Developer Note

Macintosh Performa 6400 Computer

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Contents

Figures and Tables

About This Note

This developer note describes the Apple Macintosh Performa 6400 computer and emphasizes features that are new or different from previous Macintosh models. It is intended to help experienced Macintosh hardware and software developers design compatible products. If you are unfamiliar with Macintosh computers or would simply like more technical information, you may wish to read the related technical manuals listed in the section "Supplemental Reference Documents."

Contents of This Note

The information is arranged in four chapters and an index:

- Chapter 1, "Introduction," summerizes of the features of the Macintosh Performa 6400 computer, describes the physical appearance, and lists the available configurations and options.
- Chapter 2, "Architecture," describes the internal organization of the computer. It includes a block diagram and descriptions of the main components of the logic board.
- Chapter 3, "I/O Features," describes the built-in input/output (I/O) devices and the external I/O ports. It also lists the external video monitors that can be used with the computer.
- Chapter 4, "Expansion Features," describes the expansion slots of the Macintosh Performa 6400 computer. This chapter provides guidelines for designing cards for the I/O expansion slot and brief descriptions of the expansion modules for the other slots.

Supplemental Reference Documents

To supplement the information in this developer note, developers should have copies of the appropriate Motorola reference books for the PowerPC™ 603e microprocessor. Software developers should have a copy of Motorola's *PowerPC Programmer's Reference Manual.* Hardware developers should have copies of Motorola's *PowerPC 603 RISC Microprocessor User's Manual.*

For additional information about the digital data format used in the video input module, refer to *Power Macintosh DAV Interface for PCI Expansion Cards.*

For information about the digital video interface, refer to the *SAA7140 Philips Desktop Video Handbook*.

Developers may also need copies of the appropriate Apple reference books. You should have the relevant books of the *Inside Macintos*h series. You should also have *Designing PCI Cards and Drivers for Power Macintosh Computers*. These books are available in technical bookstores and through the *Apple Developer Catalog*.

The Apple Developer Technology Services group also publishes technical notes which cover a variety of topics related to optimizing software and hardware performance on Macintosh computers. Technical notes can be found on the Reference Library Edition of the Developer CD and on the internet at http://www.devworld.com.apple.com, which is the Apple Developer World web site.

For More Information

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Conventions and Abbreviations

This developer note uses the following typographical conventions and abbreviations.

Typographical Conventions

New terms appear in **boldface** where they are first defined.

Computer-language text—any text that is literally the same as it appears in computer input or output—appears in `Courier` font.

Hexadecimal numbers are preceded by a dollar sign ($). For example, the hexadecimal equivalent of decimal 16 is written as $10.

Note
A note like this contains information that is interesting but not essential for an understanding of the text. ◆

IMPORTANT
A note like this contains important information that you should read before proceeding. ▲

Sidebar

Sidebars are for digressions—information that is not part of the main discussion. A sidebar may contain background information that is interesting to know, information about a related subject, or technical details that are not required reading.

Standard Abbreviations

When unusual abbreviations appear in this book, the corresponding terms are also spelled out. Standard units of measure and other widely used abbreviations are not spelled out. Here are the standard units of measure used in this developer note:

A	amperes	mA	milliamperes
dB	decibels	µA	microamperes
GB	gigabytes	MB	megabytes
Hz	hertz	MHz	megahertz
in.	inches	mm	millimeters
k	1000	ms	milliseconds
K	1024	µs	microseconds
KB	kilobytes	ns	nanoseconds
kg	kilograms	Ω	ohms
kHz	kilohertz	sec.	seconds
kΩ	kilohms	V	volts
lb.	pounds	W	watts

Here are other abbreviations used in this developer note:

$*n*	hexadecimal value *n*
AC	alternating current
ADB	Apple Desktop Bus
AV	audiovisual
AWACS	audio waveform amplifier and converter for sound
CD-ROM	compact-disk read-only memory
CLUT	color lookup table
DAV	digital audio video
DESC	digital video decoder and scaler
DIMM	dual inline memory module
DMA	dynamic memory access
DRAM	dynamic random-access memory
DVA	digital video application
EMI	electromagnetic interference
FPU	floating-point unit
IC	integrated circuit
IDE	integrated device electronics
IIC	inter-integrated circuit (an internal control bus)
I/O	input/output

IR	infrared
LS TTL	low-power Schottky TTL (a standard type of device)
MMU	memory management unit
MOS	metal-oxide semiconductor
NTSC	National Television Standards Committee (the standard system used for broadcast TV in North America and Japan)
NMI	nonmaskable interrupt
PAL	Phase Alternating Line system (the standard for broadcast TV in most of Europe, Africa, South America, and southern Asia)
PCI	Peripheral Component Interconnect
PDS	processor-direct slot
PWM	pulse-width modulation
RAM	random-access memory
RGB	a video signal format with separate red, green, and blue components
RISC	reduced instruction set computing
RMS	root-mean-square
ROM	read-only memory
SANE	Standard Apple Numerics Environment
SCSI	Small Computer System Interface
SCC	serial communications controller
SECAM	the standard system used for broadcast TV in France and the former Soviet countries
SIMM	single inline memory module
S-video	a type of video connector that keeps luminance and chrominance separate; also called a Y/C connector
SWIM	Super Woz Integrated Machine, a custom IC that controls the floppy disk interface
TTL	transistor-transistor logic (a standard type of device)
VCR	video-cassette recorder
VLSI	very large scale integration
VRAM	video RAM; used for display buffers
Y/C	a type of video connector that keeps luminance and chrominance separate; also called an S-video connector
YUV	a video signal format with separate luminance and chrominance components

CHAPTER 1

Introduction

The Macintosh Performa 6400 computer is a new Macintosh model that incorporate a PowerPC™ 603e microprocessor running at 160, 180, and 200 MHz, a second-level cache expansion slot, two Peripheral Component Interconnect (PCI) card expansion slots, enhanced AV features (audio and video input and output), and a new PCI-based communications slot (comm slot II). The Macintosh Performa 6400 computer is housed in a new tower enclosure, featuring easy access, an expansion bay, and a built-in subwoofer.

Summary of Features

Here is a summary of the hardware features of the Macintosh Performa 6400 computer.

- Microprocessor: PowerPC 603e microprocessor running at 160, 180, and 200 MHz.
- RAM: 8 MB soldered to the main logic board; expandable to 136 MB using 168-pin JEDEC-standard DIMM devices. Two DIMM slots are provided for DRAM expansion.
- ROM: 4 MB soldered on main logic board; 64-bit ROM data bus width.
- Cache: 256 KB second-level (L2) cache on a 160-pin DIMM card (optional).
- Video display modes supported on built-in monitor port: 640 by 480 and 800 by 600 @ 16 bits per pixel, 832 by 624 and 1024 by 768 @ 8 bits per pixel; 1 MB DRAM frame buffer on the main logic board.
- Video input: optional video-in card allows video input through RCA and S-Video connectors; a 60-pin DAV (digital audio video) connector on the video-in card supports an optional video card for real-time video display, capture, and overlay. An adapter cable provides backward compatibility with DVA (digital video application) cards designed for the Power Macintosh 5200 computer.
- Video output: optional DAV PCI cards provide video output.
- Sound: 16 bits/channel stereo sound input and 16 bits/channel stereo sound ouput using SRS® (surround retrieval system), an external jack for sound in, a front jack for headphones, a rear jack for stereophonic speakers, and one built-in speaker/subwoofer. SRS stereo surround sound can be turned on or off through the Sound panel of the Monitors and Sound control panel. SRS is incorporated in the design under license from SRS Labs, Inc.
- TV/FM receiver: optional internal TV/FM tuner with F-type antenna connector.
- Remote control: infrared for TV/FM tuner.
- Hard disks: one internal 3.5-inch ATA (IDE) hard disk with 2.4 GB or larger capacity and an external SCSI port for additional SCSI devices. PIO, singleword DMA, and multiword DMA data transfers are supported.
- Expansion bay: allows addition of an internal 5.25-inch SCSI device.
- Floppy disk: one internal 1.4 MB Apple SuperDrive.
- CD-ROM drive: internal 8X-speed CD-ROM drive; the expansion bay supports the addition of another CD-ROM drive.

- Processor bus: 64-bit wide, 40 MHz, supporting split address and data tenures.
- Standard Macintosh I/O ports: two serial ports, sound input and output jacks, a SCSI port, and an ADB port.
- GeoPort: supported on both the modem and printer port.
- PCI-based communications slot: a 112-pin connector accepts an optional modem or ethernet interface. This is the same type of communications slot found in the Power Macintosh 5400 computer.
- PCI card expansion slots: accepts two 7-inch PCI cards; 15 watts maximum on each card.
- Power switch: soft power controlled from keyboard and remote control.
- Voltage switch: allows selection of either 115 for voltages of 100-130 V or 230 for voltages of 200-230 V depending on the voltage you will be connecting to. The voltage selection must be set manually.
- Case design: the Macintosh Performa 6400 has a new tower case design with an easy to remove front panel and expansion bay panel. The tower case also incorprates a built-in subwoofer.
- Fan speed control: the speed of the fan is thermally controlled and is automatically set to the lowest possible speed to minimize noise. The fan speed varies according to the temperature inside the enclosure.
- Energy saving: sleep, startup, and shutdown scheduling can be controlled with the Energy Saver control panel.

Comparison With Power Macintosh 5400 Computer

The Macintosh Performa 6400 computer uses a main logic board nearly identicle to the logic board in the Power Macintosh 5400. Table 1-1 compares the features of these computers.

Table 1-1 Comparison with the Power Macintosh 5400 computer

Features	Power Macintosh 5400	Macintosh Performa 6400
Processor type	PowerPC 603e	PowerPC 603e
Processor speed	120 MHz or faster	160 MHz, 180 MHz, and 200 MHz
Cache	256 KB L-2 cache (optional)	256 KB L-2 cache (optional)
Amount of RAM	8 MB–136 MB	16 MB–136 MB
RAM expansion	2 168-pin DIMMs	2 168-pin DIMMs
Memory bus	64 bits, 40 MHz	64 bits, 40 MHz

continued

Table 1-1 Comparison with the Power Macintosh 5400 computer (continued)

Features	Power Macintosh 5400	Macintosh Performa 6400
Video RAM	1 MB (DRAM)	1 MB (DRAM)
Video input	Optional card for video input, capture, and overlay	Optional card for video input, capture, and overlay
Video output	Built-in 15-inch display; Optional mirror connector supports an external monitor operating in mirror mode; built-in video supports up to 832-by-624 pixel resolution at 8 bits per pixel, VGA and SVGA	Built-in video supports up to 1024-by-768 pixel resolution at 8 bits per pixel, VGA and SVGA
Sound capabilities	8 or 16 bits/channel; stereo in, stereo record, stereo out; SRS surround-sound mode	8 or 16 bits/channel; stereo in, stereo record, stereo out; SRS surround-sound mode, built-in subwoofer with volume control
Remote control	Built-in IR receiver for optional TV tuner card	Built-in IR receiver for optional TV/FM tuner card; IR port does not support IRTalk
Floppy disk drive	1, internal	1, internal
ADB ports	1	1
Internal hard disk	1 (IDE)	1 (IDE)
Internal CD-ROM	optional	1
Internal SCSI expansion bay	none	1, for one 5.25-inch SCSI device
External SCSI ports	1	1
Communications slot	1, for optional modem or Ethernet interface (PCI bus configuration)	1, for optional modem or Ethernet interface (PCI bus configuration)
Expansion slot	1 PCI I/O slot for 7-inch PCI card	2 PCI I/O slots for 32-bit 7-inch PCI cards
DMA I/O	10 DMA channels	10 DMA channels
Serial ports	2, LocalTalk and GeoPort supported	2, LocalTalk and GeoPort supported

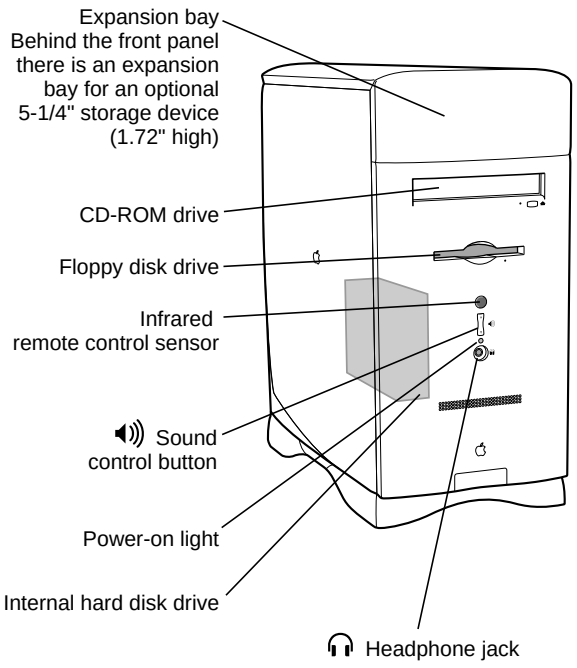
External Features

The Performa 6400 computer has a new tower design featuring more clearance at the bottom of the enclosure to provide better cooling and enhance the low frequency sound quality of a small built-in subwoofer. The tower also includes an expansion bay at the top of the enclosure for addtional SCSI devices.

Front View

Figure 1-1 is a front view of a Performa 6400 computer. The front view shows the location of the expansion bay, the openings for the CD-ROM drive and floppy disk, the CD-ROM open and close button, the IR sensor for the remote control, the push button that controls the sound level, the power-on light, and the headphone jack.

Figure 1-1 Front view of the computer

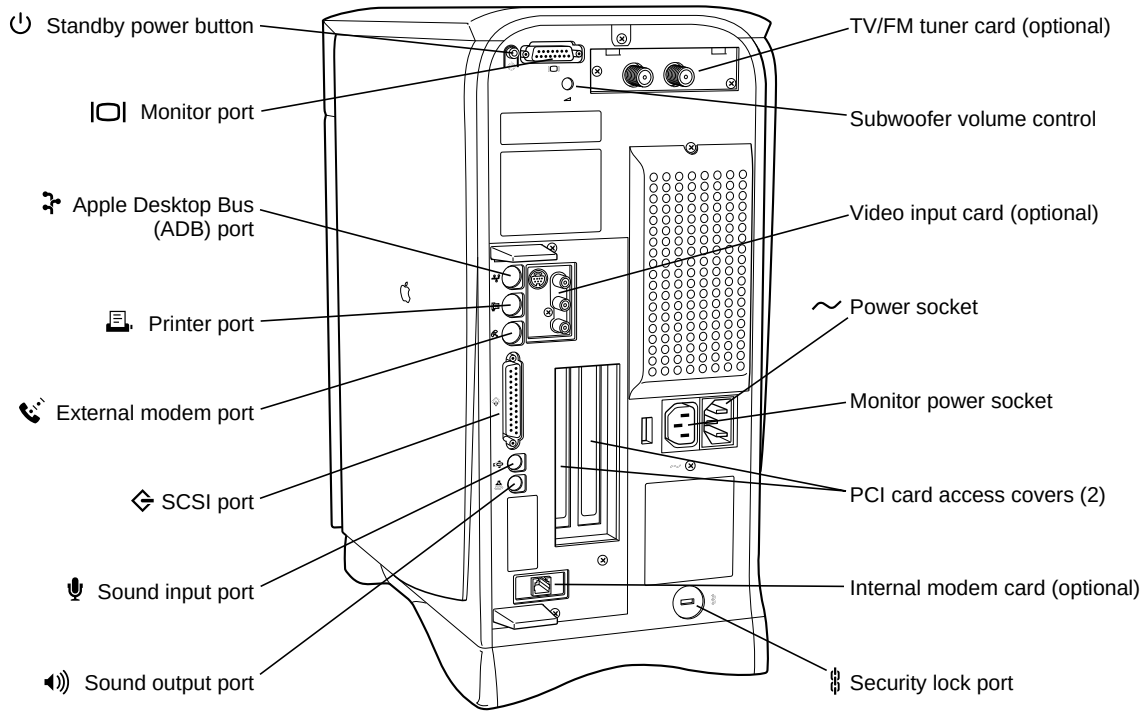


Back View

The back panel includes the power socket, the monitor power socket, the standby power button, the I/O ports, and the openings for I/O access to the expansion modules: the I/O expansion card, the communications card, and the video input card.

