Developer Note

Macintosh PowerBook 3400 Computer

Macintosh PowerBook 3400c/180
Macintosh PowerBook 3400ce/200

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About This Developer Note

This developer note is a concise description of the Macintosh PowerBook 3400 computer, with the emphasis on the features that are new or different from those of the Macintosh PowerBook 5300 computer.

This developer note is intended to help hardware and software developers design products that are compatible with the Macintosh products described in the note. If you are not already familiar with Macintosh computers or if you would simply like more technical information, you may wish to read the supplementary reference documents described in this preface.

This note is published electronically. You can obtain a copy in two ways:

- on Apple Computer's Developer World web page on the Internet, at http://devworld.apple.com/dev/devnotes/dntable1.html
- on the Reference Library Edition of the Developer CD Series, available through the *Apple Developer Catalog*.

Contents of This Note

The information in this note is arranged in five chapters.

- Chapter 1, "Introduction," introduces the PowerBook 3400 computer and describes its new features.
- Chapter 2, "Architecture,"describes the internal logic of the computer, including the main ICs that appear in the block diagram.
- Chapter 3, "I/O Features,"describes the input/output features, including both the internal I/O devices and the external I/O ports.
- Chapter 4, "Expansion Modules,"describes the expansion features of interest to developers. It includes development guides for expansion-bay devices, the RAM expansion card, the internal PCI card, and the PC Card slot.
- Chapter 5, "Software Features," describes the system software, with emphasis on new and changed features.

This developer note also contains a glossary and an index.

Supplemental Reference Documents

The following documents provide information that complements or extends the information in this developer note.

Apple Publications

For information about the PCI bus as it is supported on Macintosh desktop computers, developers should refer to *Designing PCI Cards and Drivers for Power Macintosh Computers* and to Macintosh Technote Number 1008, *Understanding PCI Bus Performance.*

For information about PC Cards and the PC Card slot, developers should have a copy of *PC Card Family Programming Interface for Mac OS.* Currently in preparation, it defines the new PC Card software model for System 7.5.3 and future releases of Mac OS.

For information about Mac OS system 7.6, the system software that accompanies the PowerBook 3400 computer, developers should refer to *TECHNOTE: System 7.6.* It is available on the Developer CD Series and on the technote web site at <http://devworld.apple.com/dev/technotes.shtml>.

Developers should also have copies of the appropriate Apple reference books, including the relevant volumes of *Inside Macintosh.* These Apple publications are available in technical bookstores and through the *Apple Developer Catalog*.

The *Apple Developer Catalog* (ADC) is Apple Computer's worldwide source for hundreds of development tools, technical resources, training products, and information for anyone interested in developing applications on Apple computer platforms. Customers receive the *Apple Developer Catalog* featuring all current versions of Apple development tools and the most popular third-party development tools. ADC offers convenient payment and shipping options, including site licensing.

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Fax	716-871-6511
AppleLink	ORDER.ADC
Internet	order.adc@applelink.apple.com

Other Publications

For information about programming the PowerPC™ family microprocessors, developers should have copies of Motorola's *PowerPC 603 RISC Microprocessor User's Manual* and *PowerPC 603ev Microprocessor Implementation Definition Book IV*.

For information about ATA devices such as the built-in IDE hard disk, developers should have access to the ATA/IDE specification, ANSI proposal X3T10/0948D, Revision 2K or later (ATA-2).

For information about the IR data link, consult the Physical Layer Standard created by the Infrared Data Association (IrDA). The standard is available on the Internet at ftp://irda.org.

For information about the PCI interface, developers should contact the PCI special interest group at

PCI-SIG
M/S HF3-15A
5200 NE Elam Young Parkway
Hillsboro, OR 97124
Phone: 508-696-2000

For information about PC Cards and the PC Card slot, developers should refer to the *PC Card Standard*. You can order that book from

Personal Computer Memory Card International Association
1030G East Duane Avenue
Sunnyvale, CA 94086
Phone: 408-720-0107
Fax: 408-720-9416

Conventions and Abbreviations

This developer note uses the following typographical conventions and abbreviations.

Typographical Conventions

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 of interest but is not essential for an understanding of the text. ◆

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

▲ **WARNING**
Warnings like this direct your attention to something that could cause injury to the user, damage to either hardware or software, or loss of data. ▲

Standard Abbreviations

Standard units of measure used in this note include

A	amperes	MHz	megahertz
dB	decibels	mm	millimeters
GB	gigabytes	ms	milliseconds
Hz	hertz	mV	millivolts
K	1024	µF	microfarads
KB	kilobytes	µW	microwatts
kbps	kilobits per second	ns	nanoseconds
kHz	kilohertz	Ω	ohms
kΩ	kilohms	pF	picofarads
M	1,048,576	V	volts
mA	milliamperes	VAC	volts alternating current
MB	megabytes	VDC	volts direct current
Mbps	megabits per second	W	watts

Other abbreviations used in this note include

$*n*	hexadecimal value *n*
AC	alternating current
ADB	Apple Desktop Bus
API	application program interface
ASIC	application-specific integrated circuit
ATA	AT attachment
ATAPI	ATA packet interface
AUI	auxiliary unit interface
BCD	binary coded decimal
BGA	ball grid array
CAS	column address strobe (a memory control signal)
CCFL	cold cathode fluorescent lamp
CD	compact disc

CIS	card information structure
CLUT	color lookup table
CMOS	complementary metal oxide semiconductor
CPU	central processing unit
DAA	data access adapter (a telephone line interface)
DAC	digital-to-analog converter
DC	direct current
DCE	device control entry (a data structure)
DDC	display data channel
DDM	driver descriptor map
DMA	direct memory access
DMF	distribution media format
DOS	disk operating system
DRAM	dynamic RAM
DSP	digital signal processor
EDO	extended data out
FIFO	first in, first out
FPU	floating-point unit
HBA	host bus adapter
IC	integrated circuit
IDE	integrated device electronics
I/O	input/output
IR	infrared
IrDA	Infrared Data Association
LCD	liquid crystal display
LS TTL	low-power Schottky TTL (a standard type of device)
MMU	memory management unit
NiCad	nickel cadmium
NiMH	nickel metal hydride
PC Card	an expansion card conforming to the specifications of the PCMCIA
PCI	Peripheral Component Interconnect, an industry-standard expansion bus
PCMCIA	Personal Computer Memory Card International Association
PDS	processor-direct slot
PGA	pin grid array
PMU	power management unit
PROM	programmable read-only memory

PWM	pulse width modulation
RAM	random-access memory
RAMDAC	random-access memory, digital to analog converter
RAS	row address strobe
RGB	red-green-blue (a type of color video system)
RISC	reduced instruction set computing
rms	root-mean-square
ROM	read-only memory
SCC	Serial Communications Controller
SCSI	Small Computer System Interface
SNR	signal-to-noise ratio
SOJ	small outline J-lead package
SOP	small outline package
SVGA	super video graphics adapter
TDM	time division multiplexing
TFT	thin-film transistor (a type of LCD)
TSOP	thin small outline package
TTL	transistor-transistor logic (a standard type of device)
VCC	positive supply voltage (voltage for collectors)
VGA	video graphics adapter
VRAM	video RAM

Introduction

The Macintosh PowerBook 3400 computer is an all-in-one notebook computer with several new features that greatly increase its performance. The PowerBook 3400 computer also has a PC Card slot, a PCI expansion slot, an improved expansion bay, a CD-ROM module, and a larger display.

Features

Here is a list of the features of the Macintosh PowerBook 3400 computer. Each feature is described in a later chapter, as indicated in the list.

- **Processor**: The PowerBook 3400 computer has a PowerPC™ 603ev microprocessor running at a clock frequency of either 180 or 200 MHz, depending on the configuration. See "Main Processor" on page 10.
- **Cache:** The computer has a 256 KB second-level (L2) cache. See "Second-Level Cache" on page 11.
- **Processor bus:** The computer's processor data bus is 64 bits wide. See "RAM" on page 11.
- **RAM:** The computer comes with 16 MB of dynamic RAM (DRAM). See "RAM" on page 11.
- **RAM expansion:** The RAM expansion card available from Apple Computer provides 16 MB of additional RAM for a total of 32 MB. A RAM expansion card can contain up to 128 MB of RAM for a total of 144 MB of RAM. See "RAM Expansion" beginning on page 76.
- **Hard disk:** The computer has an internal 2.5-inch IDE hard disk drive with a storage capacity of 1.3 or 2 GB. See "Internal ATA Hard Disk Drive" on page 18.
- **Disk mode:** With an optional HDI-30 SCSI Disk Adapter cable, the computer allows the user to read and store data on the computer's internal hard disk from another Macintosh computer.
- **CD-ROM:** Some configurations come with a 6x-speed CD-ROM module in the expansion bay.
- **Floppy disk:** A 1.4-MB DOS-compatible floppy-disk drive is installed in the expansion bay.
- **Display:** The computer has a 12.1-inch color flat panel display with SVGA resolution (800 by 600 pixels). The display is backlit by a cold cathode fluorescent lamp (CCFL). See "Flat Panel Display" beginning on page 23.
- **Video output:** The computer has built-in support for an external video monitor. The computer works with VGA or SVGA monitors and can display up to 1024 by 768 pixels. With an adapter cable, the computer can also support all Apple monitors, including the 17-inch and 20-inch multiple scan displays. See "External Video Monitor" beginning on page 24.
- **PCI expansion slot:** The computer has an internal slot that accepts a plug-in card using the PCI expansion bus. See "PCI Expansion Slot" beginning on page 36.

- **Expansion bay:** The computer has an opening that accepts a plug-in module with either a 5.25-inch CD-ROM drive, a 1.4-MB DOS-compatible floppy-disk drive, some other IDE storage device, or a power device such as an AC adapter. The expansion bay accepts expansion modules that use the PCI expansion bus; it can also accept the 3.5-inch expansion modules designed for the PowerBook 5300 and 190 computers. See "Expansion Bay" beginning on page 53.
- **PC Card slot:** The computer accepts one Type III or two Type II PC Cards (PCMCIA). The lower socket is compatible with zoom video. See "Zoom Video" on page 86.
- **Standard I/O ports:** The computer has all the standard Macintosh inputs and outputs. The I/O ports are an HDI-30 connector for external SCSI devices, a 4-pin mini-DIN Apple Desktop Bus (ADB) port, a 9-pin mini-DIN serial port, stereo audio input and output jacks, and a VGA-type video output connector. See Chapter 3, "I/O Features."
- **DMA:** The computer supports DMA operation on the following I/O devices: sound input and output, internal ATA hard disk, ATA CD-ROM, SCSI devices, and floppy disk drive.
- **Networking:** The computer has a built-in LocalTalk network interface. See "Serial Port" on page 27. Most configurations come with either a combination ethernet and modem card in the PCI expansion slot or an ethernet card in the PCI slot and a modem card in the PC Card slot. See "Ethernet and Modem Cards" on page 33.
- **Sound:** The computer has a built-in microphone and speakers as well as a line-level input jack and a stereo headphone jack. See "Sound System" on page 31.
- **Keyboard:** The keyboard design provides 76 (United States) or 77 (ISO) keys, including 12 function keys. See "Keyboard" on page 22.
- **Trackpad:** The integrated flat pad includes new features: tap/double tap and drag. See "Trackpad" on page 22.
- **Infrared link:** The computer has an infrared module that can communicate with other IR-equipped devices at speeds up to 1.152 Mbps. See "Infrared Communication Link" on page 30.
- **Modem:** Some configurations include a PCI card with a modem and ethernet interface. See "Ethernet and Modem Cards" on page 33.
- **Batteries:** The computer has space for one Macintosh PowerBook Intelligent Battery. Batteries of different weights, capacities, and technologies will be available from Apple and from other vendors.
- **Power supply:** The computer comes with a 45 watt external recharger/power adapter that accepts any worldwide standard voltage from 100–240 VAC at 50–60 Hz.
- **Security connector:** The computer has a connector on the side panel that allows users to attach a security device. The security device also secures the battery and any module in the expansion bay.
- **Weight:** The computer weighs 6.7 pounds with the battery and with a PC Card holder installed in the expansion bay. With a floppy-disk drive in the expansion bay, the computer weighs 7.1 pounds.
- **Size:** The computer is 11.5 inches wide, 9.4 inches deep, and 2.4 inches high.

Appearance

The Macintosh PowerBook 3400 computer has a streamlined case that opens up like a clamshell. The case is a new design with more flexibility than earlier PowerBook models. Figure 1-1 shows a front view of the computer; Figure 1-2 shows a back view.

Figure 1-1 Front view of the computer

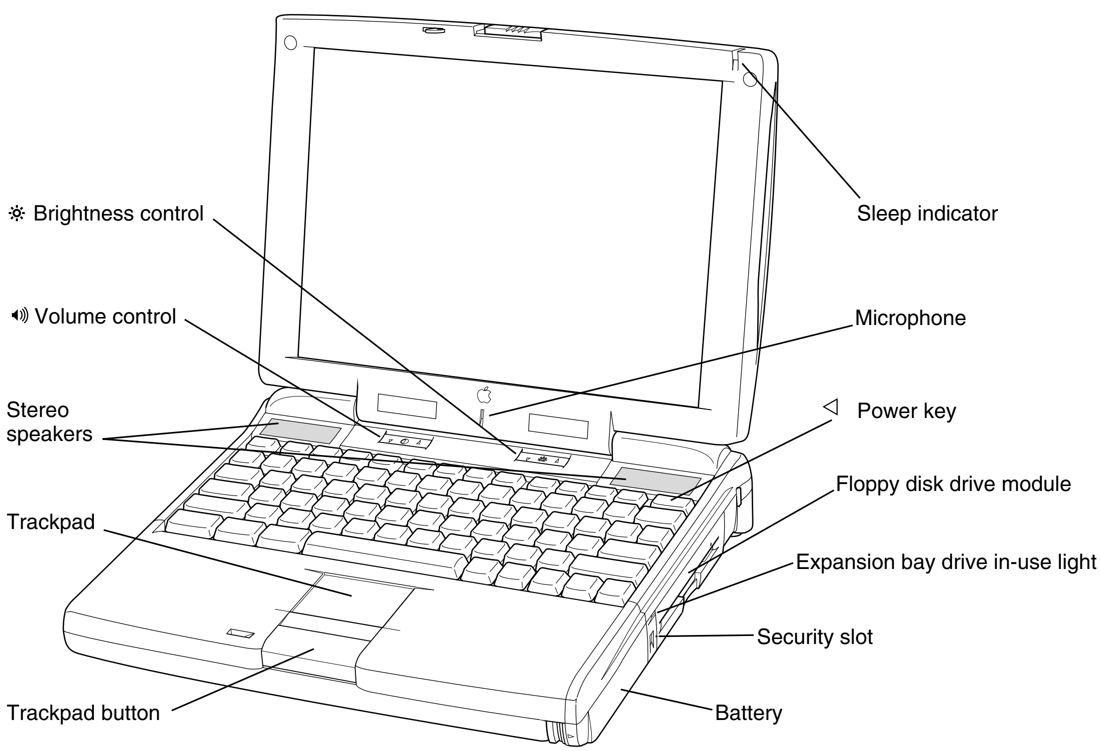
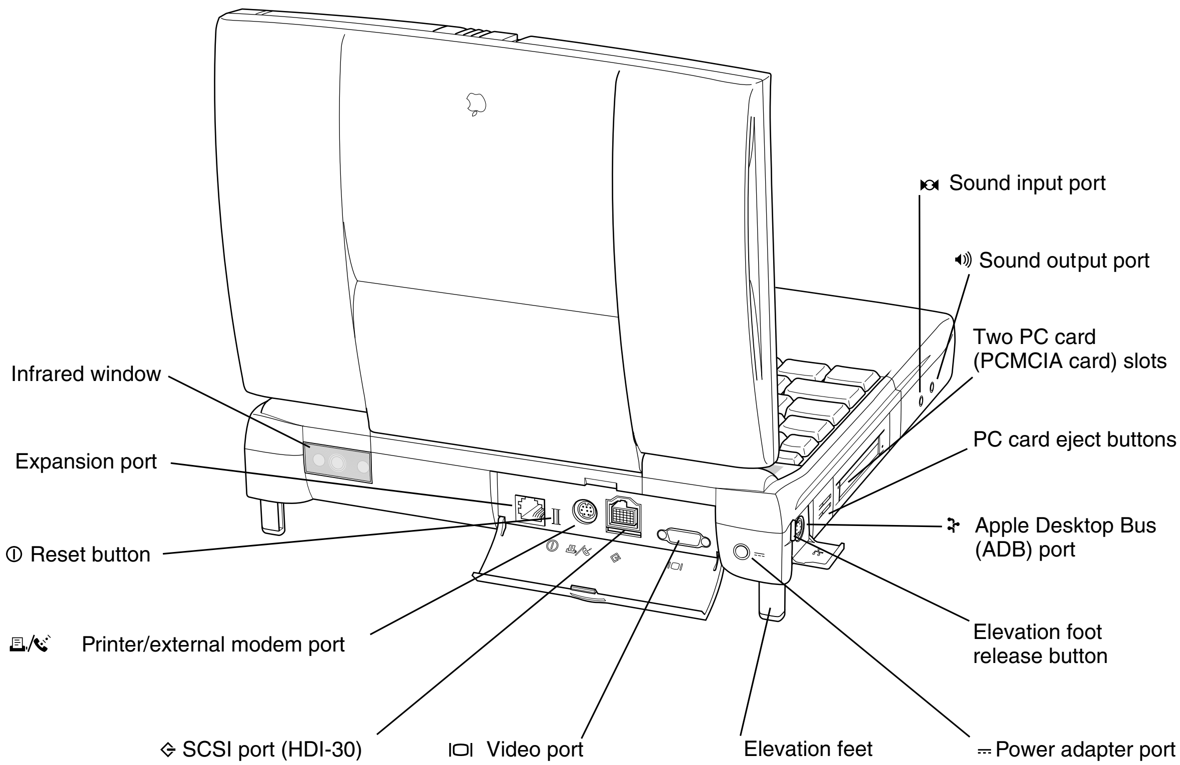


Figure 1-2 Back view of the computer



Configurations

Table 1-1 lists the configurations of the PowerBook 3400 computer. All configurations include 16 MB of RAM and a 12.1-inch color display with active-matrix technology.

Table 1-1 Configurations

Model	Regions	Clock speed	Hard disk	CD-ROM	Ethernet
PowerBook 3400c/180	US and Pacific	180 MHz	1.3 GB	no	no
PowerBook 3400c/180	US and Pacific	180 MHz	1.3 GB	yes	yes (PCI)
PowerBook 3400ce/200	US and Pacific	200 MHz	2 GB	yes	yes (PCI)
PowerBook 3400c/180	Europe	180 MHz	1.3 GB	yes	yes (PCI)
PowerBook 3400ce/200	Europe	200 MHz	2 GB	yes	yes (PCI)

Peripheral Devices

In addition to the devices that are included with the PowerBook 3400 computer, several peripheral devices are available separately:

- The Macintosh PowerBook 16 MB Memory Expansion Card expands the RAM in the computer to 32 MB.
- The Macintosh PowerBook 6x-speed CD-ROM drive module, which fits into the expansion bay, is available separately for models that do not include it.
- The Macintosh PowerBook Intelligent Battery is available separately as an additional or replacement battery.
- The Macintosh PowerBook 45W AC Adapter, which comes with the computer, is also available separately. The adapter can recharge the internal battery in just four hours while the computer is running or two hours while the computer is shut down or in sleep mode.

Compatibility Issues

The Macintosh PowerBook 3400 computer incorporates several significant changes from the earlier PowerBook 5300 computer. This section highlights key areas you should investigate in order to ensure that your hardware and software work properly with the new PowerBook model. These topics are covered in more detail in subsequent sections.

Internal PCI Bus

The I/O subsystem in the PowerBook 3400 computer is entirely different from the one in the PowerBook 5300. It is similar to the I/O subsystem in the Power Macintosh 7500, 8500, and 9500 and runs at the same speed: 33 MHz.

Enhanced Trackpad

The trackpad in the PowerBook 3400 computer is similar to the one in the Macintosh PowerBook Duo 2300 and includes the tap, double-tap, and drag functions.

Open Transport

The system software supplied with the PowerBook 3400 includes Open Transport networking only. While the Open Transport software supports existing network device drivers in compatibility mode, developers may wish to write new higher-performance drivers for use with Open Transport.

Note
The new TCP/IP control panel supports Open Transport; the older MacTCP control panel does not. ◆

PC Card Software

The PowerBook 3400 computer comes with a new version of the PC Card software. See "PC Card Software" on page 87.

C H A P T E R 2

Architecture

The architecture of the Macintosh PowerBook 3400 computer is designed around two main buses: the processor bus and the PCI bus. The processor bus operates at 40 MHz, a submultiple of the microprocessor's clock speed. The PCI bus operates at 33 MHz. An Apple custom IC called the PSX IC acts as the bridge between the two buses. The input and output devices are connected by way of the PCI bus.

The block diagram in Figure 2-1 shows how the devices are connected to the buses.

Processor Bus

The devices on the processor bus include the PowerPC 603ev microprocessor, the second-level cache, the main RAM, and the ROM. An optional RAM expansion card can be plugged into the main logic board and is connected to the processor bus. The PSX custom IC is also connected to the processor bus and provides the interface to the PCI bus.

