Developer Note

Apple iBook Computer

Developer Note

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About This Developer Note

This developer note gives a technical description of the iBook computer. The note provides information about the computer's internal design, input-output features, and expansion capabilities.

Note
This developer note has been updated to include information about the latest product features and configurations. ◆

This developer note is intended to help hardware and software developers design products that are compatible with the Macintosh products described here. If you are not already familiar with Macintosh computers or if you would like additional technical information, you should refer to "Supplemental Reference Documents."

The information in this note is arranged in four chapters and two appendixes.

- Chapter 1, "Introduction," introduces the iBook and describes its features.
- Chapter 2, "Architecture," describes the internal logic of the iBook, including the main ICs that appear in the block diagram.
- Chapter 3, "Devices and Ports," describes the standard I/O ports and the built-in I/O devices.
- Chapter 4, "RAM Expansion," describes the RAM expansion module.
- Appendix A, "Supplemental Reference Documents," tells where to find more information about specific technologies used in the iBook.
- Appendix B, "Abbreviations," lists the standard units and abbreviations used in this developer note.

CHAPTER 1

Introduction

The iBook is Apple's portable computer for the consumer and education markets. This chapter lists the computer's features, with emphasis on the changes from the previous models. It also provides information about compatibility issues.

New Features

The features that have changed are listed here along with references to the sections that describe them. For a quick comparison of new and old features, see Table 1-1.

- **Processor speed:** The clock speed of the microprocessor is 500 MHz. See "G3 Microprocessor" (page 24).
- **Memory:** The CD-ROM model has 64 MB of SDRAM installed on the main logic board and one standard SO-DIMM slot for memory expansion up to 576 MB total. The other models have 128 MB of SDRAM installed on the main logic board and one standard SO-DIMM slot for memory expansion up to 640 MB total. See "System RAM" (page 26).
- **Display:** The computer has a 12.1-inch TFT display with XGA (1024 by 768) resolution. See "Flat Panel Display" (page 56).
- **Graphics IC:** The display controller is an ATI RAGE Mobility M128. See "Graphics IC" (page 27).
- **Composite video output:** The computer has an A/V port with a composite video output signal. See "Composite Video Output" (page 57).
- **RGB video output:** The computer has an output port for connecting an RGB video monitor. See "RGB Video Output" (page 57).
- **Hard disk storage:** The computer has a hard disk drive with a storage capacity of 10 GB. See "Hard Disk Drive" (page 40).
- **USB ports:** The computer has two USB ports. See "USB Ports" (page 32).
- **FireWire port:** The computer has an IEEE-1394 FireWire high-speed serial port. See "FireWire Port" (page 34).
- **CD-ROM drive:** One configuration has a 24x-speed CD-ROM drive. See "CD-ROM Drive" (page 45).

- **DVD-ROM drive:** One configuration has an 8x-speed DVD-ROM drive. See "DVD-ROM Drive" (page 46).
- **Combination DVD-ROM/CD-RW drive:** One configuration has a combination DVD-ROM/CD-RW drive. For more information, see "DVD-ROM/CD-RW Drive" (page 46).
- **CD-RW drive:** A CD-RW drive is available as an option. For more information, see "CD-RW Drive" (page 47).
- **Sound:** The iBook has a built-in microphone and stereo speakers along with stereo output signals on the A/V jack. See "Sound System" (page 59).
- **Battery:** The computer has a 6-cell battery with 42 WHr capacity.

Weight: With the battery installed, the computer weighs approximately 2.2 kg (4.9 pounds); the exact weight depends on the configuration.

- **Size:** The iBook computer is 28.50 cm (11.2 inches) wide and 23.03 cm (9.06 inches) deep. Its thickness is 3.39 cm (1.33 inches).

Table 1-1 lists the features that have changed, giving a side-by-side comparison of the new models with the previous models.