Figure 1-2 shows the back view of a Performa 6400 computer.

Figure 1-2 Back view of the computer



Access to the Logic Board

The logic board can be removed from the case so that the user can add expansion RAM, L2 cache, or I/O expansion cards. The rear fence of the logic board is connected to the back panel. The back panel is secured to the computer chassis by two screws at the side of the plastic tabs on the back panel. After removing the two screws, you can gently pull on the two tabs to remove the logic board from the internal logic board connector and chassis.

Volume Control

The Macintosh Performa 6400 computer has a push button on the front panel to control the sound volume of the internal speaker. Sound volume can also be controlled with the Sound component of the Monitors and Sound control panel. A knob located below the monitor port on the back of the computer controls the low frequency volume of the subwoofer.

Power On and Off

The user can turn the power off and on by pressing one of two buttons:

- the Power key on the keyboard
- the Power key on the remote control (with TV/FM tuner installed)

If files are still open when the user attempts to turn off the computer by using either one of the Power keys or the Shut Down menu item, the system displays an alert box warning the user that files are open and should be closed to avoid loss of data.

Optional Features

Several features of the Macintosh Performa 6400 computer are implemented as plug-in modules available either as a configuration option at the time of purchase or as a later upgrade. The modules are designed so that they can be installed by the user.

TV and FM Radio Tuner

The TV and FM radio tuner module turns the computer into a television and FM radio receiver, complete with remote control. The features of the TV tuner module are the same as those for the TV tuner in the Power Macintosh 5400 computers. The TV picture is in its own window on the desktop, and the TV signal is carried in YUV format for improved picture clarity.

The features of the TV tuner module are

- the ability to remotely tune 181 broadcast and cable channels (U.S. version)
- a coaxial connector for TV antenna or cable input (F-type connector in U.S. and Japanese versions; IEC-type connector in Europe)
- the TV picture is in a resizable and movable window
- YUV format for improved clarity (see sidebar)
- support for closed captioning and teletext
- software password protection
- automatic and manual channel programming
- a single remote control for TV, FM radio, and for playback of audio CDs

The features of the FM radio tuner are

- the ability to receive and display FM radio frequencies
- the ability to scan and search stations up and down the frequency spectrum
- step frequency
- a DX mode to tune out harmonic spillover from other stations
- a stereo/mono station indicator
- preset station programming

The TV and FM radio tuner module is available in versions for NTSC, PAL, and SECAM television systems.

The TV picture appears in its own window. The default size of the window is 320-by-240 pixels. The user can resize the TV window up to a maximum size of 640-by-480 pixels or down to a minimum size of 160-by-120 pixels. The resolution of the TV picture does not increase at the larger window sizes; instead, the image is expanded by either doubling the size of the pixels or by two-dimensional linear interpolation.

The TV tuner module works in conjunction with the video input module, which converts the video data into digital YUV format and stores it in the display buffer.

The TV tuner comes with a remote control device similar to the one used with the Macintosh TV computer. The user can switch channels either by using the remote control or by typing the channel numbers on the keyboard. The user can toggle between the current and previous channel by pressing the Tab key on the keyboard. Each time the channel changes, the computer displays the channel name (assigned by the user) on the picture in the video window.

The user can customize the operation of the TV tuner by adding or removing TV channels that are unused or unwanted. The computer can program the channels automatically, scanning through all available channels and disabling those that do not have a valid signal. When the user then scans for the next channel by using the remote control or the Tab key on the keyboard, the tuner skips the disabled channels.

The software that supports the TV tuner module is an application called Apple Video Player. The application includes password protection for the disabled channels. Parents might use this feature to prevent children from watching undesirable channels.

Why YUV Looks Clearer

You may be wondering how the digital YUV format used in the Macintosh Performa 6400 computer provides a clearer TV picture than the RGB format used in the Macintosh TV computer—after all, picture information can be freely converted between the two formats. The difference is due to the way the bits are allocated. The RGB format used in the Macintosh TV is a 16-bit format using 5 bits each for red, green, and blue, with the remaining bit unused. The YUV format used in the Macintosh Performa 6400 computer is also a 16-bit format, with 8 bits for the Y (luminance) channel and 8 bits for the U and V (chrominance) channels to share by multiplexing. The YUV format looks clearer because the YUV format carries more levels of luminance information.

The software allows the user to capture or freeze a single frame of video or record a segment of video as a QuickTime Movie. The TV window cannot be resized while the computer is recording a movie.

Video Input

The optional video input card accepts video from an external source and displays the video in a window on the computer's display. The features of the video input card are

- acceptance of video input in NTSC, PAL, or SECAM format
- connectors for stereo sound, composite video, and S-video (Y/C)
- video display in a 320-by-240 pixel window
- pixel expansion for 640-by-480 pixel maximum display
- video overlay capability
- YUV format for digital video input
- a digital video connector (DAV) for adding a video processor on an expansion card

The video input card provides AV features similar to those of the Macintosh Quadra 660AV, with one key improvement. Whereas the Macintosh Quadra 660AV digitizes color video using a 16-bit RGB format, the video input card uses a digital YUV format. Because a standard television signal has more information in its chrominance channel than in its luminance channels, digitizing the video signal as YUV format results in a clearer picture.

The video input card can accept video input from either an external device such as a VCR or camcorder or from the internal TV tuner module. The external device can be connected to the video input card either through the composite video connector or the S-video connector.

The default window size is 320-by-240 pixels; the user can resize the window up to 640-by-480 pixels—the full screen on a 14-inch monitor. The large image uses pixel expansion of the 320-by-240 pixel image.

Note
The video input card does not work on all video monitors. It will work with 800-by-600 pixel monitors that have a 60 Hz refresh rate, but not with that size monitor at a 72 Hz refresh rate. In addition, 60 Hz monitors at 800-by-600 pixels must be set to 8 bits per pixel or less. ◆

The video input card plugs into a dedicated slot on the main logic board. The slot connector is a 60-pin microchannel connector. The module fits only its proper slot and only in the proper orientation so that the user can safely install the video input card.

The video input card has a separate connector called the DAV (digital audio video) connector. The DAV connector makes the digitized video data available to optional DAV cards which may be plugged into a PCI I /O expansion slot. Such a card can contain a hardware video compressor or other video processor. Video data cannot be output to

other external devices, such as a VCR, without an optional video out card. For more information, see the section “The DAV Connector” beginning on page 53.

Communications

The main logic board in the Macintosh Performa 6400 computer has a communications slot that allows the computer to support a communications module without occupying one of the PCI expansion slots. A communications card can be installed by either the user or the dealer.

The communications slot in the Macintosh Performa 6400 computer uses a PCI bus, rather than the 680xx bus. The following cards are supported:

- the 10BaseT (twisted pair) ethernet card
- the 10Base2 (thin coax) ethernet card
- the AAUI (Apple standard) ethernet card
- the 28.8 bps fax/data modem card

Expansion Bay

The expansion bay in the tower enclosure includes data, and power connectors for adding another SCSI device. The bay is configured for 5.25-inch devices. However, with modification to the carrier, a 3.5-inch SCSI device could be installed. For additional information about the expansion bay mechanical and electrical characteristics see “Expansion Bay for SCSI Devices” beginning on page 66.

Compatibility Issues

The Macintosh Performa 6400 computer incorporates several changes from earlier desktop models. This section describes key issues you should be aware of to ensure that your hardware and software work properly with this new model.

Communications Slot

The communications slot in the Macintosh Performa 6400 computer is a PCI bus compatible slot (comm slot II) and is in general not compatible with communication cards for the Macintosh LC family of computers, the Macintosh Quadra 630 computer, or cards that operate in the communications slot (comm slot I) in Power Macintosh 5200 and 6200 computers. The exception is that cards that do not use the bus, such as serial modem cards, can be designed to work in both comm slot I and comm slot II. For more information about designing serial modem cards that are compatible with both communications slots, see “The PCI Bus Communications Slot” beginning on page 59.

DAV Slot

The digital audio video (DAV) slot in the Macintosh Performa 6400 computer is compatible with Power Macintosh 5400, 7600, 8500, and 9500 computers. However, it is not compatible with the DAV slot in the Macintosh Quadra 660AV, Macintosh Quadra 840AV, Power Macintosh 6100, 7100, and 8100 computers, nor is it direct plug-in compatible with the DVA (digital video application) slot in the Power Macintosh 5200 and 6200 computers. The DAV slot is a 60-pin slot with additional signals and capabilities. A 40-to-60 pin adapter cable provides backward compatibility with DVA cards developed for the Power Macintosh 5200 and 6200 computers. For additional information about the DAV slot, see “The DAV Connector” beginning on page 53.

Expansion Slots

The I/O expansion slots in the Macintosh Performa 6400 computer are PCI expansion slots and are not compatible with PDS expansion cards for the Macintosh LC family of computers, the Macintosh Quadra 630 computer, or with cards that operate in the I/O expansion slot in Power Macintosh 5200 and 6200 computers.

Cards that are incompatible with the I/O expansion slot include

- cards with drivers that include incompatible code. Some drivers that do not follow Apple Computer’s programming guidelines won’t work on machines that use the PowerPC 603 microprocessor. For example, some of those drivers write directly to the cache control register in an MC68030. Such code won’t work on a PowerPC 603 microprocessor.
- cards with drivers that include code to check the `gestaltMachineType` value and refuse to run on a newer CPU. The idea is to protect users by refusing to run on a machine that the cards haven’t been tested on. Such cards have compatibility problems with all new Macintosh models.

RAM Expansion

The Macintosh Performa 6400 computer uses JEDEC-standard 168-pin DIMMs (dual inline memory module) DRAM cards rather than the 72-pin SIMM DRAM cards used in the Power Macintosh 5200 and 6200 computers. For information about DRAM DIMM configurations supported on the Macintosh Performa 6400 computer, see “RAM DIMMs” beginning on page 42.

DRAM DIMM developers should note that the PSX memory controller on the main logic board of the Macintosh Performa 6400 computer does not provide support for 4 M by 4-bits (12 by 10 addressing) or 1 M by 16-bits (12 by 8 addressing) DRAM devices.

RAM DIMM Dimensions

Apple Computer has made the following change to the mechanical specification for the RAM DIMM.

IMPORTANT

The JEDEC MO-161 specification shows three possible heights for the 8-byte DIMM. For Power Macintosh computers, developers should use only the shortest of the three: 1.100 inches. Taller DIMMs put excessive pressure on the DIMM sockets due to mechanical interference inside the case. ▲

Cache Expansion

On the Macintosh Performa 6400 computer, the optional 256K L2 cache includes an integrated cache controller. Apple does not support development of third-party cache cards for these computer models. The 160-pin cache expansion slot is the same as the cache expansion slot in the Power Macintosh 5400.

ATA (IDE) Hard Disk

The internal hard disk in the Macintosh Performa 6400 computer is an ATA (IDE) drive, not a SCSI drive. This could cause compatibility problems for hard disk utility programs. The system software release for the Macintosh Performa 6400 computer includes version 3.0 of the ATA Manager and supports PIO, singleword DMA, and multiword DMA data transfers. For more information about the software that controls the ATA drive, see the Power Macintosh 5400 Developer Note.

Sound I/O Specifications

The sound specifcations for the built-in sound ports on the Performa 6400 are:

- 16-bit stereo output featuring SRS 3D surround sound technology
- sample rates of 11.025, 22.05, and 44.1 kHz
- input line level: 2 Vpp max. into 10 kilohms impedence; signal to noise ratio 75 dB, 80 dB typical (A-weighted, 2 Vpp output, 1 kHz, digital record and playback, sound input port to sound output port, with SRS disabled)
- frequency response: 20 Hz-18 kHz (-3dB relative to 1 kHz under the same conditions as the SNR (signal-to-noise ratio) measurement)

Power Supply

The power supply in the Macintosh Performa 6400 computer is not self configuring for different input voltages. The voltage switch on the Performa 6400 computer is delivered preconfigured for the input voltage of the region in which the unit is originally purchased. If the computer is moved to another location where the input voltage is different, a voltage switch must be adjusted to accomodate the voltage change. The switch has two positions that support voltage ranges of 100 to 130 V or 220 to 270 V.

CHAPTER 2

Architecture

This chapter describes the architecture of the Macintosh Performa 6400 computer. It describes the major components of the main logic board: the microprocessor, the custom ICs, and the display RAM. It also includes a simplified block diagram.

Block Diagram and Main ICs

The architecture of the Macintosh Performa 6400 computer is based on the PowerPC 603e. Figure 2-1 shows the system block diagram. The architecture of the Macintosh Performa 6400 computer is based on two buses: the processor bus and the PCI bus. The processor bus connects the microprocessor, video, cache, and memory; the PCI bus connects the expansion slots and the I/O devices.

PowerPC 603e Microprocessor

The Macintosh Performa 6400 computer uses a PowerPC 603e microprocessor running at 160, 180, and 200 MHz. The principle features of the PowerPC 603e microprocessor include

- full RISC processing architecture
- parallel processing units: two integer and one floating point
- a branch manager that can usually implement branches by reloading the incoming instruction queue without using any processing time
- an internal memory management unit (MMU)
- 32 KB of on-chip cache memory (16 KB each for data and instructions)

For complete technical details, see the Motorola *PowerPC 603 RISC Microprocessor User's Manual.* This book is listed in "Supplemental Reference Documents," in the preface.

Memory Subsystem

The memory subsystem of the Macintosh Performa 6400 computer consists of ROM and an optional second-level (L2) cache, in addition to the internal cache memory of the PowerPC 603e microprocessor. The PSX custom IC provides burst mode control to the cache and ROM.

