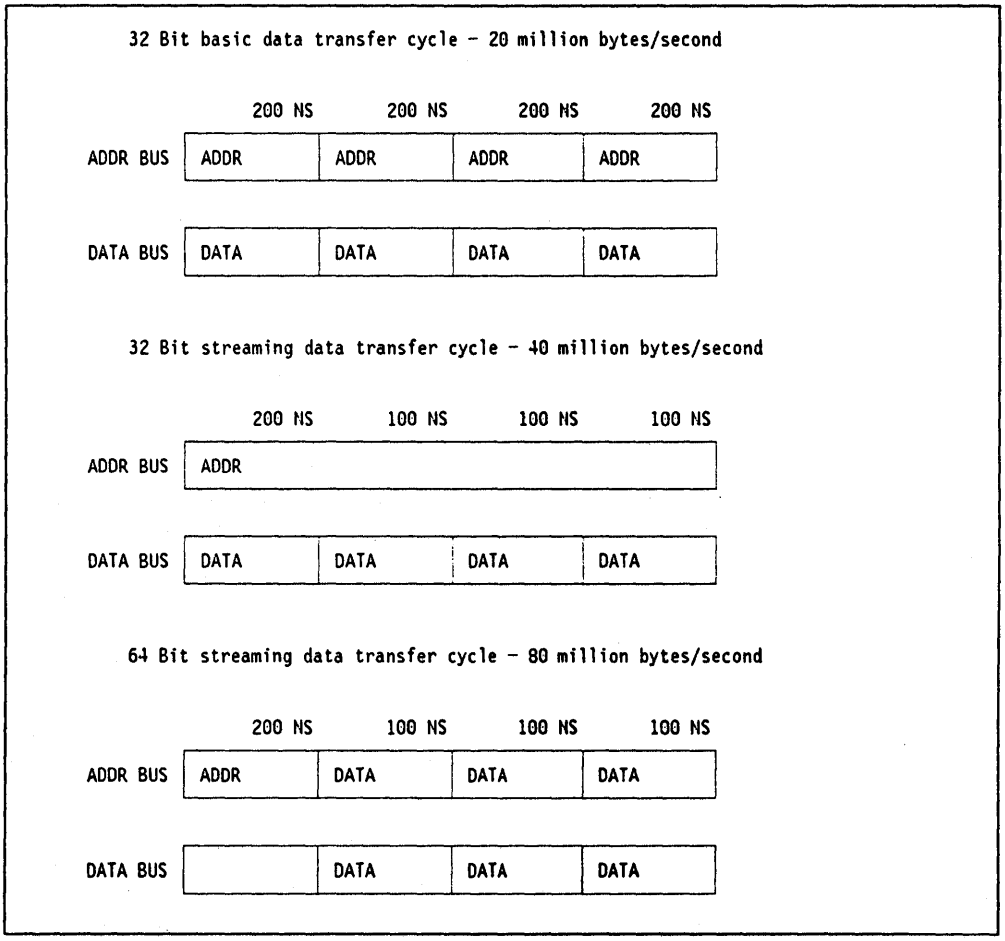


Figure 80. Data Streaming Mode - Transfer Cycles

The 64-bit streaming data transfer cycle shows how the address bus that is not being used during the transfer of data can actually be used to transfer data as well. This effectively doubles the size of the data throughput again. This method is called multiplexed streaming data mode.

Appendix B. Antialiased Fonts

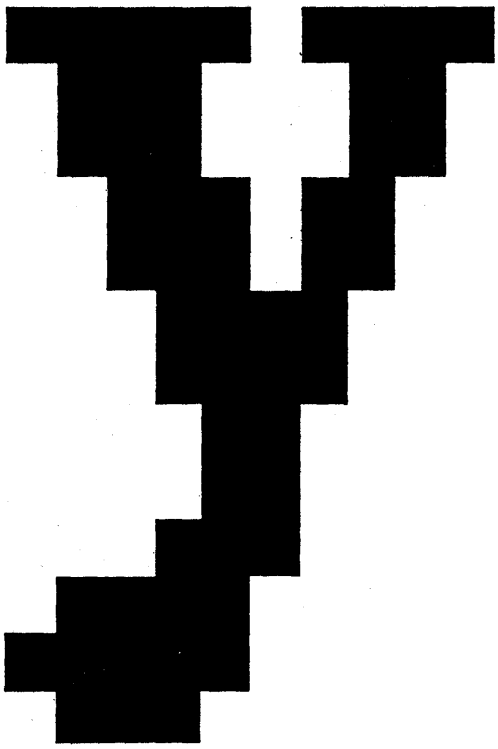
This appendix covers a new capability that the higher resolution of the new video subsystems will exploit. This is the capability to use antialiased fonts for system and application displays.

B.1 OS/2 Software Considerations

One of the considerations in choosing between the 512 KB and the 1 MB video memory option lies in whether you elect to install and use antialiased fonts.

The major benefit of an antialiased font is an improved reading speed capability that approximates that of printed material. As more and more product documentation, online help and manuals are delivered on magnetic media, it is increasingly important that we can access and read such information as quickly as or even more quickly than we can find it in a printed manual. These two diagrams help to show the differences between existing fonts and antialiased fonts. The first example is taken from the actual Presentation Manager* Times Roman font. Each black square is an enlargement of a pixel. The second example is taken from the antialiased Times Roman font. It is the same letter, at the same point size. Each square is an enlargement of a pixel. Some squares have been modified manually to approximate gray scales for the printing process.

Standard Times Roman Lower Case "y"



Notice the jagged appearance of the outline. This has been the character set as used by text applications to date.

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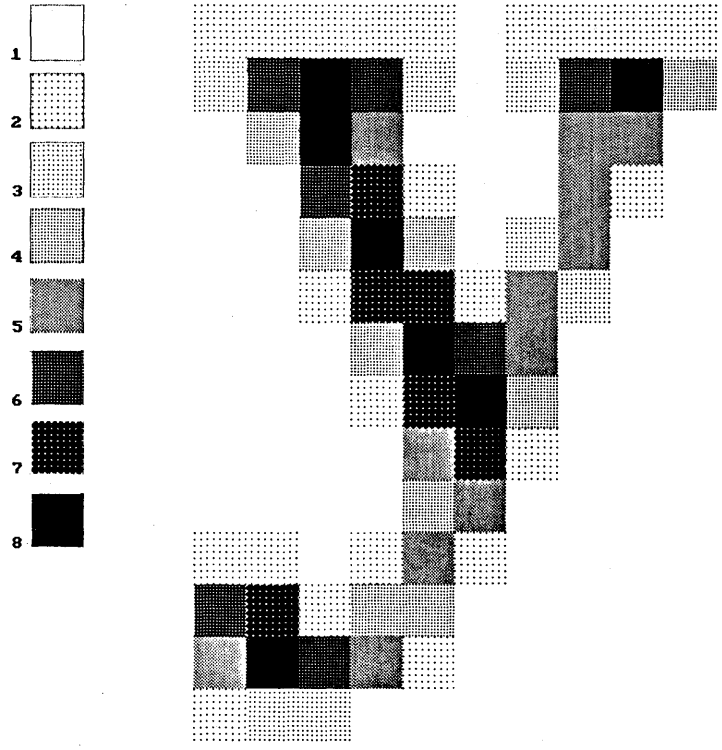
Antialiased Times Roman Lower Case "y"



This is an approximation of the eight levels of intensity used in the antialiased font.