Main Processor

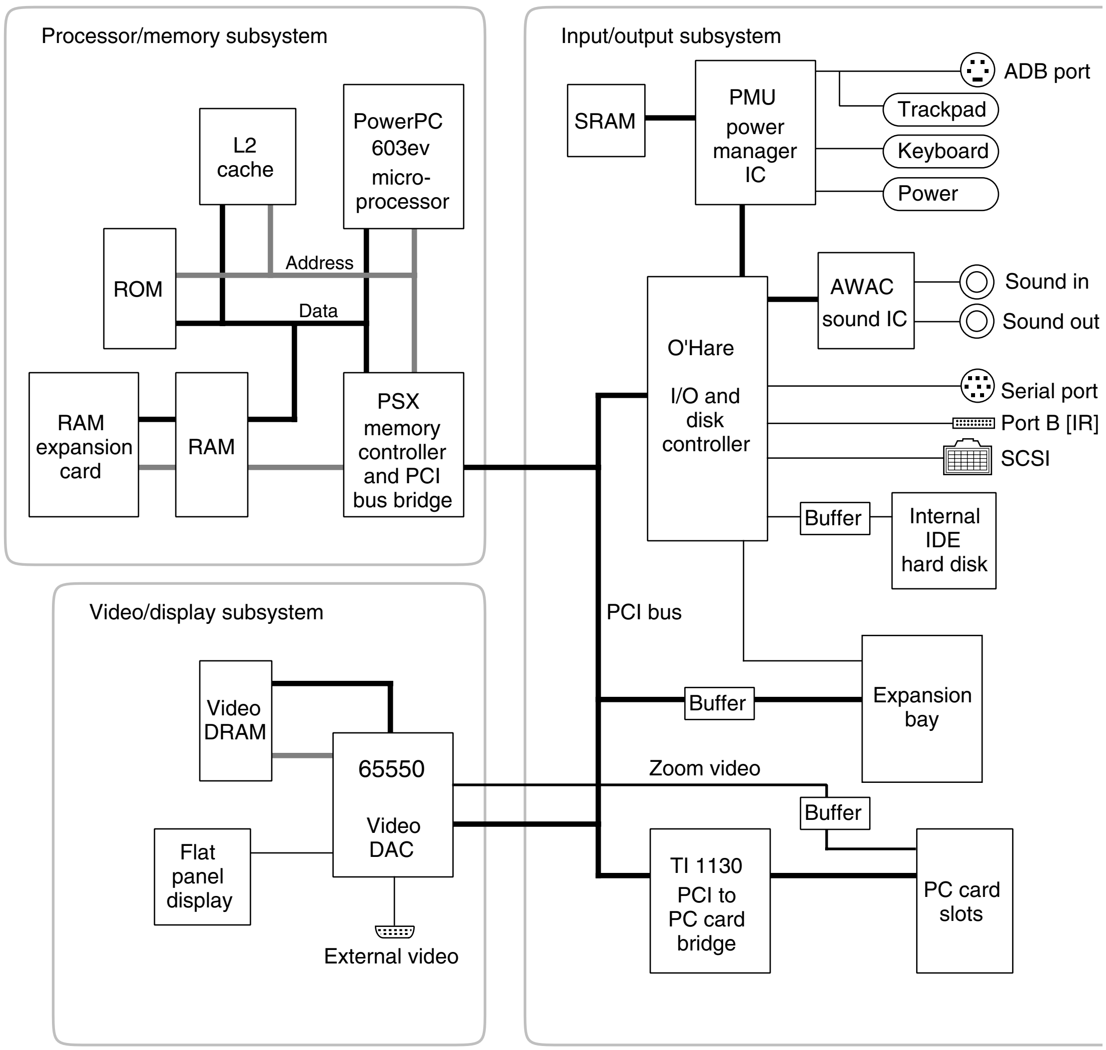
The main processor in the PowerBook 3400 computer is a PowerPC 603ev microprocessor, an enhanced version of the PowerPC 603. Its principal features include

- RISC processing architecture
- a load-store unit that operates in parallel with the processing units
- a branch manager that implements branches by reloading the incoming instruction queue, usually without using any processing time
- two internal memory management units (MMU), one for instructions and one for data
- two 16 KB on-chip caches for data and instructions

For technical details, please refer to the reference books listed in the preface.

The PowerPC 603ev microprocessor in the PowerBook 3400 computer normally runs at a clock speed of 180 or 200 MHz. The microprocessor's clock speed is locked at 4.5 or 5 times the processor bus's clock speed, which is 40 MHz.

Figure 2-1 Block diagram



Second-Level Cache

The PowerBook 3400 computer has a second-level (L2) cache with of 256 KB of fast static RAM. The L2 cache is a look-aside cache implemented in a single BGA package that includes the cache controller, tag RAM, and data RAM.

RAM

The PowerBook 3400 computer has 16 MB of dynamic RAM (DRAM) on the main logic board. The RAM ICs are low-power, non-self-refreshing, EDO type with an access time of 70 ns.

An optional RAM expansion card plugs into a 120-pin connector on the logic board. The RAM expansion card can contain up to 128 MB of RAM for a total of up to 144 MB of RAM. See the section “RAM Expansion” beginning on page 76 for details.

Note
The RAM expansion card for the PowerBook 3400 computer is a new design. The RAM expansion cards used in earlier PowerBook models will not work in the PowerBook 3400. ◆

The memory data bus (part of the processor bus) is 64 bits wide. The on-board RAM and the expansion RAM are connected to the memory data bus through low-power bus buffers. Microprocessor accesses to RAM and ROM are typically burst accesses and are cached.

Memory control is provided by the PSX custom IC, which has a memory bank decoder in the form of an indexed register file. By writing the appropriate values into the register file at startup time, the system software makes the memory addresses contiguous from $0000 0000 even if some banks are not populated. See “PSX Memory Controller and Bridge IC.”

ROM

The ROM in the PowerBook 3400 computer consists of 4 MB of storage on a data bus that is 64 bits wide. The ROM is implemented as a 512K by 64-bit array consisting of four 512K by 16-bit ROM ICs. The ROM devices support burst mode for better processor access.

PSX Memory Controller and Bridge IC

The PSX IC is an Apple custom IC that provides RAM and ROM memory control and also acts as the bridge between the processor bus and the PCI 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 “Address Multiplexing” on page 80.

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.

PCI Bus

The PCI bus connects the following devices:

- the PSX IC that provides the bridge to the processor bus, already described
- the O'Hare peripheral support IC
- the display controller IC (Chips and Technologies 65550)
- the PCI to PC Card bridge IC (TI 1130) that controls the PC Card sockets

The PCI bus also connects to the internal expansion slot and the expansion bay. See the sections "PCI Expansion Slot" beginning on page 36 and "Expansion Bay" beginning on page 53 for details.

O'Hare Peripheral Support IC

The O'Hare IC 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.

The O'Hare IC provides the interface between the PCI bus and the I/O device controllers. The O'Hare IC uses three clocks:

- 33 MHz PCI bus clock
- 45 MHz sound device clock
- 31.33 MHz I/O device clock

The O'Hare IC derives other clock signals from these three.

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
- two ATA bus interfaces with DMA
- sound control logic and buffers

The SCC section of the O'Hare includes 8-byte FIFO buffers for both transmit and receive data streams. The O'Hare IC supports DMA transfers between its I/O ports and the computer's main memory.

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

- PMU microcontroller IC

- AWAC sound amplifier and codec IC
- ATA and floppy disk devices in the expansion bay

The O'Hare IC controls the power to the expansion bay and the signals that allow the user to insert a device into the expansion bay while the computer is operating. Those signals are fully described in the section "Expansion Bay" beginning on page 53.

The O'Hare IC controls the interface for both the internal ATA hard disk drive and a possible second ATA drive in the expansion bay. For information about the internal ATA drive see the section "Internal ATA Hard Disk Drive" beginning on page 18. For information about the ATA drive signals in the expansion bay, see the section "PCI Signals on the Expansion Bay Connector," particularly Table 4-4 on page 67.

The O'Hare IC also handles the signals to a floppy disk drive installed in the expansion bay. For more information, see the section "PCI Signals on the Expansion Bay Connector," particularly Table 4-4 on page 67.

The floppy disk drive for the PowerBook 3400 computer is an Apple drive with auto eject. The control signals are generated by the O'Hare custom IC.

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 a 24 MHz clock. The SCC circuitry supports GeoPort and LocalTalk protocols.

AWAC Sound IC

The audio waveform amplifier and converter (AWAC) 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 a description of the operation of the AWAC IC, see *Power Macintosh DAV Interface for PCI Expansion Cards*. For information about sound inputs and outputs in this computer, see the section "Sound System" beginning on page 31.

Note
The AWAC IC is also used in the Power Macintosh 6000, 7000, and 8000 series desktop computers. ◆

Power Management Unit

The power management unit (PMU) is a 68HC05 microprocessor that operates with its own RAM and ROM. The PMU IC performs the following functions:

- controls sleep and power on and off sequences
- controls power to the other ICs

- controls clock signals to the other ICs
- supports the ADB
- scans the keyboard
- controls display brightness
- monitors battery charge level
- controls battery charging

Display Controller IC

The Chips and Technologies 65550 IC controls both the flat panel display and the external video monitor. It is set up to address 1 MB of video RAM.

The components of the display controller IC include

- 256-entry CLUT (color lookup table) in RAM
- display buffer controller with hardware cursor support
- flat panel control circuits
- zoom video support

The display controller IC also includes a zoom video input that accepts video information directly from a PC Card. The video controller performs scaling and video merging in hardware, so the zoom video feature provides full-motion video at the same time the computer is performing other tasks. See "Zoom Video" on page 86.

The processor in the display controller IC is capable of providing graphics acceleration for certain QuickDraw operations.

PC Card Bridge IC

The TI 1130 IC provides the bridge between the PCI bus and the PC Card sockets. The TI 1130 IC performs the following functions

- provides the interrupt structure for the PC Card sockets
- transfers single-byte and word data to and from the PC Cards
- manages power for the PC Cards, including
  - sleep mode
  - control of power to individual sockets
  - support of insertion and removal of PC Cards while the computer is operating

For more information about the operation of PC Cards in the PowerBook 3400 computer, see "PC Card Expansion" on page 85.

C H A P T E R 3

I/O Features

This chapter describes both the built-in I/O devices and the interfaces for external I/O devices. It also contains descriptions of the Ethernet cards installed in the PCI expansion slot in some configurations.

This chapter describes the following I/O ports and devices:

- internal ATA hard disk drive
- built-in trackpad
- built-in keyboard
- built-in flat panel display
- built-in video for an external monitor
- serial port
- SCSI port
- Apple Desktop Bus (ADB) port
- infrared (IR) communication link
- sound system
- PCI cards for Ethernet and modem

Internal ATA Hard Disk Drive

The Macintosh PowerBook 3400 computer has an internal hard disk that uses the standard IDE (integrated drive electronics) interface. This interface, used for IDE drives on IBM AT–compatible computers, is also referred to as the ATA interface. The implementation of the ATA interface on the PowerBook 3400 computer is a subset of the ATA/IDE specification, ANSI proposal X3T10/0948D, Revision 2K (ATA-2).

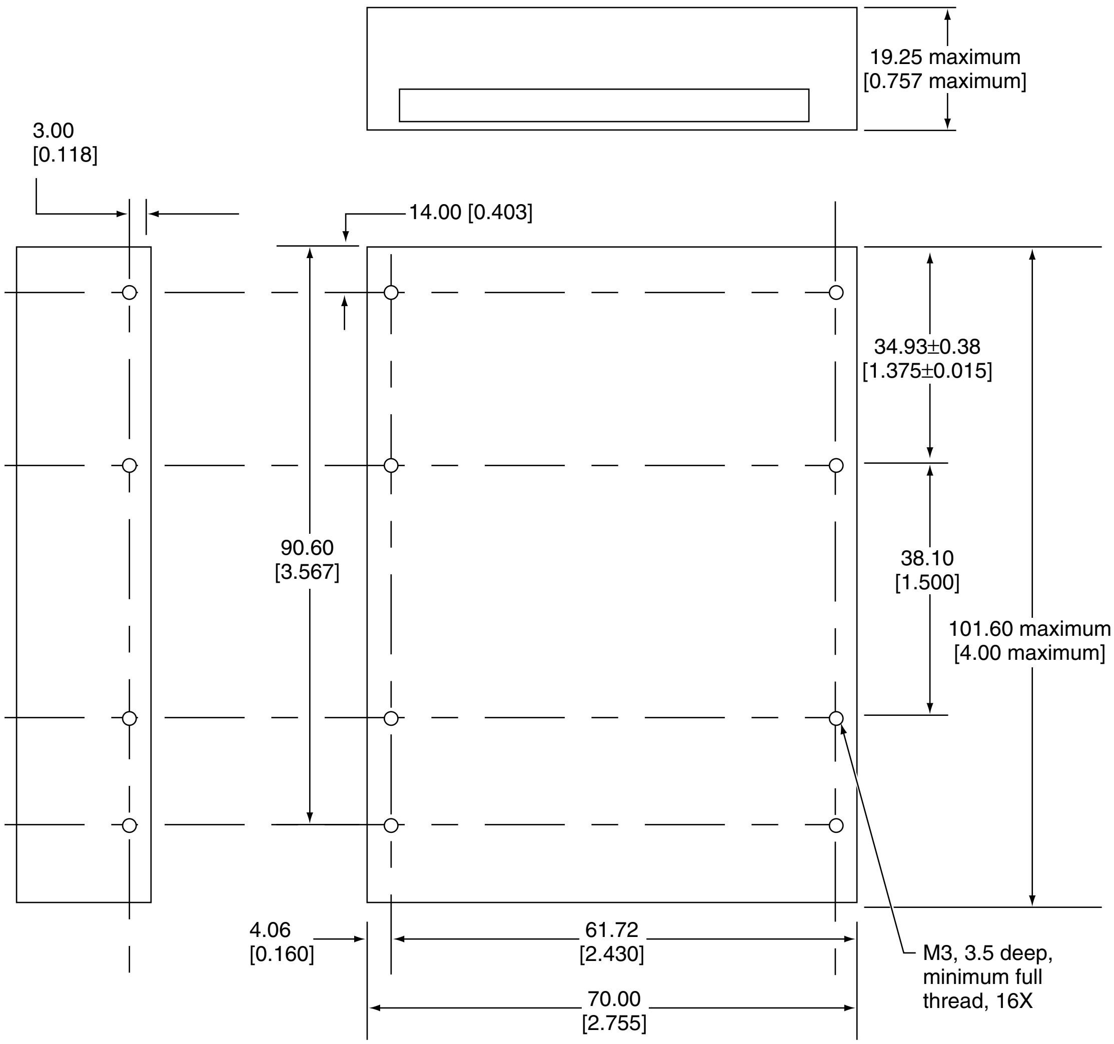
The software that supports the internal hard disk is the same as that in previous Macintosh PowerBook models with internal IDE drives except that DMA support has been added. For a complete description of that software, see “Software for ATA Devices” in *Macintosh Developer Note Number 14.*

Hard Disk Specifications

Figure 3-1 shows the maximum dimensions of the hard disk and the location of the mounting holes. For more flexibility in the choice of hard disk drives, the PowerBook 3400 computer has more mounting holes than earlier PowerBook computers.

The minimum clearance between any conductive components on the drive and the bottom of the mounting envelope is 0.5 mm.

Figure 3-1 Maximum dimensions of the internal ATA hard disk

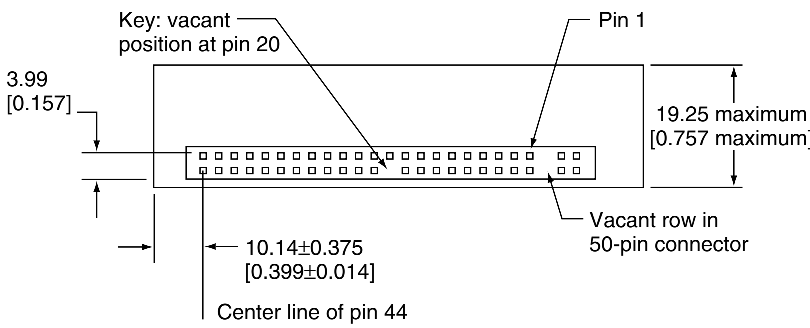


Note: Dimensions are in millimeters [inches].

Hard Disk Connector

The internal hard disk has a 48-pin connector that carries both the ATA signals and the power for the drive. The connector has the dimensions of a 50-pin connector, but with one row of pins removed, as shown in Figure 3-2. The remaining pins are in two groups: pins 1–44, which carry the signals and power, and pins 46–48, which are reserved. Pin 20 has been removed, and pin 1 is located nearest the gap, rather than at the end of the connector.

Figure 3-2 Connector for the internal ATA hard disk



Note: Dimensions are in millimeters [inches].

Signal Assignments

Table 3-1 shows the signal assignments on the 44-pin portion of the hard disk connector. A slash (/) at the beginning of a signal name indicates an active-low signal.

Table 3-1 Pin assignments on the ATA 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	DMARQ	22	GROUND
23	/DIOW	24	GROUND
25	/DIOR	26	GROUND
27	IORDY	28	CSEL
29	/DMACK	30	GROUND

continued

Table 3-1 Pin assignments on the ATA hard disk connector (continued)

Pin number	Signal name	Pin number	Signal name
31	INTRQ	32	/IOCS16
33	DA1	34	/PDIAG
35	DA0	36	DA2
37	/CS0	38	/CS1
39	/DASP	40	GROUND
41	+5V LOGIC	42	+5V LOGIC
43	GROUND	44	Reserved

NOTE CSEL, /DASP, /IOCS16, and /PDIAG are not used; see Table 3-2

ATA Signal Descriptions

Table 3-2 describes the signals on the ATA hard disk connector.

Table 3-2 Signals on the ATA hard disk connector

Signal name	Signal description
DA(0–2)	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)	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	Register select signal. It is asserted low to select the main task file registers. The task file registers indicate the command, the sector address, and the sector count.
/CS1	Register select signal. It is asserted low to select the additional control and status registers on the ATA drive.
CSEL	Cable select; not available on this computer (n.c.).
/DASP	Device active or slave present; not available on this computer (n.c.).
IORDY	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	I/O channel select; not used on this computer (pulled low by 1 kΩ).
/DIOR	I/O data read strobe.
/DIOW	I/O data write strobe.

continued

Table 3-2 Signals on the ATA hard disk connector (continued)

Signal name	Signal description
/DMACK	Used by the host to initiate a DMA transfer in response to DMARQ.
DMARQ	Asserted by the device when it is ready to transfer data to or from the host.
INTRQ	Interrupt request. This active high signal is used to inform the computer that a data transfer is requested or that a command has terminated.
/PDIAG	Asserted by device 1 to indicate to device 0 that it has completed the power-on diagnostics; not available on this computer (n.c.).
/RESET	Hardware reset to the drive; an active low signal.
Key	This pin is the key for the connector.

The built-in ATA devices and ATA devices in the expansion bay are separately connected to the I/O bus through bidirectional bus buffers.

Trackpad

The pointing device in the PowerBook 3400 computer is a trackpad, an integrated flat pad that replaces the trackball used in some earlier PowerBook computers. The trackpad provides precise cursor positioning in response to motions of the user's fingertip over the surface of the pad. A single button below the trackpad is used to make selections.

The trackpad is a solid-state device that emulates a mouse by sensing the motions of the user's finger over its surface and translating those motions into ADB commands. The trackpad is lighter and more durable than the trackball used in earlier PowerBook computers, and it consumes less power.

The trackpad includes tap and double tap features. As described in the user's manual, the trackpad responds to one or two taps on the pad itself as one or two clicks of the button. The user can tap and drag on the trackpad in much the same manner as clicking and dragging with the mouse.

Keyboard

The keyboard provides 76 (United States) or 77 (ISO) keys, including 12 function keys. Figure 3-3 shows the version of the keyboard used on machines sold in the United States. Figure 3-4 shows the version of the keyboard used on machines sold in countries that require the ISO standard.

Figure 3-3 Keyboard, United States layout

Figure 3-4 Keyboard, ISO layout

The keyboard is attached to the computer's case by screws. After removing the screws, the user can remove the keyboard and lift it out to obtain access to the internal components and expansion connectors inside the computer.

Flat Panel Display

The PowerBook 3400 computer has a built-in color flat panel display. The display is 12.1 inches across (measured diagonally) and is backlit by a cold cathode fluorescent lamp (CCFL). The display contains 800 by 600 pixels and can show up to thousands of colors.

The display uses active matrix (TFT) technology for high contrast and fast response.

External Video Monitor

The PowerBook 3400 computer has a built-in connector for an external video monitor. The connector is a standard DB9/15 connector for use with a VGA or SVGA monitor. An optional adapter allows the user to attach a standard Apple video cable.

Monitors Supported

With the adapter, the computer can display on any Apple monitor, including the AV monitors and the 17-inch and 20-inch multiple scan monitors. The computer also supports VGA and SVGA monitors and PAL and NTSC television monitors, as shown in Table 3-3.

The computer includes 1 MB of DRAM, which enables it to support up to 16 bits per pixel on most monitors and up to 8 bits per pixel on the larger monitors. Table 3-3 lists the pixel depths supported for each type of monitor.

Table 3-3 Monitors and pixel depths supported

Monitor type	Resolution	Bits per pixel
12-inch color	512 by 384	1, 4, 8, 16, 24
12-inch monochrome	640 by 480	1, 4, 8
13-inch and 14-inch color	640 by 480	1, 4, 8, 16
VGA and SVGA	640 by 480*	1, 4, 8, 16
SVGA	800 by 600	1, 4, 8, 16
SVGA	1024 by 768	1, 4, 8
Full-page monochrome	640 by 870	1, 4, 8
Full-page color	640 by 870	1, 4, 8
16-inch color	832 by 624	1, 4, 8
Apple 15-inch multiple scan	640 by 480	1, 4, 8, 16
Apple 15-inch multiple scan	800 by 600*	1, 4, 8, 16
Apple 15-inch multiple scan	832 by 624	1, 4, 8
Apple 17-inch multiple scan	640 by 480	1, 4, 8, 16
Apple 17-inch multiple scan	800 by 600*	1, 4, 8, 16
Apple 17-inch multiple scan	832 by 624	1, 4, 8
Apple 17-inch multiple scan	1024 by 768	1, 4, 8

continued

Table 3-3 Monitors and pixel depths supported (continued)

Monitor type	Resolution	Bits per pixel
Apple 20-inch multiple scan	640 by 480	1, 4, 8, 16
Apple 20-inch multiple scan	800 by 600*	1, 4, 8, 16
Apple 20-inch multiple scan	832 by 624	1, 4, 8
Apple 20-inch multiple scan	1024 by 768	1, 4, 8
NTSC TV monitor	512 by 384*	1, 4, 8, 16, 24
NTSC TV monitor	640 by 480	1, 4, 8, 16
PAL TV monitor	640 by 480*	16 only
PAL TV monitor	768 by 576	1, 4, 8, 16

NOTE An asterisk indicates the startup resolution. Other resolutions can be selected using the Monitors control panel or the control strip.

Note
The computer does not provide a display with 2 bits per pixel. ◆

For multiple scan monitors, Table 3-3 indicates the default resolution with an asterisk. For example, when first connected to the computer, an SVGA monitor's display resolution will be 640 by 480 pixels. The user can switch to a higher resolution by using the Monitors control panel or the control strip. The resolution set by the user will be used the next time the computer is started up.

If the external monitor can display 800 by 600 pixels at 60 Hz, the PowerBook 3400 computer can display simultaneously on both the external monitor and the flat panel display. This mode of display, called *Simulscan*, provides the same information on both displays.

Video Connector

The video connector is a standard DB9/15 connector. Figure 3-5 shows the pin configurations of the DB-9/15 connector. Table 3-4 lists the signal pin assignments.

Figure 3-5 Signal pins on the video connector

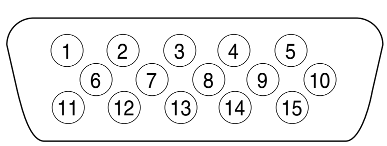


Table 3-4 Signals on the video connector

Pin	Signal name	Description
1	RED	Red video signal
2	GREEN	Green video signal
3	BLUE	Blue video signal
4	MONID(0)	Monitor ID signal 0
5	GND	DDC return
6, 7, 8	AGND_VID	Analog video ground
9	+5V_IO	5 V power for I/O device
10	GND	HSYNC and VSYNC ground
11	VGA_ID	VGA ID signal
12	MONID(2)	Monitor ID signal 2
13	HSYNC	Horizontal synchronization signal
14	VSYNC	Vertical synchronization signal
15	MONID(1)	Monitor ID signal 1

Video Adapter

An optional video adapter allows the user to connect a standard Apple video cable to the computer. The adapter is similar to another video adapter used with older Macintosh PowerBooks. It is a different color—granite—and it enables the PowerBook 3400 computer to recognise a wider range of monitor types. The Apple part number for the new adapter is 590-0289-A.