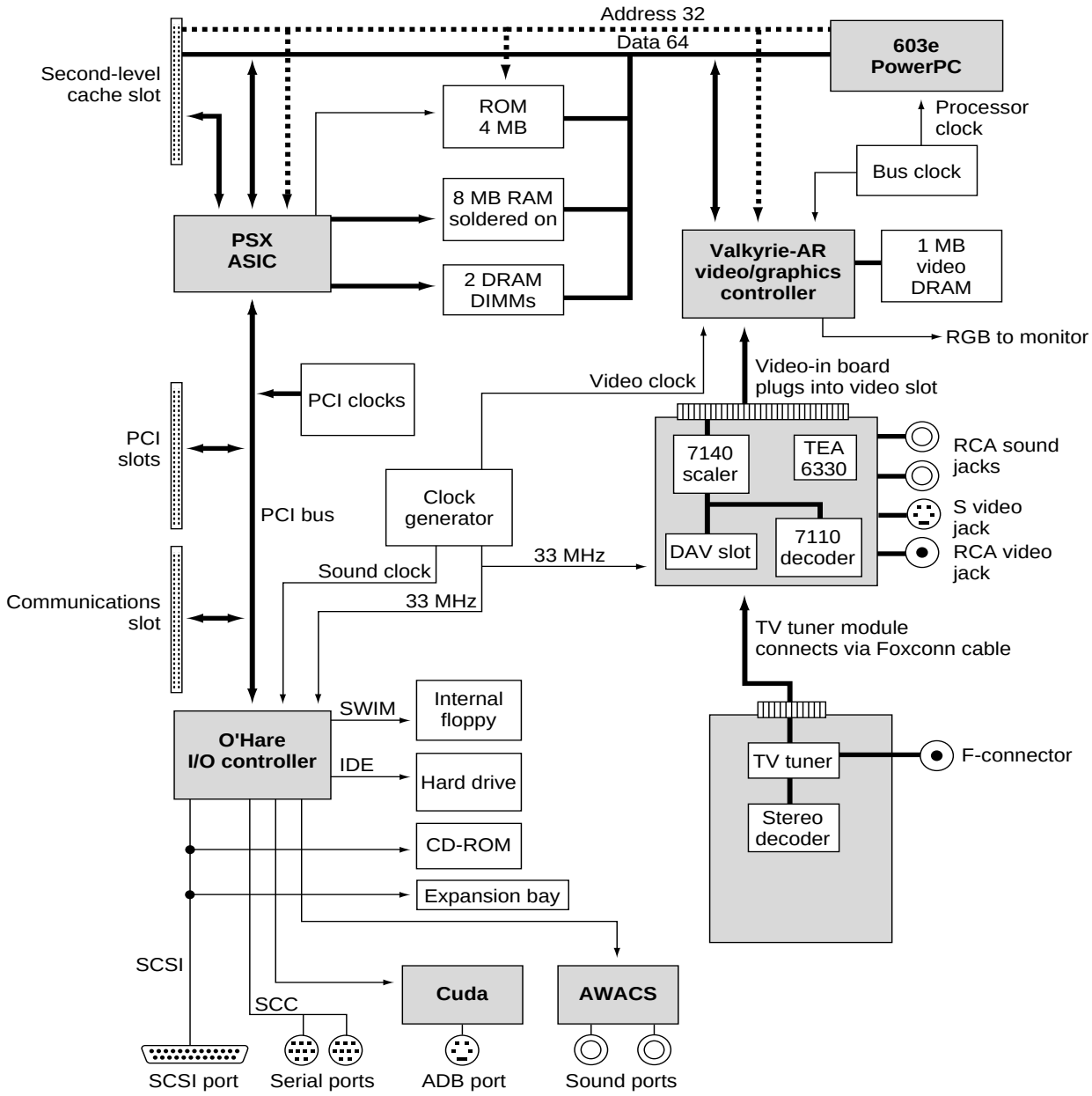
ROM

The ROM consists of 4 MB of masked ROM soldered to the main logic board.

Second-Level Cache (Optional)

The optional second-level (L2) cache consists of 256 KB of high-speed RAM on a 160-pin DIMM card, which is plugged into a 160-pin edge connector on the main logic board.

Figure 2-1 System block diagram



System RAM

The Macintosh Performa 6400 computer has 8 MB of DRAM memory soldered on the main logic board. All RAM expansion is provided by DRAM devices on 8-byte JEDEC-standard DIMMs (dual inline memory modules). Two 168-pin DIMM sockets are used for memory expansion. Available DIMM sizes are 8, 16, 32, and 64 MB. The DIMM sockets support both single- and double-sided DRAM modules. The PSX custom IC provides memory control for the system RAM.

Custom ICs

The architecture of the Macintosh Performa 6400 computer is designed around five large custom integrated circuits:

- the PSX memory controller and PCI bridge
- the O'Hare I/O subsystem and DMA engine
- the AWACS sound processor
- the Cuda ADB controller
- the Valkyrie-AR video subsystem

The computer also uses several standard ICs that are used in other Macintosh computers. This section describes only the custom ICs.

PSX IC

The PSX IC functions as the bridge between the PowerPC 603e microprocessor and the PCI bus. It provides buffering and address translation from one bus to the other.

The PSX IC also provides the control and timing signals for system cache, ROM, and RAM. The memory control logic supports byte, word, long word, and burst accesses to the system memory. If an access is not aligned to the appropriate address boundary, PSX generates multiple data transfers on the bus.

Memory Control

The PSX IC controls the system RAM and ROM and provides address multiplexing and refresh signals for the DRAM devices. For information about the address multiplexing, see "RAM Address Multiplexing" on page 46.

PCI Bus Bridge

The PSX IC acts as a bridge between the processor bus and the PCI expansion bus, converting signals on one bus to the equivalent signals on the other bus. The PCI bridge functions are performed by two converters. One accepts requests from the processor bus and presents them to the PCI bus. The other converter accepts requests from the PCI bus and provides access to the RAM and ROM on the processor bus.

The PCI bus bridge in the PSX IC runs asynchronously so that the processor bus and the PCI bus can operate at different rates. The processor bus operates at a clock rate of 40 MHz and the PCI bus operates at 33 MHz.

The PCI bus bridge generates PCI parity as required by the PCI bus specification, but it does not check parity or respond to the parity error signal.

Big-Endian and Little-Endian Bus Addressing

Byte order for addressing on the processor bus is big endian, and byte order on the PCI bus is little endian. The bus bridge performs the appropriate byte swapping and address transformations to translate between the two addressing conventions. For more information about the translations between big-endian and little-endian byte order, see Part One, "The PCI Bus," in *Designing PCI Cards and Drivers for Power Macintosh Computers.*

Processor Bus to PCI Bus Transactions

Transactions from the processor bus to the PCI bus can be either burst or non burst. Burst transactions are always 32 bytes long and are aligned on cache-line or 8-byte boundaries. In burst transactions, all the bytes are significant. Burst transactions are used by the microprocessor to read and write large memory structures on PCI devices.

Note
For the processor to generate PCI burst transactions, the address space must be marked as cacheable. Refer to *Macintosh Technote Number 1008, Understanding PCI Bus Performance,* for details. ◆

Non burst transactions can be of arbitrary length from 1 to 8 bytes and can have any alignment. Non burst transactions are used by the processor to read and write small data structures on PCI bus devices.

PCI Bus to Processor Bus Transactions

For transactions from the PCI bus to the processor bus, the bridge responds only to PCI bus memory commands and configuration commands. On the processor bus, the bridge generates a burst transaction or a non burst transaction depending on the type of command and the address alignment. For Memory Write and Invalidate commands that are aligned with the cache line, the bridge generates a burst write transaction. Similarly, for Memory Read Line and Memory Read Multiple commands whose alignment is less than three-quarters through a cache line, the bridge generates a burst read transaction. The maximum burst read or burst write transaction allowed by the bridge is 32 bytes—8 PCI beats.

Commands other than those mentioned here are limited to two beats if aligned to a processor bus doubleword boundary and to one beat otherwise.

O'Hare IC

The O'Hare IC is based on the Grand Central IC present in the Power Macintosh 7500 computer. It is an I/O controller and DMA engine for Power Macintosh computers using

the PCI bus architecture. It provides power management control functions for Energy Star–compliant features included in the Macintosh Performa 6400 computer. The O'Hare IC is connected to the PCI bus and uses the 33 MHz PCI bus clock.

The O'Hare IC includes circuitry equivalent to the IDE, SCC, SCSI, sound, SWIM3, and VIA controller ICs. The functional blocks in the O'Hare IC include the following:

- support for descriptor-based DMA for I/O devices
- system-wide interrupt handling
- a SWIM3 floppy drive controller
- SCSI controller (MESH based)
- SCC serial I/O controller
- IDE hard disk interface controller
- sound control logic and buffers

The O'Hare IC provides bus interfaces for the following I/O devices:

- Cuda ADB controller IC (VIA1 and VIA2 registers)
- AWACS sound input and output IC
- 8 KB non volatile RAM control

The SCSI controller in the O'Hare IC is a MESH controller. DMA channels in the O'Hare IC are used to support data transfers. In the Macintosh Performa 6400 computer, the clock signal to the SCSI controller is 45 MHz.

The O'Hare IC also contains the sound control logic and the sound input and output buffers. There are two DMA data buffers—one for sound input and one for sound output—so the computer can record sound input and process sound output simultaneously. The data buffer contains interleaved right and left channel data for support of stereo sound.

The SCC circuitry in the O'Hare IC is an 8-bit device. The `PCLK` signal to the SCC is an 24.5 MHz clock. The SCC circuitry supports GeoPort and LocalTalk protocols.

AWACS Sound IC

The audio waveform amplifier and converter (AWACS) is a custom IC that combines a waveform amplifier with a 16-bit digital sound encoder and decoder (codec). It conforms to the IT&T *ASCO 2300 Audio-Stereo Codec Specification* and furnishes high-quality sound input and output. For information about the operation of the AWACS IC, see Chapter 3 of Developer Note: *Power Macintosh Computers,* available on the developer CD-ROM and as part of *Macintosh Developer Note Number 8.*

Cuda IC

The Cuda IC is a custom version of the Motorola MC68HC05 microcontroller. It provides several system functions, including

- the ADB interface
- management of system resets
- management of the real-time clock
- on/off control of the power supply (soft power)
- the programming interface to devices on the IIC (interintegrated circuit) bus

The devices on the IIC bus include the AWACS sound IC, the digital video decoder and scaler (DESC) on the video input module, and the Cyclops IC, which is the controller for the remote control receiver. The computer reads and writes status and control information to those devices by commands to the Cuda IC.

Valkyrie-AR IC

The Valkyrie-AR IC is a custom IC containing the logic for the video display. It includes the following functions:

- display memory controller
- video CLUT (color lookup table)
- video DAC (digital-to-analog converter)

A separate data bus handles data transfers between the Valkyrie-AR IC and the display memory. The display memory data bus is 32 bits wide, and all data transfers consist of 32 bits at a time. The Valkyrie-AR IC breaks each 32-bit data transfer into several pixels of the appropriate size for the current display mode—4, 8, or 16 bits per pixel. The Valkyrie-AR IC does not support 24 bits per pixel.

To keep up with the large amount of data that must be transferred into and out of the display memory, the Valkyrie-AR IC has several internal buffers. Besides input and output buffers for display data, the Valkyrie-AR IC also has a buffer for both addresses and data being sent from the main processor to the display. That buffer can hold up to four transactions, allowing the main processor to complete a write instruction to the display memory and continue processing without waiting for some other transaction that might be taking place on the display memory bus.

The CLUT in the Valkyrie-AR custom IC provides color palettes for 4-bit and 8-bit display modes. In 16-bit display mode, the CLUT is used to provide gamma correction for the stored color values. With a black-and-white or monochrome display mode, all three color components (R, G, and B) are the same.

The Valkyrie-AR IC uses several clocks. Its transactions with the CPU are synchronized to the system bus clock. Data transfers from the frame-buffer DRAM are clocked by the MEM_CLK signal, which runs at 60 MHz. Data transfers to the CLUT and the video output are clocked by the dot clock, which has a different rate for different display monitors.

For more information about the interaction between the Valkyrie-AR IC, the display memory, and the main processor, see the section “Display RAM.”

Display RAM

The display memory in the Macintosh Performa 6400 computer is separate from the main memory. To reduce the cost of the computer, the display memory is implemented with DRAM devices instead of more expensive VRAM devices. The display memory consists of 1 MB of 60 nanosecond (ns) DRAM devices configured to make a 32-bit data bus. The display memory cannot be expanded.

The display memory contains three separate frame buffers. The first frame buffer holds the graphics data—the display that is generated by the computer. The other two frame buffers hold video data from the video input module. The video data frame buffers are used alternately: while one is supplying data to be sent to the video monitor, the other is receiving the next frame of video input.

The display data generated by the computer can have pixel depths of 4, 8, or 16 bits for monitors up to 800-by-600 pixels and 4 or 8 bits for larger monitors up to 1024-by-768 pixels. Data from the video input module is always stored and transferred at 16 bits per pixel. The video frame buffers support live video in a 320-by-240 pixel frame at 30 frames per second.

Note
The Macintosh Performa 6400 computer cannot display live video from the video-in module on monitor sizes larger than 800-by-600 pixels. Apple Computer, Inc., does not recommend the use of such monitors for these applications. ◆

The Macintosh Performa 6400 computer can display video in a window inside the computer graphics display. The Valkyrie-AR IC has registers that contain the starting location of the video window within the display, the starting address of the video data in the video buffer, and the size of the video window.

CHAPTER 3

I/O Features

This chapter describes both the built-in I/O devices and the interfaces for external I/O devices. It also describes the types of external video monitors that can be used with the Macintosh Performa 6400 computer.

Serial I/O Ports

The Macintosh Performa 6400 computer has two serial ports, one for a printer and one for a modem. Both serial ports have 9-pin mini-DIN sockets that accept either 8-pin or 9-pin plugs. Both serial ports support the GeoPort serial protocol. Figure 3-1 shows the mechanical arrangement of the pins on the serial port sockets; Table 3-1 shows the signal assignments.

Figure 3-1 Serial port sockets

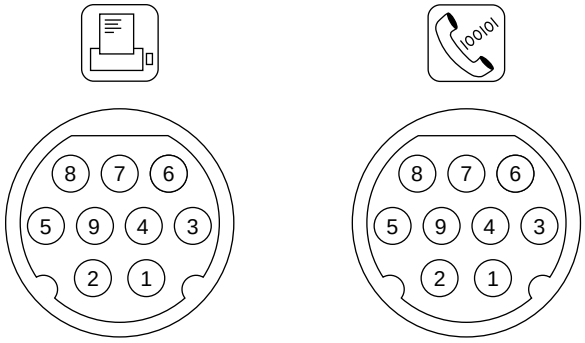


Table 3-1 Serial port signals

Pin	Name	Signal description
1	HSKo	Handshake output
2	HSKi	Handshake input (external clock on modem port)
3	TxD–	Transmit data –
4	Gnd	Ground
5	RxD–	Receive data –
6	TxD+	Transmit data +
7	GPi	General-purpose input (wakeup CPU or perform DMA handshake)
8	RxD+	Receive data +
9	+5V	+5 volts to external device (100 mA maximum)

Pin 9 on each serial connector provides +5 V power from the ADB power supply. An external device should draw no more than 100 mA from that pin. The total current available for all devices connected to the +5 V supply for the ADB and the serial ports is 500 mA. Excessive current drain will cause a fuse to interrupt the +5 V supply; the fuse automatically resets when the load returns to normal.

Both serial ports include the GPi (general-purpose input) signal on pin 7. The GPi signal for each port connects to the corresponding data carrier detect input on the SCC portion of the O'Hare custom IC, described in Chapter 2. On serial port A (the modem port), the GPi line can be connected to the receive/transmit clock (RTxCA) signal on the SCC. That connection supports devices that provide separate transmit and receive data clocks, such as synchronous modems. For more information about the serial ports, see *Guide to the Macintosh Family Hardware,* second edition.

ADB Port

The Apple Desktop Bus (ADB) port on the Macintosh Performa 6400 computer is functionally the same as on other Macintosh computers.

The ADB is a single-master, multiple-slave serial communications bus that uses an asynchronous protocol and connects keyboards, graphics tablets, mouse devices, and other devices to the computer. The custom ADB microcontroller drives the bus and reads status from the selected external device. A 4-pin mini-DIN connector connects the ADB to the external devices. Table 3-2 lists the ADB connector pin assignments. For more information about the ADB, see *Guide to the Macintosh Family Hardware,* second edition.

Table 3-2 ADB connector pin assignments

Pin number	Name	Description
1	ADB	Bidirectional data bus used for input and output. It is an open-collector signal pulled up to +5 volts through a 470-ohm resistor on the main logic board.
2	PSW	Power-on signal that generates reset and interrupt key combinations.
3	+5V	+5 volts from the computer.
4	GND	Ground from the computer.

Note
The total current available for all devices connected to the +5 V pins on the ADB and the modem port is 500 mA. Each device should use no more than 100 mA. ◆

Disk Drives

The Macintosh Performa 6400 computer has one internal high-density floppy disk drive, one internal ATA (IDE) hard disk drive, and an internal SCSI CD-ROM drive.