Table 1-1 Comparison of features

Feature	Previous models	Current models
CPU speed	366 or 466 MHz	500 MHz
L2 cache type and speed	256 KB internal, 366 or 466 MHz	256 KB internal, 500 MHz
Memory	64 MB (320 MB max.)	64 or 128 MB (640 MB max.)
Graphics IC	ATI RAGE Mobility 128	ATI RAGE Mobility M128
Display size	12.1-inch SVGA	12.1-inch XGA
Hard disk drive	10 GB (20 GB available)	10 GB (20 GB available)
Optical drive	24x CD-ROM or 6x DVD-ROM	24x CD-ROM, 8x DVD-ROM, or DVD-ROM/CD-RW; 4x/8x/24x CD-RW also available

Table 1-1 Comparison of features (continued)

Feature	Previous models	Current models
I/O ports	1 USB port; 1 FireWire port	2 USB ports; 1 FireWire port
Sound features	Built-in speaker, stereo outputs	Built-in mic; stereo speakers and outputs
Battery	48 WHr	42 WHr
Weight	3.0 kg to 3.2 kg (6.6 to 6.8 pounds)	2.2 kg (4.9 pounds)
Size	Width 34.4 cm (13.5 inches), depth 29.4 cm (11.6 inches), thickness 3.1–5.2 cm (1.24–2.06 inches)	Width 28.50 cm (11.2 inches), depth 23.03 cm (9.06 inches), thickness 3.42 cm (1.35 inches)

All Features

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

- **Processor speed:** The clock speed of the microprocessor is 500 MHz. See "G3 Microprocessor" (page 24).
- **PowerStep:** The 500 MHz model allows the user to slow down the processor speed from 500 to 400 MHz to conserve power. See "PowerStep" (page 18).
- **Cache:** The microprocessor has a built-in L2 cache consisting of 256 KB of fast static RAM. The clock speed for the backside cache is the same as the clock speed of the microprocessor. See "Backside (L2) Cache" (page 25).
- **Hard disk storage:** The computer has a hard disk drive with a storage capacity of 10 GB. A 20 GB drive is also available. For more information and developer guidelines for alternative hard drives, see "Hard Disk Drive" (page 40).

- **CD-ROM drive:** One configuration has a built-in 24x-speed CD-ROM drive. See "CD-ROM Drive" (page 45).
- **DVD-ROM drive:** One configuration has a built-in 8x-speed DVD-ROM drive. See "DVD-ROM Drive" (page 46).
- **Combination DVD-ROM/CD-RW drive:** One configuration has a combination DVD-ROM/CD-RW drive. For more information, see "DVD-ROM/CD-RW Drive" (page 46).
- **CD-RW drive:** A built-in 4x/8x/24x CD-RW drive is available as an option. For more information, see "CD-RW Drive" (page 47).
- **Display:** The computer has a 12.1-inch TFT display with XGA (1024 by 768) resolution. See "Flat Panel Display" (page 56).
- **Composite video output:** The computer has an A/V port with a composite video output signal. See "Composite Video Output" (page 57).
- **RGB video output:** The computer has an output port for connecting an RGB video monitor. See "RGB Video Output" (page 57).
- **Graphics IC:** The display controller is an ATI RAGE Mobility M128. See "Graphics IC" (page 27).
- **Video RAM:** The display controller includes 8 MB of video RAM. See "Graphics IC" (page 27).
- **Microphone:** The computer has a built-in microphone. See "Sound System" (page 59).
- **Battery:** The computer has one battery bay. The battery uses six lithium ion cells and has a capacity of 3900 mAh at a nominal 10.8 V. Battery life under normal use is up to 6 hours.
- **USB ports:** The computer has two USB ports. See "USB Ports" (page 32).
- **FireWire port:** The computer has an IEEE-1394 FireWire high-speed serial port. See "FireWire Port" (page 34).
- **Target Disk Mode:** The computer can act like a FireWire storage device connected to another computer. See "Target Disk Mode" (page 18).
- **Modem:** The iBook has a built-in modem that supports 56 Kbps data rate. See "Internal Modem" (page 37).
- **Ethernet:** The iBook has a built in Ethernet port for 10Base-T and 100Base-T operation. See "Ethernet Port" (page 36).