B.2 Guidance for Users of Antialiased Text

The following few pages have been extracted from the *XGA Device Drivers Diskette 2 OS/2 1.2 Support* diskette.

B.2.1 Introduction

This font software supports antialiased text, which offers improved appearance and readability of text displayed on CRT display screens.

Conventional text on display screens is displayed as an array of dots or picture elements (pixels or pels). Each pixel is displayed in one of two colors: a foreground color - the color of the text characters - or a background color. With antialiased text, pixels can be displayed using a range of color shades (up to eight in this implementation) that can have values intermediate between the foreground and background color. Antialiased fonts are designed to use this capability to improve the appearance and readability of text.

Antialiased fonts are available on systems that support 256 colors as follows:

Video Memory	Configured As	Antialiased Fonts
1 MB	No option applies	Available
512 KB	640 x 480 with 256 colors	Available
512 KB	1024 x 768 with 16 colors	Not Available

Figure 81. Availability of Antialiased Fonts by Configuration

You can select an antialiased system font after you have installed the device driver and fonts as follows: In the OS/2 Desktop Manager, select the *screen setup* option. Then, in the screen setup group, run *select system font.* This program lets you view antialiased system fonts and compare them with the normal system font before deciding which to use. You can rerun the program at any time if you want to select a different font.

Note: Antialiased fonts use an optimized set of colors that are loaded by the device driver. If you use a program that changes the default set of colors loaded by the device driver (by using a Realize Color Table call), the color shades selected for antialiased fonts will be incorrect. You should therefore not use antialiased fonts with programs that change the default colors. For example, you should observe the effect of using the OS/2 PM control panel to change the window background to a dark shade.

The remainder of this section gives background information about the display of text, describes some of the advantages of using antialiased fonts, and explains how to install and to use them. It is optional reading for end users with an interest in antialiased fonts. It will be of particular interest to application programmers who plan to use antialiased fonts in their applications. References to papers and journals may be found in "Bibliography" on page 169 at the end of this document.

B.2.2 Background

Typeface design has been studied and taught for over 500 years (Reference 2: Duerer, 1535). Over the years, printed typefaces have evolved into two distinct classes, display (or ornamental) faces and text faces designed for general reading. The text faces were refined over the years, mainly to optimize their appearance and readability when printed on paper. Reading text from a video display screen is a recent mode of human communication. Cathode ray tube (CRT) displays with their typefaces have been used to produce text for about three decades. This new technology has advantages and limitations never considered for ink on paper typeface design. We know that human reading speed from CRT displays is slower than from printed output (Reference 3: Gould, 1984, Reference 4: Gould, 1987). Despite many improvements to display technology, the difficulty of reading from screens, until recently, remained an unsolved problem. However, reports now show that some typefaces that have had the antialiasing technique applied to their design allow much of the lost screen-reading speed to be regained. (Reference 1: Bender, 1987 and Reference 5: Gould, 1987). Antialiasing technology enables precise control of line width, line placement, and "color" (also known as line density). This control permits diagonal lines to be shown as visually straight lines without a jagged (or stair-step) appearance. It also allows the typographic designer to smoothly control line width. With antialiasing techniques, a typographer can design CRT typefaces that are close visual matches to some of the well-known classical printed

designs. Photometric measurements have quantified this control of placement width and shape (Reference 6: Kennedy, 1989). Antialiased typefaces restore some of the high spatial frequencies that are lost on CRT displays.

Many factors should be considered when selecting a typeface for use with a software application. Among these factors are typestyle (serif or sans serif), size (10 point or 12 point), and color or polarity (black characters on a white background or white characters on a black background). The ability to select different styles, sizes, and colors is built into this software to permit the users the flexibility of choosing those characteristics they need. The typeface designs included with the antialiasing fonts were created for the purpose of optimizing the appearance and text readability characteristics. Tests have shown readability and preference is most improved with the antialiased Roman face using black characters on a white background.

B.3 Guidelines on Using Antialiased Fonts

A number of complex factors are involved in the choice of a font for your display, quite apart from the availability of fonts. The best choice depends on you, your applications, and your display:

- Each individual has different preferences because of previous experience and eyesight.
- The display you use, particularly its sharpness, affects the appearance of the fonts.
- The application (that is, how your software displays the font and what you use it for) can also have a marked effect.

If you are an end user, select the system font by viewing the examples in the Select System Font program. Choose the one that looks best to you, on your display, in the colors that you and your applications use most often. If you are using an application that gives you a choice of fonts, you should adopt the same approach. Also, application developers should design applications that offer a choice of fonts (including antialiased) to end users. When making the choice of font, remember that:

- The antialiased fonts are designed to be close in appearance to printed fonts that you may use often.
  - Consider a match to your favorite printer font, for example.
- Text applications can be expected to benefit most from the typographical qualities of antialiased fonts.
  - Non-text applications, for example programming with many codes that need recognition of individual characters, may be better with normal non-serif fonts.
  - Consider whether the text looks smooth or jagged, bold or thin, sharp or fuzzy. These factors depend on you and the display, so different people make different choices.
- The antialiased fonts are optimized for black-on-white display.
  - If you use much white-on-black text, look at white-on-black examples carefully before deciding.
  - Other color combinations will also work, but check them out.

- Make the choice on the display that you will actually use.
- If you are setting up for someone else, get them to make the choice of font.
- Remember that you can run the Select System Font program at any time, so that you can review your choice of system font if your application changes or you think another font might be better.

B.3.1 Available Antialiased Fonts

Antialiased fonts are provided for use as OS/2 Presentation Manager *system* fonts and OS/2 Presentation Manager *application* fonts.