Floppy Disk Drive

The Macintosh Performa 6400 computer has one internal high-density floppy disk drive (Apple SuperDrive). The drive is connected to a 20-pin connector on a cable that is connected to the main logic board by the internal chassis connector. Table 3-3 shows the pin assignments on the floppy disk connector.

Table 3-3 Pin assignments on the floppy disk connector

Pin number	Signal name	Signal description
1	GND	Ground
2	PH0	Phase 0: state control line
3	GND	Ground
4	PH1	Phase 1: state control line
5	GND	Ground
6	PH2	Phase 2: state control line
7	GND	Ground
8	PH3	Phase 3: register write strobe
9	+5V	+5 volts
10	/WRREQ	Write data request
11	+5V	+5 volts
12	SEL	Head select
13	+12V	+12 volts
14	/ENBL	Drive enable
15	+12V	+12 volts
16	RD	Read data

continued

Table 3-3 Pin assignments on the floppy disk connector (continued)

17	+12V	+12 volts
18	WR	Write data
19	+12V	+12 volts
20	n.c.	Not connected

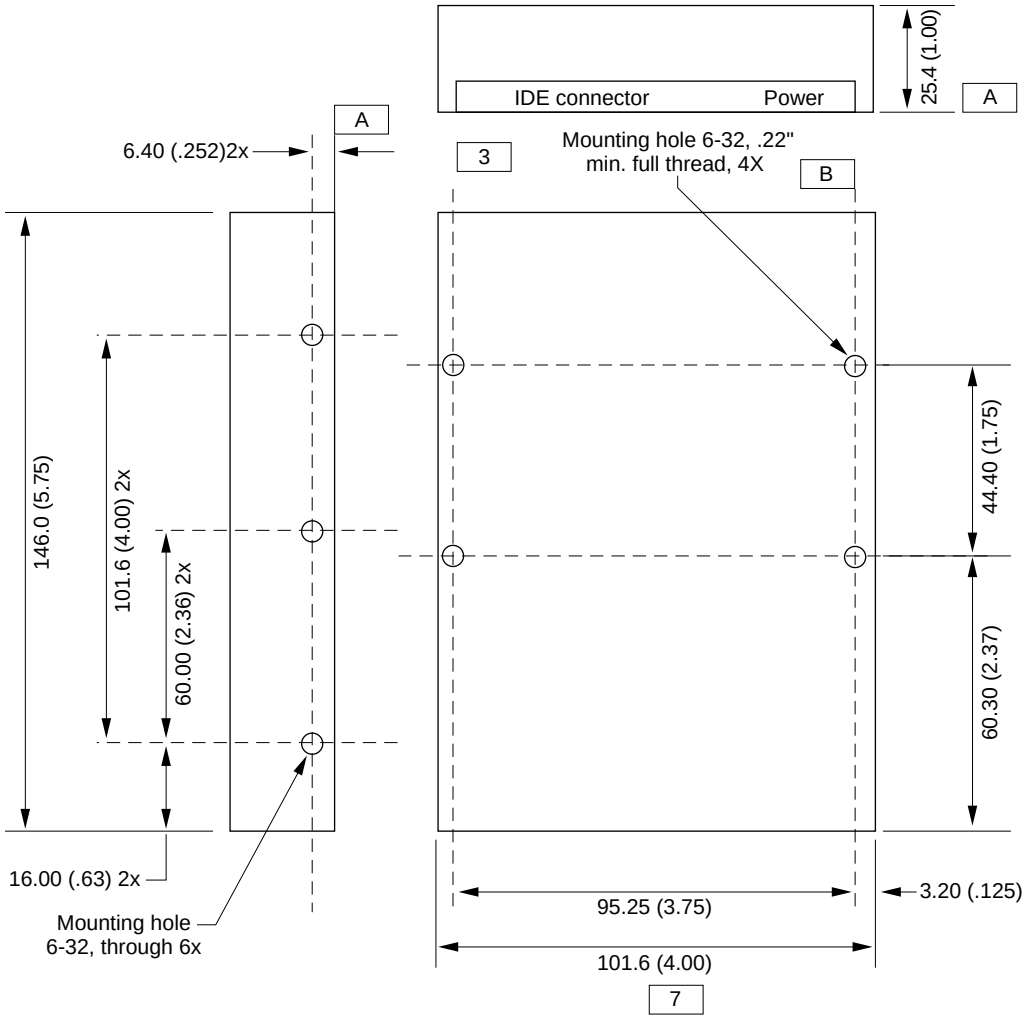
ATA (IDE) Hard Disk

The Macintosh Performa 6400 computer has an internal hard disk that uses the standard ATA-2 interface. This interface, used for ATA drives on IBM AT–compatible computers, is also referred to as the IDE interface. The implementation of the ATA interface on the Macintosh Performa 6400 computer is a subset of the ATA interface specification, ANSI proposal X3T9.2/90-143, Revision 3.1.

Hard Disk Specifications

Figure 3-2 shows the maximum dimensions of the hard disk and the location of the mounting holes. As the figure shows, the minimum clearance between conductive components and the bottom of the mounting envelope is 0.5 mm.

Figure 3-2 Maximum dimensions of the hard disk



Notes:

1 A Defined by plane of bottom mount holes

2 B Defined by center line of bottom mount holes

3 40-pin IDE and 4-pin power connector placement must not be reversed

4 Dimensions are in millimeters (inches)

5 Drawing not to scale

6 Tolerances .X = ±0.50, .XX = ±0.25

7 Dimension to be measured at center line of side-mount holes

8 Minimum 0.5 MM clearance from any conductive PCB components to A

Hard Disk Connectors

The internal hard disk has a standard 40-pin ATA connector and a separate 4-pin power connector. The 40-pin connector cable is part of the cable harness attached to the main logic board by the internal chassis connector. The power cable is attached directly to the power supply.

The exact locations of the ATA connector and the power connector are not specified, but the relative positions must be as shown in Figure 3-2 so that the cables and connectors will fit.

Pin Assignments

Table 3-4 shows the pin assignments on the 40-pin ATA (IDE) hard disk connector. A slash (/) at the beginning of a signal name indicates an active-low signal.

Table 3-4 Pin assignments on the ATA (IDE) hard disk connector

Pin number	Signal name	Pin number	Signal name
1	/RESET	2	GROUND
3	DD7	4	DD8
5	DD6	6	DD9
7	DD5	8	DD10
9	DD4	10	DD11
11	DD3	12	DD12
13	DD2	14	DD13
15	DD1	16	DD14
17	DD0	18	DD15
19	GROUND	20	Key
21	Reserved	22	GROUND
23	DIOW	24	GROUND
25	DIOR	26	GROUND
27	/IORDY	28	Reserved
29	Reserved	30	GROUND
31	INTRQ	32	/IOCS16
33	DA1	34	/PDIAG
35	DA0	36	DA2
37	/CS0	38	/CS1
39	/DASP	40	GROUND

ATA (IDE) Signal Descriptions

Table 3-5 describes the signals on the ATA (IDE) hard disk connector.

Table 3-5 Signals on the ATA (IDE) hard disk connector

Signal name	Signal description
DA(0–2)	ATA device address; used by the computer to select one of the registers in the ATA drive. For more information, see the descriptions of the CS0 and CS1 signals.
DD(0–15)	ATA data bus; buffered from IOD(16–31) of the computer's I/O bus. DD(0–15) are used to transfer 16-bit data to and from the drive buffer. DD(8–15) are used to transfer data to and from the internal registers of the drive, with DD(0–7) driven high when writing.
/CS0	ATA register select signal. It is asserted high to select the additional control and status registers on the ATA drive.
/CS1	ATA register select signal. It is asserted high to select the main task file registers. The task file registers indicate the command, the sector address, and the sector count.
/IORDY	ATA I/O ready; when driven low by the drive, signals the CPU to insert wait states into the I/O read or write cycles.
/IOCS16	ATA I/O channel select; asserted low for an access to the data port. The computer uses this signal to indicate a 16-bit data transfer.
DIOR	ATA I/O data read strobe.
DIOW	ATA I/O data write strobe.
INTRQ	ATA interrupt request. This active high signal is used to inform the computer that a data transfer is requested or that a command has terminated.
/RESET	Hardware reset to the drive; an active low signal.
Key	This pin is the key for the connector.

CD-ROM Drive

The Macintosh Performa 6400 computer has an 8X-speed internal CD-ROM drive. The CD-ROM drive supports the worldwide standards and specifications for CD-ROM and CD-digital audio discs described in the Sony/Philips Yellow Book and Red Book. The drive can read CD-ROM, CD-ROM XA, CD-I, and PhotoCD discs as well as play standard audio discs.

The CD-ROM drive has a sliding tray to hold the disc. The drive features a quadruple-speed mechanism that supports sustained data transfer rates of 1200 KB per

second and a data buffer that further enhances performance. Table 3-6 is a summary of the specifications of the CD-ROM drive.

Table 3-6 Specifications of the AppleCD 600i CD-ROM drive

Feature	Specification
Rotation speed	Approximately 920 to 2120 rpm
Average access time	Less than 200 ms
Sustained transfer rate	1200 KB per second
SCSI burst rate	More than 3 MB per second

SCSI Bus

The Macintosh Performa 6400 computer has a SCSI bus for the internal CD-ROM device, one additional internal SCSI device, and one or more external SCSI devices. The CD-ROM device and any additional internal SCSI device receive power directly from the power supply.

SCSI Connectors

The SCSI connector for the internal SCSI devices is a 50-pin connector with the standard SCSI pin assignments. It attaches to a cable that is connected to the main logic board by the internal chassis connector. The external SCSI connector is a 25-pin D-type connector with the same pin assignments as other Apple SCSI devices. Table 3-7 shows the pin assignments on the internal and external SCSI connectors.

Table 3-7 Pin assignments for the SCSI connectors

Pin number (internal 50-pin)	Pin number (external 25-pin)	Signal name	Signal description
2	8	/DB0	Bit 0 of SCSI data bus
4	21	/DB1	Bit 1 of SCSI data bus
6	22	/DB2	Bit 2 of SCSI data bus
8	10	/DB3	Bit 3 of SCSI data bus
10	23	/DB4	Bit 4 of SCSI data bus
12	11	/DB5	Bit 5 of SCSI data bus
14	12	/DB6	Bit 6 of SCSI data bus

continued

Table 3-7 Pin assignments for the SCSI connectors (continued)

Pin number (internal 50-pin)	Pin number (external 25-pin)	Signal name	Signal description
16	13	/DB7	Bit 7 of SCSI data bus
18	20	/DBP	Parity bit of SCSI data bus
25	–	n.c.	Not connected
26	25	TPWR	+5 V terminator power
32	17	/ATN	Attention
36	6	/BSY	Bus busy
38	5	/ACK	Handshake acknowledge
40	4	/RST	Bus reset
42	2	/MSG	Message phase
44	19	/SEL	Select
46	15	/C/D	Control or data
48	1	/REQ	Handshake request
50	3	/I/O	Input or output
20, 22, 24, 28, 30, 34, and all odd pins except pin 25	7, 9, 14, 16, 18, and 24	GND	Ground

SCSI Bus Termination

The internal end of the SCSI bus is terminated by an active terminator. The terminator is located on the main logic board near the portion of the internal chassis connector that contains the signals for the internal CD-ROM drive. On enclosures with only one internal SCSI device located close to the logic board, the active termination is automatically enabled. On enclosures with multiple SCSI devices, the active termination is disabled, and a positive terminator is located at the end of the internal bus.

Sound

The sound system supports both 8-bit and 16-bit stereo sound output and input. SRS (sound retrieval system) enhanced sound output can be optionally turned on and off through the Sound panel of the Monitors and Sound control panel. No additional software API is available for controlling the SRS sound enhancement.

Like other Macintosh computers, the Macintosh Performa 6400 computer can create sounds digitally and play the sounds through the internal speakers or send the sound signals out through the sound output jacks. The Macintosh Performa 6400 computer also

records sound from several sources: a microphone connected to the sound input jack, the video input module, or a compact disc in the CD-ROM player. With each sound input source, sound playthrough can be enabled or disabled.

Sound Output

The Macintosh Performa 6400 computer has one built-in speaker/subwoofer and two sound output jacks, one on the front and one on the back. Both output jacks are connected to the sound amplifier; the jack on the front is intended for ease of access when connected to a pair of headphones. Inserting a plug into either jack disconnects the internal speakers. The rear jack is intended for use with external speakers, and it is muted when headphones are plugged into the front jack. (Options in the Monitors and Sound control panel can be used to determine the interaction between the sound input and output devices.)

Sound output is controlled by the O'Hare IC. The AWACS IC provides the stereo sound output to both the internal speakers and the sound output jacks.

Sound Input

The Macintosh Performa 6400 computer has a stereo sound input jack on the back for connecting an external microphone or other sound source. The sound input jack accepts a standard 1/8-inch stereophonic phone plug (two signals plus ground).

The sound input jack accepts either the Apple PlainTalk line-level microphone or a pair of line-level signals.

Note
The Apple PlainTalk microphone requires power from the main computer, which it obtains by way of an extra-long, 4-conductor plug that makes contact with a 5-volt pin inside the sound input jack. ◆

IMPORTANT
The microphone for the Macintosh LC and LC II does not work with the Macintosh Performa 6400 computer; it requires the line-level signal provided by the Apple PlainTalk microphone. ▲

Sound from an external source, such as a TV, VCR, or VTR, can also be input through the right and left channel sound input jacks on the optional video-in module.

Sound Input Specifications

The sound input jack has the following electrical characteristics:

- input impedance: 15k ohms
- maximum input level: 1.06 V RMS

Routing of the Sound Signals

All audio sources are routed to the AWACS custom IC. The AWACS IC can enable the input sources in two groups: the sound input jack (external microphone) or (CD-ROM, TV/FM tuner, modem, DAV card, cross-platform card).

Digitizing Sound

The Macintosh Performa 6400 computer digitizes and records sound as 16-bit samples. The computer can use anu one of three sampling rates: 11k samples per second, 22k samples per second, or 44k samples per second.

The sound system plays samples at the sampling rate specified in the control panel for sound.

Sound Modes

The sound mode is selected by a call to the Sound Manager. The sound circuitry normally operates in one of three modes:

- Sound playback: computer-generated sound is sent to the speaker and the sound output jacks.
- Sound playback with playthrough: computer sound and sound input are mixed and sent to the speakers and the sound output jacks.
- Sound record with playthrough: input sound is recorded and also sent to the speakers and the sound output jacks.

When recording from a microphone, applications should reduce the playthrough volume to prevent possible feedback from the speakers to the microphone.

The O'Hare IC provides separate sound buffers for input and for stereo output, so the computer can record and send digitized sound to the sound outputs simultaneously.

Keyboard

The keyboard has a Power key, identified by the symbol ⏏. When the user chooses Shut Down from the Special menu, the computer either shuts down or a dialog box appears asking if you really want to shut down. The user can also turn off the power by pressing the Power key.

There are no programmer's switches, so the user invokes the reset and nonmaskable interrupt (NMI) function by pressing Command key combinations while holding down the Power key, as shown in Table 3-8. The Command key is identified by the symbols and ⌘.

Note
The user must hold down a key combination for at least 1 second to allow the ADB microcontroller enough time to respond to the NMI or hard-reset signal. ◆

Table 3-8 Reset and NMI key combinations

Key combination	Function
Command-Power (⌘-◁)	NMI (always active)
Control-Command-Power (Control-⌘-◁)	Reset

Note
The NMI function can always be activated from the keyboard. This is a change from the Macintosh LC computer, where keyboard activation of the NMI function can be disabled by the software. ◆

Built-in Video

The built-in video circuitry supports pixel display sizes of 512-by-384, 640-by-480, 800-by-600, 832-by-624, and 1024-by-768. When power is applied, the monitor is initially set for a display size of 640-by-480 pixels. The user can switch the monitor resolution on the fly from the Monitor BitDepth and Monitor Resolution modules in the Control Strip or the Monitors and Sound control panel.