Monitor Sense Codes

To identify the type of monitor connected, the computer first determines whether the adapter is connected. It does this by checking pin 11; on the new adapter, this pin is connected to the VSYNC signal. If the adapter is not found, the computer next checks to determine whether a DDC-type monitor is connected. DDC is the interface that provides monitor ID signals for VGA and SVGA monitors.

If the computer does not detect a DDC-capable monitor, it uses the Apple monitor sense codes on the signals MONID(0–2) in Table 3-4. Table 3-5 shows the sense codes and the extended sense codes for each of the monitors the card can support. Refer to the Macintosh Technical Note *M.HW.SenseLines* for a description of the sense code system.

Table 3-5 Monitor sense codes

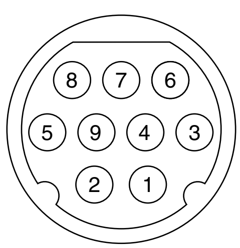
Monitor type	Standard sense codes	Extended sense codes		
	(2–0)	(1, 2)	(0, 2)	(0, 1)
12-inch RGB	0 1 0	n.a.	n.a.	n.a.
13-inch RGB	1 1 0	n.a.	n.a.	n.a.
Portrait	0 0 1	n.a.	n.a.	n.a.
16-inch RGB	1 1 1	1 0	1 1	0 1
17-inch multiscan	1 1 0	1 1	0 1	0 0
VGA and SVGA	1 1 1	0 1	0 1	1 1
No monitor	1 1 1	1 1	1 1	1 1

Note
Both VGA and SVGA monitors have the same sense code. The first time the user starts up with an SVGA monitor, the video card treats it as a VGA monitor and shows a 640-by-480 pixel display. The user can switch to the 800-by-600 pixel mode from the Monitors control panel; when that happens, the computer changes the display to the 800-by-600 pixel mode immediately and uses that mode the next time it is started up. ◆

Serial Port

The PowerBook 3400 computer has a standard Macintosh serial port. The 9-pin circular mini-DIN socket on the back panel is the same as those on other Macintosh computers. The serial port socket accepts either 8-pin or 9-pin plugs. Figure 3-6 shows the connector.

Figure 3-6 Serial port connector



The serial port can be programmed for asynchronous or synchronous communication formats up to 4 Mbps, including AppleTalk and the full range of Apple GeoPort protocols. With an external module connected to the serial port, the computer can communicate with a variety of ISDN and other telephone transmission facilities. For more information, refer to Macintosh Technote Number 1018, *Serial DMA*.

Table 3-6 shows the signal assignments for the serial port.

Table 3-6 Pin assignments on the serial port connector

Pin	Name	Function
1	HSKo	Handshake output
2	HSKi	Handshake input or external clock (up to 4 Mbps)
3	TxD–	Transmit data –
4	Gnd	Ground
5	RxD–	Receive data –
6	TxD+	Transmit data +
7	GPi	General-purpose input (wake up CPU or perform DMA handshake)
8	RxD+	Receive data +
9	+5V	Power to external device (300 mA maximum)

SCSI Port

The SCSI port on the PowerBook 3400 computer supports the SCSI interface as defined by the American National Standards Institute (ANSI) X3T9.2 committee.

The external HDI-30 connector is identical to those used in other PowerBook models. The data and control signals on the SCSI bus are active low signals that are driven by open drain outputs. The SCSI bus has built-in active termination.

Table 3-7 shows the signal assignments for the external SCSI connector. Pin 1 of the external SCSI connector is the /SCSI.DISK.MODE signal. When this signal is asserted at startup time, the computer operates in disk mode instead of starting up the Mac OS.

Table 3-7 SCSI connector signals

Pin	Signal name	Pin	Signal name
1	/SCSI.DISK.MODE	16	/DB6
2	/DB0	17	GND
3	GND	18	/DB7
4	/DB1	19	/DBP

Table 3-7 SCSI connector signals (continued)

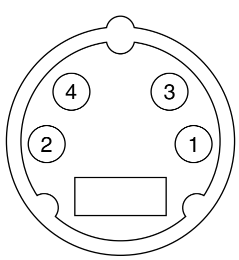
Pin	Signal name	Pin	Signal name
5	TERMPWR (not used; reserved)	20	GND
6	/DB2	21	/REQ
7	/DB3	22	GND
8	GND	23	/BSY
9	/ACK	24	GND
10	GND	25	/ATN
11	/DB4	26	/C/D
12	GND	27	/RST
13	GND	28	/MSG
14	/DB5	29	/SEL
15	GND	30	/I/O

ADB Port

The Apple Desktop Bus (ADB) port on the PowerBook 3400 computer is functionally the same as on other Macintosh computers. The connector is located on the left side of the computer near the back.

The ADB connector is a 4-pin mini-DIN connector. Figure 3-7 shows the arrangement of the pins on the ADB connector.

Figure 3-7 ADB connector



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 controller to the outside world. Table 3-8 lists the ADB connector pin assignments. For more information about the ADB, see *Guide to the Macintosh Family Hardware,* second edition.

Table 3-8 ADB connector pin assignments

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

IMPORTANT
The total current available for all devices connected to the +5-V pins on the ADB is 100 mA. ▲

Infrared Communication Link

The computer has a directed infrared (IR) communication link connected internally to serial port B. When the computer is placed within range of another device with an IR interface, it can send and receive serial data using one of several communications protocols. The other device may be another IR-equipped PowerBook, a desktop computer with an IR communications link, or some other device that complies with the Infrared Data Association (IrDA) standard. The minimum range of the IR link is approximately two inches, and the maximum range is one meter for IrDA compliant devices and six feet for PowerBooks.

The IR link in the PowerBook 3400 computer supports the following communications methods:

- IRTalk (LocalTalk over IR)
- IrDA at up to 1.152 Mbps

For LocalTalk operation, the IR link takes serial bits from the SCC and transmits them using a modified form of pulse encoding called PPM-4. This method of encoding uses four cycles of a 3.92-MHz carrier for each pulse, which increases the system's immunity to interference from ambient light sources. Two serial bits are encoded as a symbol consisting of a start pulse followed by either a second pulse in one of three possible positions or no second pulse.

The modulation method used in the Newton PDA consists of gating a 500-kHz carrier on and off. This method is capable of data rates up to 38.4k bits per second. Apple currently has no plans to support Macintosh to Newton connectivity using this method due to its low data rate. Future Newton PDAs will support the IrDA standard. The IrDA modulation method complies with the IrDA physical layer standard, which can be found at ftp://irda.org.

Sound System

The 16-bit stereo audio circuitry provides high-quality sound input and output through the built-in microphone and speakers. The user can also connect external input and output devices by way of the sound input and output jacks.

The sound system is based on the AWAC codec IC along with input and output amplifiers and signal conditioners. In the PowerBook 3400 computer, the AWAC codec supports three channels of digital sound: two stereo channels plus a multiplexed channel. The sound system supports sample sizes up to 16 bits and sample rates of 11.025 kHz, 22.05 kHz, and 44.1 kHz.

The frequency response of the sound circuits, not including the microphone and speakers, is within plus or minus 2 dB from 20 Hz to 20 kHz. Total harmonic distortion and noise is less than 0.05 percent with a 1-V rms sine wave input. The signal-to-noise ratio (SNR) is 85 dB, with no audible discrete tones.

Note
All sound level specifications in this section are rms values. ◆

Sound Inputs

The sound system accepts inputs from six possible sources:

- built-in microphone
- external sound input jack
- sound from the PCI expansion slot
- sound from the expansion bay
- sound from a zoom video device in the lower PC Card socket
- 1-bit sound from the PC Card sockets

The microphone and the sound input jack have dedicated input channels on the AWAC IC; the other four inputs share a third input on the IC. Those four inputs are switched on and off by the hardware; they can be selected either as a group or in any combination for play-through or recording.

Built-in Microphone

The sound signal from the built-in microphone goes through a dedicated preamplifier that raises its nominal 30-mV level to the 1-V level of the codec circuits in the AWAC IC.

External Sound Input

The external sound input jack accepts a line-level signal or an Apple PlainTalk microphone. When a connector is plugged into the external sound input jack, the computer turns off the sound input from the built-in microphone. The input jack has the following electrical characteristics:

- input impedance: 6.8k
- maximum level: 2.0 V rms

Note
The sound input jack accepts the maximum sound output of an audio CD without clipping. When working with sound sources that have significantly lower levels, you may wish to increase the signal gain of the sound input circuit. You can do that using the Sound Manager as described in *Inside Macintosh: Sound.* ◆

Expansion Bay Sound Input

The sound input from the expansion bay has the following electrical characteristics:

- input impedance: 3.2k
- maximum level: 0.5 V rms

PC Card Sound Input

Each PC Card socket has one sound output pin (SPKR_OUT) and the computer accepts either one or two cards. The one-bit digital signals from the sound output pins are exclusive-ORed together and routed to the built-in speaker and the external sound output jack.

Sound Outputs

The sound system sends computer-generated sounds or sounds from an expansion-bay device or PC Card to the built-in speakers and to an external sound output jack. The sound output jack is located on the left side of the computer near the front.

External Sound Output

The sound output jack provides enough current to drive a pair of low-impedance headphones. The sound output jack has the following electrical characteristics:

- output impedance: 33 Ω
- minimum recommended load impedance: 32 Ω
- maximum level: 1 V rms
- maximum current: 32 mA peak

Internal Speakers

The computer has a total of four internal speakers: two 20 mm speakers located beneath the bezel between the back of the keyboard and the display, and two 50 mm speakers located in a tuned port enclosure in the back of the display. The 20 mm speakers are driven by the high-frequency portion of the stereo sound signals from the computer. The 50 mm speakers are driven by a monophonic mix of the low-frequency portion of the sound signals.

The computer turns off the sound signals to the internal speaker when an external device is connected to the sound output jack and during power cycling.

PCI Slot and Expansion Bay

Sound output signals are provided at both the PCI slot and the expansion bay. The sound signals are line-level audio.

Ethernet and Modem Cards

Most configurations of the PowerBook 3400 computer come with an ethernet interface installed in the PCI expansion slot. Two types of card are used, one with an ethernet interface and a modem, the other with ethernet only. Both cards have an RJ-45 connector that is accessible through an opening in the back of the computer's case.

Ethernet and Modem Card

The ethernet and modem card for the PowerBook 3400 computer has the following features:

- 10 Mbps ethernet interface with a 10baseT connection
- modem bit rates up to 33.6 Kbps
- fax modem bit rates up to 14.4 Kbps

Facsimile applications must support Class 1 fax; a Class 1 fax application comes with the computer.

The modem appears as a serial port that responds to the typical AT commands. The card provides a sound output for monitoring the progress of the modem connection.

Ethernet-Only Card

The ethernet-only card provides a 10 Mbps ethernet interface with a 10baseT connection. The ethernet interface conforms to the ISO/IEC 8802-3 specification, where applicable.

C H A P T E R 4

Expansion Modules

This chapter describes each of the expansion features of the PowerBook 3400 computer:

- PCI expansion slot
- expansion bay
- RAM expansion
- PC Card slot

PCI Expansion Slot

The PowerBook 3400 computer has an internal slot for an expansion card. The card fits between the expansion bay and the PC Card slots. The user can get access to the expansion card by removing the keyboard.

PCI Expansion Signals

This section describes the signals on the internal PCI expansion connector. The expansion slot uses the PCI expansion bus with a few additional signals to support modems.

Connector Signal Assignments

Table 4-1 shows the signal assignments on the PCI expansion connector.

Table 4-1 Signal assignments on the PCI expansion connector

Pin	Signal name	Pin	Signal name
1	+5V_MAIN	51	+5V_MAIN
2	+3V_MAIN	52	/PCISERR
3	/PCI_RST_3V	53	PCIPAR
4	/SLOT_INT	54	+3V_MAIN
5	GND	55	GND
6	GND	56	GND
7	/PCI_SLOT_GNT	57	PCIAD(15)
8	SLOT_PCI_CLK	58	/PCICBE(1)
9	+5V_MAIN	59	PCIAD(13)
10	/PCI_SLOT_REQ	60	PCIAD(14)
11	PCIAD(30)	61	+5V_MAIN
12	PCIAD(31)	62	PCIAD(12)

continued

Table 4-1 Signal assignments on the PCI expansion connector (continued)

Pin	Signal name	Pin	Signal name
13	PCIAD(28)	63	PCIAD(11)
14	PCIAD(29)	64	+3V_MAIN
15	GND	65	GND
16	GND	66	GND
17	PCIAD(26)	67	PCIAD(9)
18	PCIAD(27)	68	PCIAD(10)
19	PCIAD(24)	69	/PCICBE(0)
20	PCIAD(25)	70	PCIAD(8)
21	+5V_MAIN	71	/PCMCIA_IRQ2
22	PCIAD(23)	72	PCIAD(7)
23	PCIAD(22)	73	PCIAD(6)
24	+3V_MAIN	74	/PCMCIA_IRQ1
25	GND	75	GND
26	GND	76	GND
27	/PCICBE(3)	77	PCIAD(4)
28	+3V_MAIN	78	PCIAD(5)
29	PCIAD(20)	79	PCIAD(2)
30	PCIAD(21)	80	PCIAD(3)
31	+5V_MAIN	81	+5V_MAIN
32	PCIAD(19)	82	PCIAD(1)
33	PCIAD(18)	83	PCIAD(0)
34	+3V_MAIN	84	+3V_MAIN
35	GND	85	GND
36	GND	86	GND
37	PCIAD(16)	87	SLEEP
38	PCIAD(17)	88	/CFW_3V
39	/PCIFRAME	89	RING_DET
40	/PCICBE(2)	90	+3V_MAIN
41	+5V_MAIN	91	+5V_MAIN
42	/PCIIRDY	92	+3V_MAIN
43	/PCITRDY	93	n.c.

continued

Table 4-1 Signal assignments on the PCI expansion connector (continued)

Pin	Signal name	Pin	Signal name
44	+3V_MAIN	94	PSLOT_IDSEL
45	GND	95	MB_COM_OUT
46	GND	96	PSLOT_SND_COM
47	/PCISTOP	97	MB_R_OUT
48	/PCIDEVSEL	98	PSLOT_SND_R
49	/PCIPERR	99	MB_L_OUT
50	/PCILOCK	100	PSLOT_SND_L

PCI Signals

The PCI signals on the expansion card conform to the standards for 32-bit-wide PCI with 3.3 V signaling. For more information about the PCI interface, contact the PCI-SIG (special interest group) at the address given in the preface.

IMPORTANT
The interface for the PCI expansion card supports only 3.3 V signaling levels. ▲

Other Signals

The PCI expansion slot has several signals in addition to the PCI signals. Table 4-2 gives the definitions of those signals.

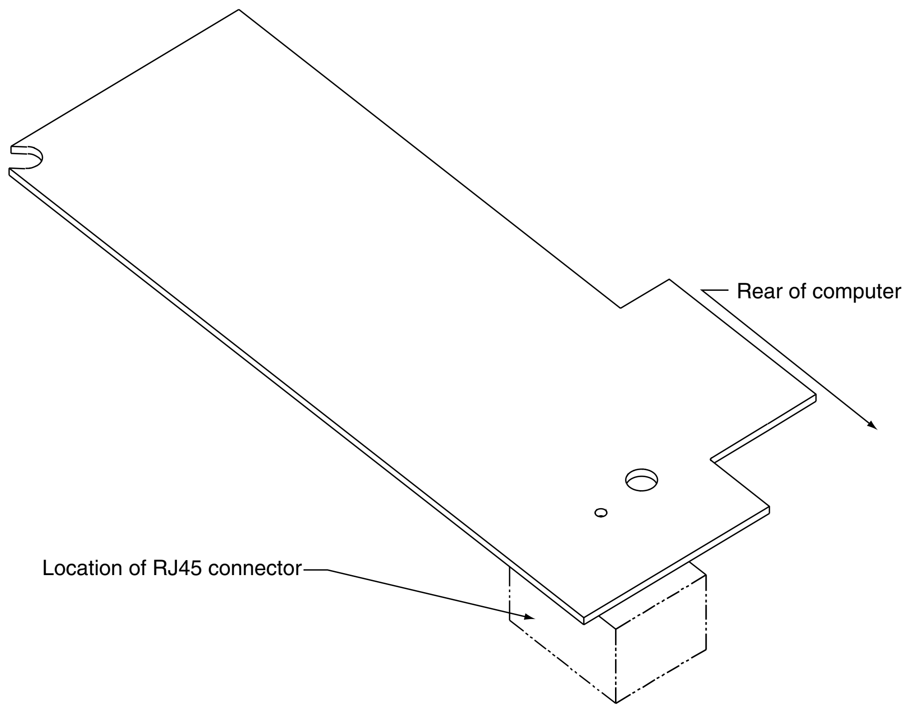
Table 4-2 Other signals on the PCI expansion connector

Signal name	Signal description
/CFW_3V	Clock failure warning: The PCI clock will stop 16 ms after this signal (active low). The expansion card should use this time to prepare for the removal of the clock.
MB_L_OUT, MB_R_OUT, MB_COM_OUT	Main sound output from the computer; a stereo pair of line-level signals. These signals are shared outputs to the expansion bay connector.
PSLOT_SND_L, PSLOT_SND_R, PSLOT_SND_COM	Sound input signals from the card to the computer; a stereo pair of line-level signals.
SLEEP	Active (high) when the computer is in sleep mode; SLEEP is a 5 V signal, not 3.3 V. See “Expansion Card Operation and Sleep Mode” beginning on page 49.

Expansion Card Design

This section describes the mechanical design of the PCI expansion card. Figure 4-1 shows a perspective view of the expansion card and its orientation.

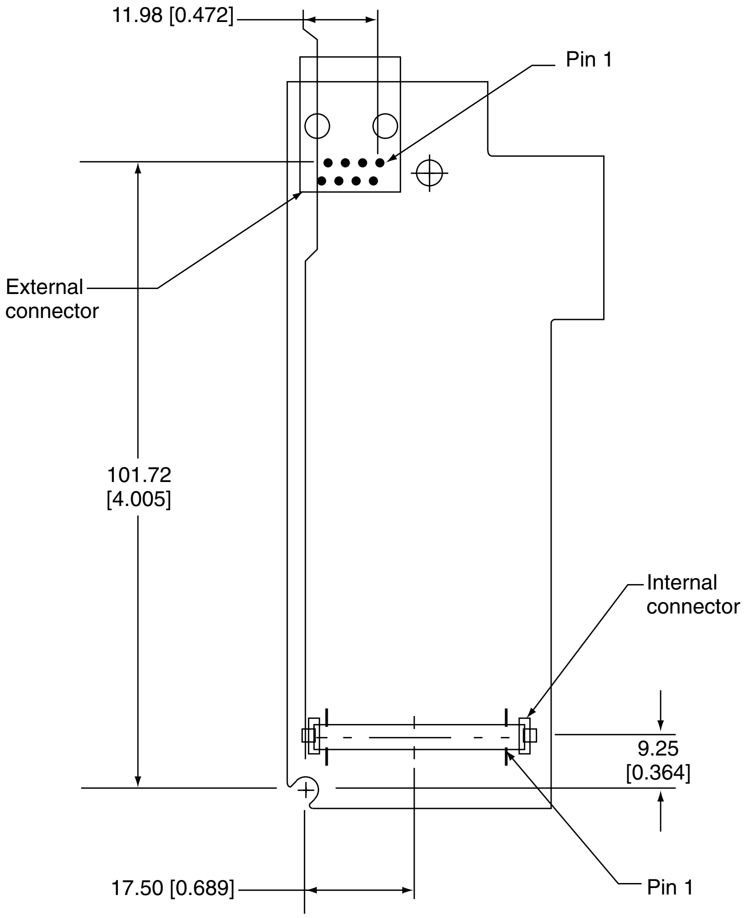
Figure 4-1 PCI expansion card



Connectors on the Expansion Card

The PCI expansion card has two connectors: an internal connector that plugs into the computer's logic board and an external connector that occupies an opening in the back of the case. Figure 4-2 shows the location of the connectors on the PCI expansion card.

Figure 4-2 Connectors on the PCI expansion card

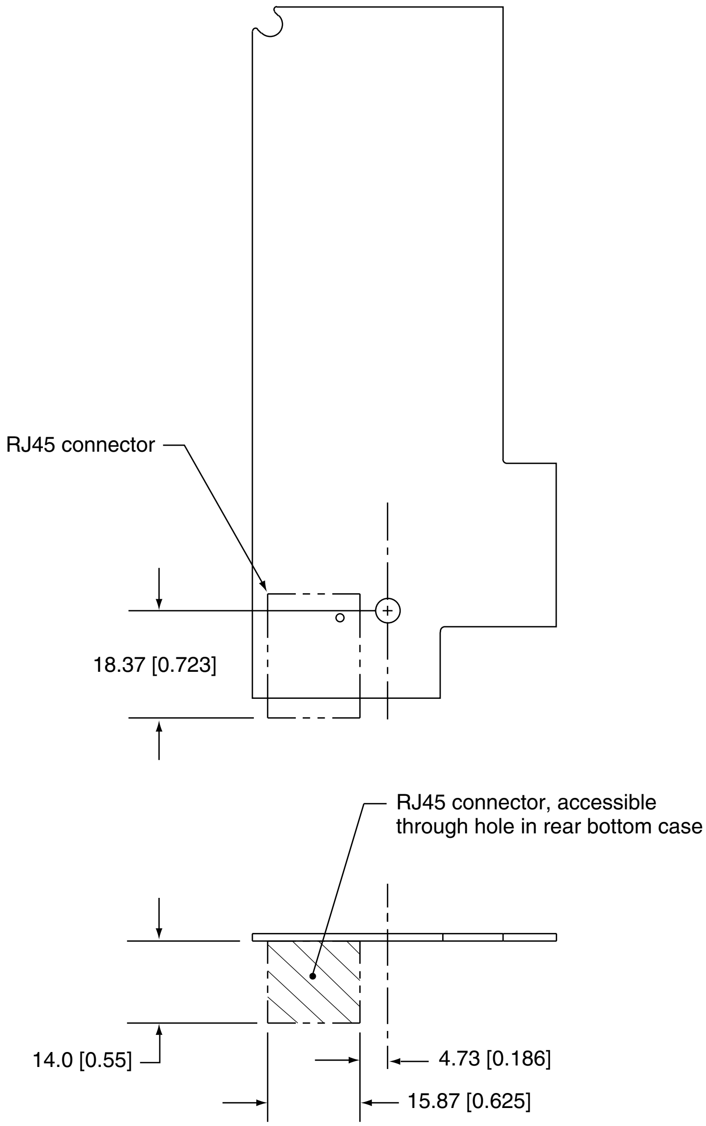


Note
The following tolerances apply to all the drawings in this section:
One digit after the decimal point (X.X): ±0.20 [0.01]
Two digits after the decimal point (X.XX): ±0.13 [0.005]
Three digits after the decimal point (X.XXX): ±0.100 [0.0039]

External Connector

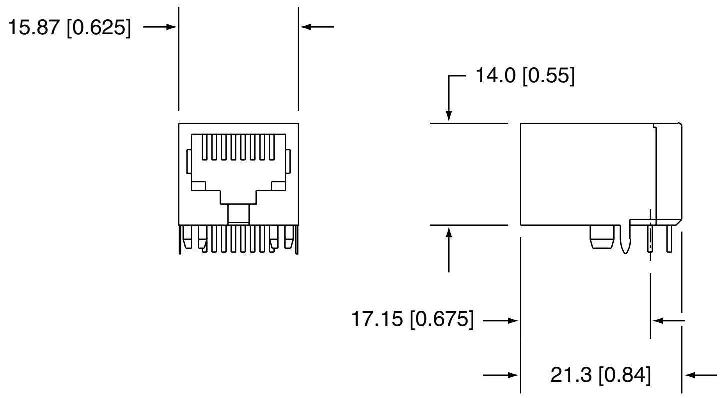
A card in the PCI expansion slot can include an external connector by way of an opening in the rear of the case. The case opening can accommodate a shielded RJ45 connector or some other connector of a compatible size and shape. Figure 4-3 shows the location of the external connector on the expansion card. Figure 4-4 shows the dimensions of the shielded RJ45 connector.