- **Wireless LAN:** An internal wireless LAN module is available as a build-to-order option or as a user-installable upgrade. See "AirPort Card Wireless LAN Module" (page 38).
- **Sound:** The iBook has a built-in microphone and stereo speakers and provides stereo output signals on the A/V jack. See "Sound System" (page 59).
- **Keyboard:** The keyboard has function keys and inverted-T arrow keys. Some of the function keys are used to control the brightness and sound; the other function keys are user programmable to open applications or files. The keyboard also includes an embedded numeric keypad. See "Keyboard" (page 48).
- **Trackpad:** The integrated trackpad includes tap/double tap and drag features. See "Trackpad" (page 47).

Weight: With the battery installed, the computer weighs approximately 2.2 kg (4.9 pounds); the exact weight depends on the configuration.

- **Size:** The iBook computer is 28.50 cm (11.2 inches) wide and 23.03 cm (9.06 inches) deep. Its thickness is 3.39 cm (1.33 inches).
- **Security slot:** The iBook computer has a slot for attaching a Kensington security cable.

Peripheral Devices

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

- The AirPort Card wireless LAN module is available separately as a user-installable option.
- The battery is available separately as an additional or replacement battery.
- The power adapter, which comes with the computer, is also available separately. The adapter can recharge the internal battery in six hours while the computer is running or in three and a half hours while the computer is shut down or in sleep mode.
- A power cable for use on airliners is also available. The voltage provided by the airliner is not high enough to charge the computer's battery, so the power

cable includes a sense resistor. When the computer detects the sense resistor, its power manager does not attempt to charge the battery. See also "Power Control IC" (page 29).

System Software

The iBook computer comes with Mac OS 9.1 installed.

Here are a few items of interest about the system software on the iBook computer.

Mac OS 9.1

Mac OS 9.1 has a new file arrangement that simplifies the root directory and helps to prepare the user for the transition to Mac OS X. The new file layout has fewer folders at the root level. In fact, it has only three: System, Documents, and Applications (Mac OS 9).

There are more folders under Applications (Mac OS 9), including Apple Extras, Assistants, Utilities, and Internet Utilities. Files that formerly resided in the Internet Applications folder are now found in the Applications folder.

For the latest information about Mac OS 9.1, see the references listed in "Mac OS 9" (page 70).

Machine Identification

All Macintosh ROMs based on Open Firmware and ROM in RAM share the same BoxFlag. The intent is for applications to use properties in the Open Firmware device tree rather than checking BoxFlag to find out the features of the machine. As with other computers that use ROM-in-RAM, a call to `gestaltMachineType` returns the value 406 ($196).

IMPORTANT
Programs such as control panels and installers that use Box Flag to verify that this is a valid CPU on which to execute need to be changed to verify the existence of the hardware they require. Developers should look for the features they need, rather than reading the box flag and then making assumptions about the computer's features. ▲

Asset management software that reports the kind of machine it is run on can obtain the value of the property at `Devices:device-tree:compatible` in the name registry. The model string is the first program-usable string in the array of C strings in the `compatible` field. For the iBook, the `model` property value is `PowerBook4,1`.

The string obtained from the `compatible` property cannot be displayed to the computer user. If it is available, you can use the result from calling `Gestalt ('mnam', &result)` where `result` is a string pointer. This call returns a Pascal style string that can be displayed to the user.

Applications should not use either of these results to infer the presence of certain features; instead, applications should use Gestalt calls to test for the features they requires.