External Video Connection for the Macintosh Performa 6400

The Macintosh Performa 6400 computer requires an external monitor. The cable from the external monitor plugs into a standard DB-15 video port located on the upper-left part of the enclosure's rear panel. The pin assignments for the external video connector on the Macintosh Performa 6400 are shown in Table 3-9.

Table 3-9 Pin assignments for the external video connector

Pin number	Signal name	Description
1	RED.GND	Red video ground
2	RED.VID	Red video signal
3	/CSYNC	Composite synchronization signal
4	SENSE0	Monitor sense signal 0

continued

Table 3-9 Pin assignments for the external video connector (continued)

Pin number	Signal name	Description
5	GRN.VID	Green video signal
6	GRN.GND	Green video ground
7	SENSE1	Monitor sense signal 1
9	BLU.VID	Blue video signal
10	SENSE2	Monitor sense signal 2
11	GND	CSYNC and VSYNC ground
12	/VSYNC	Vertical synchronization signal
13	BLU.GND	Blue video ground
14	HSYNC.GND	HSYNC ground
15	/HSYNC	Horizontal synchronization signal
Shell	SGND	Shield ground

External Video Monitors

The computer can work with several sizes of external video monitors. Table 3-10 shows the monitor types supported and the maximum pixel depths available. The pixel depth determines the maximum number of colors that can be displayed. The maximum pixel depth available depends on the size of the monitor's screen.

Table 3-10 Maximum pixel depths for video monitors

Monitor type	Screen size, in pixels	Maximum pixel depth, in bits per pixel	Maximum number of colors displayed
12-inch color	512 by 384	16	32,768
14-inch color	640 by 480	16	32,768
15-inch multiscan	800 by 600	16	32,768
17-inch multiscan	1024 by 768	8	256
VGA	640 by 480	8	256
SVGA	800 by 600	16	256
EVGA	1024 by 768	8	256
16-inch color	832 by 624	8	256

Video Timing Parameters

The Macintosh Performa 6400 computer supports several different types of monitors and screen sizes, as listed in Table 3-10.

Table 3-11 Monitors supported

Monitor type	Screen size (pixels)
12-inch color	512 by 384
14-inch color	640 by 480
15-inch multiscan	800 by 600
17-inch multiscan	1024 by 768
VGA	640 by 480
SVGA	800 by 600
EVGA	1024 by 768
16-inch color	832 by 624

Figure 3-3 shows simplified timing diagrams and identifies the horizontal and vertical timing parameters in a video signal. Table 3-13, and Table 3-14 list the values of those parameters for the different types of monitors.

Figure 3-3 Video timing diagram

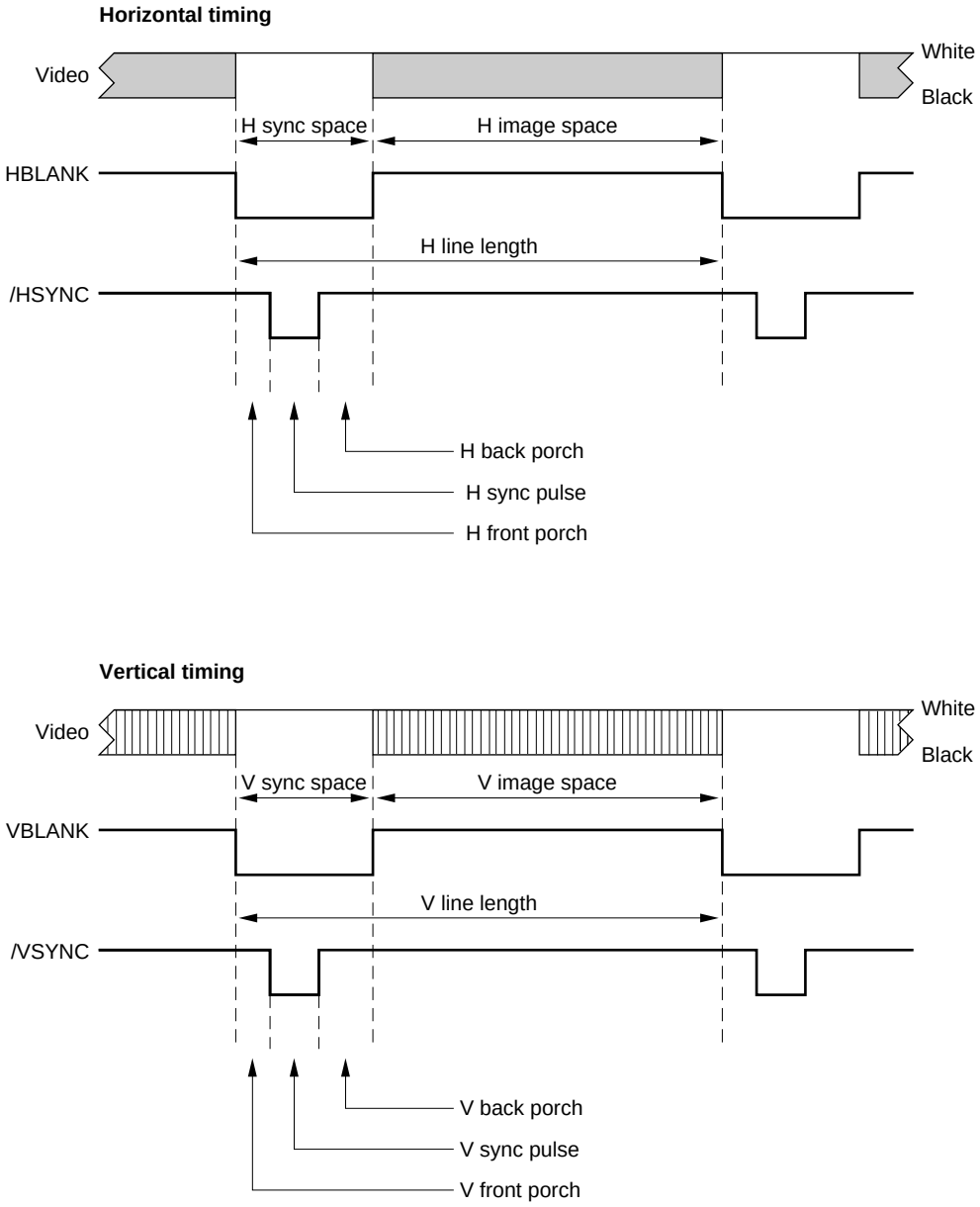


Table 3-13 lists the timing parameters for the smaller monitors listed: the 12-inch color monitor, the 14-inch color monitor, and a standard VGA monitor.

Table 3-12 Video timing parameters for smaller monitors

	Monitor type and dimensions		
Parameter	12-inch color (512 by 384)	14-inch color (640 by 480)	VGA (640 by 480)
Dot clock	15.67 MHz	30.24 MHz	25.18 MHz
Dot time	63.83 ns	33.07 ns	39.72 ns
Line rate	24.48 kHz	35.00 kHz	31.47 kHz
Line time	40.85 µs (640 dots)	28.57 µs (864 dots)	31.78 µs (800 dots)
Horizontal active video	512 dots	640 dots	640 dots
Horizontal blanking	128 dots	224 dots	160 dots
Horizontal front porch	16 dots	64 dots	16 dots
Horizontal sync pulse	32 dots	64 dots	96 dots
Horizontal back porch	80 dots	96 dots	48 dots
Frame rate	60.15 Hz	66.67 Hz	59.94 Hz
Frame time	16.63 ms (407 lines)	15.01 ms (525 lines)	16.68 ms (525 lines)
Vertical active video	384 lines	480 lines	480 lines
Vertical blanking	23 lines	45 lines	45 lines
Vertical front porch	1 line	3 lines	10 lines
Vertical sync pulse	3 lines	3 lines	2 lines
Vertical back porch	19 lines	39 lines	33 lines

Table 3-13 lists the timing parameters for SVGA monitors running at 60 and 72 frames per second and for the 16-inch color monitor.

Table 3-13 Video timing parameters for larger monitors

	Monitor type and dimensions		
Parameter	SVGA (800 by 600 at 60 frames per second)	SVGA (800 by 600 at 72 frames per second)	16-inch color (832-by-624)
Dot clock	40.00 MHz	50.00 MHz	57.2832 MHz
Dot time	25.00 ns	20.00 ns	17.46 ns
Line rate	37.88 kHz	48.08 kHz	49.725 kHz
Line time	26.4 µs (1056 dots)	20.80 µs (1040 dots)	20.11 µs (1152 dots)
Horizontal active video	800 dots	800 dots	832 dots
Horizontal blanking	256 dots	240 dots	320 dots
Horizontal front porch	40 dots	56 dots	32 dots
Horizontal sync pulse	128 dots	120 dots	64 dots
Horizontal back porch	88 dots	64 dots	224 dots
Frame rate	60.31 Hz	72.18 Hz	74.55 Hz
Frame time	16.58 ms (628 lines)	13.85 ms (666 lines)	13.41 ms (667 lines)
Vertical active video	600 lines	600 lines	624 lines
Vertical blanking	28 lines	66 lines	43 lines
Vertical front porch	1 line	37 lines	1 line
Vertical sync pulse	4 lines	6 lines	3 lines
Vertical back porch	23 lines	23 lines	39 lines

Table 3-14 lists the timing parameters for EVGA monitors running at 60 and 70 frames per second.

Table 3-14 Video timing parameters for 1024-by-768 EVGA monitors

	Monitor type and dimensions	
Parameter	EVGA (1024 by 768 at 60 frames per second)	EVGA (1024 by 768 at 70 frames per second)
Dot clock	65.0 MHz	75.0 MHz
Dot time	15.38 ns	13.33 ns
Line rate	48.36 kHz	56.48 kHz
Line time	20.68 µs (1344 dots)	17.7 µs (1328 dots)
Horizontal active video	1024 dots	1024 dots
Horizontal blanking	320 dots	304 dots
Horizontal front porch	24 dots	24 dots
Horizontal sync pulse	136 dots	136 dots
Horizontal back porch	160 dots	144 dots
Frame rate	60 Hz	70.07 Hz
Frame time	16.67 ms (806 lines)	14.27 ms (806 lines)
Vertical active video	768 lines	768 lines
Vertical blanking	38 lines	38 lines
Vertical front porch	3 lines	3 lines
Vertical sync pulse	6 lines	6 lines
Vertical back porch	29 lines	29 lines

CHAPTER 4

Expansion Features

This chapter describes the expansion features of the Macintosh Performa 6400 computer: the RAM expansion slot, the L2 cache expansion slot, the PCI expansion slot, the DAV connector on the video input module, the communications slot, and the expansion bay for SCSI devices.

Note
Apple does not support development of third-party cards for the video input slot, nor does Apple support development of third-party second level (L2) cache cards, because the L2 cache controller is integrated into the design of the cache card. ◆

RAM DIMMs

The Macintosh Performa 6400 computer has two RAM expansion slots. The RAM expansion slots accept the 8-byte DIMM (dual inline memory module). As its name implies, the 8-byte DIMM has a 64-bit-wide data bus.

The mechanical design of the 8-byte DIMM is defined by the MO-161 specification published by the JEDEC JC-11 committee; its electrical characteristics are defined by the JEDEC Standard No. 21-C. The 8-byte DIMM connector used in the Macintosh Performa 6400 computer is Burndy Corporation's part number ELF168E5GC-3Z50 or equivalent.

The minimum bank size supported by the PSX IC is 4 MB and the largest is 32 MB; the largest DIMM supported is a two-bank DIMM holding 64 MB. Table 4-1 shows the single-bank DIMM configurations and sizes for a range of DRAM device sizes that are supported on the Macintosh Performa 6400 computer.

Table 4-1 Memory sizes and configurations

Device size	DIMM configuration	DIMM size	Maximum memory with 2 DIMMs installed
4 Mbit	512K by 64	4 MB	16 MB
4 Mbit	1 Mbit by 64	8 MB	24 MB
16 Mbit	1 Mbit by 64	8 MB	24 MB
16 Mbit	2 Mbits by 64	16 MB	40 MB
16 Mbit	4 Mbits by 64	32 MB	72 MB

Note
It is possible to use 5 volt EDO (extended data out) memory devices in the Macintosh Performa 6400, however any added performance available with EDO devices will not be realized. 3.3 volt EDO DIMM cards are not supported and should not mechanically fit into the DIMM connectors on the Macintosh Performa 6400 main logic board. ◆

The 8-byte DIMMs can be installed one or more at a time. The Macintosh Performa 6400 computer supports only linear memory organization, therefore no performance gains are seen when two DIMMs of the same size are installed. Any size DIMM can be installed in either DIMM slot, and the combined memory of all of the DIMMs installed will be configured as a contiguous memory space.

RAM DIMM Connectors

Table 4-2 gives the pin assignments for the RAM DIMM connectors.

Table 4-2 Pin assignments on the RAM DIMM connectors

Pin number	Signal name	Pin number	Signal name
1	VSS	85	VSS
2	DQ(0)	86	DQ(32)
3	DQ(1)	87	DQ(33)
4	DQ(2)	88	DQ(34)
5	DQ(3)	89	DQ(35)
6	VCC	90	VCC
7	DQ(4)	91	DQ(36)
8	DQ(5)	92	DQ(37)
9	DQ(6)	93	DQ(38)
10	DQ(7)	94	DQ(39)
11	Reserved	95	Reserved
12	VSS	96	VSS
13	DQ(8)	97	DQ(40)
14	DQ(9)	98	DQ(41)
15	DQ(10)	99	DQ(42)
16	DQ(11)	100	DQ(43)
17	DQ(12)	101	DQ(44)
18	VCC	102	VCC
19	DQ(13)	103	DQ(45)
20	DQ(14)	104	DQ(46)
21	DQ(15)	105	DQ(47)
22	Reserved	106	Reserved
23	VSS	107	VSS

continued

Table 4-2 Pin assignments on the RAM DIMM connectors (continued)

Pin number	Signal name	Pin number	Signal name
24	Reserved	108	Reserved
25	Reserved	109	Reserved
26	VCC	110	VCC
27	/WE(0)	111	Reserved
28	/CAS(0)	112	/CAS(1)
29	/CAS(2)	113	/CAS(3)
30	/RAS(0)	114	/RAS(1)
31	/OE(0)	115	Reserved
32	VSS	116	VSS
33	A(0)	117	A(1)
34	A(2)	118	A(3)
35	A(4)	119	A(5)
36	A(6)	120	A(7)
37	A(8)	121	A(9)
38	A(10)	122	A(11)
39	Not connected	123	Not connected
40	VCC	124	VCC
41	Reserved	125	Reserved
42	Reserved	126	B(0)
43	VSS	127	VSS
44	/OE(2)	128	Reserved
45	/RAS(2)	129	/RAS(3)
46	/CAS(4)	130	/CAS(5)
47	/CAS(6)	131	/CAS(7)
48	/WE(2)	132	/PDE
49	VCC	133	VCC
50	Reserved	134	Reserved
51	Reserved	135	Reserved
52	DQ(16)	136	DQ(48)
53	DQ(17)	137	DQ(49)
54	VSS	138	VSS

continued

Table 4-2 Pin assignments on the RAM DIMM connectors (continued)

Pin number	Signal name	Pin number	Signal name
55	DQ(18)	139	DQ(50)
56	DQ(19)	140	DQ(51)
57	DQ(20)	141	DQ(52)
58	DQ(21)	142	DQ(53)
59	VCC	143	VCC
60	DQ(22)	144	DQ(54)
61	Reserved	145	Reserved
62	Reserved	146	Reserved
63	Reserved	147	Reserved
64	Reserved	148	Reserved
65	DQ(23)	149	DQ(55)
66	Reserved	150	Reserved
67	DQ(24)	151	DQ(56)
68	VSS	152	VSS
69	DQ(25)	153	DQ(57)
70	DQ(26)	154	DQ(58)
71	DQ(27)	155	DQ(59)
72	DQ(28)	156	DQ(60)
73	VCC	157	VCC
74	DQ(29)	158	DQ(61)
75	DQ(30)	159	DQ(62)
76	DQ(31)	160	DQ(63)
77	Reserved	161	Reserved
78	VSS	162	VSS
79	PD(1)	163	PD(2)
80	PD(3)	164	PD(4)
81	PD(5)	165	PD(6)
82	PD(7)	166	PD(8)
83	ID(0)	167	ID(1)
84	VCC	168	VCC

Table 4-3 describes the signals on the RAM DIMM connector.