Figure 4-3 Location of external connector



Note: Dimensions are in millimeters [inches].

Figure 4-4 Shielded RJ45 connector

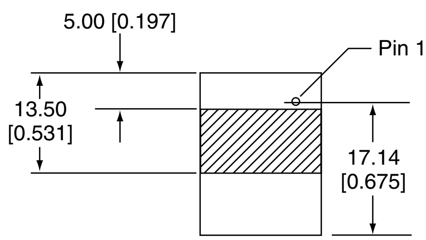


Note: Dimensions are in millimeters [inches].

Grounding the External Connector

To prevent excessive electromagnetic radiation, the external connector on the PCI expansion card must be a shielded connector. The computer's case has conductive metal fingers that make electrical contact with the shield and ground it to the case. Figure 4-5 shows the location of the contact area on the connector. If some other type of connector is used, the opening in the computer's case must still be covered, grounded, and shielded against EMI.

Figure 4-5 Connector grounding considerations

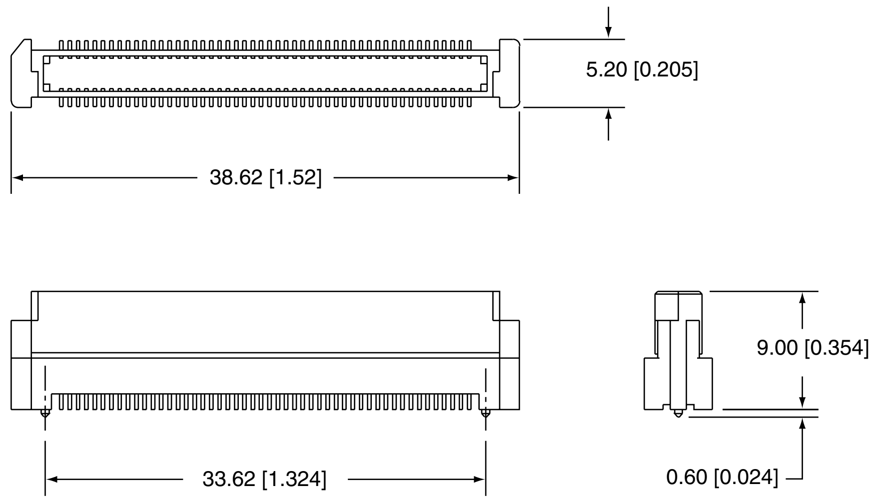


Note: Dimensions are in millimeters [inches].

Internal Connector

The internal connector for the PCI expansion card is a 100-pin Molex connector. The connector has a pitch of 0.63 mm and a stack height of 10 mm. Figure 4-6 shows the dimensions of the connector.

Figure 4-6 Expansion card internal connector

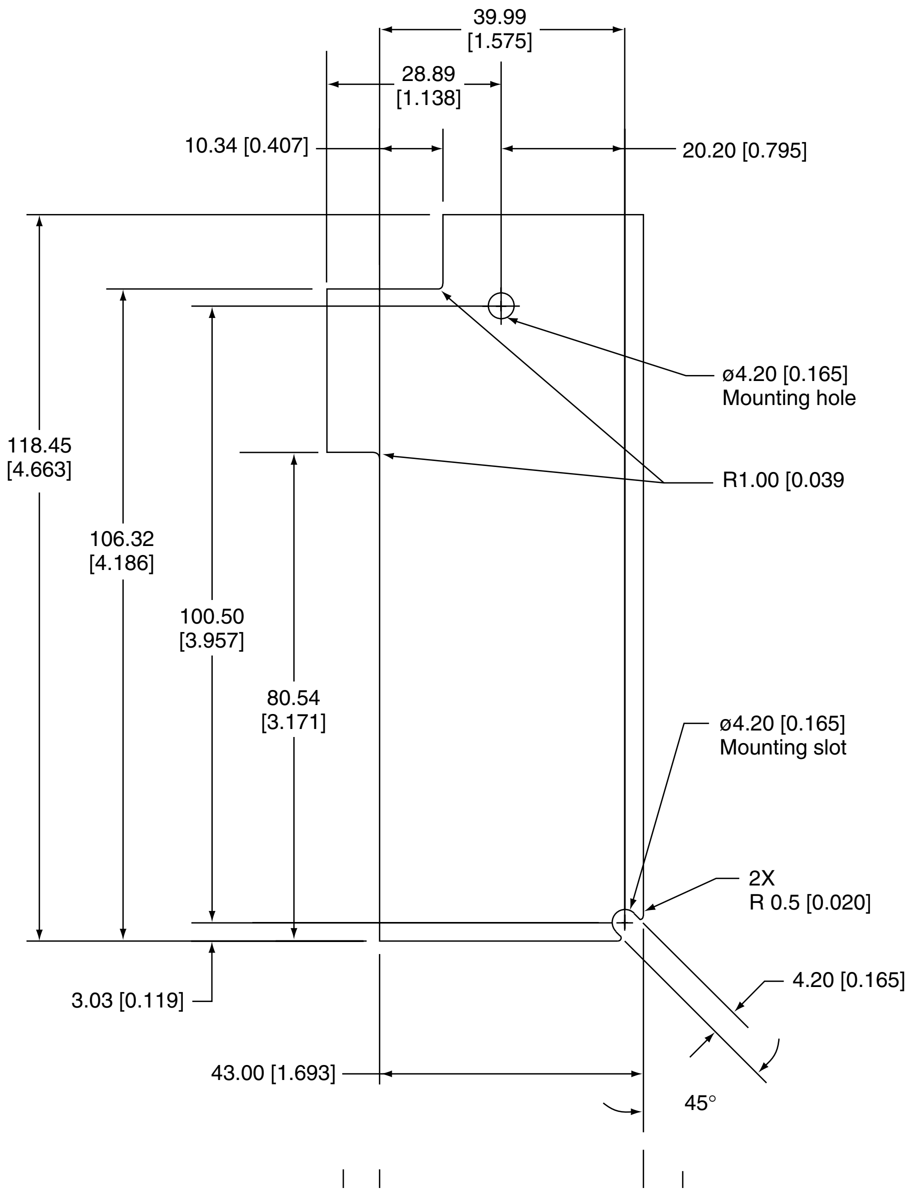


Note: Dimensions are in millimeters [inches].

Card Dimensions

Figure 4-7 shows the dimensions of the internal PCI expansion card.

Figure 4-7 Dimensions of the PCI expansion card



Component Height Limits

Figure 4-8 shows a general view of the maximum component heights on the internal PCI expansion card. Figure 4-9 shows the height limits on the top of the card, and Figure 4-10 shows the height limits on the bottom of the card.

Figure 4-8 PCI expansion card maximum component space

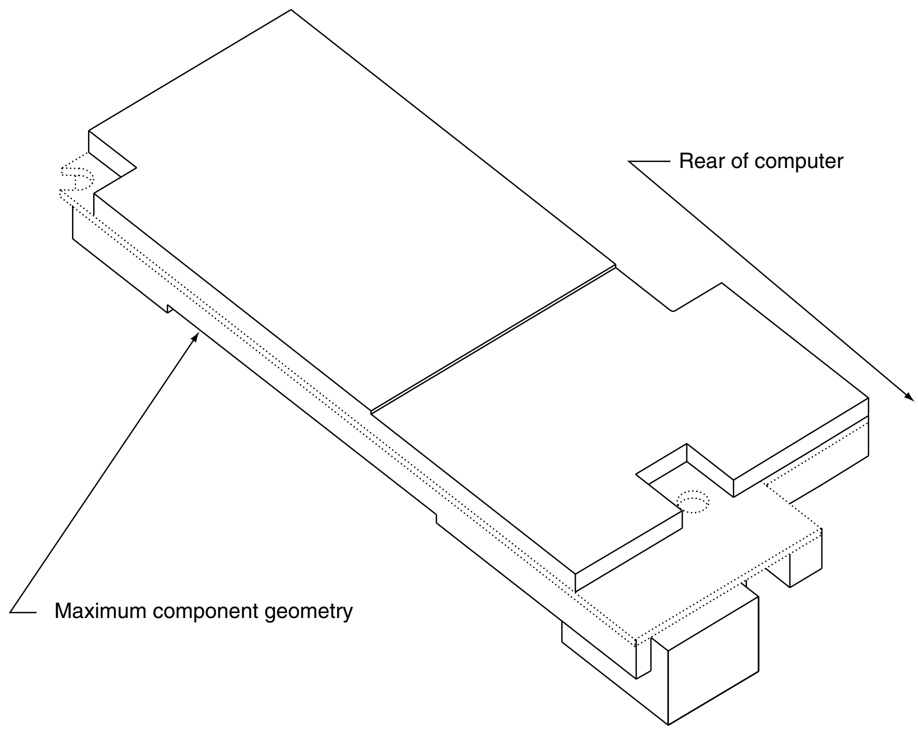
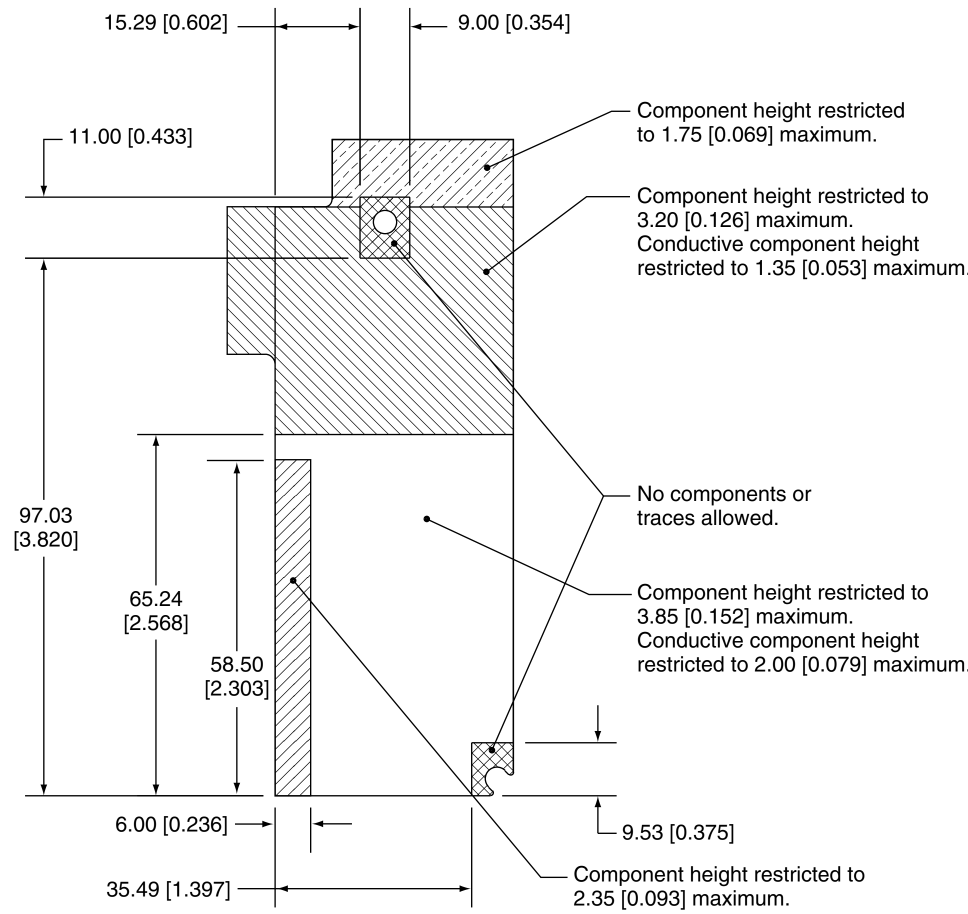
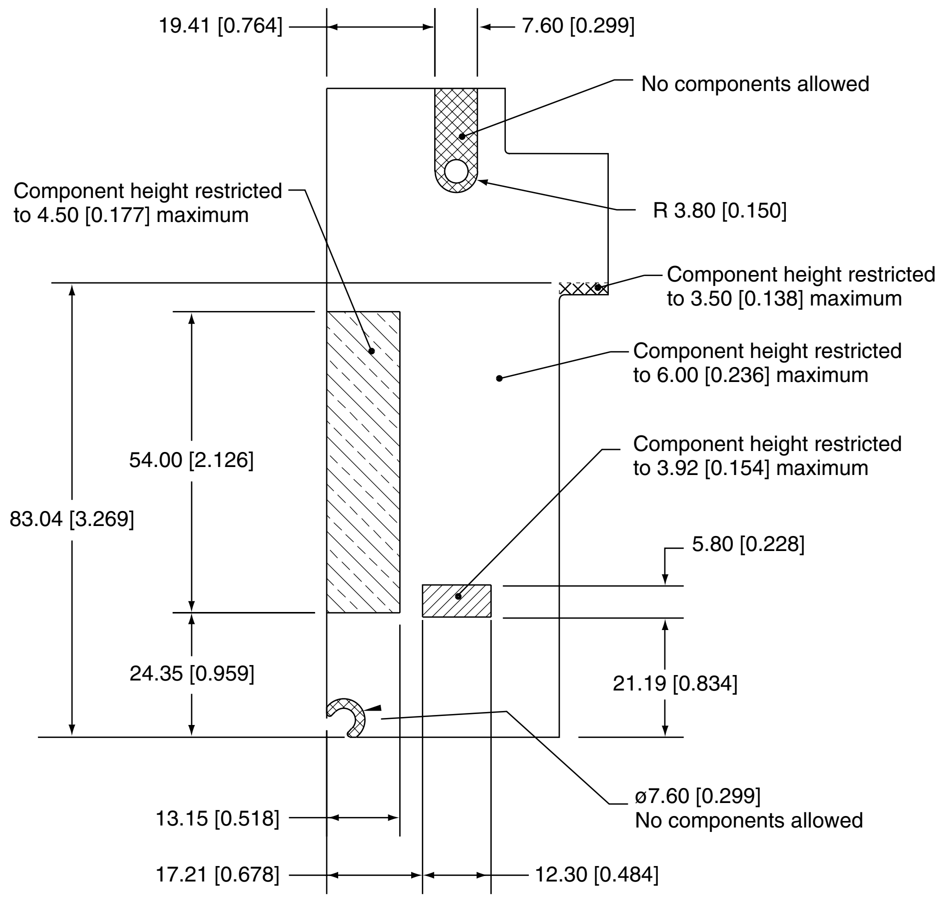


Figure 4-9 Maximum component heights on the top of the PCI expansion card



Note: Dimensions are in millimeters [inches].

Figure 4-10 Maximum component heights on the bottom of the PCI expansion card

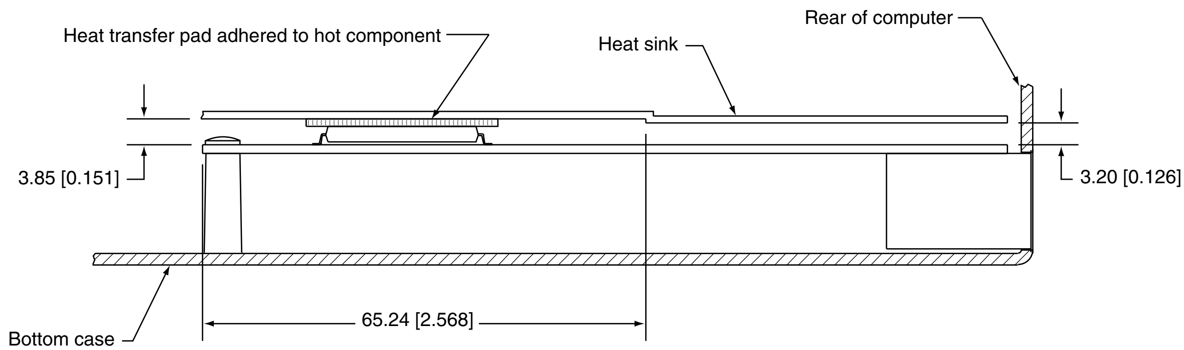


Note: Dimensions are in millimeters [inches].

Thermal Considerations for the Expansion Card

The computer's case encloses a copper heat sink above the PCI expansion card. Figure 4-11 shows the positions of the heat sink and the card with respect to the bottom of the case.

Figure 4-11 Heatsink for the PCI expansion card



Note: Dimensions are in millimeters [inches].

An insulating layer between the heatsink and the PCI expansion card prevents electrical shorts between the heatsink and tall components on the card. Hot components on the top of the card can be thermally connected to the heatsink with a compliant thermal transfer material. To complete the thermal transfer path, the insulating layer should be removed or cut away in the component area to allow direct contact with the copper heatsink. For effective thermal transfer, the thermal transfer material must touch both the hot component and the copper heatsink.

IMPORTANT
The force exerted by the thermal transfer material against the heatsink must not exceed 1 pound. A higher force may lift the heatsink away from the main processor, causing the processor to overheat. ▲

Power Budget for the Expansion Card

Designers of expansion cards for the PowerBook 3400 computer must make sure their cards do not exceed the limits on power consumption. The peak currents the card may draw from the power mains are:

- 3.3 V supply: 900 mA
- 5 V supply: 600 mA

The maximum total power dissipation from both mains combined is 3.0 W. The expansion card must not draw the maximum current from both supply mains because doing so exceeds the 3.0 W total limit on power dissipation. ▲

▲ **WARNING**
Exceeding these current limits will shorten the time the computer can operate from its battery and may result in damage to the computer. ▲

Expansion Card Operation and Sleep Mode

Power is constantly supplied to the PCI expansion card while the computer is in sleep mode. The circuitry on the card can monitor the SLEEP and /CFW_3V signals to determine the state of the computer. During sleep mode, the card must reduce its power consumption to a maximum of 3.3 mW.

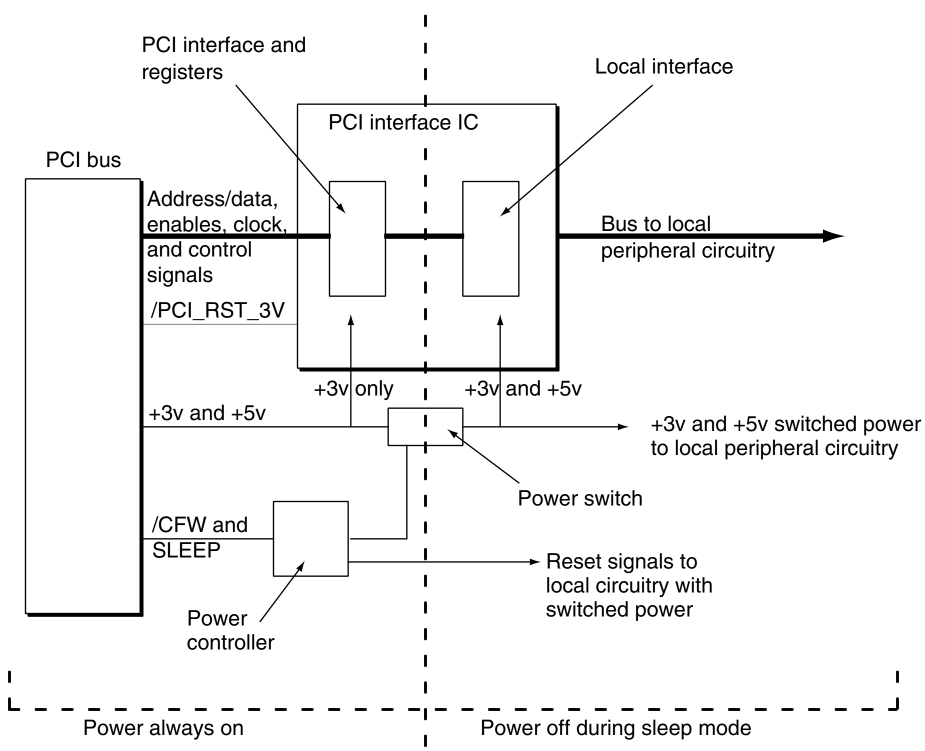
All clocks become inactive and are driven low when the computer switches to sleep mode. All PCIAD signals are driven low during sleep mode. Some PCI control signals are not driven low before entering sleep mode.

Note
Many of the sleep mode considerations described here also apply to the operation of PCI devices in the expansion bay module. See "PCI Control Signals in Sleep Mode" beginning on page 69. ◆

Switching Power to the Card

Figure 4-12 shows a typical circuit that switches power to the devices on the expansion card but maintains power to the PCI interface IC. In addition to switching the power mains, the circuitry on the card must also provide its own reset signal to the devices whose power is switched.