- The *system* font is used by Presentation Manager in window components such as title bars and menus, in help panels, and as a default font for applications that do not explicitly select a font. Four alternative antialiased system fonts are supplied on the device driver diskette:

  10 point Swiss

  12 point Swiss

  10 point Roman

  12 point Roman

  Swiss fonts are sans serif, Roman fonts have serifs.

- The *application* fonts are available for selection by application programs. Antialiased application fonts provided are similar to the normal image fonts provided by the OS/2 Presentation Manager. They are in the same font families, styles and sizes as normal Presentation Manager image fonts.

32 antialiased application fonts are provided on the device driver diskette in the following sizes:

Roman normal:	8, 10, 12, 14, 18, 24 point
Roman italic:	8, 10, 12, 14 point
Roman bold:	8, 10, 12, 14 point
Swiss normal:	8, 10, 12, 14, 18, 24 point
Swiss italic:	8, 10, 12, 14 point
Swiss bold:	8, 10, 12, 14 point
Courier normal:	8, 10, 12, 14 point

B.4 How to Install and Use Antialiased Fonts

B.4.1 System Fonts

The four antialiased system fonts provided are copied to your hard disk when you install the device driver. They are stored in the \OS2\DDFONTS directory on your C: drive. You can select an antialiased system font after you have installed the device driver, as follows:

1. In the OS/2 Desktop Manager, select Screen Setup.
2. In the Screen Setup group, run Select System Font. This program lets you view antialiased fonts and compare them with the regular system font before deciding which to use. You can rerun the program at any time if you want to select a different font.

Antialiased fonts are available on systems that support 256 colors, as described in Figure 81 on page 143.

B.4.2 Application Fonts

Antialiased fonts supplied on the device driver diskette are in compressed form. To unpack them and copy them to your hard disk:

1. Insert the *XGA Device Driver Diskette 2* in drive A.
2. Select "OS/2 Full Screen" from the "OS/2 Group-Main".
3. Type **a:aainstal** and press Enter.
4. Follow the on-screen instructions to install some or all of the antialiased fonts.

You can expect to see a screen that looks like this:

```
To Install antialiased fonts, Type:
aainstal all      ...to install all AA fonts     (32 fonts, 2.3Mb)
aainstal roman    ...to install Roman AA fonts   (14 fonts, 1.0Mb)
aainstal swiss    ...to install Swiss AA fonts   (14 fonts, 1.0Mb)
aainstal courier  ...to install Courier AA fonts ( 4 fonts, 0.2Mb)
```

Figure 82. Prompt for Antialiased Font Installation, Showing Disk Requirements

Selection of Antialiased Application Fonts

Antialiased application fonts are selected by application programs. Although the fonts are device fonts and are in a different format from Presentation Manager fonts, you use them in the same way as you use Presentation Manager image fonts. The GPI calls "GPIQueryFonts" and "GPICreateLogicalFont" work with antialiased fonts in the same way as with normal Presentation Manager fonts. The OS/2 File Manager and the OS/2 System Editor both have options to select fonts. Any antialiased fonts that have been installed can be selected by the end user by using the font options provided by the OS/2 File Manager and the OS/2 System Editor.

B.5 Programming Considerations

- Antialiased font face names are different from normal font face names. Antialiased face names are:

  Swiss AA

  Swiss AA Italic

  Swiss AA Bold

  Roman AA

  Roman AA Italic

  Roman AA Bold

  Cour AA

- The "OS/2 Presentation Manager Font Editor" cannot be used with antialiased fonts because the font editor assumes 1 bit per pel whereas antialiased fonts use 3 bits per pel.

- Antialiased font characters cannot be used to define an area fill pattern.
- Drawing text using an antialiased font into a (1,1) format bitmap is not supported.
- Memory and disk requirements: Antialiased fonts use more memory and disk space than normal fonts. Figure 82 on page 146 shows disk space requirements. Each antialiased character definition uses 3 bits to define a character pixel as compared with 1 bit for normal text. Therefore antialiased fonts use up to three times more space than normal fonts in memory and on your hard disk. The size of antialiased fonts is shown in Figure 83. The size depends only on the point size of the font and not on the font family or font style.

Point Size	Memory Required
8 point	38334 bytes
10 point	47874 bytes
12 point	61230 bytes
14 point	75540 bytes
18 point	118470 bytes
24 point	190020 bytes

Figure 83. Memory and Disk Space Requirements by Font Size

You may, of course, delete from your hard disk any of the antialiased fonts that are not used.

Appendix C. Programming the XGA

In this appendix, we describe some of the differences in the IBM Extended Graphics Array that set it apart from the VGA and the 8514/A. This is not meant to be a comprehensive tutorial on all the capabilities of the new hardware. For that, you need to refer to the relevant technical reference manuals and guides listed under "Related Publications" on page xvii. What this section does give you is a taste of some selected features that make this new video subsystem so powerful. These new facilities are common to both the XGA and the XGA Adapter/A.

In what follows, the term "host processor" refers to the main processor in the PS/2. The term "coprocessor" refers to the processor within the IBM Extended Graphics Array that manipulates pixels.

C.1.1 Registers

In general, the IBM Extended Graphics Array contains several registers that allow you to control and exploit the video subsystem. Some registers are directly addressed in the I/O space, just like the VGA. Some registers are addressed through an indexed I/O addressing scheme, while others are addressed in ordinary memory space.

C.1.2 Typical Coprocessor Operation

The typical operation of the coprocessor involves these steps:

1. The host processor loads the coprocessor registers to perform a particular operation.
2. The host system processor writes the definition of the operation in a "pixel operation register" to start the coprocessor.
3. The coprocessor performs the operation defined. The host system processor can perform other functions at this time.
4. The coprocessor completes the operation, informs the host processor, and becomes idle.
5. The process repeats.

C.1.3 Pixel Interface Overview

This section looks at the operations that can be performed.

Warning

Many new terms are introduced here. They are not defined immediately, because that would obscure the meaning. Some will be covered in the following sections, but others are not covered here.

The pixel interface provides autonomous drawing functions. In brief, what happens is this:

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In one sentence

Pixels from a source are combined with pixels from a destination under the control of a pattern and a mask, and the result is written back to a destination.

After each access the source, destination, pattern and mask addresses are updated according to the function being performed, and the operation is repeated until a programmed limit is reached.

This address update function takes place for a pixel block transfer (PxBlt), Bresenham line draw, or draw and step.

The function performed to combine the source and destination data can be a logical or an arithmetic operation. One of two possible operations is selected for each pixel by the value of the corresponding pattern pixel. Also, a mask pixel for each pixel allows the destination to be protected from update.