Table 4-3 RAM DIMM connector signals

Signal name	Description
A(0–11)	Address inputs
/CAS(0–7)	Column address strobe signals
DQ(0–63)	Data input and output signals
ID(0–1)	Memory module identification (not used)
/OE(0, 2)	Output enable signals
PD(1–8)	Presence detect signals
/PDE	Presence detect enable signal (not used)
/RAS(0–3)	Row address strobe signals
Reserved	Reserved, don't use
VCC	+5 V power
VSS	Ground
/WE(0, 2)	Read/write input signals

RAM Address Multiplexing

Signals A[0–11] on each RAM DIMM make up a 12-bit multiplexed address bus that can support several different types of DRAM devices. Table 4-4 shows the address multiplexing modes used with several types of DRAM devices. The devices are characterized by their bit dimensions; For example, a 512K by 8-bit device has 512K addresses and stores 8 bits at a time.

Table 4-4 Address multiplexing modes for various DRAM devices

Device size	Device type	Size of row address	Size of column address
4 Mbits	512K by 8 bits	10	9
4 Mbits	1 M by 4 bits	10	10
16 Mbits	1 M by 16 bits	10	10
16 Mbits	2 M by 8 bits	11	10
16 Mbits	2 M by 8 bits	12	9
16 Mbits	4 M by 4 bits	11	11

Table 4-5 shows how the address signals to the RAM devices are multiplexed during the row and column address phases for noninterleaved banks.

Table 4-5 Address multiplexing in noninterleaved banks

	Individual signals on the DRAM_ADDR bus											
	A(11)	**A(10)**	**A(9)**	**A(8)**	**A(7)**	**A(6)**	**A(5)**	**A(4)**	**A(3)**	**A(2)**	**A(1)**	**A(0)**
Row address	22	23	21	20	19	18	17	16	15	14	13	12
Column address		24	22	11	10	9	8	7	6	5	4	3

IMPORTANT
The PSX DRAM controller on the main logic board of the Macintosh Performa 6400 computer does not provide support for 4 M by 4 bits (12 by 10 addressing) or 1 M by 16 bits (12 by 8 addressing) DRAM devices. ▲

RAM Devices

The memory controller in the PSX IC supports 1 MB, 4 MB, and 16 MB DRAM devices. The access time (T_{RAS}) of the DRAM devices is 70 ns or faster.

Note
The computer supplies +5 volts at VCC on the RAM expansion slot for DRAM DIMMs. Power for DRAM devices that require 3.3 volts is not supplied on the RAM expansion slot. ◆

RAM Refresh

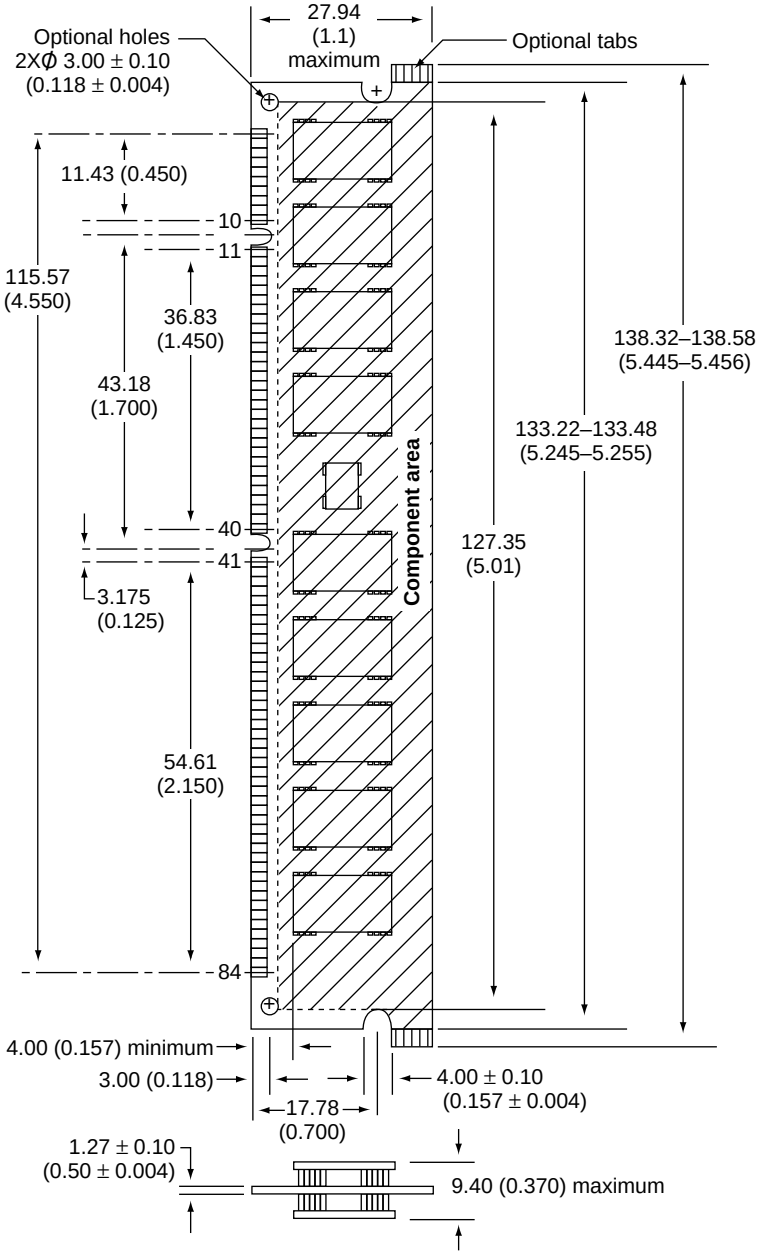
The PSX IC provides a CAS-before-RAS refresh cycle every 15.6 µs. DRAM devices must be compatible with this refresh cycle; for example, this cycle will refresh 2K-refresh parts within 32 milliseconds.

RAM DIMM Dimensions

Figure 4-1 shows the dimensions of the RAM DIMM.

IMPORTANT
The JEDEC MO-161 specification shows three possible heights for the 8-byte DIMM. For Power Macintosh computers, developers should use only the shortest of the three: 1.100 inches. Taller DIMMs put excessive pressure on the DIMM sockets due to possible mechanical interference inside the case. ▲

Figure 4-1 Dimensions of the RAM DIMM



Note: Dimensions are in millimeters (inches).

Second-Level Cache DIMM

The Macintosh Performa 6400 computer has a slot for a second-level (L2) cache on a DIMM.

The L2 cache DIMM contains the cache controller, tag, and data-store memory. It is a lookaside cache, which is connected to the PowerPC processor bus. Several signals are also included to control cache operation. These signals include /L2_DIS, /MEM_INHIBIT, /L2_BR, /L2_BG, and L2_PRSNT.

Table 4-6 shows the pin and signal assignments on the L2 cache DIMM connector.

Table 4-6 Pin and signal assignments for the L-2 cache DIMM connector

Pin	Signal name	Pin	Signal name	Pin	Signal name	Pin	Signal name
1	+5 V	41	A15	81	D63 (LSB)	121	A16
2	D31	42	A13	82	D62	122	A14
3	D30	43	+3.3 V	83	D61	123	A12
4	D29	44	A11	84	GND	124	A10
5	D28	45	A9	85	D60	125	A8
6	D27	46	A7	86	D59	126	GND
7	+5 V	47	A5	87	D58	127	A6
8	D26	48	A3	88	D57	128	A4
9	D25	49	+3.3 V	89	D56	129	A2
10	D24	50	A1	90	GND	130	A0 (MSB)
11	D23	51	/WT	91	D55	131	/DBB
12	D22	52	/GBL	92	D54	132	GND
13	+5 V	53	Reserved	93	D53	133	/CPU_BG
14	D21	54	/SRESET	94	D52	134	/CPU_BR
15	D20	55	+3.3 V	95	D51	135	L2_PRSNT
16	D19	56	TTYPE0	96	GND	136	Reserved
17	D18	57	TTYP1	97	D50	137	TSIZ0
18	D17	58	TTYPE2	98	D49	138	GND
19	+5 V	59	TTYPE3	99	D48	139	TSIZ1
20	D16	60	TTYPE4	100	/L2_DIS	140	TSIZ2

continued

Table 4-6 Pin and signal assignments for the L-2 cache DIMM connector (continued)

Pin	Signal name	Pin	Signal name	Pin	Signal name	Pin	Signal name
21	/L2_BR	61	+3.3 V	101	/TBST	141	SHD
22	/L2_BG	62	D15	102	GND	142	D47
23	TC0	63	D14	103	/CI	143	D46
24	TC1	64	D13	104	/RSRV	144	GND
25	+3.3 V	65	D12	105	Reserved	145	D45
26	/HRESET	66	D11	106	/MEM_INHIBIT	146	D44
27	/TEA	67	+5 V	107	/AACK	147	D43
28	/TS	68	D10	108	GND	148	D42
29	GND	69	D9	109	/TA	149	D41
30	SYS_CLK	70	D8	110	/ARTRY	150	GND
31	+3.3 V	71	D7	111	/ABB	151	D40
32	A31 (LSB)	72	D6	112	A30	152	D39
33	A29	73	+5 V	113	A28	153	D38
34	A27	74	D5	114	GND	154	D37
35	A25	75	D4	115	A26	155	D36
36	A23	76	D3	116	A24	156	GND
37	+3.3 V	77	D2	117	A22	157	D35
38	A21	78	D1	118	A20	158	D34
39	A19	79	+5 V	119	A18	159	D33
40	A17	80	D0 (MSB)	120	GND	160	D32

Table 4-7 defines the signals on the L-2 cache DIMM connector.

Table 4-7 Signal descriptions for the L-2 cache DIMM connector

Signal name	Description
+5 V	Power supply voltage of +5 volts for tag RAM (5% tolerance)
+ 3.3 V	Power supply voltage of +3.3 volts for data RAM (5% tolerance)
GND	Ground
A(0-31)	Processor address bus signals 0 through 31
D(0-63)	Processor data bus signals 0 through 63; sampled on the rising edge of the CLK signal during a write cycle

continued

Table 4-7 Signal descriptions for the L-2 cache DIMM connector (continued)

Signal name	Description
/AACK	Address acknowledge, same as AACK_ signal on PowerPC 603
/ARTRY	Address retry, same as ARTRY_ signal on PowerPC 603
/ABB	Address bus busy, same as ABB_ signal on PowerPC 603
/CI	Cache inhibit, same as CI_ signal on PowerPC 603
/CPU_BG	Bus transaction granted, same as BG_ signal on PowerPC 603
/CPU_BR	Bus transaction requested, same as BR_ signal on PowerPC 603
/DBB	Data bus busy, same as DBB_ signal on PowerPC 603
/GBL	Global transaction
/HRESET	Main logic board hardware reset
/L2_BG	Bus grant to L2 cache; used only in copyback mode
/L2_BR	Bus request from L2 cache; used only in copyback mode
/L2_DIS	Disables cache when low; contents are invalidated
L2_PRSNT	L2 cache present; tied directly to power rail on cache DIMM
/MEM_INHIBIT	Indicates L2 cache will source the data for the current cycle; inhibits main logic board memory controller.
/RSRV	Reservation signal, same as RSRV_ signal on PowerPC 603
Reserved	DO NOT USE
SHD	Share
/SRESET	Soft reset, same as SRESET_ signal on PowerPC 603
SYS_CLK	System clock, same as SYSCLOCK signal on PowerPC 603
/TA	Transfer acknowledge, same as TA_ signal on PowerPC 603
/TBST	Transfer burst in progress, same as TBST_ signal on PowerPC 603
TC(0-1)	Transfer code, same as TC signal on PowerPC 603
/TEA	Transfer error acknowledge, same as TEA_ signal on PowerPC 603
/TS	Transfer start signal, same as TS_ signal on PowerPC 603
TSIZ (0-2)	Transfer size for the data transaction
TTYPE(0-4)	Transfer type, same as TT signal on PowerPC 603
/WT	Write-thru, same as WT_ signal on PowerPC 603

PCI Expansion Slot

The Macintosh Performa 6400 computer uses the industry-standard peripheral component interconnect (PCI) bus for an I/O expansion bus. The PCI bus is a 32-bit multiplexed address and data bus. The PCI expansion slot has a 33.33 MHz system clock.

PCI I/O expansion cards are mounted horizontally in a 90-degree straight-through adapter board, which is installed in the PCI expansion slot on the main logic board.

A total of 15 watts of power is provided for each of the PCI expansion slots. Both 5 volts and 3.3 volts are supplied; the total power consumed by both voltages must not exceed the 15-watts maximum.

The Macintosh Performa 6400 computer requires that PCI cards use the 5-volts signaling standard described in the *PCI Local Bus Specification*, Revision 2.0.

The Macintosh Performa 6400 computer accepts standard 6.88-inch PCI cards as defined by the *PCI Local Bus Specification*, Revision 2.0. The cards are required to use the standard ISA fence described in the specification.

The PCI slots support all the required PCI signals and certain optional PCI signals. The supported PCI signals are listed in Table 4-3.

Table 4-8 PCI signals

Signal name	Description
AD[0–31]	Address and data, multiplexed
C/BE[0–3]	Bus command and byte enable signals, multiplexed
PAR	Parity; used with AD and C/BE signals
FRAME#	Cycle frame; asserted to indicate a bus transaction
TRDY#	Target ready; selected device is able to complete the current phase
IRDY#	Initiator ready; master device is able to complete the current phase
STOP#	Stop; indicates the current target device is requesting the master to stop the current transaction
DEVSEL#	Device select; indicates that the driving device has decoded its address as the target of the current access
IDSEL	Initialization device select; used during configuration
REQ#	Request; indicates to the arbiter that the asserting agent requires use of the bus
GNT#	Grant; indicates to the agent that access to the bus has been granted
CLK	Clock; rising edge provides timing for all transactions

continued

Table 4-8 PCI signals (continued)

Signal name	Description
RST#	Reset; used to bring registers and signals to a known state
INTA#, INTB#, INTC#, INTD#	Interrupt request pins; wired together on each slot
LOCK#	Lock; indicates an operation that may require multiple transactions to complete
PERR#	Parity error; used to report data parity errors during PCI transactions excluding a Special Cycle transaction
SERR#	System error; used to report address parity errors, data parity errors during a Special Cycle, or any other system error that will be catastrophic

The PCI slot in the Macintosh Performa 6400 computer does not support the optional 64-bit bus extension signals or cache support signals.