Figure 4-12 PCI peripheral in sleep mode, interface unswitched

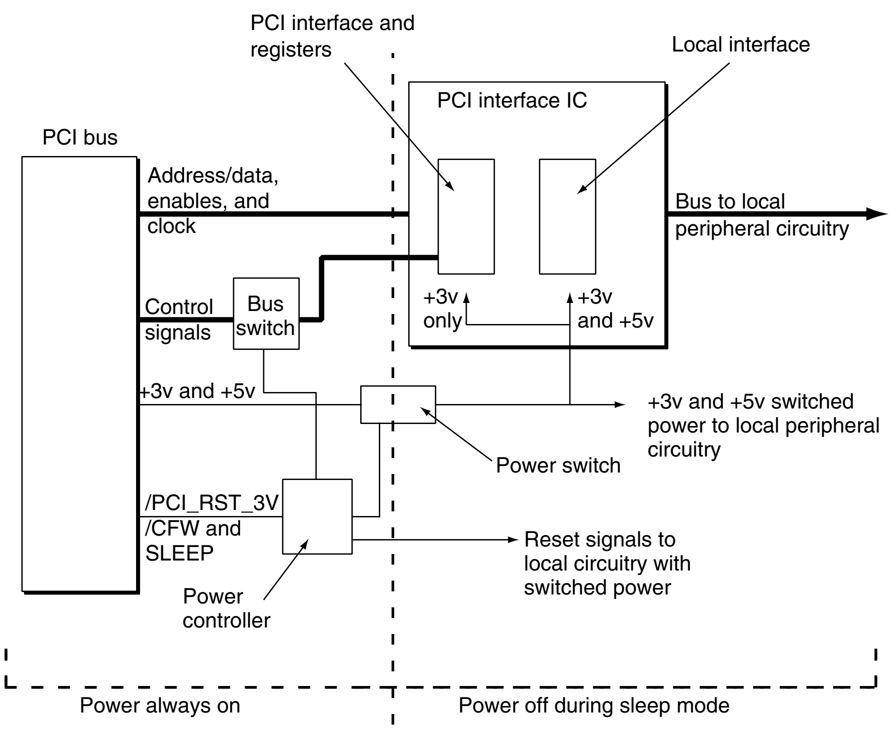


Depending on the power requirements of the devices on the expansion card, it may be necessary to provide low-power operation of the PCI interface IC. The circuit in Figure 4-13 is similar to the one in Figure 4-12, except it also switches the power to the PCI interface IC.

The following control signals are connected to pull-up resistors on the main logic board: /DEVSEL, /FRAME, /GRANT, /INT, /IRDY, /LOCK, /PERR, /REQ, /SERR, /STOP, and /TRDY. A bus switch can be added to disconnect those control signals from the PCI interface IC during low-power operation of the card.

For cards on which the PCI interface is being switched off, the device driver software must save the card configuration information each time the computer switches to sleep mode and restore it when the card is switched back to full power operation.

Figure 4-13 PCI peripheral in sleep mode, interface switched



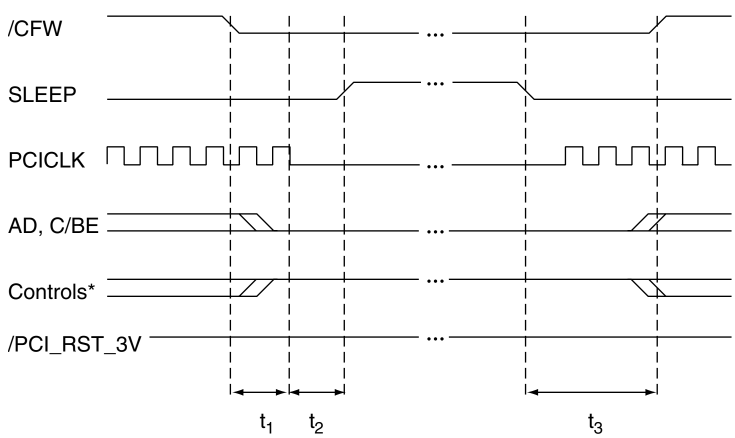
IMPORTANT

The same control signals are used for PCI devices on a card in the PCI expansion slot and on a module in the expansion bay, but those signals are electrically different during sleep mode. See "PCI Control Signals in Sleep Mode" beginning on page 69. ▲

Timing of Control Signals in Sleep Mode

Figure 4-14 shows the timing of the control signals on the PCI expansion card when the computer goes into and out of sleep mode.

Figure 4-14 Timing of the expansion card control signals for sleep mode



t_1 = 16 ms min. /CFW to clocks stopped

t_2 = 16 ms min. Clocks stopped to system sleep

t_3 = 50 ms min. Clocks started to clock valid

Power Saving Considerations

Because PCI peripherals have the ability to switch to low-power operation during sleep mode, developers should provide a software option to switch to low-power operation during normal operation of the computer. If the user knows that the PCI peripheral will not be used for some time, the user can select the option to reduce power consumption and extend the battery life. Providing such an option would probably involve a special driver call that would invoke the card’s power-down sequence.

If you choose to provide such a low-power or nonuse mode, you must be aware of the differences between system sleep mode and your local low-power mode. For example, in sleep mode the system clocks, PCIAD, and CB/E are stopped and driven low, and the control signals listed in Figure 4-13 are pulled up to 3.3 V. On the other hand, while your card is in its local low-power mode, the PCI bus signals are still active.

Power Sequences

Here are the sequences of events on the power supply and control signals when the operating mode of the computer changes. Knowledge of these sequences will help developers design devices that operate properly when the computer switches from one power mode to another.

Note
These power sequences apply to both the internal PCI expansion slot and a PCI device in an expansion bay module. ◆

Power Sequence From Off to On

Here is the sequence of states and events when the computer switches from off to on:

1. The computer is in the power-off mode.
2. The PMU detects power on.
3. The main power supplies (+5V, +3.3V, and +2.6V) switch on.
4. The clocks begin operating.
5. The /CFW signal changes to high (inactive).
6. The /RESET signal changes to high (inactive).
7. The processor starts executing the ROM code.
8. If a module is installed in the expansion bay, power to the expansion bay switches on.
9. The processor continues to execute the startup sequence and configures PCI cards, if any.
10. The computer loads and launches the operating system from the available mass storage device.
11. The computer is in the on (normal operating) mode.

Power Sequence From On to Sleep

Here is the sequence of states and events when the computer switches from on to sleep:

1. The computer is in the on (normal operating) mode.
2. The SLEEP mode is initiated by the user or by some predetermined condition.
3. The processor stops running.
4. The /CFW signal changes to low (active).
5. There is a time delay of 16 ms.
6. The clocks stop operating.
7. The SLEEP signal switches to high (active), which switches off the power to unused circuitry (sound, oscillators, and so on).
8. If a PCI device is installed in the expansion bay, power to the expansion bay remains on.
9. If the expansion bay does not have a PCI device installed in it, power to the expansion bay switches off.
10. The computer is in sleep mode.

Power Sequence From Sleep to On

Here is the sequence of states and events when the computer switches from sleep to on:

1. The computer is in sleep mode.
2. The PMU detects keyboard activity or the power-on switch.
3. The SLEEP signal changes to low (inactive).
4. The clocks begin operating.
5. The /CFW signal changes to high (inactive).
6. An interrupt is sent to the main processor.
7. The processor starts executing code.
8. If power to the expansion bay was off and an expansion bay module is still present, expansion bay power switches to on.
9. The display buffer is reloaded.
10. The computer is in the on (normal operating) mode.

Power Sequence From On to Off

Here is the sequence of states and events when the computer switches from on to off:

1. The computer is in the on (normal operating) mode.
2. The computer detects the shutdown signal.
3. The processor stops running.
4. The /CFW signal changes to low (active).
5. There is a time delay of 16 ms.
6. The system /RESET signal is asserted on the CPU and PCI busses.
7. The clocks stop operating.
8. The main power supplies (+5 V, +3.3 V, and +2.6 V) switch off.
9. The computer is in the power-off mode.

Expansion Bay

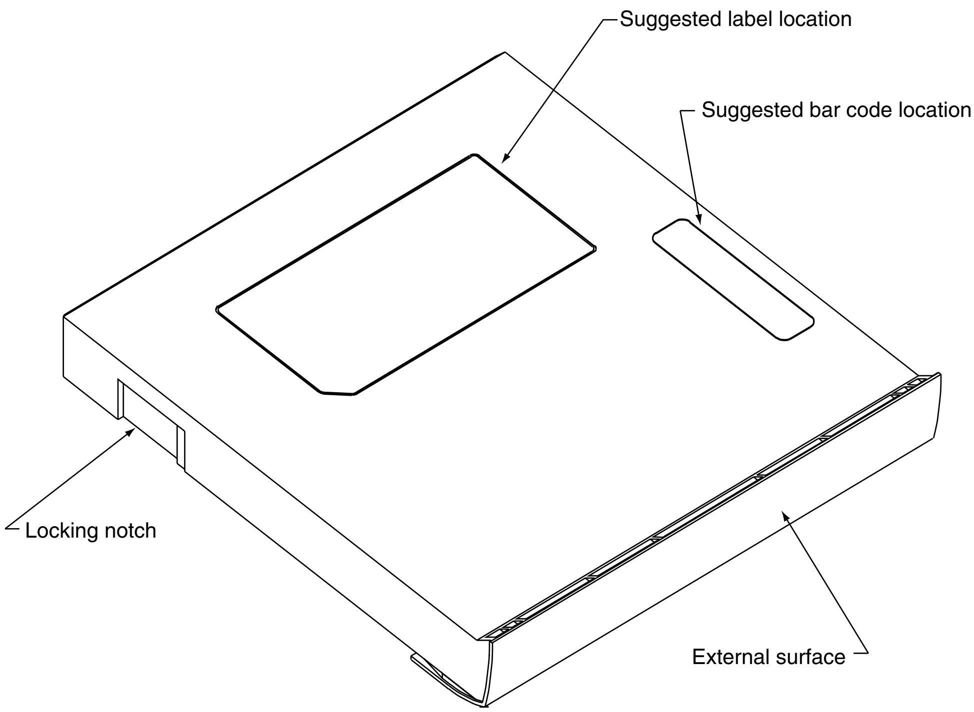
The expansion bay is an opening in the PowerBook 3400 computer that accepts a plug-in disk drive such as a CD-ROM or floppy disk. The expansion bay can also accept a PCI device or a power device such as an AC adapter.

Note
While the expansion bay in the PowerBook 3400 computer can accept expansion modules designed for the Macintosh PowerBook 5300 and PowerBook 190 computers, Apple Computer recommends that modules for the new computer use the new, larger size described here. ◆

Expansion Bay Module

Figure 4-15 shows a module designed to fit into the expansion bay. A notch on the side of the module engages a catch inside the computer to prevent the module from being pulled out.

Figure 4-15 Front view of expansion bay module



Datum Slot

As the module is inserted into the expansion bay, a tab on the main logic board mates with the datum slot, thereby aligning the module with the logic board. Because the datum slot determines the position of the module with respect to the main logic board, the datum slot should be used as the reference for the mechanical design of the expansion bay module.

Figure 4-16 is a view of the expansion bay module from the rear showing the connector and the datum slot. Figure 4-17 shows the exact location of the connector and the datum slot.

Figure 4-16 Rear view of expansion bay module

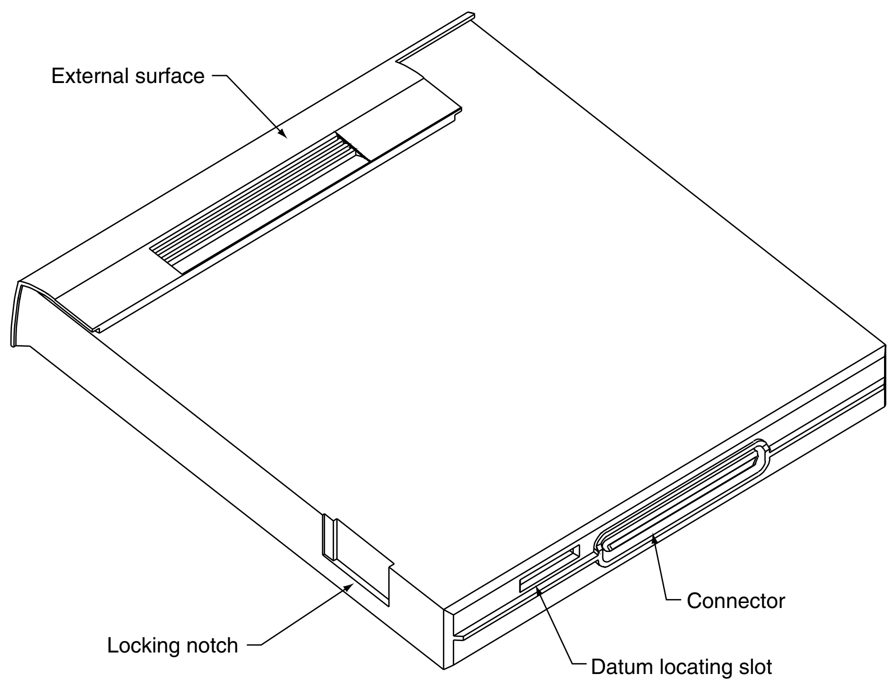
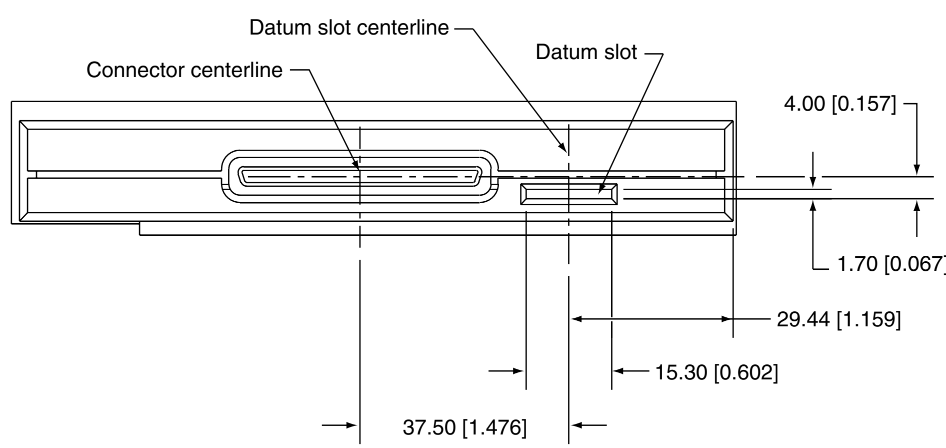


Figure 4-17 Location of expansion bay connector and datum slot

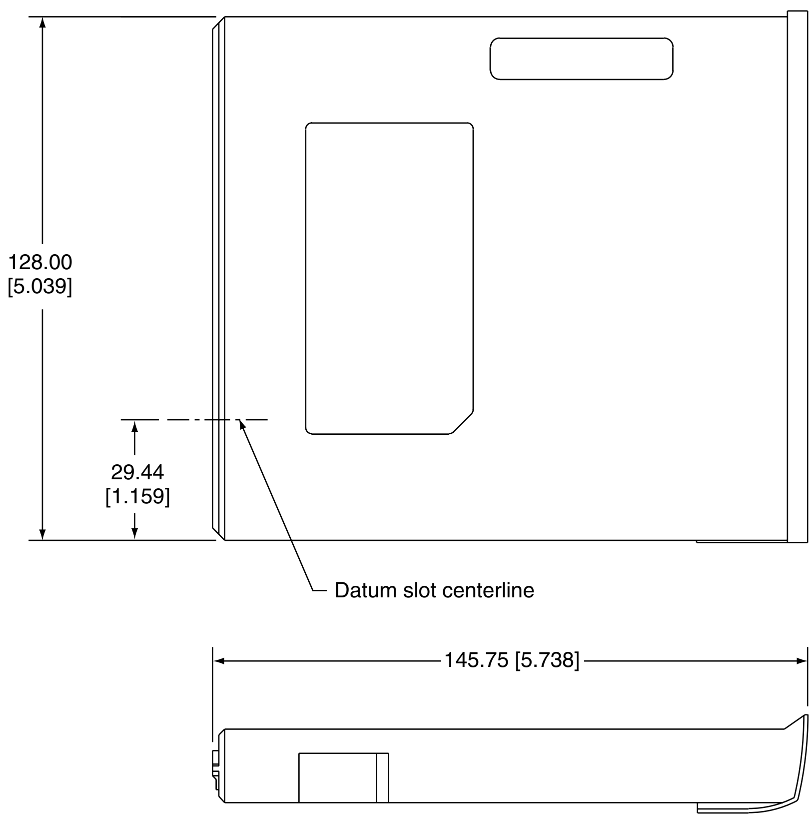


Note: Dimensions are in millimeters [inches].

Maximum Dimensions

Figure 4-18 shows the maximum dimensions of a module that can be accommodated by the expansion bay.

Figure 4-18 Maximum dimensions of the expansion module



Note: Dimensions are in millimeters [inches].

Location of the Circuit Board and Connectors

Figure 4-19 is an exploded view of a typical expansion bay module showing the locations of the circuit board and the connectors.

Figure 4-19 Exploded view of expansion bay module

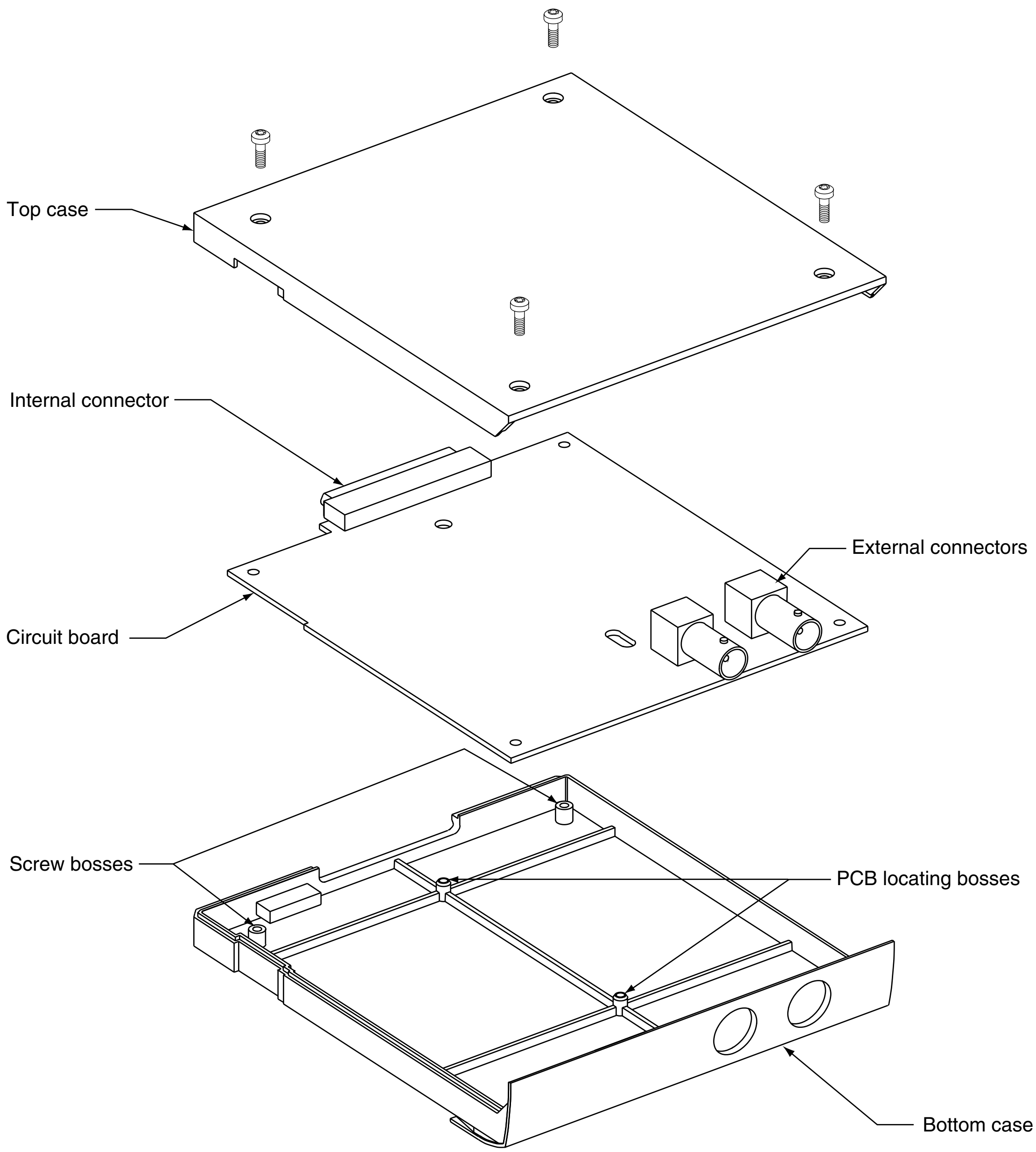
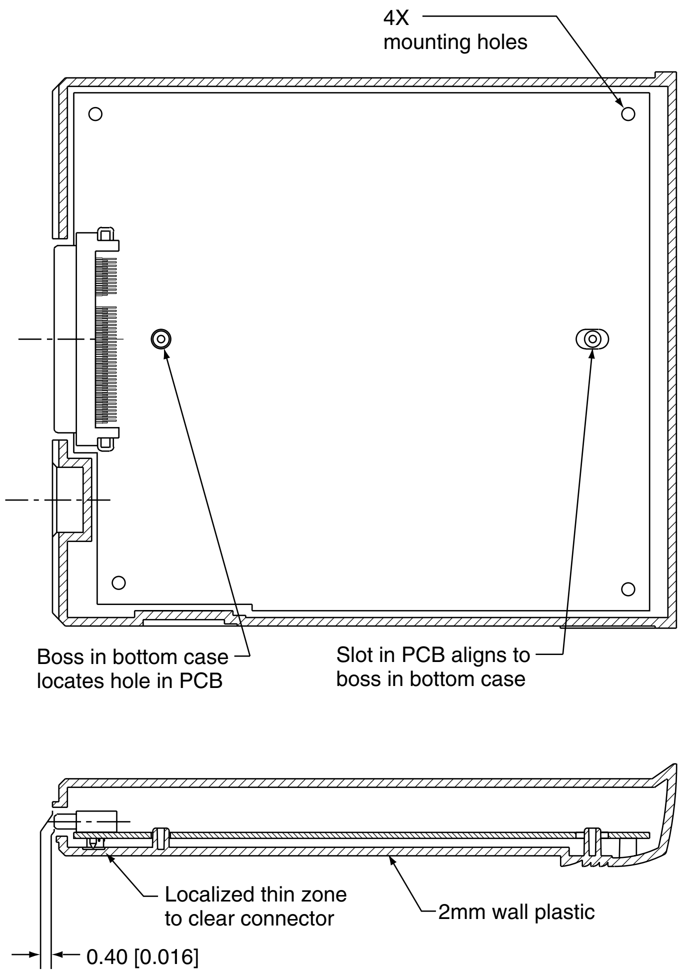


Figure 4-20 shows the recommended method of installing the circuit board in the expansion module. This pin and slot arrangement provides accurate location of the board without overconstraining it.

Figure 4-20 Suggested locations of circuit board and connector



Note: Dimensions are in millimeters [inches].

Figure 4-21 and Figure 4-22 show typical and alternative ways of mounting the connectors.