To simplify the process, the pattern data can be generated automatically from the source data. This is done by detecting pixels in the source that have a zero value.

A color compare function is provided. This allows the modification of the destination pixel to be dependent on the result of the comparison of the destination pixel with a programmable value.

You can define three general-purpose pixel maps (A, B and C) in memory. For each map you define a start address, height in pixels, width in pixels, and number of bits per pixel. Source, destination and pattern data can reside in any combination of these maps. There is also a mask map that has its own defined start address, height, width and format. Mask data is always taken from this map.

Source, destination and pattern data are each addressed by unique X and Y pointers. Should the source or pattern X and Y pointers move outside the extremities of their pixel maps, they automatically wrap around to the opposite side of the pixel map. However, if the destination X and Y pointers move outside the extremities of the destination map, no update of the destination map takes place until the pointers move back inside the map. Figure 84 on page 151 shows a simplified representation of the coprocessor graphics data flow.

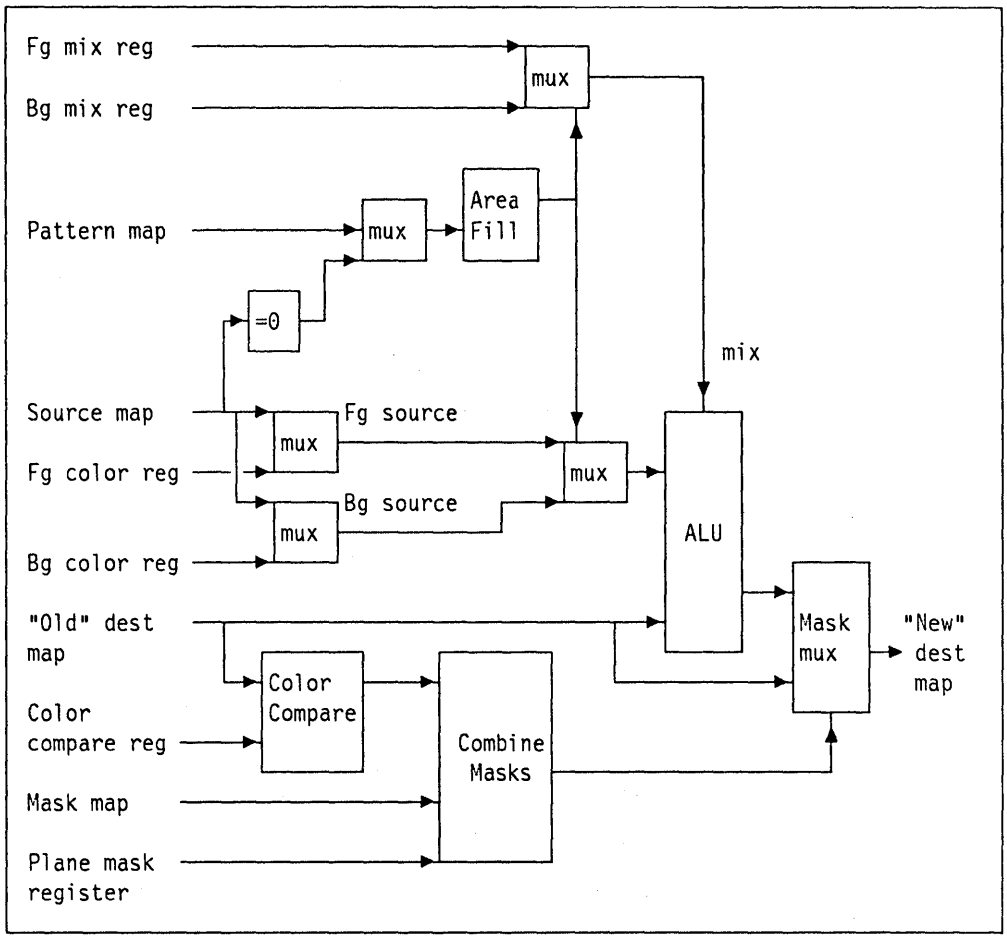

Figure 84. Coprocessor Data Flow. The diagram shows most of the elements of data flow logic. Abbreviations are Fg for foreground, Bg for background, reg for register, mux for multiplexor, dest for destination, ALU for arithmetic and logic unit.

C.1.4 Purpose of the Mask Map

Besides the three general-purpose maps, the IBM Extended Graphics Array also defines a mask map. This map is closely related to the destination map. It allows the destination to be protected from update on a pixel-by-pixel basis. Therefore, it can provide a scissoring or clipping function. Furthermore, it can do so on any arbitrary shaped area.

The size of the mask map must be less than or equal to that of the destination map. If it is smaller than the destination map, its location relative to the destination map must be indicated. You do this by loading two pointers, called the Mask Map Origin X Offset and Mask Map Origin Y Offset. Figure 85 on page 152 illustrates the mask map and its offset pointers.

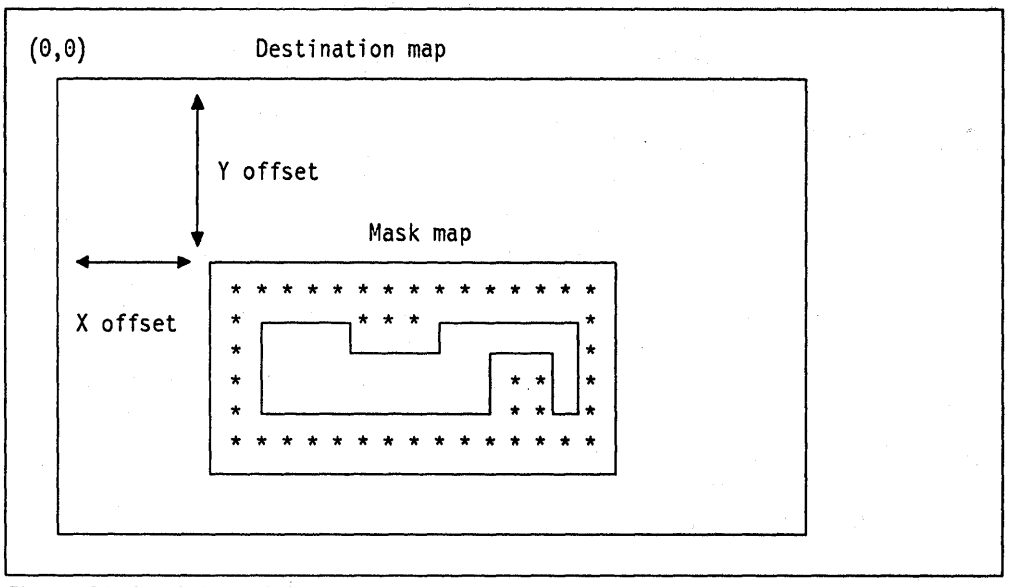

Figure 85. Mask Map Origin X and Y Offsets. An asterisk indicates that this destination pixel is masked. Note that the mask map is located within the destination map.