PowerStep

PowerStep is a feature that allows the user to change the processor's clock speed, either slowing down to 400 MHz to conserve power or speeding up when the full 500-MHz speed is needed. The user can select this feature by using either the Energy Saver control panel or the Energy Saver control strip. In the Energy Saver control panel, the user can check a check box labeled Reduce Processor Speed in the Advanced Settings panel. In the Energy Saver control strip, the user can select Faster Processor Speed or

Slower Processor Speed.

Target Disk Mode

The user has the option at boot time to put the computer into a mode of operation called Target Disk Mode (TDM). This mode is similar to SCSI Disk mode on a PowerBook computer equipped with a SCSI port, except it uses a FireWire cable instead of a special SCSI cable.

When the iBook computer is in Target Disk Mode and connected to another Macintosh computer by a FireWire cable, the iBook operates like a FireWire mass storage device with the SBP-2 (Serial Bus Protocol) standard. Target Disk Mode has two primary uses:

- data transfer between computers
- diagnosis and repair of a corrupted internal hard drive

The iBook computer can operate in Target Disk Mode as long as the other computer has a FireWire port and the FireWire software version 2.3.3 or later.

To put the iBook into Target Disk mode, you restart the computer and hold down the T key until the FireWire icon appears on the display. You then connect a FireWire cable from the iBook to the other computer. When the other computer completes the FireWire connection, a TDM icon appears on its display.

If you disconnect the FireWire cable or turn off the iBook while in Target Disk Mode, an alert appears on the other computer asking you to reconnect the TDM volume.

To take the iBook out of Target Disk Mode, you drag the TDM icon on the other computer to the trash, then press the power button on the iBook.

For more information about Target Disk Mode, see the section "Target Mode" in Technote 1189, *The Monster Disk Driver Technote*. For information about obtaining the Technote, see "Apple Technotes" (page 69).

Introduction

CHAPTER 2

Architecture

This chapter describes the architecture of the iBook computer.