Figure 4-21 Locations of connectors

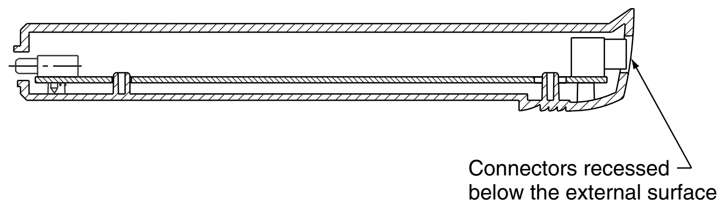
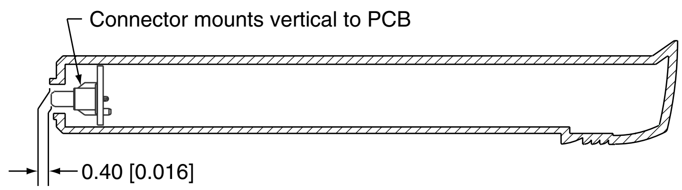


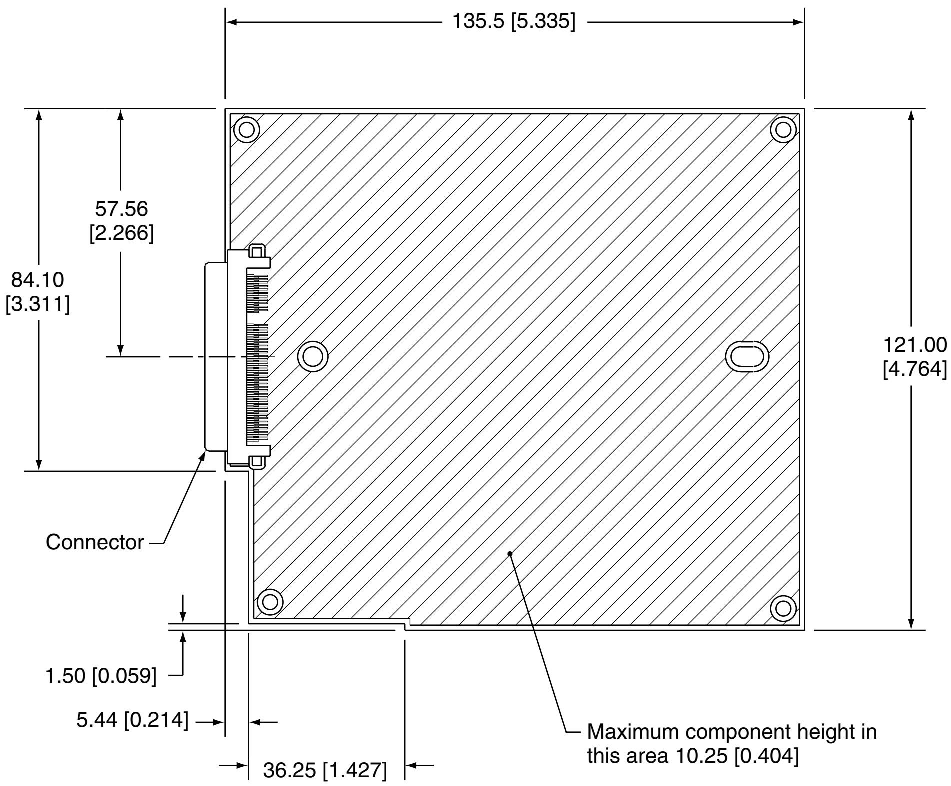
Figure 4-22 Alternate mounting for connector



Note: Dimensions are in millimeters [inches].

Figure 4-23 shows the maximum dimensions of the circuit board and the location of the expansion bay connector.

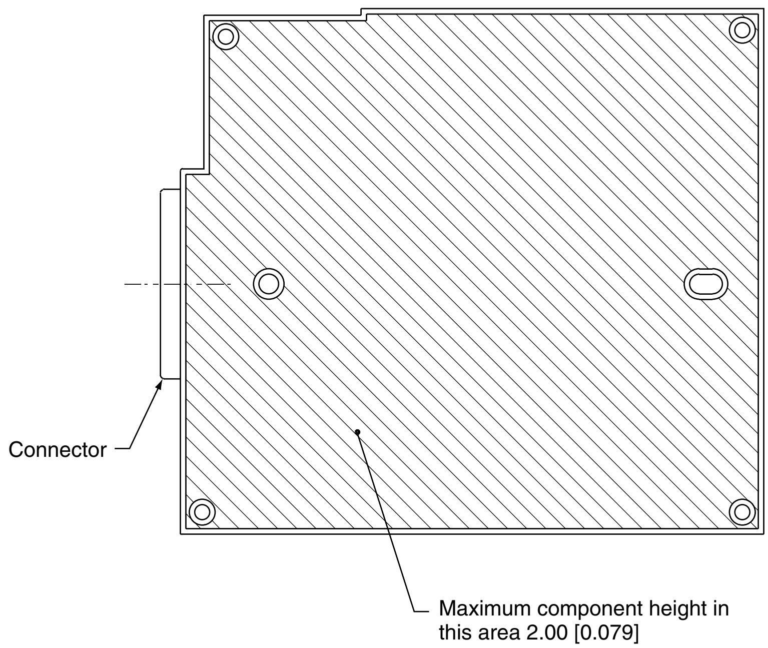
Figure 4-23 Suggested dimensions of circuit board



Note: Dimensions are in millimeters [inches].

Figure 4-24 shows the maximum component height on the bottom of the circuit board.

Figure 4-24 Maximum component height on bottom of circuit board

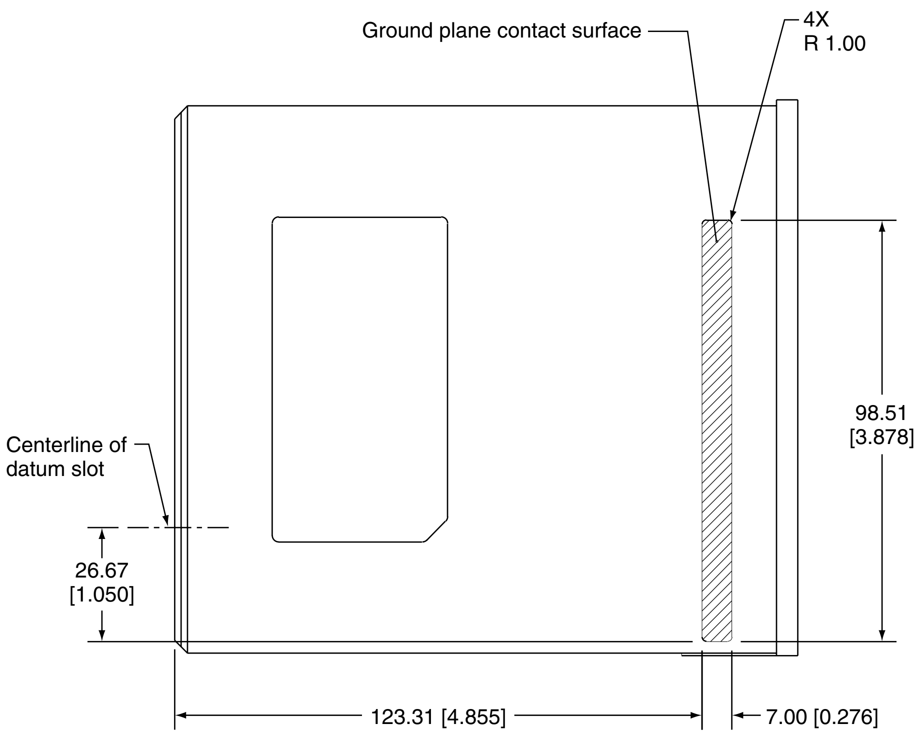


Note: Dimensions are in millimeters [inches].

Grounding the Module

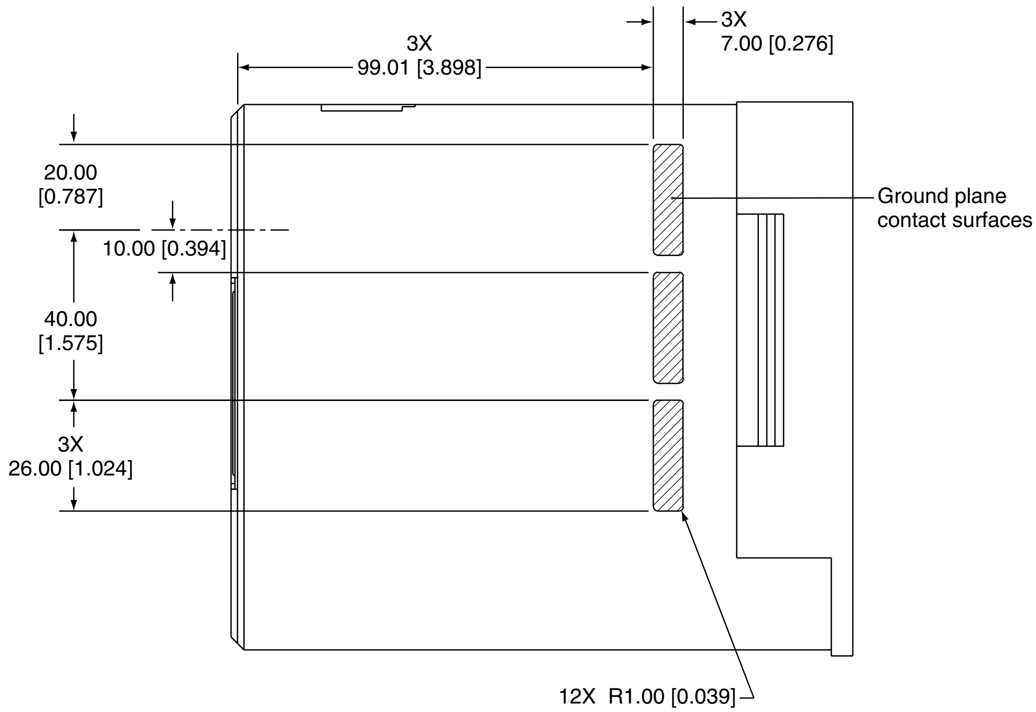
If the device in the expansion bay module requires grounding to reduce electromagnetic radiation, the module should be provided with electrically grounded conductive surfaces as shown in Figure 4-25 and Figure 4-26.

Figure 4-25 Electrical grounding surfaces, top view



Note: Dimensions are in millimeters [inches].

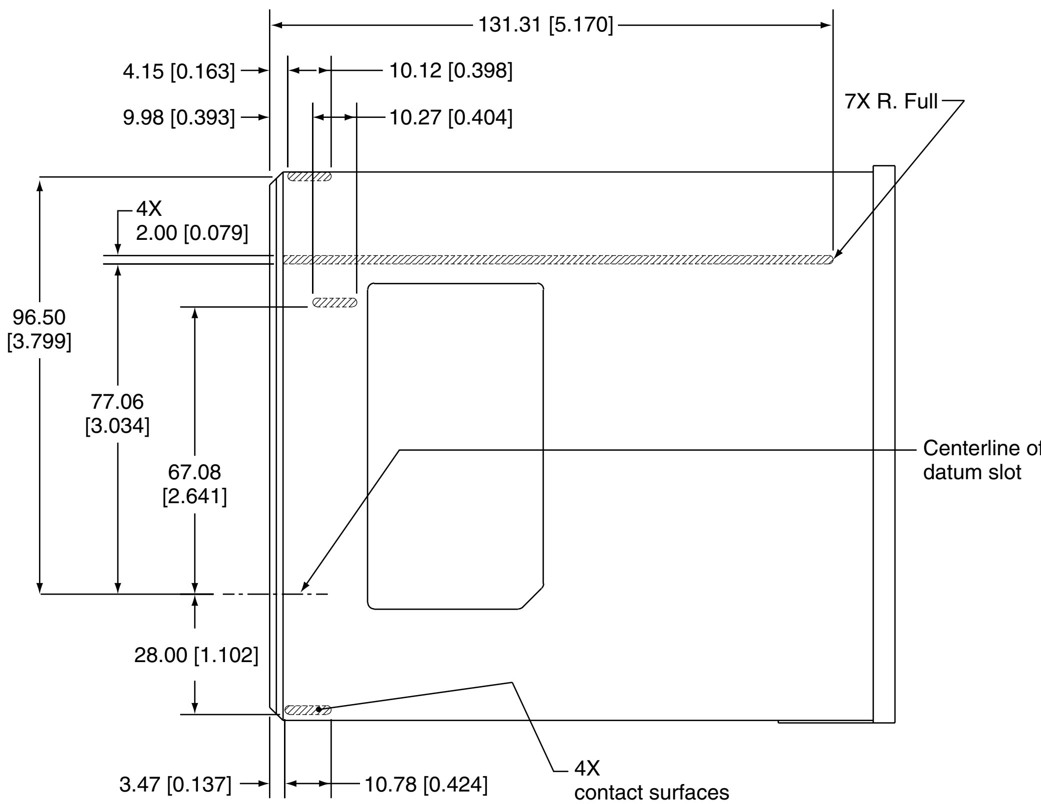
Figure 4-26 Electrical grounding surfaces, bottom view



Mechanical Support Areas

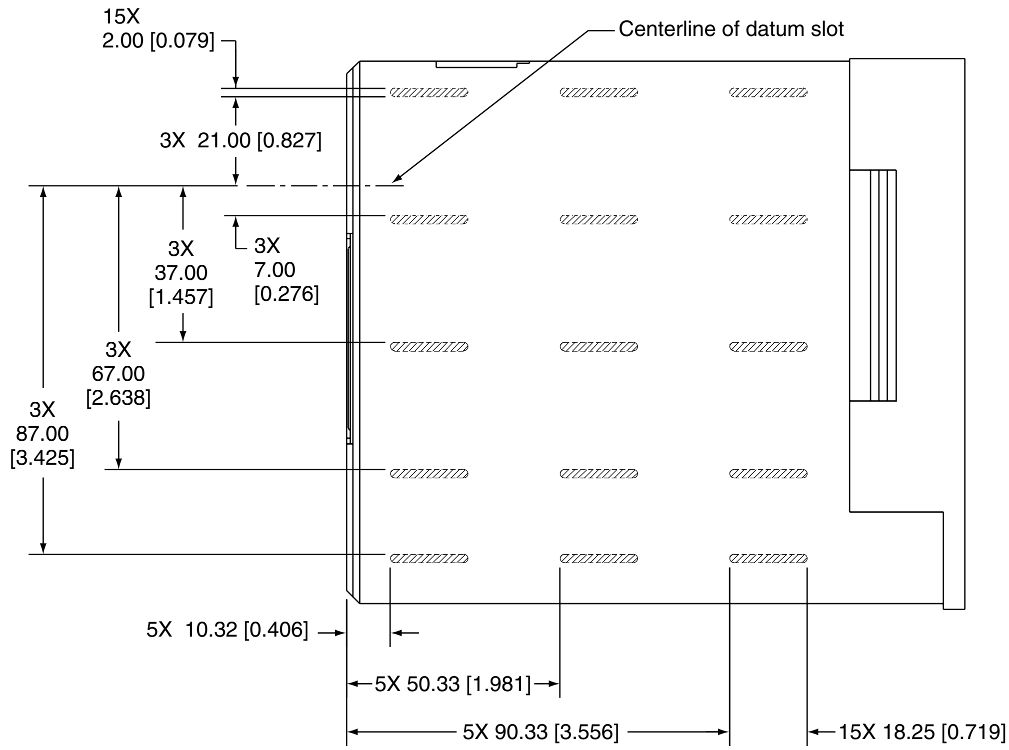
The expansion bay comes in contact with the module and supports it in the areas shown in Figure 4-27 and Figure 4-28. Those areas should not be recessed below the surface of the module.

Figure 4-27 Mechanical contact areas, top view



Note: Dimensions are in millimeters [inches].

Figure 4-28 Mechanical contact areas, bottom view



Note: Dimensions are in millimeters [inches].

Expansion Bay Connector

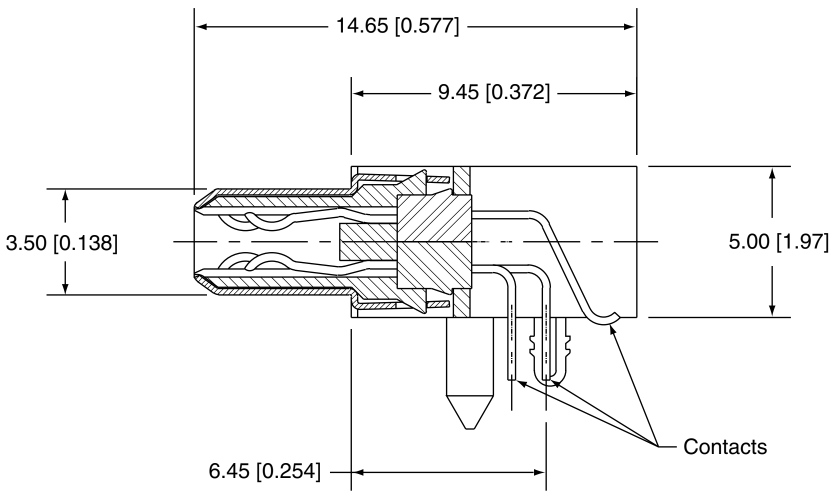
The expansion bay connector is a 90-pin shielded connector. The pins are divided into two groups by a gap. The gap breaks one row of pins between pins 11 and 12 and the other row between pins 56 and 57.

The connector on the expansion module is AMP part number 787481-1. For a specification sheet or information about obtaining this connector, contact AMP at

AMP, Inc.
19200 Stevens Creek Blvd.
Cupertino, CA 95014-2578
408-725-4914
AppleLink: AMPCUPERTINO

Figure 4-29 shows a section through the expansion bay connector and gives its dimensions.

Figure 4-29 Section through expansion bay connector



Note: Dimensions are in millimeters [inches].

IMPORTANT
The expansion bay connector is designed so that when a module is inserted into the bay, the first connection is the ground by way of the connector shells, then the power pins make contact, and last of all the signal lines. ▲

The expansion bay connector can be used for several different kinds of devices. The values of the device ID signals DEV_ID(2–0) determine how the other signals are connected, as shown in Table 4-3. A value of 0 corresponds to a device ID line connected to ground; a value of 1 corresponds to an open line.

IMPORTANT
An expansion bay module must never tie or pull up any device ID line to any power main. ▲

Table 4-3 Device ID signals and types of devices

DEV_ID(2)	DEV_ID(1)	DEV_ID(0)	Type of device
0	0	0	MFM/GCR floppy disk, auto eject
0	0	1	Reserved
0	1	0	Reserved
0	1	1	ATA device; if the device supports DMA operation, DEV_ID(1) and DEV_ID(0) are connected together

continued

Table 4-3 Device ID signals and types of devices (continued)

DEV_ID(2)	DEV_ID(1)	DEV_ID(0)	Type of device
1	0	0	Reserved
1	0	1	PCI device
1	1	0	Power input device
1	1	1	No device installed

PCI Signals on the Expansion Bay Connector

Table 4-4 shows the signal assignments on the expansion bay connector when it is used with a PCI device. Signal names that begin with a slash (/) are active low.

Note
The table shows the signals in the same arrangement as the pins on the connector; that is, with pin 1 next to pin 46 and pin 45 next to pin 90. ◆

Table 4-4 PCI signals on the expansion bay connector

Pin	Direction	Signal name	Pin	Direction	Signal name
1		Reserved	46		Reserved
2		Reserved	47		Reserved
3		A3.3V	48	I	SND_IN_L
4	I	SND_IN_RET	49	I	SND_IN_R
5		SND_OUT_L	50		SND_OUT_RET
6		SND_OUT_R	51	O	RAW_BAT
7		LONG AGND	52	O	RAW_BAT
8	O	MB_PCI_IDSEL	53		n.c.
9	I	/DEV_IN	54	I/O	DEV_ID(0)
10	I/O	DEV_ID(1)	55	I/O	DEV_ID(2)
11		GND	56	O	PCI_CLK
—	—	(Gap)	—	—	(Gap)
12		+5V	57	O	IN_USE_LED
13	I	/INTA	58		GND
14	I/O	/C/BE(0)	59	I/O	/C/BE(1)
15		+5V	60	I/O	/C/BE(2)
16	I/O	/C/BE(3)	61		LONG GND
17	I	/REQ	62		+5V

Table 4-4 PCI signals on the expansion bay connector (continued)

Pin	Direction	Signal name	Pin	Direction	Signal name
					continued
18	O	/GNT	63	I/O	/PERR
19	I/O	PAR	64	O	/BUF_PCI_RST
20		GND	65	I/O	/IRDY
21	I/O	/TRDY	66	I/O	/FRAME
22	I/O	/SERR	67		+5V
23	I/O	/DEVSEL	68	I/O	/LOCK
24	I/O	/STOP	69	I/O	AD(0)
25		LONG GND	70	I/O	AD(1)
26	I/O	AD(2)	71	I/O	AD(3)
27		+3V	72	I/O	AD(4)
28	I/O	AD(5)	73	I/O	AD(6)
29	I/O	AD(7)	74		GND
30	I/O	AD(8)	75	I/O	AD(9)
31	I/O	AD(10)	76	I/O	AD(11)
32		+3V	77	I/O	AD(12)
33	I/O	AD(13)	78	I/O	AD(14)
34	I/O	AD(15)	79		LONG GND
35	I/O	AD(16)	80	I/O	AD(17)
36	I/O	AD(18)	81	I/O	AD(19)
37		+3V	82	I/O	AD(20)
38	I/O	AD(21)	83	I/O	AD(22)
39	I/O	AD(23)	84		GND
40	I/O	AD(24)	85	I/O	AD(25)
41	I/O	AD(26)	86	I/O	AD(27)
42		+3V	87	I/O	AD(28)
43	I/O	AD(29)	88	I/O	AD(30)
44	I/O	AD(31)	89		GND
45		RAW_BAT	90		RAW_BAT

PCI Control Signals in Sleep Mode

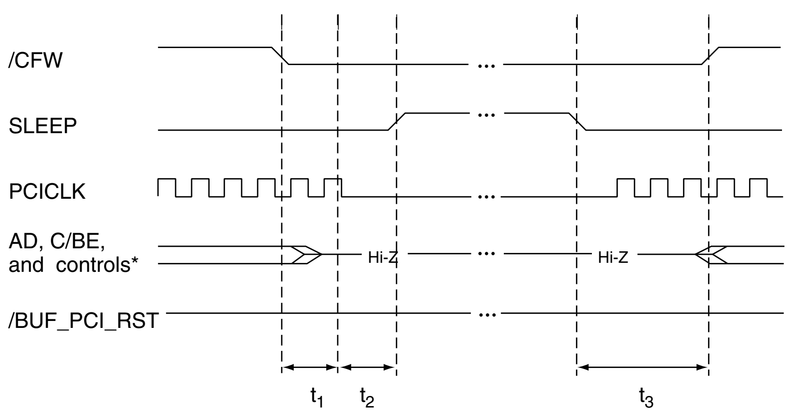
The following PCI control signals are disconnected from the expansion bay during sleep: /DEVSEL, /FRAME, /GRANT, /INT, /IRDY, /LOCK, /PERR, /REQ, /SERR, /STOP, and /TRDY. PCI devices on a module in the expansion bay should have these signals pulled up through 100 KΩ resistors to the PCI device Vcc.