For more information about the PCI expansion slot, refer to *Designing PCI Cards and Drivers for Power Macintosh Computers.*

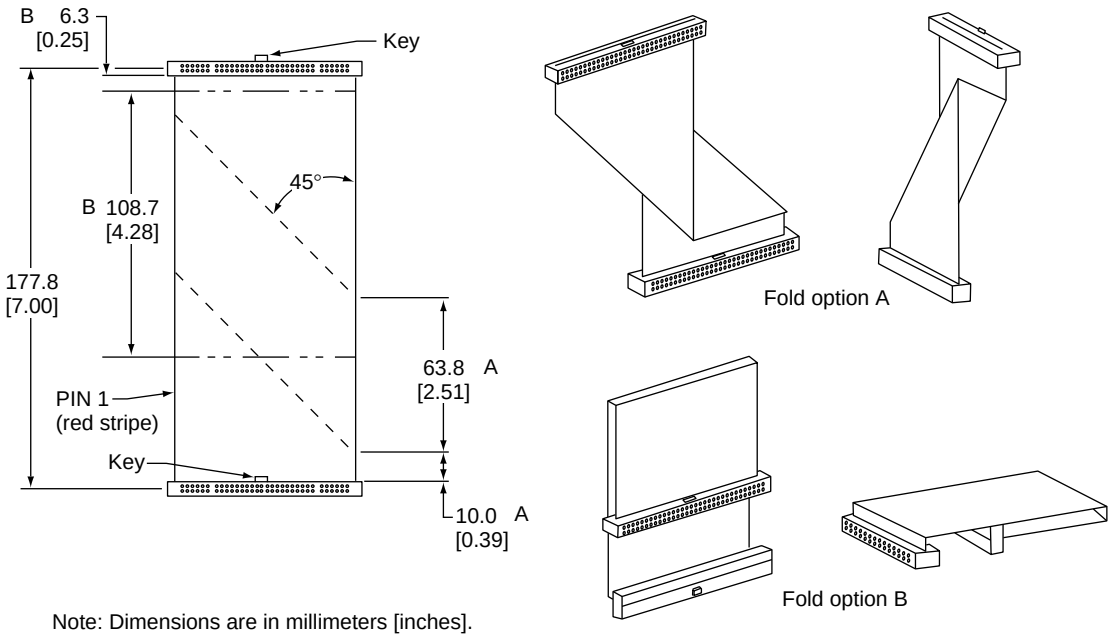
The DAV Connector

The optional video input card has a separate connector called the DAV (digital audio video) connector. The DAV connector provides access to the video input card's 4:2:2 unscaled YUV video input data bus and associated control signals. By means of a 60-pin cable to the DAV connector, a PCI expansion card can gain access to the digital video bus on the video input card and use it to transfer real-time video data to the computer. Such a PCI expansion card can contain a hardware video compressor or other video processor.

The DAV connector accepts YUV video and analog sound from the expansion card but does not itself generate YUV video output or audio output signals.

The DAV connector is a 60-pin flat ribbon connector located at the top edge of the video input card. Optional PCI video out expansion cards are connected to the video input card with a 7-inch 60-conductor flat ribbon cable that the user can install between the DAV connector and the PCI card. The DAV connecting cable is shown in Figure 4-2, where dimensions are given in millimeters with inch equivalents in brackets.

Figure 4-2 DAV connecting cable

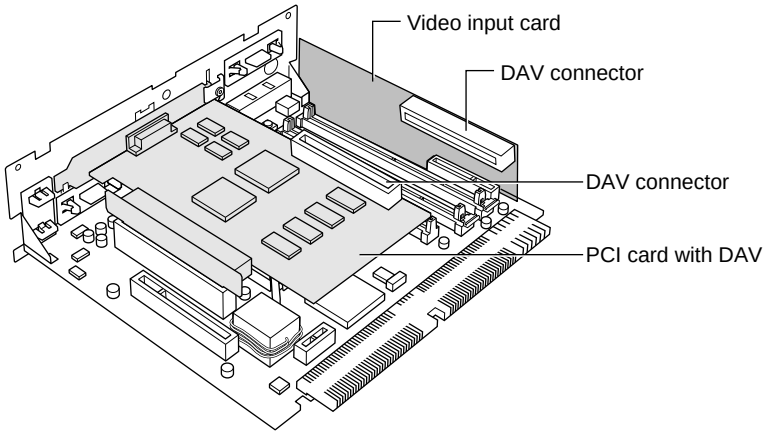


Note: Dimensions are in millimeters [inches].

Cable fold option A, shown in Figure 4-2, is used for tower and mini-tower models such as the Power Macintosh 7500 and 8500; fold option B is used in the Macintosh Performa 6400 and all-in-one models such as the Power Macintosh 5400. Total cable length in both cases is 7 inches.

Figure 4-3 is a view of the main logic board showing an optional PCI expansion card and the location of the DAV connector on the video input card.

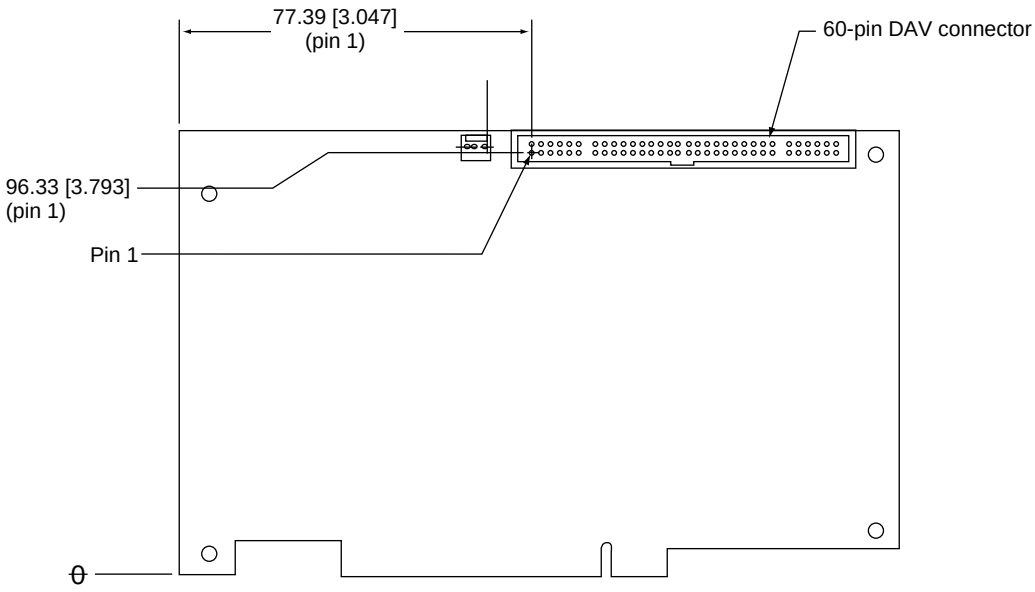
Figure 4-3 Location of the DAV connector



Note
The interface of the 60-pin DAV connector is a superset of the interface on the 34-pin DVA connector on the Power Macintosh 5200, Power Macintosh 6200, and Macintosh Quadra 630 computers. An adapter cable is provided with the Macintosh Performa 6400 video-in cards to connect 34-pin DVA compatible cards developed for the Power Macintosh 5200 and 6200 computers to the new 60-pin DAV connector. ◆

Figure 4-4 shows the orientation of the DAV connector on the video input module.

Figure 4-4 Orientation of the DAV connector



IMPORTANT
The DAV connector on the video input card provides some of the functionality of the DAV connectors found on the Power Macintosh 7100 and 8100 models and the Macintosh Quadra AV models, but it is not compatible with any of those connectors. Refer to *Macintosh DAV Interface for NuBus Expansion Cards* in *Developer Note Number 8* for more information.

AV cards designed for the DVA connector in the Power Macintosh 5200 and 6200 computers are compatible with the 60-pin DAV connector when an adapter cable is used. ▲

DAV Connector Pin Assignments

The DAV connector on the video-in card for the Macintosh Performa 6400 computer is a 60-pin dual-row type with 0.100-inch pin spacing. The pin assignments on the DAV connector are shown in Table 4-9.

Table 4-9 Pin assignments on the DAV connector

Pin number	Signal name	Pin number	Signal name
1	Ground	2	GEOPORT_CLK
3	Ground	4	LLC_OUT
5	Ground	6	PXQ_OUT
7	Ground	8	VS_OUT
9	Ground	10	HS_OUT
11	UV bit 7	12	UV bit 6
13	UV bit 5	14	UV bit 4
15	UV bit 3	16	UV bit 2
17	UV bit 1	18	UV bit 0
19	Y bit 7	20	Y bit 6
21	Y bit 5	22	Y bit 4
23	Y bit 3	24	Y bit 2
25	Y bit 1	26	Y bit 0
27	Ground	28	LLC_IN
29	Ground	30	PXQ_IN
31	Ground	32	VS_IN
33	Ground	34	HS_IN
35	Ground	36	HREF_IN
37	Ground	38	FLD
39	IIC_DATA	40	IIC_CLK
41	Ground	42	SND_L
43	SND_RET	44	SND_R
45	Ground	46	AUDIO_SDIN
47	Ground	48	AUDIO_SDOUT
49	Ground	50	AUDIO_BITCLK
51	Ground	52	AUDIO_SYNC

continued

Table 4-9 Pin assignments on the DAV connector (continued)

Pin number	Signal name	Pin number	Signal name
53	Ground	54	N.C.
55	VID_RET	56	N.C.
57	VID_RET	58	N.C.
59	N.C.	60	N.C.

Table 4-10 gives descriptions of the signals on the DAV connector.

Table 4-10 Descriptions of the signals on the DAV connector

Signal name	Signal description
LLC_OUT	Clock reference signal
FLD	YUV directional signal
HS_IN	Horizontal reference signal
HS_OUT	Horizontal sync signal
LLC_IN	Line-locked clock signal
UV(bits 0–7)	Digital chrominance data bus
VS_OUT	Vertical sync signal
Y(bits 0–7)	Digital luminance data bus

Signal Levels

When designing PCI card hardware to support the DAV connection, observe these rules:

- Connect a 47 Ω resistor in series between the bidirectional signals of the DAV connector and any PCI expansion card circuitry that drives output or bidirectional signals. This rule applies to pins 11 through 26, 28, 30, 32, and 36.
- Do not make any electrical connections to pins 2, 4, 6, 8, 10, 34, and 58 through 60.

Table 4-11 lists the required signal levels for the digital input and output pins in the DAV interface.

Table 4-11 DAV signal levels

Specification	Minimum	Maximum
Input voltage low	–0.3 V	0.8 V
Input voltage high	2.4 V	

continued

Table 4-11 DAV signal levels (continued)

Specification	Minimum	Maximum
Input current drain		± 20 µA
Output voltage low		0.4 V
Output voltage high	3.5 V	
Output current		± 400 µA

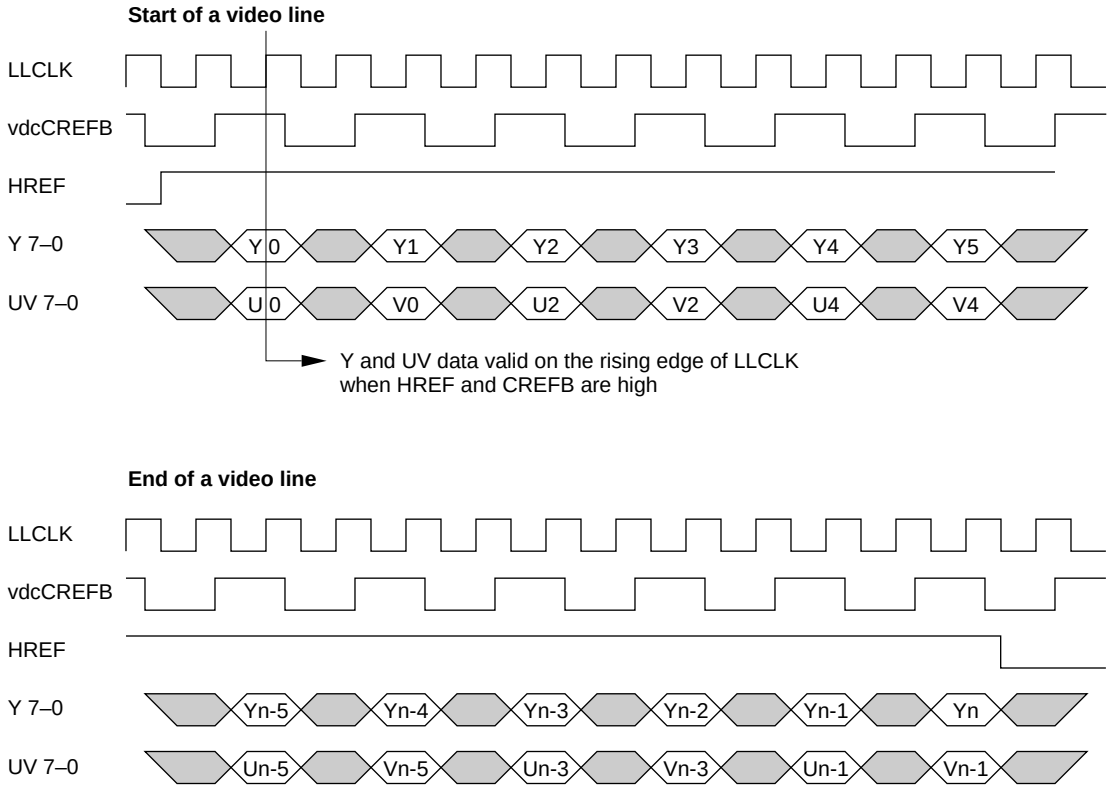
Using the YUV Bus

The video input module contains a digital video decoder and scaler (DESC), the Philips SAA7140 IC. Logic on the video input card uses the CVBS port on the DESC and pulls the FLD signal low, disabling the YUV bus. For an expansion card to use the YUV bus, the software associated with the card must set the FLD signal high so that the DESC will accept data on the YUV bus. To do that, the software can use the Cuda Dispatch Manager to issue a IIC command to write to register $E of the DESC. For information about using the registers in the DESC IC, please refer to the *SAA7140 Philips Desktop Video Handbook.*

Video Data Format

Digital video data is transmitted as lines and fields. Each line consists of an even number of samples on the Y and UV buses as shown in Figure 4-5. HREF is high during a video line and low during the horizontal blanking interval. The falling edge of the VS signal indicates the beginning of a video field. For more information about digital video data in YUV format, see the *Power Macintosh DAV Interface for PCI Expansion Cards Developer Note.*

Figure 4-5 Video data timing



The PCI Bus Communications Slot

The main logic board has a separate slot for an optional communications card. The communications slot on the Macintosh Performa 6400 computer is a PCI-bus based communications slot rather than a processor direct PDS-based communications slot like that found on the Power Macintosh 5200 and 6200 computers.

The electrical interface of the communications slot includes a parallel bus, the SCC lines, and lines for supporting modem audio. The PSX custom IC provides bus conversion from the host PowerPC 603e bus to the PCI parallel bus. Cards that use the communications slot are memory mapped into the I/O space of the Macintosh Performa 6400 computer via the parallel bus. The communications slot supports SCC port A (modem port) for a universal modem card that is compatible with both the communications slot in the Power Macintosh 5200 and 6200 computers and the PCI communications slot in the Macintosh Performa 5400 and 6400 computers.

PCI Bus Communications Slot Connector

The PCI bus based communications slot connector is a 112-pin half-height microchannel connector. A communications card mounts vertically in the connector and its I/O connector is accessed through the communications port access hole on the right hand side of the back panel. The size constraints of a communications card are 1.57 inches (40 mm) wide by 6 inches (152 mm) long.

A maximum of 2.5 watts of power is allocated to the communications slot. The maximum possible current ratings for each power line are:

Voltage	Current
+5 V	500 mA
+12 V	100 mA
Trickle +5 V	5 mA
–5 V	20 mA

Table 4-12 lists the pin assignments of the PCI bus communications slot.