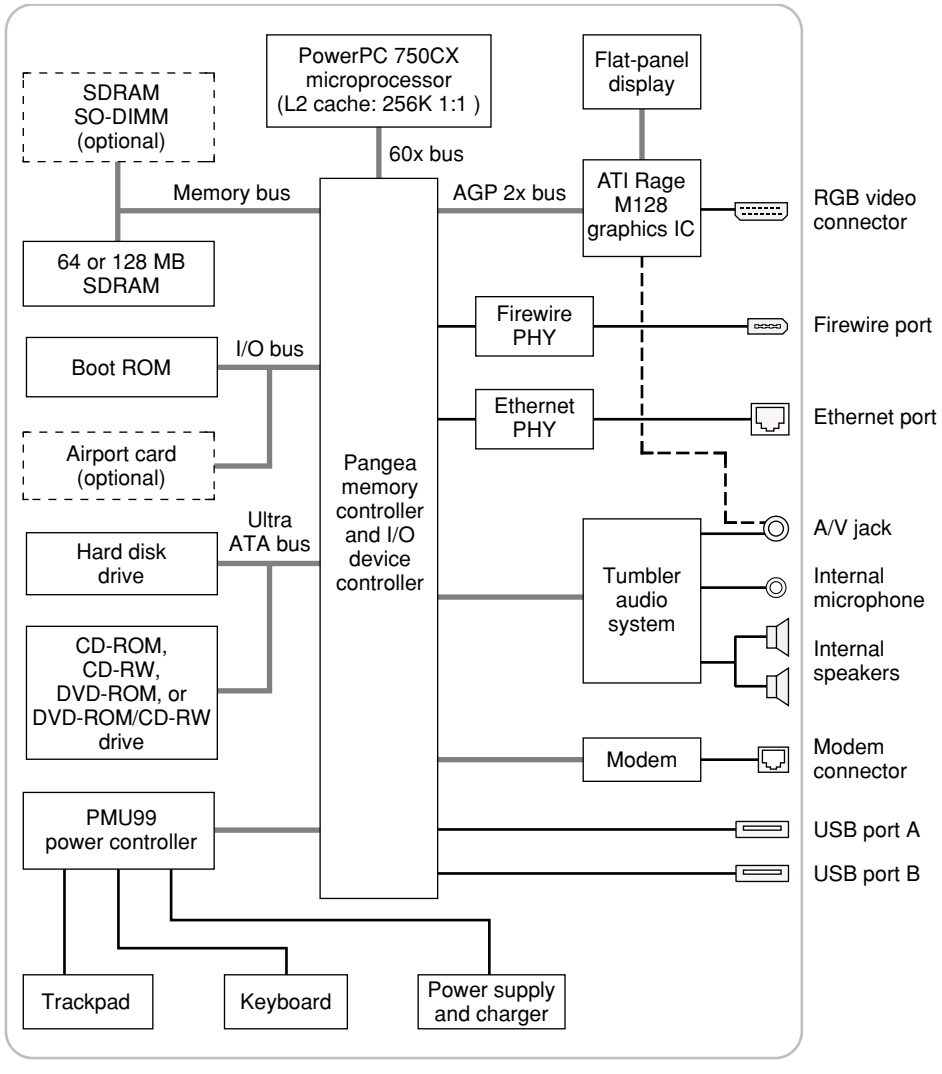
Block Diagram and Buses

This section is an overview of the major ICs and buses on the computer's main logic board.

Block Diagram

Figure 2-1 is a simplified block diagram of the main logic board. The diagram shows the input and output connectors, the main ICs, and the buses that connect them together.

Figure 2-1 Block diagram



Main ICs and Buses

The architecture of the iBook computer is designed around the PowerPC G3 microprocessor and a new custom IC: the Pangea memory controller and the I/O device controller. The Pangea IC occupies the center of the block diagram.

Note
The Pangea IC combines the functions of the Uni-N and KeyLargo ICs used in earlier models. ◆

The microprocessor is connected to the Pangea IC by a 60x bus with 64 data lines and a bus clock speed of 66 MHz. The Pangea IC has other buses that connect with the Boot ROM, the main system RAM, the graphics IC, and the Ethernet and FireWire PHY ICs. Each of the components listed here is described in one of the following sections. The buses implemented by the Pangea IC are summarized in Table 2-1, which is in the section "Memory and I/O Device Controller".

Microprocessor and Cache

The microprocessor communicates with the rest of the system by way of a 66-MHz, 64-bit 60x bus to the Pangea IC. The backside cache is built into the microprocessor.

G3 Microprocessor

The microprocessor used in the iBook is a PowerPC 750CX microprocessor, which is a type of G3 microprocessor. It has several features that contribute to superior performance, including:

- on-chip level 1 (L1) caches, 32 KB each for instruction cache and data cache
- an on-chip second level (L2) cache consisting of 256 KB with a clock speed ratio of 1:1
- a microprocessor core optimized for Mac OS applications

The PowerPC 750CX microprocessor in the iBook normally runs at a clock speed of 500 MHz. The PowerStep feature allows the user to slow the clock speed down to 400 MHz. See "PowerStep" (page 18).

Backside (L2) Cache

The data storage for the L2 cache consists of 256 KB of fast static RAM that is built into the microprocessor chip along with the cache controller. The built-in L2 cache runs at the same clock speed as the microprocessor.

Memory and I/O Device Controller

The Pangea memory controller and I/O device controller IC provides cost and performance benefits by combining many functions into a single IC. It contains the memory controller, the PCI bus bridge, the Ethernet and FireWire interfaces, and the AGP port.

In addition to the buses listed in Table 2-1, the Pangea IC also has separate interfaces to the physical layer (PHY) ICs for Ethernet and FireWire and an I^2C interface that is used for configuring the memory subsystem.