IMPORTANT

The same control signals are used for PCI devices on a module in the expansion bay and on a card in the PCI expansion slot, but those signals are electrically different during sleep mode. See "Expansion Card Operation and Sleep Mode" beginning on page 49. ▲

Figure 4-30 shows the timing of the control signals on the expansion bay connector as the computer goes into and emerges from sleep mode.

Figure 4-30 Timing of expansion bay control signals for sleep mode



t_1 = 16 ms min. /CFW to clocks stopped

t_2 = 16 ms min. Clocks stopped to system sleep

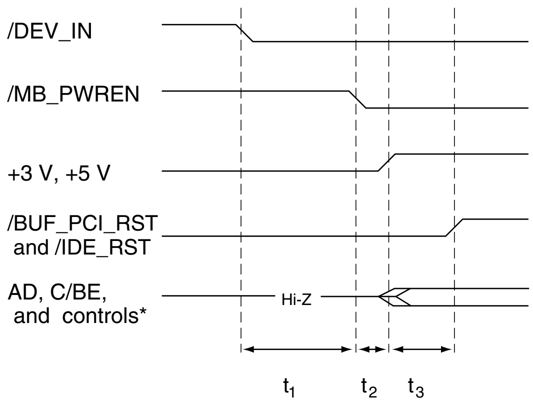
t_3 = 50 ms min. Clocks started to clock valid

*/DEVSEL, /FRAME, /GRANT, /INT, /IRDY, /LOCK, /PERR, /REQ, /SERR, /STOP, and /TRDY

PCI Signals During Power On and Off

Figure 4-31 shows the timing of the control signals on the expansion module during the power-on sequence. Figure 4-32 shows the timing of the control signals on the expansion module during the power-off sequence.

Figure 4-31 Timing of the expansion bay control signals during power on



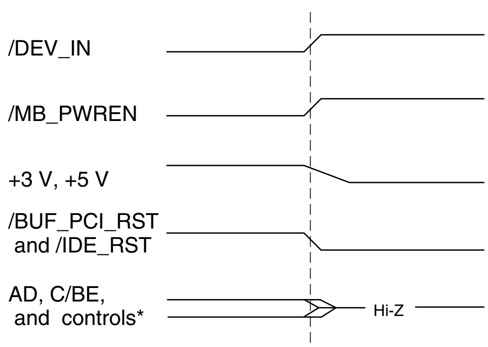
t_1 = 250 ms min.

t_2 = 5 ms min.

t_3 = 10 ms min.

*/DEVSEL, /FRAME, /GRANT, /INT, /IRDY, /LOCK, /PERR, /REQ, /SERR, /STOP, and /TRDY

Figure 4-32 Timing of the expansion bay control signals during power off



*/DEVSEL, /FRAME, /GRANT, /INT, /IRDY, /LOCK, /PERR, /REQ, /SERR, /STOP, and /TRDY

For descriptions of the sequences of operations that occur whenever the computer power is switched on or off, see “Power Sequences” beginning on page 51.

ATA and Floppy Disk Signals on the Expansion Bay Connector

Table 4-5 shows the signal assignments on the expansion bay connector when it is used with an ATA device or a floppy disk drive. Signal names that begin with a slash (/) are active low.

Note
The table shows the signals in the same arrangement as the pins on the connector; that is, with pin 1 next to pin 46 and pin 45 next to pin 90. ◆

Table 4-5 ATA and floppy disk signals on the expansion bay connector

Pin	Direction	Signal name	Pin	Direction	Signal name
1	I/O	/TPB	46	I/O	TPB
2	I/O	/TPA	47	I/O	TPA
3		A3.3V	48	I	SND_IN_L
4	I	SND_IN_RET	49	I	SND_IN_R
5	R	SND_OUT_L	50	R	SND_OUT_RET
6	R	SND_OUT_R	51	R	RAW_BAT
7		LONG AGND	52	R	RAW_BAT
8	R	Reserved (video)	53	R	Reserved (video)
9	I	/DEV_IN	54	I/O	DEV_ID(0)
10	I/O	DEV_ID(1)	55	I/O	DEV_ID(2)
11		GND	56		n.c.
—	—	(Gap)	—	—	(Gap)
12		+5V	57	O	IN_USE_LED
13	O	/WRREQ	58		GND
14	O	PHASE(0)	59	O	PHASE(1)
15		+5V	60	O	PHASE(2)
16	O	PHASE(3)	61		LONG GND
17	O	WRDATA	62		+5V
18	I	RDDATA	63	O	/FL_ENABLE
19	O	HDSEL	64	O	/IDE_RST
20		GND	65		n.c.
21		n.c.	66		n.c.
22		n.c.	67		+5V

continued

Table 4-5 ATA and floppy disk signals on the expansion bay connector (continued)

Pin	Direction	Signal name	Pin	Direction	Signal name
23		n.c.	68		n.c.
24	I	IOCHRDY	69	I/O	IDE_D(0)
25		LONG GND	70	I/O	IDE_D(1)
26	I/O	IDE_D(2)	71	I/O	IDE_D(3)
27		+3V	72	I/O	IDE_D(4)
28	I/O	IDE_D(5)	73	I/O	IDE_D(6)
29	I/O	IDE_D(7)	74		GND
30	I/O	IDE_D(8)	75	I/O	IDE_D(9)
31	I/O	IDE_D(10)	76	I/O	IDE_D(11)
32		+3V	77	I/O	IDE_D(12)
33	I/O	IDE_D(13)	78	I/O	IDE_D(14)
34	I/O	IDE_D(15)	79		LONG GND
35	O	/DIOR	80	O	/DIOW
36	O	/CS3FX	81	O	/CS1FX
37		+3V	82	O	DA(0)
38	O	DA(1)	83	O	DA(2)
39	O	/DMACK	84		GND
40	I	DMARQ	85	I	IDE_INTRQ
41		n.c.	86		n.c.
42		+3V	87		n.c.
43		n.c.	88		n.c.
44		n.c.	89		GND
45		RAW_BAT	90		RAW_BAT

Signal Definitions

The signals on the expansion bay connector are of three types: expansion bay audio and control signals, floppy disk signals, and ATA signals. The next three tables describe the three types of signals: Table 4-6 describes the audio and control signals, Table 4-7 describes the floppy disk signals, and Table 4-8 describes the ATA signals.

Table 4-6 Audio and control signals on the expansion bay connector

Signal name	Signal description
DEV_ID(0–2)	These three signal lines identify the type of expansion bay device. Table 4-3 shows the identification codes for different devices.
/DEV_IN	This signal should be low whenever a device is installed in the expansion bay; it is used by the O'Hare IC to determine when a device has been inserted or removed. The expansion bay module should connect this pin to ground.
/IDE_RST /BUF_PCI_RST	Reset signals.
MB_SND_COM	Common (ground) line for expansion bay sound signals.
MB_SND_L	Left channel sound signal from the expansion bay device.
MB_SND_R	Right channel sound signal from the expansion bay device.

NOTE The MB_SND signals on the expansion bay connector are shared with the MB sound signals on the PCI expansion connector.

Table 4-7 Floppy disk signals on the expansion bay connector

Signal name	Signal description
FD_RD	Read data from the floppy disk drive.
/FL_ENABLE	Floppy disk drive enable.
PHASE(0–3)	Phase(0–2) are state-control lines to the drive; Phase(3) is the strobe signal for writing to the drive's control registers.
WRDATA	Write data to the floppy disk drive.
/WRREQ	Write data request signal.

Table 4-8 ATA signals on the expansion bay connector

Signal name	Signal description
/CS1FX	Register select signal. It is asserted low to select the main task file registers. The task file registers indicate the command, the sector address, and the sector count.
/CS3FX	Register select signal. It is asserted low to select the additional control and status registers on the IDE drive.
/DIOR	I/O data read strobe.
/DIOW	I/O data write strobe.
DMARQ	DMA request signal.
DMACK	DMA acknowledge signal.

Table 4-8 ATA signals on the expansion bay connector (continued)

Signal name	Signal description
	continued
IDE_ADDR(0–2)	IDE device address; used by the computer to select one of the registers in the drive. For more information, see the descriptions of the /CS1FX and /CS3FX signals.
IDE_D(0–15)	IDE data bus, buffered from IOD(16–31) of the controller IC. IDE_D(0–15) are used to transfer 16-bit data to and from the drive buffer. IDE_D(0–7) are used to transfer data to and from the drive's internal registers, with IDE_D(8-15) driven high when writing.
IOCHRDY	I/O channel ready; when driven low by the IDE drive, signals the CPU to insert wait states into the I/O read or write cycles.
IDE_INTRQ	IDE interrupt request. This active high signal is used to inform the computer that a data transfer is requested or that a command has terminated.
/MB_IDE_RST	Hardware reset to the IDE drive.

Note
Signal names that begin with a slash (/) are active low. ◆

Unused IDE Signals on the Expansion Bay Connector

Several signals defined in the standard interface for the IDE drive are not used by the expansion bay. Those signals are listed in Table 4-9 along with any action required for the device to operate in the expansion bay.

Table 4-9 Unused IDE signals on the expansion bay connector

Signal name	Comment
CSEL	This signal must be tied to ground to configure the device as the master in the default mode.
IOCS16	No action required.
PDIAG	No action required; the device is never operated in master-slave mode.
DAS	No action required.

Power on the Expansion Bay Connector

Table 4-10 describes the power lines on the expansion bay connector. The MB_+5V and MB_+3V lines are controlled by the /MB_PWR signal from the O'Hare IC.

Table 4-10 Power lines on the expansion bay connector

Signal name	Signal description
GND	Ground.
MB_+5V	5 V power; maximum total current is 1.0 A.
MB_+3V	3 V power; maximum total current is 1.5 A.

IMPORTANT
The maximum combined total power available from the MB_+5V and MB_+3V lines is 5 W. ▲

User Installation of an Expansion Bay Module

The user can insert a module into the expansion bay while the computer is operating. This section describes the sequence of control events in the computer and gives guidelines for designing an expansion bay module so that such insertion does not cause damage to the module or the computer.

IMPORTANT
The user must not remove a module from the expansion bay while the computer is communicating with the module or, for a module with a disk drive, while the disk is spinning. ▲

Sequence of Control Signals

Specific signals to the O'Hare IC allow the computer to detect the insertion of a module into the expansion bay and take appropriate action. For example, when module with an ATA device is inserted, the computer performs the following sequence of events:

1. When a module is inserted, the /DEV_IN signal goes low, causing the O'Hare IC to generate an interrupt.
2. System software responds to the interrupt, determines the type of module inserted, and sets the /MB_PWR_EN signal low, which turns on the power to the expansion bay; see Figure 4-31 on page 70.
3. System software internally notifies the appropriate driver of the presence of a newly inserted module.

Essentially the reverse sequence occurs when a module is removed from the expansion bay:

1. When the module is removed, the /DEV_IN signal goes high causing the O'Hare IC to generate an interrupt.

2. System software responds to the interrupt and notifies the appropriate driver that the module has been removed.

Guidelines for Developers

Each expansion bay module must be designed to prevent damage to itself and to the computer when the user inserts or removes an expansion bay module with the computer running.

The expansion bay connector is designed so that when the module is inserted the ground and power pins make contact before the signal lines.

Even though you can design an expansion bay module that minimizes the possibility of damage when it is inserted hot—that is, while the computer is running—your instructions to the user should include warnings about the possibility of data corruption.

RAM Expansion

This section includes electrical and mechanical guidelines for designing a RAM expansion card for the PowerBook 3400 computer.

IMPORTANT
The RAM expansion card for the PowerBook 3400 computer is a new design. RAM expansion cards for earlier PowerBook models will not work in this computer. ▲

The RAM expansion card can contain from 4 MB to 128 MB of dynamic RAM in one to four banks, with 4 to 32 MB in each bank.

▲ **WARNING**
Installation of a RAM expansion card computer must be performed by an experienced technician. Installation requires care to avoid damage to the pins on the RAM expansion connector. ▲

Electrical Design Guidelines for the RAM Expansion Card

This section provides the electrical information you need to design a RAM expansion card for the PowerBook 3400 computer.

Connector Pin Assignments

Table 4-11 lists the names of the signals on the RAM expansion connector. Entries in the table are arranged the same way as the pins on the connector: pin 1 across from pin 2, and so on. Signal names that begin with a slash (/) are active low.

Table 4-11 Signal assignments on the RAM expansion connector

Pin	Signal name	Pin	Signal name
1	GND	2	GND
3	GND	4	GND
5	GND	6	/CAS(6)
7	GND	8	/CAS(4)
9	+12V_MAIN	10	/CAS(5)
11	/RAS(4)	12	/RAS(2)
13	/RAS(1)	14	RADDR(9)
15	RADDR(8)	16	RADDR(10)
17	RADDR(7)	18	RADDR(0)
19	RADDR(6)	20	RADDR(1)
21	RADDR(5)	22	RADDR(2)
23	RADDR(4)	24	RADDR(3)
25	DATA(32)	26	DATA(0)
27	GND	28	GND
29	DATA(33)	30	DATA(1)
31	+3V_MAIN	32	+3V_MAIN
33	DATA(34)	34	DATA(2)
35	DATA(35)	36	DATA(3)
37	GND	38	GND
39	/CAS(1)	40	/CAS(2)
41	+3V_MAIN	42	/CAS(0)
43	DATA(7)	44	DATA(39)
45	DATA(6)	46	DATA(38)
47	DATA(5)	48	DATA(37)
49	DATA(4)	50	DATA(36)
51	DATA(11)	52	DATA(43)
53	DATA(10)	54	DATA(42)
55	DATA(9)	56	DATA(41)
57	/RAMOE	58	GND
59	DATA(8)	60	DATA(40)
61	+3V_MAIN	62	+3V_MAIN

continued

Table 4-11 Signal assignments on the RAM expansion connector (continued)

Pin	Signal name	Pin	Signal name
63	DATA(15)	64	DATA(47)
65	DATA(14)	66	DATA(46)
67	DATA(13)	68	DATA(45)
69	+3V_MAIN	70	+3V_MAIN
71	DATA(12)	72	DATA(44)
73	DATA(19)	74	DATA(51)
75	DATA(18)	76	DATA(50)
77	DATA(17)	78	DATA(49)
79	DATA(16)	80	DATA(48)
81	DATA(23)	82	DATA(55)
83	DATA(22)	84	DATA(54)
85	DATA(21)	86	DATA(53)
87	GND	88	GND
89	DATA(20)	90	DATA(52)
91	+3V_MAIN	92	+3V_MAIN
93	DATA(27)	94	DATA(59)
95	DATA(26)	96	DATA(58)
97	DATA(25)	98	DATA(57)
99	DATA(24)	100	DATA(56)
101	DATA(31)	102	DATA(63)
103	DATA(30)	104	DATA(62)
105	DATA(29)	106	DATA(61)
107	DATA(28)	108	DATA(60)
109	/CAS(3)	110	/CAS(7)
111	+3V_MAIN	112	/RAMWE
113	RADDR(11)	114	/RAS(3)
115	GND	116	GND
117	+3V_MAIN	118	+3V_MAIN
119	+3V_MAIN	120	+3V_MAIN

IMPORTANT

The RAM expansion connector is the same type as the one in the PowerBook 5300, but it is oriented in the opposite direction and the pin assignments are different. A RAM expansion card designed for the PowerBook 5300 will not work in a PowerBook 3400 computer. ▲

Signal Descriptions

Table 4-12 describes the signals on the RAM expansion connector. Signal names that begin with a slash (/) are active low.

Table 4-12 Signals on the RAM expansion connector

Signal name	Description
+12V_MAIN	12.0 V for flash memory; 30 mA maximum.
+3V_MAIN	3.3 V ± 5%; 500 mA maximum.
/CAS(0–7)	Column address select signals for the individual bytes in a longword. The /CAS signals are assigned to the byte lanes as follows: /CAS(0): Data(0–7) /CAS(4): DataL(32–39) /CAS(1): Data(8–15) /CAS(5): DataL(40–47) /CAS(2): Data(16–23) /CAS(6): DataL(48–55) /CAS(3): Data(24–31) /CAS(7): DataL(56–63)
DATA(0–63)	Bidirectional 64-bit DRAM data bus.
GND	Chassis and logic ground.
RADDR(0–11)	Multiplexed row and column address to the DRAM devices. (See the section "Address Multiplexing" on page 80 to determine which address bits to use for a particular type of DRAM device.)
/RAMOE	Output enable signal to the DRAM devices.
/RAS(0–4)	Row address select signals for the five banks of DRAM. (Signals /RAS(1–4) are for DRAM banks on the expansion card. The /RAS(0) signal selects the bank of DRAM on the main logic board. The byte lanes of the 64-bit data bus are selected by the /CAS(0–7) signals.)
/RAMWE	Write enable for all banks of DRAM.

In the table, signals are specified as inputs or outputs with respect to the main logic board that contains the CPU and memory module; for example, an input is driven by the expansion card into the logic board.

Address signals must be stable before the falling edge of RAS. Each RAS line is connected to only one bank of devices whereas each address signal must reach all the devices. If each address line were connected to every DRAM device, the difference in loading would cause the address signals to change more slowly than the RAS signals. To ensure that the address signals are stable before the RAS transition, RAM expansion cards must have buffers on the address lines; see "RAM Expansion Card Electrical Limits" beginning on page 82.

Address Multiplexing

Signals RA(0-11) are a 12-bit multiplexed address bus and can support several different types of DRAM devices. Depending on their internal design and size, different types of DRAM devices require different row and column address multiplexing. The operation of the multiplexing is determined by the way the address pins on the devices are connected to individual signals on the RA(0-11) bus and depends on the exact type of DRAM used.

Table 4-13 shows how the signals on the address bus are connected for several types of DRAM devices. The device types are specified by their size and by the number of row and column address bits they require.

Table 4-13 also shows how the signals are multiplexed during the row and column address phases. The numbers in square brackets at the top of the table identify the signals on the RAM address bus that are connected to the device's address pins. For each type of DRAM device, the table shows the address bits that drive each address pin during row addressing and column addressing.

IMPORTANT

The address bits in Table 4-13 are numbered in PowerPC notation: MSB to LSB from left to right, starting with bit 0. Some other documentation uses the MC680x0 notation where MSB is bit 31. To convert from one convention to the other, simply subtract each bit number from 31. ▲

The address multiplexing scheme used in the PowerBook 3400 computer supports only the types of RAM devices shown in Table 4-13. Other types of devices should not be used with this computer. ▲

Table 4-13 Address multiplexing for some types of DRAM devices

	DRAM address signals connected to device address pins											
Type of DRAM device	**[11]**	**[10]**	**[9]**	**[8]**	**[7]**	**[6]**	**[5]**	**[4]**	**[3]**	**[2]**	**[1]**	**[0]**
512K by 8; 10 row bits, 9 column bits												
Row address bits	–	–	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	–	20	21	22	23	24	25	26	27	28
2M by 8; 12 row bits, 9 column bits												
Row address bits	9	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28

continued

Table 4-13 Address multiplexing for some types of DRAM devices (continued)

	DRAM address signals connected to device address pins											
Type of DRAM device	**[11]**	**[10]**	**[9]**	**[8]**	**[7]**	**[6]**	**[5]**	**[4]**	**[3]**	**[2]**	**[1]**	**[0]**
1M by 4 or 1M by 16; 10 row bits, 10 column bits												
Row address bits	–	–	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28
2M by 8; 11 row bits, 10 column bits												
Row address bits	–	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28
4M by 1 or 4M by 4; 11 row bits, 11 column bits												
Row address bits	–	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	7	9	20	21	22	23	24	25	26	27	28
4 M by 16; 12 row bits, 10 column bits												
Row address bits	9	8*	10*	11	12	13	14	15	16	17	18	19
Column address bits			7*	20	21	22	23	24	25	26	27	28

NOTE Expansion cards using 4 M by 16 bit devices must connect device address bits 9 and 10 as shown (swapped).

IMPORTANT
The only 64-megabit DRAM devices supported by the PowerBook 3400 computer are 4 M by 16-bit devices with 12-by-10 address multiplexing. As Table 4-13 shows, the connections to device address bits 9 and 10 must be swapped on the card for this type of DRAM device. ▲

RAM Banks

The RAM expansion card can have up to four banks of RAM. Banks can be 4 MB, 8 MB, 16 MB, or 32 MB in size.

Banks are selected by individual signals /RAS(0–4) as shown in Table 4-14.

Table 4-14 RAM bank selection

Signal names	Bank	Bank location
/RAS(0)	0	Main logic board
/RAS(1)	1	RAM expansion card
/RAS(2)	2	RAM expansion card
/RAS(3)	3	RAM expansion card
/RAS(4)	4	RAM expansion card

Because only one bank is active at a time, and because different-sized DRAM devices consume about the same amount of power when active, a card having fewer devices per bank consumes less power than a card having more devices per bank.

DRAM Device Requirements

The DRAM devices used in a RAM expansion card must meet the following minimum specifications:

- Power supply voltage: 3.3 V
- Access type: EDO
- Access time: 60 ns or shorter access time
- Refresh: CBR, extended refresh capable (L-type)
- Refresh cycle: 15.6 ms

IMPORTANT
Space limitations require devices used on the RAM expansion card to have TSOP packages. ▲

RAM Expansion Card Electrical Limits

The RAM expansion card must not exceed the following maximum current limits on the +3 V supply:

Active	500 mA
Standby	24 mA
Sleep	12 mA

During system sleep at the 15.6 µs refresh rate, the current for the entire RAM card must not exceed 12 mA. Vendors of cards that exceed the refresh-current restriction will be required to state in their user manuals that their cards may reduce the amount of time the computer can remain in sleep mode before running down the battery.

The capacitive loading on the signal lines must not exceed the following limits:

- DATA(0–63): 50 pF
- RADDR(0–11): 140 pF
- /RAMWE: 140 pF
- RAMOE: 140 pF
- /RAS(n): 80 pF
- /CAS(n): 50 pF

Buffers on the Ram Expansion Card

The RAM expansion card must have buffers on the RADDR(0–11), /RAMWE, RAMOE, /RAS(n), and /CAS(n) signals. The buffer ICs must meet the following requirements:

- operate at 3 V
- conform to package height limits (TSOP)
- have less than 4 ns propagation delay
- draw less than 20 µA from the supply when static

▲ **WARNING**
Do not use buffers such as the TI 74ALVC and 74ALVCH series that have a bus hold feature on the input signals. ▲

Card Layout Suggestions

The following suggestions will reduce noise and improve the performance of the RAM expansion card.

- Route address traces so that stubs are minimized, with no stub longer than 0.5 inch.
- Route address traces on higher impedance layers (50 Ω nominal).
- Interleave banks of devices physically so that /CAS(n) and DATA(n) traces are routed together.