For any operation, there are three ways that the mask can be used.

Disabled The map and its contents are ignored.

Boundary Enabled The contents of the map are ignored, but the boundary acts as a rectangular scissor window on the destination map.

Enabled The contents of the mask map act as a possibly non-rectangular window. The extremities of the mask map also provide a rectangular scissor window.

Figure 86 shows the effect of a mask map enabled operation. In this illustration, we transfer two horizontal lines of pixels to the destination map. Pixels have been scissored because they are either outside the destination map, outside the mask map boundary, or masked by the mask map.

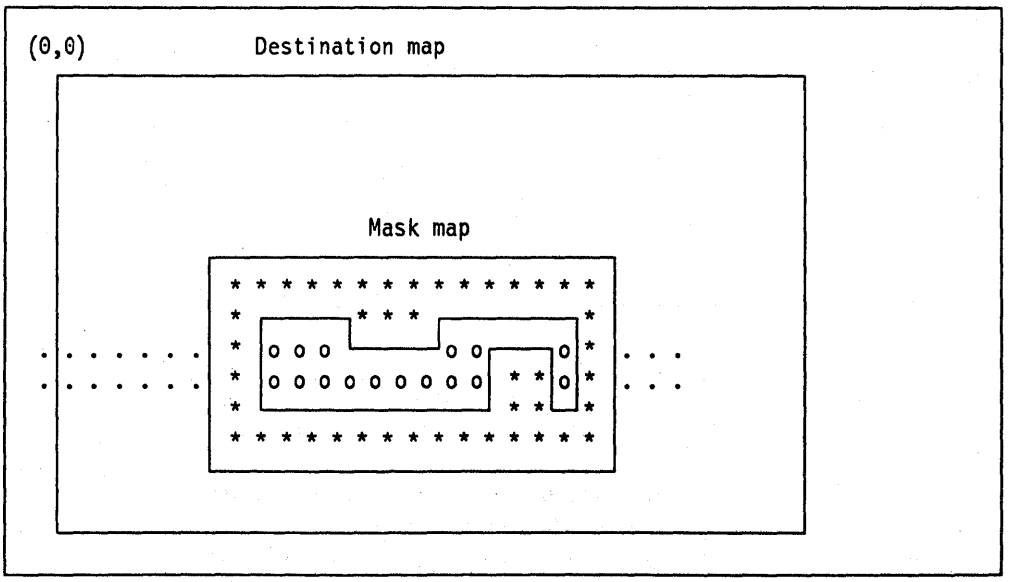

Figure 86. Mask Map Enabled. The "." indicates that the pixel is not drawn. The "o" indicates that the pixel is drawn

The entire operation illustrated in Figure 86 would be performed by the coprocessor without any recourse to the use of the host system processor until the operation was complete.

C.1.5 Real-Life Application

In real-life terms, the Pixel Block Transfer (PxBlt or "pixel blit") illustrated in this example can be both very useful and extremely powerful. Imagine that the source is a scanned image representing a human face. Perhaps you want to include this face in a document. Assume, however, that this is just one face in a crowd. You want to publish the face, but not the background. To isolate the part of the image that you want, you can now set up a mask that covers the unwanted area. In practice, you could use the pointing device to "cut out" the face. Now you can place the mask in the center of a destination area, and use the PxBlt to transfer the source so that the background is cleared and the face remains.

C.1.6 Performance Note

The function described here is one that is new to this graphics subsystem. It does not exist on the predecessor VGA or 8514/A offerings. Since it is not a commonly available function, it is not likely to be found or exploited in benchmark tests. Therefore, do not rely on benchmark test results as an adequate method of determining the performance of this video subsystem relative to others.

C.1.7 Purpose of the Pattern Map

In the practical example described in the previous section, we described how the hardware of the video subsystem assists the user in a real-life application. Let's extend that example further. Suppose that you decide to apply a pattern effect to the image of a face that you are extracting from the background. You might want to make the picture look grainy, so that it appears less distinct than it really is. One way to achieve this is to turn off every second pixel of the image. What you need is a selective pattern where the pixels are a single bit, and alternate between on and off. Two valid possibilities for this pattern map are shown in Figure 87.

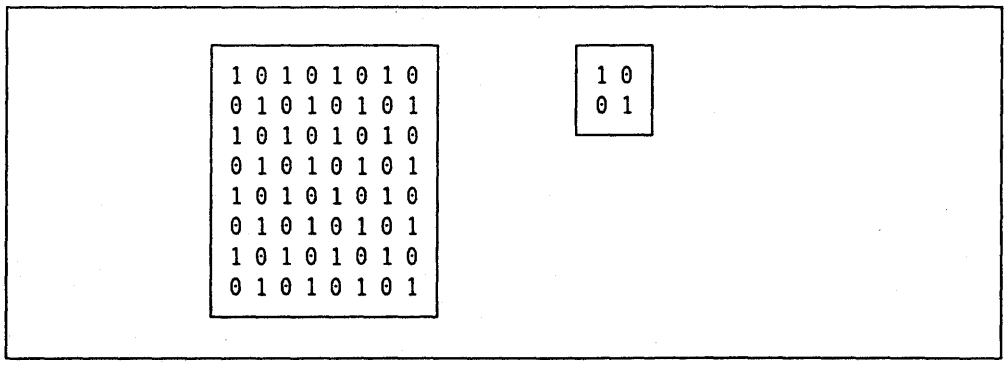

Figure 87. Pattern Map Example. The diagram shows two examples of a pattern map. Since the pattern is regular, and the X and Y pointers wrap around, both examples achieve the same result.

Because the pattern X and Y pointers automatically wrap around to the opposite side when they move outside the extremities of their map boundaries, and because the pattern map is so regular, either pattern map will suffice.

Now, back to the pixel block transfer operation. Once the user has cut out the face, a program can set up the mask as described in appendix C.1.5, "Real-Life Application." The user can then select a pattern to be applied to the face, such as the one shown in Figure 87. Now review the capabilities of the coprocessor shown in Figure 84 on page 151. What is most impressive about this new video subsystem, is that the operation of masking the unwanted background from the source, moving it to the destination, and applying the pattern to the image, is accomplished in one operation! Furthermore, it is accomplished without the use of the host processor's resources.