Table 2-1 Buses supported by the Pangea IC

Name of bus	Destinations	Width of data path	Bus clock speed
60x bus	Microprocessor	64 bits	66 MHz
Memory bus	System RAM	64 bits	66 MHz
AGP 2X bus	Graphics IC	32 bits	66 MHz
Ultra DMA IDE bus	Hard drive and CD or DVD drive	16 bits	33 MHz

The Pangea IC provides DB-DMA (descriptor-based direct memory access) support for the I/O channels. The DBDMA system provides a scatter-gather process based on memory resident data structures that describe the data transfers. The DMA engine is enhanced to allow bursting of data files for improved performance.

The microprocessor and the I/O controller IC are described in their own sections. The following sections describe the other subsystems that are connected to the Pangea IC.

System RAM

The memory subsystem in the iBook consists of 64 or 128 MB of SDRAM soldered on the main logic board and one expansion slot for an SO-DIMM. The data bus to the RAM and DIMM is 64 bits wide, and the memory interface is synchronized to the 60x bus interface at 66 MHz. See also "RAM Expansion" (page 61).

Boot ROM

The boot ROM includes the hardware-specific code and tables needed to start up the computer, to load an operating system, and to provide common hardware access services.

The boot ROM is connected to the card slot interface of the Pangea IC. The boot ROM is a 1 M by 8 bit flash device and can be updated in the field.

Ethernet Controller

The Pangea IC includes an Ethernet media access controller (MAC) that implements the Link layer. As a separate channel connected directly to the Pangea logic, it can operate at its full capacity without degrading the performance of other peripheral devices. The Pangea IC provides DB-DMA support for the Ethernet interface.

The controller is connected to a PHY interface IC that is capable of operating in either 10-BaseT or 100-BaseTX mode. The actual speed of the link is automatically negotiated by the PHY and the bridge or router to which it is connected. For information about the connector and the operation of the port, see "Ethernet Port" (page 36).

FireWire Controller

The Pangea IC includes an IEEE 1394 FireWire controller with a maximum data rate of 400 Mbits (50MBytes) per second. The Pangea IC provides DMA (direct memory access) support for the FireWire interface. The FireWire controller complies with the Open Host Controller Interface (OHCI) specification.

The controller IC implements the FireWire link layer. A physical layer IC, called a PHY, implements the electrical signalling protocol of the FireWire interface.

The PHY is the interface to the external connector. For information about the connector and the operation of the port, see “FireWire Port” (page 34).

Graphics IC

The graphics IC is an ATI RAGE Mobility 128M. It provides video for both the internal flat panel display and an external composite video monitor. The RAGE Mobility 128M also supports an RGB video output port.

The RAGE Mobility 128M IC includes 8 MB of SDRAM and supports a display size of 1024 by 768 pixels. The graphics IC also has a scaling mode that displays a 640-by-480 or 800-by-600 pixel image on the full screen.

The RAGE Mobility 128M IC also has a 3D graphics engine for faster rendering of 3D objects.

The display generated for the flat panel display is simultaneously available for an external monitor. See “Composite Video Output” (page 57) and “RGB Video Output” (page 57).

Because the graphics IC uses the AGP bus, it can use part of main memory as additional graphics storage. The computer’s virtual memory system organizes main memory as randomly-distributed 4 KB pages, so DMA transactions for more than 4 KB of data would have to perform scatter-gather operations. To avoid this necessity for graphics storage, the AGP logic in the Pangea IC uses a graphics address remapping table (GART) to translate a linear address space for AGP transactions into physical addresses in main memory.

Ultra DMA IDE Bus

The Pangea IC provides an Ultra DMA IDE (integrated drive electronics) channel that is connected to the internal hard disk drive and the CD or DVD drive. The Ultra DMA IDE interface, also called Ultra-DMA/33 and ATA-4, is an improved version of the EIDE interface. The Pangea IC provides DB-DMA (descriptor-based direct memory access) support for the Ultra DMA interface.

The internal hard disk drive is connected as device 0 (master) in an ATA Device 0/1 configuration. The CD or DVD drive is connected as device 1 (slave). Digital audio data from the CD or DVD drive is processed by the Sound Manager and then sent out through the Pangea IC to the sound IC.