A RAM expansion card with poorly routed traces can corrupt signal integrity on the main RAM and may cause intermittent system errors. When testing a newly designed RAM expansion card, developers should also characterize the signal integrity of RAM address signals on the main logic board.

Mechanical Design Guidelines for the RAM Expansion Card

This section provides the mechanical information you need to design a RAM expansion card for the PowerBook 3400 computer.

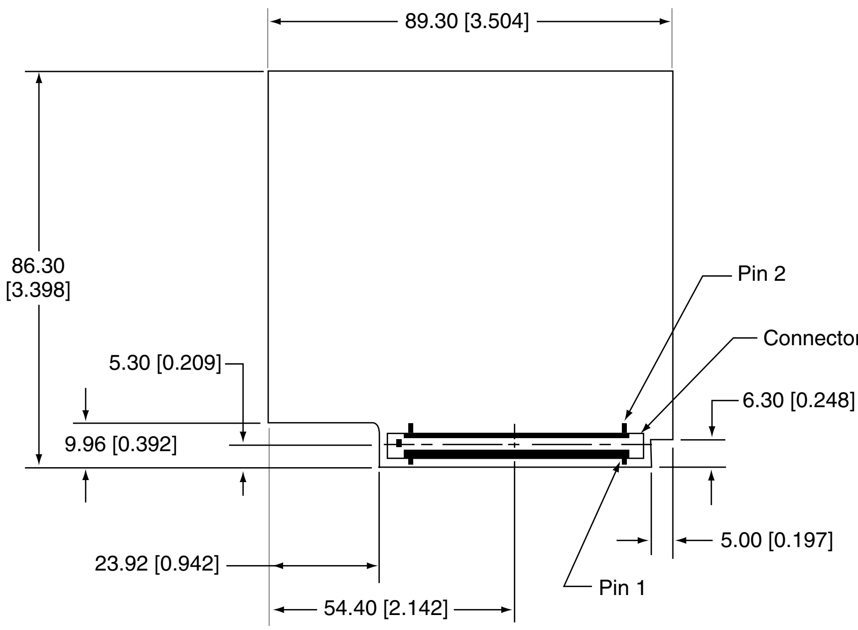
Figure 4-33 shows the dimensions of the card and the location of the connector. The connector and other components are all on the same side of the card; the figure shows the component side. Dimensions are shown in millimeters and [inches].

When the card is installed in the computer, the components and the connector are on the bottom of the card.

Figure 4-34 shows the component height restrictions on the card. Except for the connector, the maximum component height is 1.42 mm (0.056 inches). No components or leads are allowed on the reverse (top) side of the card.

As shown in Figure 4-34, the thickness of the card is 0.75 mm (0.030 inches).

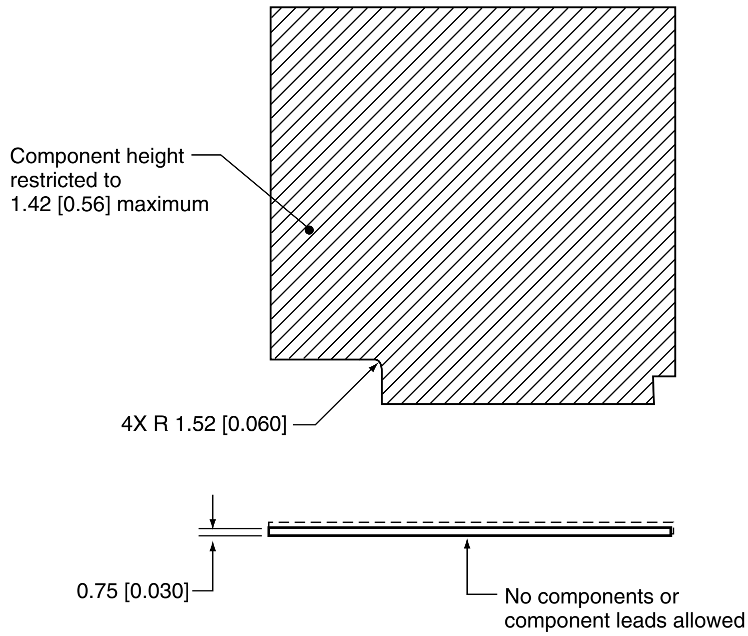
Figure 4-33 Dimensions of the RAM expansion card



Note: Dimensions are in millimeters [inches].

Note
The following tolerances apply to all the drawings in this section:
One digit after the decimal point (X.X): ±0.20 [0.01]
Two digits after the decimal point (X.XX): ±0.13 [0.005]
Three digits after the decimal point (X.XXX): ±0.100 [0.0039]

Figure 4-34 Height restrictions on the RAM expansion card



PC Card Expansion

The computer has a slot with two sockets that can accept either two type II PC Cards (PCMCIA) or one type III PC Card. This section summarizes the features and specifications of the PC Card slots.

IMPORTANT

The PowerBook 3400 computer uses new PC Card software. The changes have little effect on simple modem and ATA cards, but developers of multi-function cards or network cards must be aware of the changes. The book *PC Card Family Programming Interface for Mac OS* contains complete specifications for the new software. Also see "PC Card Software" on page 87. ▲

PC Card Slot Features

Each PC Card socket supports two types of PC Cards: mass storage cards such as SRAM and ATA drives (both rotating hard disk and flash media) and I/O cards such as modems and network cards. The Macintosh desktop metaphor includes the concept of storage device representation so it already supports mass storage cards. Apple Computer has extended the metaphor to include I/O cards as well.

The user can insert or remove a PC Card while the computer is operating. The user can eject a PC Card either by selecting Eject in Finder menu or by dragging the card's icon to the trash.

PowerBook computers currently support PC Card ejection by software command. Software ejection is controlled by Card Services and allows the system to eject a PC Card after notifying all clients of the card that its ejection is about to occur. If clients are using resources on the card, the clients have the option of refusing the request and alerting users to the reasons why an ejection can't take place.

Summary Specifications

The PC Card slot contains two standard PC Card sockets. Each socket accepts either a Type I or Type II card. The bottom PC Card socket also accepts one Type III card, which prevents the top socket from being used. The bottom socket is also capable of supporting the new PCMCIA zoom video standard for digital video applications.

The mechanical and electrical characteristics of the PC Card slot conform to the specifications given in the PCMCIA PC Card Standard, Release 5.1. Each socket supports 16-bit PC Cards with either 5 volt or 3.3 volt operating voltages, and each socket also provides a maximum of 120 mA of 12 V power for programming flash devices on PC Cards.

Note
Unlike the PC Card slot in the PowerBook 5300 series computers, the PC Card slot in the PowerBook 3400 computer provides both 3.3 and 5 volts and supports 120 mA of programming power to both sockets at the same time. ◆

The PowerBook 3400 computer utilizes an industry-standard Texas Instruments PCI1130 PCI to CardBus controller to act as the bridge between the system PCI bus and each of the PC Card slots. Although the TI device is a cardbus-capable controller, the PowerBook 3400 does not support CardBus cards due to the requirement of a specialized PC Card socket, which is not part of the system.

Each socket supports five memory windows and two I/O windows, to allow mapping PC Card memory and registers into PCI address space.

Zoom Video

The lower PC Card slot in the PowerBook 3400 computer supports zoom video, a method of displaying video information sent from a PC Card. The video information can be displayed in a window on the internal display or on an external video monitor. Because the zoom video feature sends video information from a PC Card directly to the video controller, it provides full-motion video at the same time the computer is performing other tasks.

The zoom video signals from the lower PC Card slot are accompanied by stereo audio signals in PCM (pulse-code modulated) format.

The zoom video connection makes it possible for PC Cards to provide a variety of video services such as

- MPEG video decompression hardware
- a TV tuner
- connecting a camera for video teleconferencing

The computer's software includes the Apple Video Player application, which allows the user to select the device that provides the video image and to set the size of the video window on the display.

PC Card Software

The PowerBook 3400 computer uses the new PC Card 3.0 software. PC Card 3.0 uses a multilayered architecture designed for robustness, extensibility, and ease of maintenance. The layers are implemented to make the best use of the Mac OS 7.5.x as well as future versions of the Mac OS.

PC Card 3.0 is designed to handle single-function and multifunction cards. Support for well-behaved cards is built into the system. Support for new technologies is implemented by means of plug-in card enabler modules. Custom icons, card names, and device names are available to card developers with a minimum of effort through the use of enablers.

For complete specifications and descriptions of the software interfaces, developers should consult *PC Card Family Programming Interface for Mac OS,* an upcoming document that defines the new PC Card software model for both System 7.5.3 and planned future versions of Mac OS. You may also wish to consult *Designing PCI Cards and Drivers for Power Macintosh Computers*.

CHAPTER 5

Software Features

This chapter describes the new features of the software in the ROM of the Macintosh PowerBook 3400 computer.

Note
The system software shipped with the PowerBook 3400 computer is Mac OS system 7.6. For documentation, developers should refer to *TECHNOTE: System 7.6.* The technote is available on the Developer CD Series and on the technote web site at <http://devworld.apple.com/dev/technotes.shtml>. ◆

The ROM includes new tables and code for identifying the machine. Applications can find out which computer they are running on by using the Gestalt Manager. The `gestaltMachineType` value for the PowerBook 3400 is 306 (hexadecimal $132). *Inside Macintosh: Overview* describes the Gestalt Manager and tells how to use the `gestaltMachineType` value to obtain the machine name string.

This chapter is in two parts: a description of the internal system ROM and a description of the Macintosh system ROM.

Internal System ROM

The internal system ROM for the PowerBook 3400 is composed of four major functional modules:

- Power Management Unit (PMU) ROM code
- Macintosh System ROM code
- BootPowerPC ROM code
- OpenFirmware ROM code

Starting up the PowerBook 3400 system for the first time requires the use of the power button on the back. On subsequent startups, the user can start from the keyboard because the power management unit (PMU) scans the keyboard to detect when the power key is depressed. When that happens, the PMU turns on the power to the main logic board and releases the reset signal to the PowerPC processor.

The PowerPC processor executes its reset vector, which defines the starting address of the hardware initialization section of the BootPowerPC code. That code runs diagnostic tests, determines whether the PMU ROM code should be downloaded, and provides enough hardware initialization to run the OpenFirmware ROM code. After the boot beep sound is played, the OpenFirmware ROM code starts executing. It probes the PCI bus to determine the device configuration and builds a device tree describing the hardware it finds. Unless the user interrupts it to select an alternate operating system, the OpenFirmware code loads the default OS: the Macintosh System ROM.

To be able to run the Macintosh System ROM, which is 68K code, the PowerPC nano-kernel is loaded, and the 68K emulator task is started. The emulator begins executing code in the system ROM. This code uses the device tree provided by

OpenFirmware to install device drivers and Macintosh OS Services (Toolbox Managers), and finally the system ROM loads the rest of the operating system from the startup disk.

The following sections describe the new features of each of the major modules in the ROM.

Power Management Unit ROM

At the core of the PowerBook 3400 architecture is the power management unit (PMU), a Motorola 68HC05 microprocessor that is used for I/O functions mainly concerned with controlling power to various parts of the system. The PMU functions include power control, keyboard scanning, and controlling the ADB. The code used by the PMU is downloaded from an image contained in the main ROM or on the system disk.

Battery Charging

The PMU controls the battery charging capabilities of the power supply. It does this by providing pulse width modulated (PWM) signals to control the power supply current and voltage limits.

The PowerBook 3400 can use either Nickel-Metal Hydride (NiMH) or Lithium Ion (LiIon) batteries, which require different charging algorithms. The batteries contain an identification value inside their internal controller that the PMU uses to find out the battery type.

NiMH batteries must be charged with a constant current (CC) charging algorithm that stops charging when the temperature inside the battery begins to rise rapidly. The current limit is determined by the available power from the wall adapter: 9 W when the computer is running, 45 W when the computer is off or in sleep mode. The system software examines the machine configuration to determine the amount of power available for charging the batteries and provides this information to the PMU.

LiIon batteries can be charged using the CC or the quicker constant wattage (CW) charging mode until the battery voltage reaches its predefined limit, then the constant voltage (CV) charge mode is used to complete the charge cycle. The PMU uses CW charging by monitoring the battery voltage and setting the charge current to the maximum available considering the available power. The PMU also programs the CV limit so that even if the battery disconnects from the charger, the maximum voltage will not be exceeded.

Interface to Nonvolatile RAM

The PMU provides an interface to 8192 bytes of nonvolatile RAM for use by OpenFirmware and PCI device drivers. The interface allows reading and writing multiple bytes to any address range. The maximum number of bytes is determined by the PmgrOp protocol. The PMU maintains a checksum of the RAM area; if the checksum fails, the PMU initializes the NVRAM to all zeros.

BootPowerPC ROM

When the PowerPC 603ev processor is released from reset, it begins executing the BootPowerPC code. This code includes exception handling, power-on self tests (POST), hardware initialization, the PowerPC nano-kernel, and the 68LC040 Emulator.

Among the changes that have been incorporated into the BootPowerPC ROM are:

- the PowerPC nanokernel now supports the PowerPC 603ev microprocessor
- the 68LC040 emulator is now the faster dynamic recompilation emulator

OpenFirmware ROM

The OpenFirmware code provides a machine independent mechanism for loading operating systems from a variety of startup devices. OpenFirmware probes the PCI bus looking for devices and possible OpenFirmware drivers for those devices. A driver can be either built into the OpenFirmware module or located on the same PCI card as the device, thus providing plug-and-play capabilities even for newly installed devices. The OpenFirmware code is capable of using the driver to load an operating system from the device.

The OpenFirmware ROM provides drivers for all built-in devices that are capable of loading the next generation operating system (Mac OS 8), including SCSI, internal ATA, expansion bay ATA, and ATAPI.

Normally the OpenFirmware code starts up using the default device and loads the default operating system. While that is going on, the user may interrupt the OpenFirmware code by holding down the Command-Option-O-F keys. The OpenFirmware code responds by providing a command line interface using the keyboard and the computer’s built-in display. The user can then select an alternate operating system or change the OpenFirmware code’s stored parameters, such as the default OS to be loaded.

Macintosh System ROM

The following sections describe the changes in the Macintosh System ROM for the PowerBook 3400 computer.

Note
The Macintosh System ROM is also called the 68K ROM because it begins with the 680x0 reset vector. ◆

ATA Manager and Driver

The PowerBook 3400 computer uses the native ATA Manager, which has been updated to support several new features:

- DMA accesses on both ATA buses
- new expansion bay manager API for detecting device insertion and removal
- new Card & Socket Services model
- now fully native for the PowerPC processor

The ATAPI driver now supports 4x and 6x CDROM drives in the expansion bay. The driver supports audio compact discs as well as data discs.

Floppy Disk Driver

The new floppy disk driver can read disks that use Microsoft's distribution floppy format (DMF, 1.6 MB FM).

IRTalk Driver

The new IR driver works with Open Transport and provides data transfer at two rates:

- 115 kbps IRTalk (compatible with the PowerBook 5300)
- 230 kbps IRTalk

Expansion Bay Manager

The PowerBook 3400 computer has a new Expansion Bay Manager in place of the previous Socket Services for the expansion bay, which didn't accommodate the use of the PCI bus in the expansion bay.

The Expansion Bay Manager keeps a table of the handlers that are called when a device is inserted or removed. The handlers are responsible for creating the appropriate notifications and for opening and closing the device drivers. The system ROM includes handlers for the floppy disk drive and for ATA devices.

The first time the computer is started after a PCI device has been inserted, the Expansion Bay Manager probes the PCI bus and adds any new devices to the name registry. The first time the computer is started after a PCI device has been removed, the Expansion Bay Manager deallocates the memory space that was allocated to the device and closes the appropriate driver.

IMPORTANT
Expansion modules that have PCI devices can be inserted or removed only while the computer is off. They cannot be inserted or removed while the computer is in sleep mode. ▲

The Expansion Bay Manager cooperates with the Power Manager to determine the amount of power the different devices consume.

PC Card Manager

The PC Card ROM software includes built-in clients for ATA devices (disk drives), SRAM cards, and 16550-based modem cards. The ATA devices are handled by the ATA Manager, although the ATA client is responsible for configuring the card for ATA operation. The SRAM client is a complete driver capable of supporting any file system available from the Mac OS (currently Macintosh HFS and PC FAT).

The PC Card Manager supports ATA PC Cards, SRAM cards, and modem cards. Other types of cards require drivers or card enablers.

Note
The PC Card Manager for PowerBook 3400 is a new implementation of PC Card Services; it is not the same as the PC Card software described in the *Macintosh PowerBook 5300 Developer Note (Macintosh Developer Note Number 14).* ◆

SCSI Disk Mode

New SCSI disk mode software supports SCSI disk mode (when the user connects the special SCSI cable). To improve performance, the SCSI disk mode software uses available system RAM as a large write-through disk cache and uses DMA for data transfers.

Sound Manager

The Sound Manager has been updated to deal with a new mixer function in the sound input and output subsystem. The new mixing capabilities allow the Sound Manager to select from several different sound sources:

- built-in microphone
- external sound input jack
- internal devices: expansion bay, PC Card, Zoom Video port, and PCI slot

To conserve power, the Sound Manager has been modified to turn off the sound system whenever sounds have not been played for several minutes.

Video Driver

A new video driver has been written to support driving both flat panels and an external monitor from the same frame buffer. This driver uses the new native driver model and driver services library provided for PCI-based Macintosh models. The video driver requests system services only by way of the drivers services library. The system software includes additional APIs for backlight and contrast voltage control.

This driver uses the native QuickDraw acceleration API to take advantage of the accelerated `BitBlt` feature of the 65550 video controller IC for rectangular copies and fills.

The video driver supports the hardware cursor when the display is set to 8 bpp (256 colors) or 16 bpp (thousands of colors). In the other display modes the conventional software cursor is used. The hardware cursor does not appear different, but it should provide improved performance when the application is drawing under the cursor—for example, when the user moves the cursor over a QuickTime movie that is playing.

The Display Manager has been modified to handle video mirroring when there is only one frame buffer.

Glossary

680x0 code Instructions that can run on a PowerPC microprocessor only by means of an emulator. See also **native code.**

ADB See **Apple Desktop Bus.**

Apple Developer Cataog (ADC) Apple Computer's worldwide direct distribution channel for Apple and third-party development tools and documentation products.

API See **application programming interface.**

Apple Desktop Bus (ADB) An asynchronous bus used to connect relatively slow user-input devices to Apple computers.

Apple SuperDrive Apple Computer's disk drive for high-density floppy disks.

AppleTalk Apple Computer's local area networking protocol.

application programming interface (API) The calls and data structures that allow application software to use the features of the operating system.

big endian Data formatting in which each field is addressed by referring to its most significant byte. See also **little endian.**

codec A digital encoder and decoder.

color depth The number of bits required to encode the color of each pixel in a display.

DAC See **digital-to-analog converter.**

data burst Multiple longwords of data sent over a bus in a single, uninterrupted stream.

data cache In a PowerPC microprocessor, the internal registers that hold data being processed.

digital-to-analog converter (DAC) A device that produces an analog electrical signal in response to digital data.

display data channel (DDC) A standard interface that provides monitor ID signals for VGA and SVGA monitors.

direct memory access (DMA) A process for transferring data rapidly into or out of RAM without passing it through a processor or buffer.

distribution media format (DMF) A format for 3.5-inch floppy disks. By putting three more sectors in each track (21 instead of 18), it provides 1.7 MB of storage instead of the conventional 1.4 MB on a 3.5-inch high-density disk.

DLPI Data Link Provider Interface, the standard networking model used in Open Transport.

DMA See **direct memory access.**

DRAM See **dynamic random-access memory.**

DR Emulator The Dynamic Recompilation Emulator, an improved 680x0-code emulator for the PowerPC microprocessor.

dynamic random-access memory (DRAM) Random-access memory in which each storage address must be periodically interrogated (or refreshed) to maintain its value.

ECSC Enhanced color support chip, the custom IC that provides the data and control interface to the flat panel display.

Ethernet A high-speed local area network technology that includes both cable standards and a series of communications protocols.

GCR See **group code recording.**

Group Code Recording (GCR) An Apple recording format for floppy disks.

input/output (I/O) Parts of a computer system that transfer data to or from peripheral devices.

I/O See **input/output.**

little endian Data formatting in which each field is addressed by referring to its least significant byte. See also **big endian.**

localtalk The cable terminations and other hardware that Apple supplies for local area networking from Macintosh serial ports.

mini-DIN An international standard form of cable connector for peripheral devices.

native code Instructions that run directly on a PowerPC microprocessor. See also **680x0 code.**

nonvolatile RAM RAM that retains its contents even when the computer is turned off; also known as parameter RAM.

NuBus™ A bus architecture in Apple computers that supports plug-in expansion cards.

O'Hare A custom IC that provides core I/O services in the PowerBook 3400 computer.

PSX The custom IC that provides the interface between the processor bus and the internal PCI bus in the PowerBook 3400 computer.

PC Card An expansion card that conforms to the PC Card standard. See also **PC Card standard.**

PC Card Manager The part of the Mac OS that supports PC Cards in PowerBook computers.

PC Exchange A utility program that runs on Macintosh computers and reads other floppy disk formats, including DOS and ProDOS.

PC Card standard A standard specification defined by the Personal Computer Memory Card International Association (PCMCIA) for computer expansion cards.

pixel Contraction of *picture element*; the smallest dot that can be drawn on a display.

POWER-clean Refers to PowerPC code free of instructions that are specific to the PowerPC 601 and Power instruction sets and are not found on the PowerPC 603 and PowerPC 604 microprocessors.

PowerPC Trade name for a family of RISC microprocessors. The PowerPC 601, 603, and 604 microprocessors are used in Power Macintosh computers.

reduced instruction set computing (RISC) A technology of microprocessor design in which all machine instructions are uniformly formatted and are processed through the same steps.

RISC See **reduced instruction set computing.**

SCC See **Serial Communications Controller.**

SCSI See **Small Computer System Interface.**

Serial Communications Controller (SCC) Circuitry on the Combo IC that provides an interface to the serial data ports.

SIMM See **Single Inline Memory Module.**

Single Inline Memory Module (SIMM) A plug-in card for memory expansion containing several RAM ICs and their interconnections.

Small Computer System Interface (SCSI) An industry standard parallel bus protocol for connecting computers to peripheral devices such as hard disk drives.

socket The hardware receptacle that a PC Card is inserted into.

Socket Services The layer of software that is responsible for communication between Card Services and the socket controller hardware.

tuple A parsable data group containing configuration information for a PCMCIA card.

Versatile Interface Adapter (VIA) The interface for system interrupts that is standard on most Apple computers.

VIA See **Versatile Interface Adapter**.

video RAM (VRAM) Random-access memory used to store both static graphics and video frames.

VRAM See **video RAM**.

zoom video A method of connecting video signals from a PC Card directly to the video controller.

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Hooper Developer Note

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