That's where the true power of this video subsystem lies.

C.1.8 Pixel Operation Summary

A quick summary of all the valid data source and data destinations for pixel operations follows. Where applicable, the possible address and data modifiers are listed under each combination. You should view this summary together with Figure 84 on page 151 to get an appreciation of the full range of capabilities that the IBM Extended Graphics Array provides. These capabilities combine to give a highly flexible and powerful set of drawing functions.

Pixel Data Combinations

- Source Pixels (1, 2, 4 or 8 bits/pixel)
  - Map A, B, or C
  - Foreground color register (fixed)
  - Background color register (fixed)
- Pattern Pixels (1 bit/pixel)
  - Pattern forced to foreground
  - Map A, B or C
  - Pattern generated from source
- Destination Pixels (1, 2, 4 or 8 bits/pixel)
  - Map A, B or C
- Mask Pixels (1 bit/pixel)
  - Mask map disabled
  - Mask map boundary enabled
  - Mask map enabled
- All Maps
- Specified width and height

Address Update Functions

- Read Draw and Step
- Write Draw and Step
- Read Bresenham Line Draw
- Write Bresenham Line Draw

- Pixel Block Transfer (PxBlt)
- Inverted Pixel Block Transfer
- Area-Fill Pixel Block Transfer

Update Masking

- Drawing Mode (for Draw and Step and Bresenham Line Draw)
  - Normal
  - First pixel null
  - Last pixel null
  - Area outline
- Scissoring
  - Fixed destination boundary scissor
  - Mask map rectangular or non-rectangular scissor
- Color Compare
- Plane Masking

Data Modifiers

- ALU mixes (foreground and background
  - All 16 logical
  - 6 arithmetic
- ALU Sources
  - Fixed color (foreground or background)
  - Source pixel map data

Appendix D. List of IML Errors

This appendix lists the error codes that may be displayed by the IML process.

D.1 Error Code Summary

Figure 88 (Page 1 of 2). IML Error Code Summary

Code	Description
00016900	Bad Planar/Processor Card Configuration The system model byte and submodel byte of the processor card did not match the values stored in NVRAM. This means that the user has not run SETUP since switching processor card/planar configuration.
1999001X	Invalid Disk Initial Microcode Load Record A valid master Initial Microcode Load record was not found on the hard disk.
1999002X	Disk Initial Microcode Load Record Load Error The Initial Microcode Load record could not be loaded from the hard disk. After this error is processed, diskette recovery is attempted.
1999003X	Incompatible Disk Initial Microcode Load Record/Planar The Initial Microcode Load boot record loaded from the hard disk did not have a planar ID matching the system. This error means the Initial Microcode Load boot record is not compatible with the system planar.
19990065	Disk POST/BIOS/BASIC Image Load Error The system image could not be loaded from the hard disk. In this case, the last digit in the error code indicates that diskette Initial Microcode Load was not attempted.
199900X1	Invalid Diskette Initial Microcode Load Record Disk Initial Microcode Load has failed, and diskette recovery was not possible because a valid master Initial Microcode Load record was not found on the diskette.
199900X2	Diskette Initial Microcode Load Record Load Error The Initial Microcode Load record could not be loaded from the diskette for recovery from a disk Initial Microcode Load failure.
199900X3	Incompatible Diskette Initial Microcode Load Record/Planar The Initial Microcode Load boot record loaded from diskette did not have a planar ID matching the system. This error means the IML boot record is not compatible with the system planar.
199900X4	Incompatible Diskette Initial Microcode Load Record/Processor Card The Initial Microcode Load boot record loaded from diskette did not have model/submodel byte value matching the system. This error means the IML boot record is not compatible with the processor card.
199900X5	Diskette Initial Microcode Load Not Attempted Diskette IML was not attempted because of a fatal disk IML error or active system security.
199900X6	Diskette POST/BIOS/BASIC Image Load Error The system image could not be loaded from the diskette.

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Figure 88 (Page 2 of 2). IML Error Code Summary

Code	Description
I9990403	Incompatible Disk Initial Microcode Load Record The Initial Microcode Load boot record loaded from disk was not compatible with the current system planar/processor card configuration. For disk IML, this comparison should have been done in the ROM IML routine. The IBM ROM IML routine would not have executed an incompatible IML record. Therefore if this error is detected during boot record execution, the ROM may not be an IBM ROM so the system access error is generated.

Appendix E. Announcement Summary - October/November 1990

This appendix summarizes the PS/2 systems and options that were announced during October and November 1990.

E.1 Personal System/2 - New Systems

IBM PS/2 Model 90 XP 486: The IBM Model 90 XP 486 system is a desktop i486 Micro Channel system. It has four slots as standard, three of which are free for customer use. One slot is used by the SCSI adapter with cache. The IBM Model 90 XP 486 system comes in different models, with either a 160 MB or 320 MB hard disk and either a 25 Mhz or 33 Mhz processor.

IBM PS/2 Model 95 XP 486: The IBM Model 95 XP 486 system is a floor-standing i486 Micro Channel system. It has eight slots as standard, six of which are free for customer use. One slot is used by the SCSI adapter with cache and another by the video adapter. The IBM Model 95 XP 486 system comes in different models with either a 160 MB or 320 MB hard disk and either a 25 Mhz or 33 Mhz processor.

IBM PS/2 Model 55 LS (8555-LE0, -LT0): The Model 55 LS is a medialess LAN workstation that has a 16/4 token-ring or Ethernet adapter as standard using an 80386SX processor. By the addition of a diskette and/or a hard disk drive, the Model 55 LS can be upgraded to a full function PS/2 Model 55SX.

IBM PS/2 Model 65 SX - 321 (8565-321): A new model of the 8565 systems with 320 MB hard disk.

IBM PS/2 MODEL 80 (8580-081, -161, -A16): New models of the 8580 family. They differ in disk size and processor speed.

System	Processor	Speed	Disk
8580-081	80386	20 MHz	80 MB
8580-161	80386	20 MHz	160 MB
8580-A16	80386	25 MHz	160 MB

Figure 89. New 8580 Models

E.2 Personal System/2 - Options

IBM PS/2 486/33 Processor Upgrade Option: The Processor Adapter 33 MHz can replace the Processor Adapter 25 MHz which comes standard in the 25 Mhz models of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. This allows you to upgrade your system by increasing processor speed.