USB Interface

The Pangea IC implements two independent USB controllers (root hubs), each of which is connected to one of the ports on the back panel of the computer. The use of two independent controllers allows both USB ports to support high data rate devices at the same time with no degradation of their performance. If a user connects a high-speed (12 Mbps) device to one port and another high-speed device to the other, both devices can operate at their full data rates.

The external USB connectors support USB devices with data transfer rates of 1.5 Mbps and 12 Mbps. For more information, see "USB Ports" (page 32).

USB devices connected to the iBook computer are required to support USB-suspend mode as defined in the USB specification. Information about the operation of USB-suspend mode on Macintosh computers is included in the *Mac OS USB DDK API Reference*. To obtain that document, please see the references at "USB Interface" (page 72).

The USB ports on the iBook computer comply with the Universal Serial Bus Specification 1.1 Final Draft Revision. The USB controllers comply with the Open Host Controller Interface (OHCI) specification.

Modem Support

The Pangea IC has a Macintosh serial port that is the interface to the modem connector. The Pangea IC provides an SCC (Serial Communications Controller) that communicates with the built-in hardware modem. The modem hardware is a set of ICs including a modem controller, data pump, and DAA. See "Internal Modem" (page 37).

Sound Circuitry

The iBook computer has new sound circuitry, called Tumbler, that is connected to the Pangea IC by a standard I^2S bus. The Pangea IC provides DB-DMA (descriptor-based direct memory access) support for the I^2S port.

The sound circuitry includes a signal processing IC that handles the equalization and volume control functions and a codec IC that performs A-to-D and D-to-A conversion.

All audio is handled digitally inside the computer. The Tumbler circuitry performs digital-to-analog conversion for the audio signals to the internal

speakers and the headphone jack. The Tumbler circuitry also provides parametric equalization for the internal speakers.

Modem progress audio is connected as a digital input to the sound circuitry so that it can be mixed into the sound output stream. The modem progress audio is processed as play-through only, not as a digital sound source.

The iBook has no dedicated sound input jack. The sound system supports the built-in microphone and other sound input by way of a USB microphone or other USB audio device. For information about sound system operation, see "Sound System" (page 59).

Power Control IC

The power manager IC in the iBook computer is a Mitsubishi M16C/62F microprocessor, also called the PMU99. It operates with its own RAM and ROM. The functions of the PMU99 include:

- controlling the sleep and power on and off sequences
- controlling power to the other ICs
- monitoring the battery charge level
- controlling battery charging
- supporting the interface to the built-in keyboard and trackpad

The iBook computer can operate from a 15-volt power outlet on an airliner, but the voltage available is not high enough for charging the battery. So that the computer can detect the connection to the airliner power, the airliner power cable has a sense resistor of approximately 25K ohms connected between the power plug's shell and ground.

The PMU99 also provides the hardware interface to the keyboard and trackpad. Software in the PMU99 IC scans the keyboard and receives data from the trackpad, then sends the data to the system in packets like those from the ADB. To the system, the keyboard and trackpad behave as if they were ADB devices.

AirPort Card Wireless LAN Module

The AirPort Card wireless LAN module shares card slot interface to the Pangea IC with the boot ROM.

The AirPort Card contains a media access controller (MAC), a digital signal processor (DSP), and a radio-frequency (RF) section. The card has a connector for the cable to the antennas, which are built into the computer's case.

The AirPort Card is based on the IEEE 802.11B standard. The card transmits and receives data at up to 11 Mbps and is compatible with older 802.11-standard systems that operate at 2 or 1 Mbps. For information about its operation, see "AirPort Card Wireless LAN Module" (page 38).

CHAPTER 3

Devices and Ports

This chapter describes both the built-in I/O devices and the ports for connecting external I/O devices. Each of the following sections describes an I/O port or device.