Table 4-12 Pin assignments for the PCI bus communications slot connector

Odd-numbered pins	Function	Even-numbered pins	Function
1	/DCD	2	/DTR
3	/CTS	4	/RTS
5	RxD	6	TxD
7	IN_SENSE	8	SCC_ENAB
9	INT_MIC	10	MIC_SENSE
11	MIC_RET	12	EXT_AUD_L
13	Reserved	14	EXT_AUD_RET
15	GND	16	+12 V
17	-5 V	18	+12 V
19	SYS_WAKEUP	20	Trickle +5
21	GND	22	GND
23	A1	24	A0
25	A3	26	A2
27	+3.3 V	28	+3.3 V
29	A5	30	A4
31	A7	32	A6
33	+5 V	34	+5 V

continued

Table 4-12 Pin assignments for the PCI bus communications slot connector (continued)

Odd-numbered pins	Function	Even-numbered pins	Function
35	A8	36	C/BE(0)~
37	A10	38	A9
39	GND	40	GND
41	A12	42	A11
43	A14	44	A13
45	C/BE(1)~	46	A15
47	GND	48	Gnd
49	SERR~	50	PAR
51	PERR~	52	SBO~
53	LOCK~	54	SDONE
55	+3.3 V	56	+3.3 V
57	DEVSEL~	58	STOP~
59	IRDY~	60	TRDY~
61	+5 V	62	+5 V
63	C/BE(2)~	64	FRAME~
65	A17	66	A16
67	GND	68	GND
69	A19	70	A18
71	A21	72	A20
73	A23	74	A22
75	GND	76	GND
77	C/BE(3)~	78	IDSEL
79	A25	80	A24
81	A27	82	A26
83	+3.3 V	84	+3.3 V
85	A29	86	A28
87	A31	88	A30
89	+5 V	90	+5 V
91	REQ~	92	GNT~
93	+5 V	94	+5 V
95	INT~	96	Reserved

continued

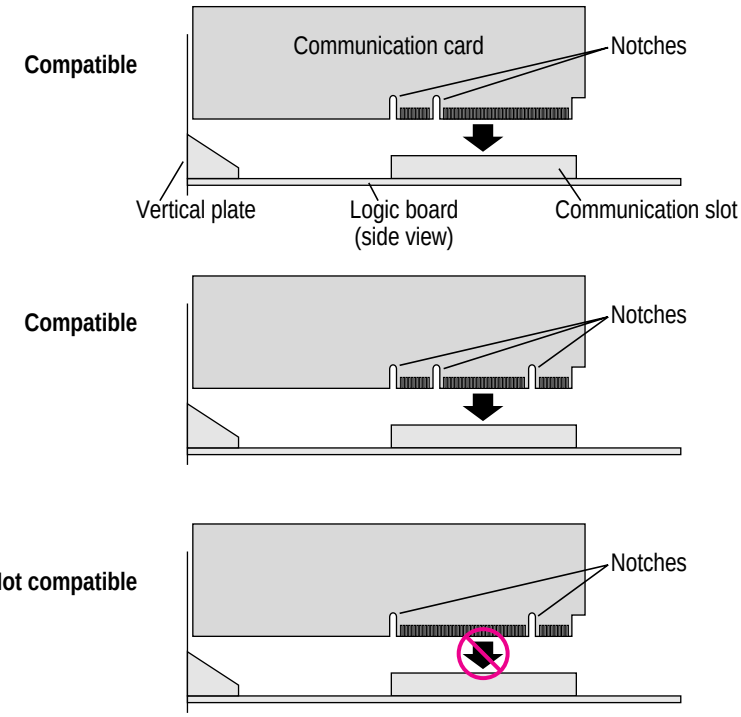
Table 4-12 Pin assignments for the PCI bus communications slot connector (continued)

Odd-numbered pins	Function	Even-numbered pins	Function
97	Reserved	98	RST~
99	GND	100	Reserved‘
101	CLK	102	Reserved
103	GND	104	Reserved
105	Reserved	106	Reserved
107	Reserved	108	Reserved
109	CommGnd	110	RefGnd
111	AudToSlot	112	AudFromSlot

Universal Serial Modem Card

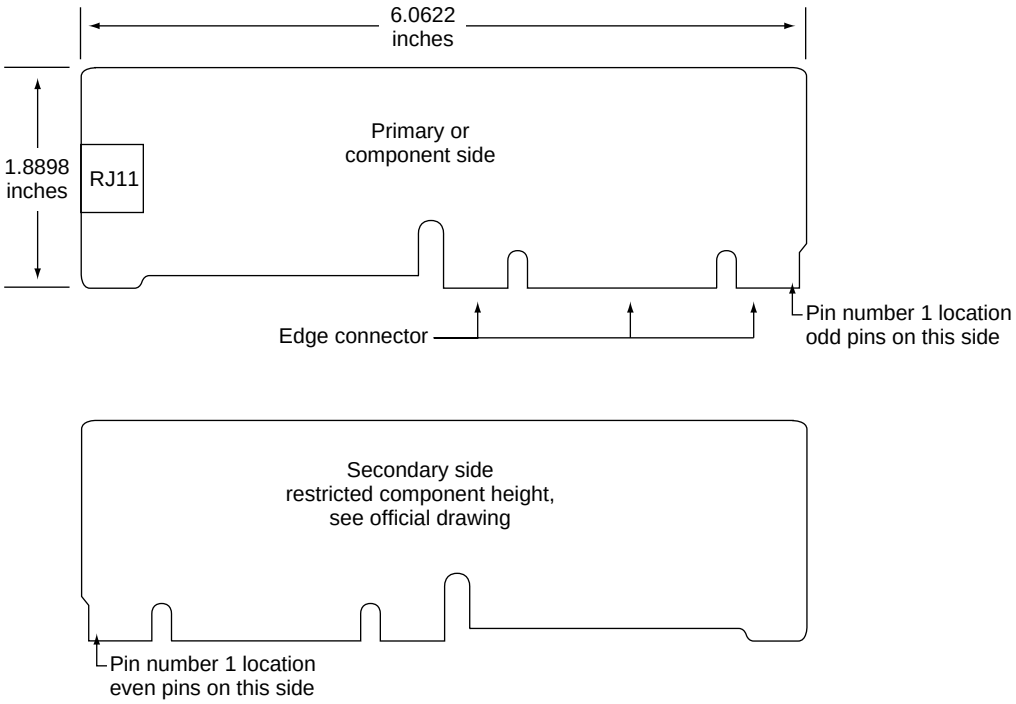
The PCI bus communications slot (comm slot II) in the Macintosh Performa 6400 computer is not compatible with cards designed only for the PDS communications slot (comm slot I) in the Power Macintosh 5200 and 6200 computers. As shown in Figure 4-6, such cards do not physically fit into the communications slot of the Macintosh Performa 6400 computer, because the communications slot is keyed at the opposite end.

Figure 4-6 Communications slot card compatibility



However, the signals on comm slot II in the Macintosh Performa 6400 computer are configured to make it possible to design a universal communications slot card that works in both comm slots if access to the parallel bus is not required (for example, a serial modem card). The power, ground, serial, and audio signals of comm slot II in the Macintosh Performa 6400 computer are located on the connector in such a way that a dual-keyed (notched) modem card will fit and operate in the communications slot of the Power Macintosh 5200, 6200, and 5400, the Macintosh LC575, LC 630, and the Macintosh Performa 6400 computer. A simplified design diagram for a dual-keyed universal modem card is shown in Figure 4-7.

Figure 4-7 Universal modem card for communications slot



IMPORTANT

Serial modem cards designed for universal operation must not attempt to access the parallel bus of either the 68030 bus or the PCI bus communications slots to be compatible in both configurations. ▲

Table 4-13 lists the pin assignments on a universal serial modem card that operates in either the 68030 bus or PCI bus communications slots. The signal assignments are the

same as those on the PCI bus communications slot, listed in Table 4-12, with the PCI bus signals removed and the key slot location added.

Table 4-13 Pin assignments for a universal serial modem card

Odd-numbered pins	Function	Even-numbered pins	Function
1	/DCD	2	/DTR
3	/CTS	4	/RTS
5	RxD	6	TxD
7	IN_SENSE	8	SCC_ENAB
9	INT_MIC	10	MIC_SENSE
11	MIC_RET	12	EXT_AUD_L
13	Not connected	14	EXT_AUD_RET
15	Gnd	16	+12 V
17	–5 V	18	Not connected
19	SYS_WAKEUP	20	Trickle+5
21	GND	22	Not connected
Key (pin 23)	Key slot (notch)	Key (pin 24)	Key slot (notch)
Key (pin 25)	Key slot (notch)	Key (pin 26)	Key slot (notch)
27	Not connected	28	Not connected
29	Not connected	30	Not connected
31	Not connected	32	Not connected
33	Not connected	34	+5V
35	Not connected	36	Not connected
37	Not connected	38	Not connected
39	Not connected	40	Not connected
41	Not connected	42	Not connected
43	Not connected	44	Not connected
45	Not connected	46	Not connected
47	GND	48	Not connected
49	Not connected	50	Not connected
51	Not connected	52	Not connected
53	Not connected	54	Not connected
55	Not connected	56	Not connected

continued

Table 4-13 Pin assignments for a universal serial modem card (continued)

Odd-numbered pins	Function	Even-numbered pins	Function
57	Not connected	58	Not connected
59	Not connected	60	Not connected
61	Not connected	62	+5 V
63	Not connected	64	Not connected
65	Not connected	66	Not connected
67	Not connected	68	Not connected
69	Not connected	70	Not connected
71	Not connected	72	Not connected
73	Not connected	74	Not connected
75	GND	76	Not connected
77	Not connected	78	Not connected
79	Not connected	80	Not connected
81	Not connected	82	Not connected
83	Not connected	84	Not connected
85	Not connected	86	Not connected
87	Not connected	88	Not connected
89	Not connected	90	+5 V
Key	Key slot (notch)	Key	Key slot (notch)
Key	Key slot (notch)	Key	Key slot (notch)
91	Not connected	92	Not connected
93	Not connected	94	Not connected
95	Not connected	96	Reserved
97	Reserved	98	RST~
99	GND	100	Reserved
101	Not connected	102	Not connected
103	GND	104	Reserved
105	Reserved	106	Reserved
107	Reserved	108	Reserved
109	CommGnd	110	RefGnd
111	AudFromSlot	112	AudToSlot

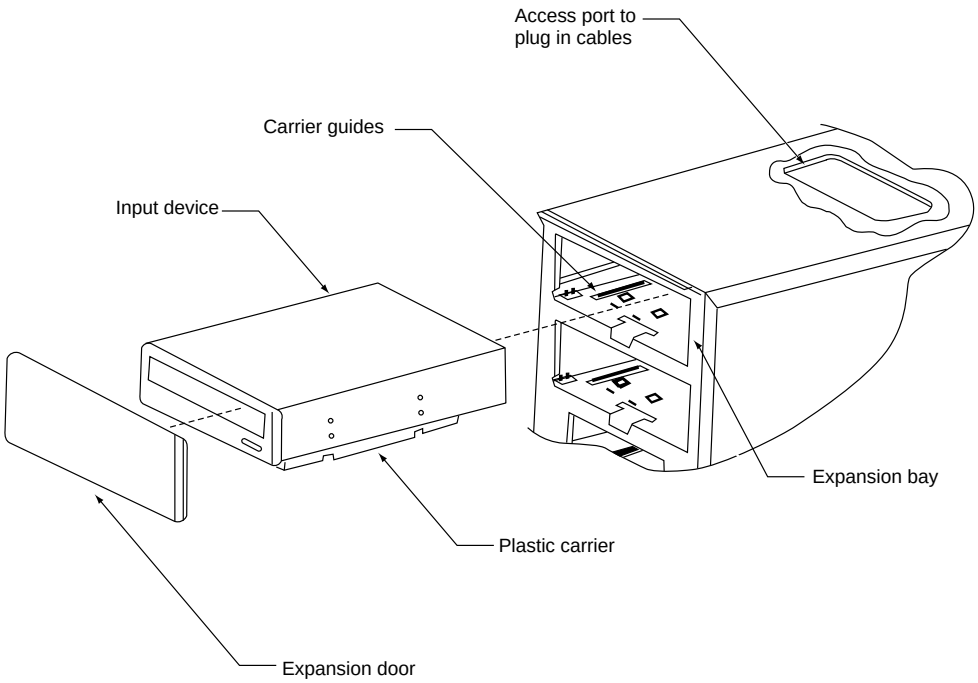
Expansion Bay for SCSI Devices

The expansion bay in the Macintosh Performa 6400 computer supports the addition of SCSI devices. The electrical and mechanical guidelines for utilizing the expansion bay are defined in this section.

Mechanical Specifications

The expansion bay, shown in Figure 4-8, is located at the top of the Macintosh Performa 6400 enclosure. It accomodates a wide range of SCSI devices with a maximum width of 5.25-inch (152.0 mm), a maximum height of 1.72 inches (43.6 mm), and a maximum length of 8.268 inches (210.0 mm).

Figure 4-8 Macintosh Performa 6400 expansion bay



Plastic Carrier

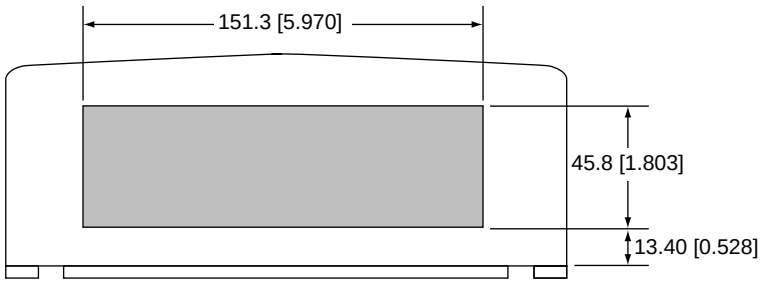
The expansion bay enclosure incorporates a carrier guide mounting mechanism that is designed to work with the Apple 5.25 plastic carrier (Apple part number 815-1122). The plastic carrier is attached to the bottom of the SCSI device. To attach the carrier to the device, the mounting holes in the plastic carrier may have to be modified to align with

the mounting holes on the SCSI device. The SCSI device with carrier slides into the enclosure and snaps into place on the carrier guide.

Expansion Bay Door

The plastic expansion bay door (Apple part number 815-2344, manufactured by Li Xin Plastic Industries, AppleLink LI.XIN) and attached EMI shield (Apple part number 805-1393, available from Allied Technologies and Shinei Sangyo in Singapore) must be modified to provide room for any opening requirements of the SCSI device to be installed. The dimensions for the maximum area on the bay door that can be modified are shown in Figure 4-9.

Figure 4-9 Maximum useable area for device opening on bay door



Connector Specifications

The expansion bay contains three connectors that are accessible through the top of the sheet metal enclosure. The connectors are a 4-pin power connector, a 50-pin SCSI connector, and a 4-pin audio connector. Each connector is on a cable at the rear of the expansion bay. You can access the connectors to connect or disconnect a SCSI device in the expansion bay by removing the top cover.

Power Connector

The power connector is a keyed 4-pin shrouded connector with four contact sockets. The pin assignments are shown in Table 4-14.

Table 4-14 Pin assignments for the expansion bay power connector

Pin number	Value
1	+12 Volts
2	+ 12 Ret
3	+5 Ret
4	+5 Volts

SCSI Connector

The SCSI connector inside the expansion bay is a 50-pin unshielded, shrouded, keyed SCSI connector. The pin assignments are the same as those listed in Table 3-7 on page 29 for the 50-pin internal SCSI connector. A terminator is also included on the cable.

Index

M, N

O

P, Q

R

S

T, U

V, W, X

Y, Z

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