IBM PS/2 256 KB Cache Option: The cache option attaches to the Processor Adapter to provide a second level of caching. This can be used to improve performance in certain environments.

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IBM PS/2 2 MB Memory Module Kit - 70 ns: This kit provides 2 MB of 70 ns memory, which can be installed on the planar of the IBM PS/2 Mcdel 90 XP 486 and Model 95 XP 486 systems.

IBM PS/2 4 MB Memory Module Kit - 70 ns: This kit provides 4 MB of 70 ns memory, which can be installed on the planar of the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems.

IBM PS/2 1.44 MB 3.5" Diskette Drive: This is a new 1.44 MB 1-Inch high diskette drive that supersedes the previous 1.44 MB 1-Inch high diskette drive. It is the only 1.44 MB supported in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. This option is supported in all systems that its predecessor worked in and is functionally equivalent.

IBM PS/2 CD-ROM Drive: This model supersedes the previous CD-ROM drive. It is functionally equivalent to its predecessor. To install the CD-ROM drive in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 or in the PS/2 external SCSI storage enclosure, you do not require the CD-ROM installation kit A but you need this kit to install the CD-ROM drive in 8560, 9565 and 8580 system units.

IBM 5.25" 1 Inch High Internal Diskette Drive.: This is a new 5.25" internal diskette drive. It is only supported on the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems. It is different from the currently available 1.2 MB 5.25" internal diskette drive in the following ways:

- Slimline model
- Bootable drive
- Electronic eject
- Supported on planar so no adapter required.

IBM PS/2 80 MB SCSI Hard Disk Drive: This is a new SCSI hard disk drive that provides 17 ms average seek time and uses the SCSI synchronous mode of data transfer.

It replaces the 60 MB SCSI hard disk drive and has a performance improvement over the 60 MB drive.

IBM PS/2 160 MB SCSI Hard Disk Drive: This is a new SCSI hard disk drive that provides 16 ms average seek time and uses the SCSI synchronous mode of data transfer.

It replaces the 120 MB SCSI hard disk drive and has a performance improvement over the 120 MB drive.

IBM PS/2 320 MB SCSI Hard Disk Drive: This is an advanced version of the previously available 320 MB SCSI hard disk drive. Both are functionally equivalent.

IBM PS/2 2.3 GB SCSI Full High Tape Drive: The IBM PS/2 2.3 GB Full High SCSI Tape Drive enables you to back up 2.3 GB of data to one tape cartridge. It is a full height 5.25" form factor unit that attaches to the SCSI interface. The average data transfer rate is 246 KB per second. It is currently supported only in the IBM Model 95 XP 486 system and the PS/2 external SCSI storage enclosure. Only one IBM PS/2 2.3 GB Full High SCSI Tape Drive can be installed in either of these units.

Software support is provided under OS/2 1.1 and OS/2 1.2 using the Sytos Plus. There is currently no support for the drive under DOS.

1.44 MB Diskette Kit B (8555 LS): This kit enables you to install a 1.44 MB diskette drive in the Model 55 LS. It consists of a front bezel, a special cable and installation instructions.

30/60 MB Hard Disk (8555 LS): The 30 MB and 60 MB hard disk drives can be used to upgrade a Model 55 LS. Only one hard disk can be installed in each system.

IBM PS/2 SCSI Hard Disk Kit D: This is the installation kit required when you install the 80 MB or 160 MB SCSI hard disk drive in the IBM PS/2 Model 90 XP 486 and Model 95 XP 486 systems or the PS/2 external SCSI storage enclosure. It consists of special trays and slides plus installation instructions on how to install the hard disk drives.

IBM PS/2 Internal Tape Backup Unit Installation Kit B: Installation kit B enables you to install the Internal Tape Backup unit in the following PS/2 systems:

- PS/2 Model 65SX
- PS/2 Model 80 (not needed for models -041,-071,-111 and -311)
- PS/2 Model 90
- PS/2 Model 95

The kit consists of a cable which has an edge connector at one end and a pin connector at the other.

IBM PS/2 Adapter/A for Ethernet Networks: The IBM Ethernet Adapter/A provides PS/2 connectivity to an Ethernet LAN. It fully complies to ANSI/IEEE standard 802.3. Device drivers for DOS, OS/2 1.2 and Novell are shipped on a diskette with the adapter.

IBM PS/2 Enhanced Performance XGA Display Adapter/A: The XGA Adapter/A is a high performance 32 bit bus master adapter. The video subsystem is both fully compatible and an evolution of the previous VGA standard. The XGA Adapter/A comes standard on the IBM Model 95 XP 486 system and can be used as an option on any current PS/2 system with an 80386SX, 80386 or i486 processor installed.

It wil support all current PS/2 displays. The XGA Adapter/A is optimized for Windows managers and graphic user interface applications.

IBM PS/2 Video Memory Expansion Option: This option provides an additional 512 KB of Video RAM (VRAM) for either the XGA Adapter/A or the XGA on the planar of the IBM Model 90 XP 486 system. This will increase both the performance of the video subsystem and provide 65,536 different colors for direct display.

IBM PS/2 External Storage Enclosure for SCSI Devices (3511-003): The PS/2 external SCSI storage enclosure provides external storage for all SCSI devices. It comes standard with a 320 MB SCSI hard disk installed. One PS/2 external SCSI storage enclosure can provide up to an additional 2.2 GB of storage for any PS/2 system with a SCSI adapter or SCSI adapter with cache installed.

IBM PS/2 400 MB SCSI Hard Disk Drive: This disk drive is a SCSI synchronous device with 11.5 ms average seek time, 1.35 MB/s data transfer rate and 128 KB look ahead buffer.

Appendix F. Remote IPL Reference Information

F.1 Remote IPL Startup Screen

The following sample screen shows all of the fields that appear as the workstation connects to the network. This information is only valid for a Model 55 LS equipped with the IBM Token-Ring 16/4 Network Adapter/A.

Note: If your Model 55 LS is using an IBM Token-Ring Network Adapter/A (4 Mbps only), refer to the *IBM Personal System/2 Token-Ring LAN Reference for Micro Channel Workstations*.

If your Model 55 LS is using an IBM Ethernet Adapter/A, refer to the *IBM Personal System/2 Ethernet LAN Reference for Micro Channel Workstations*.

If additional fields appear and remain on the screen, an error has occurred. Refer to the *IBM Personal System/2 Token-Ring LAN Reference for Micro Channel Workstations*.

```
ET-00:00:06
ID-166

BU-0000
AA-10005A6BFECA
AL-00 0008 A78064
BL-A33861C
MM-DA00 02
SR-DC00 16
OP-0000 04

RQ-0001
SF-0001
SN-0040
DS-0080
```

Figure 90. Remote IPL Startup Screen

Figure 91 gives a short description of these fields.

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Field	Description
ET	Elapsed time since the RPL module gained control of the workstation
ID	Identification of the adapter using the remote IPL function 167 - Primary token-ring adapter 168 - Secondary token-ring adapter
BU	Error during startup 0000 indicates successful adapter initialization
AA	Permanently encoded 12-digit hexadecimal address of the Token-Ring adapter
AL	Level of code on the Token-Ring adapter
BL	Level of code on the RPL module
MM	First four digits: Hexadecimal ROM address set for the adapter Last two digits: Interrupt level set for adapter
SR	First four digits: Hexadecimal shared RAM address set for the adapter Last two digits: Decimal shared RAM size in kilobytes (KB)
OP	First four digits: 0000 if adapter has successfully opened and connected to the LAN Last two digits: Adapter data rate in megabits per second (Mbps), either 16 or 04
RQ	Hexadecimal number of *Request Count Find* frames that have been transmitted
SF	Number of *Send File Request* frames that have been transmitted. A numer greater than 10 indicates that the file server has been found, but is not responding.
SN	This field indicates a value when the file server has responded to the workstations request.
DS	Data link control (DLC) status

Figure 91. Remote IPL Startup Screen Fields

Abbreviations

A

ABIOS. advanced basic input/output system

ADF. adapter description file

AIX. Advanced Interactive Executive

Alt. alternate (key on PS/2 keyboard)

ALU. arithmetic logic unit

ANSI. American National Standards Institute

ASCII. American National Standard Code for Information Interchange

AVE. auxillary video extension

B

BIOS. basic input/output system

bps. bits per second

BVE. base video extension

C

CBIOS. compatibility basic input/output system

CMOS. complementary metal oxide semiconductor

CSD. corrective service diskette

Ctrl-Alt-Del. control-alternate-delete (key sequence on PS/2 keyboard)

Ctrl-Alt-Ins. control-alternate-insert (key sequence on PS/2 keyboard)

Ctrl. control (key on PS/2 keyboard)

CTTY. change terminal type (DOS command)

D

DAC. digital-analog converter

DASD. direct access storage device

Del. delete (key on PS/2 keyboard)

DGS. diagnostics

DRAM. dynamic random access memory

G

GPI. graphics programming interface

H

Hz. Hertz (cycles per second)

I

IEEE. Institute of Electrical and Electronics Engineers (USA)

IML. initial microcode load

Ins. insert (key on PS/2 keyboard)

IPL. initial program load

K

KB. kilobyte (1024 byte)

KBps. kilobytes per second

Kb. kilobits (1024 bits)

Kbps. kilobits per second

L

LAN. local area network

M

MB. for disk storage: one million bytes (1,000,000 bytes)

MB. for memory storage: megabyte (1,048,576 bytes)

Mb. for memory storage: megabits (1,048,576 bits)

MBR. master boot record

MBps. megabytes per second

Mbps. megabits per second

MHz. Megahertz (Million cycles per second)

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N

NVRAM. non volatile random access memory

P

POS. programmable option select

POST. power on self test

PROM. programmable read only memory

R

RAM. random access memory

RIPL. remote initial program load

ROM. read only memory

RPL. remote program load

S

SCSI. small computer systems interface

SIMM. single in-line memory module

SPD. serializer/palette/DAC

V

VAC. Volt alternating current

VGA. video graphics array

VRAM. video random access memory

X

XGA. extended graphics array

Glossary

A

arbitration. A method with which multiple devices attached to a single bus can bid to get control of that bus.

asynchronous. A mode of data transfer across the SCSI Bus where each byte of data transferred must be acknowledged as received by the target before the next byte can be sent. Maximum transfer rate possible is 2 MBps.

B

blit. Block Pixel Transfer. The process of taking a rectangular array of pixels from a source location and transferring them to a destination location. This process often involves some manipulation of the pixels during the transfer.

boot. The process of starting up a personal system or PC.

Bus Master. An intelligent device that when attached to the Micro Channel bus can bid for and gain control of the Micro Channel bus to perform its specific task.

C

CD-ROM. Compact Disk Read Only Media is a disk that you can only read data from. Data cannot be written to CD-ROM.

cold boot. The procedure which initiates a Personal System after a power-on sequence. A full system self test is performed.

coprocessor. A microprocessor on an expansion board or planar that extends the address range of the main processor or adds specialized instructions to handle a particular category of operations.

D

DMA. Direct Memory Access. A method used to transfer data directly from device to system memory without using the main system processor.

firmware. Generic term for microcode. Usually resides in ROM, but initially created as program instructions. Although designed to remain unchanged, there are methods to modify it.

L

LIMulator. A program that emulates expanded memory by using extended memory or hard disk.

P

pel. Picture Element. The minimum item that can be displayed on a video display. See also pixel.

pixel. Picture Element. The minimum item that can be displayed on a video display. Also known as pel.

planar. That part of a personal system which contains the primary processor support components. May contain all or some of the following: the main processor, coprocessor, channel, parallel port, serial port, keyboard and mouse ports, memory controller and graphics array. Also known as motherboard.

PxBlt. Block Pixel Transfer. The process of taking a rectangular array of pixels from a source location and transferring them to a destination location. This process often involves some manipulation of the pixels during the transfer.

R

reboot. The process of restarting a personal system or PC.

S

SCSI. Stands for Small Computer Systems Interface. Defines the interface between an attachment feature and intelligent devices.

SCSI bus. A term used to describe the 50-Conductor cable that attaches intelligent devices to the SCSI attachment feature.

SCSI device. An intelligent device that is directly attached to the SCSI Bus. It conforms to the ANSI Standard X3.131-1986 for attached SCSI devices.

SCSI ID. A number configured on a SCSI device so that it can be accessed on the SCSI Bus. Each SCSI device has a unique SCSI ID number. It is in the range 0 t0 7.

synchronous. A mode of data transfer across the SCSI Bus where each byte of data transferred does not have to be acknowledged as received by the target device before the next byte can be sent. Maximum transfer rate possible 5 Mbps.

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T

terminator. A piece of hardware that must be attached to both ends of the 50-Conductor SCSI attachment cable (commonly known as the SCSI Bus).

warm boot. The procedure which initiates a Personal System. A limited system self test is performed. Can be invoked via the Crtl-Alt-Del keystroke combination.

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