USB Ports

The iBook computer has two Universal Serial Bus (USB) ports that can be used to connect additional I/O devices such as a USB mouse, printers, scanners, and low-speed storage devices. The USB ports are located on the left side of the computer.

For more information about USB on Macintosh computers, please refer to Apple Computer's *Mac OS USB DDK API Reference* and the other sources listed in "USB Interface" (page 72).

USB Connector

The USB port uses a USB Type A connector, which has four pins. Two of the pins are used for power and two for data. Figure 3-1 is an illustration of a Type A USB port. Table 3-1 shows the pin assignments.

Figure 3-1 USB Type A connector

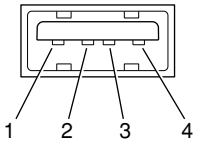


Table 3-1 Pin assignments on the USB port

Pin	Signal name	Description
1	VCC	+5 VDC
2	D–	Data –
3	D+	Data +
4	GND	Ground

The iBook provides power for the USB ports at 5 V and up to 500 mA each.

Each USB port supports both low-speed and high-speed data transfers, at up to 1.5 Mbps and 12 Mbps, respectively. High-speed operation requires the use of shielded cables.

The Macintosh USB system software that comes with the iBook computer supports all four data transfer types defined in the USB specification.

USB Features

Features of the USB ports include power saving modes and the ability to boot the computer using a USB mass-storage device.

Wake on Connect and Resume

USB Storage Devices

USB Controller

Wake on Connect and Resume

The Pangea IC contains special circuitry that allows the computer to wake from Sleep mode on connect, disconnect, and resume events. Compatible USB devices should support the USB-suspend mode defined in the USB specification. Information about the operation of USB-suspend mode on Macintosh computers is included in the *Mac OS USB DDK API Reference*.

USB Storage Devices

The Macintosh USB software supports booting from an external USB storage device.

Class drivers are software components that are able to communicate with many USB devices of a particular kind. If the appropriate class driver is present, any number of compliant devices can be plugged in and start working immediately without the need to install additional software. The Mac OS for the iBook computer includes USB Mass Storage Support 1.3, a class driver that supports devices that meet the USB Mass Storage Class specification. For information about USB support on the Macintosh, see the references in "USB Interface" (page 72).

USB Controller

The iBook computer uses an Open Host Controller Interface (OHCI) controller for USB communication. Some early USB devices (most notably keyboards) can't interoperate with an OHCI controller. Those devices are not supported by the Macintosh USB system software.

FireWire Port

The iBook computer has one external FireWire IEEE 1394 port. The FireWire port

- supports serial I/O at 100, 200, and 400 Mbps (megabits per second)
- provides up to 7 watts of peak power when the computer system is on
- supports booting the system from a mass storage device
- supports Target Disk Mode (TDM)

The FireWire hardware and software provided with the iBook computer are capable of all asynchronous and isochronous transfers defined by IEEE standard 1394.

FireWire Connector

The FireWire connector has six contacts, as shown in Figure 3-2. The connector pin assignments are shown in Table 3-2.

Figure 3-2 FireWire connector

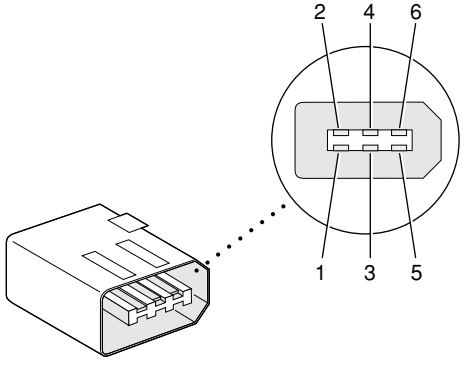


Table 3-2 Pin assignments on the FireWire connector

Pin	Signal name	Description
1	Power	Unregulated DC; 9.0–12.6 V no load when operating with battery or power adapter
2	Ground	Ground return for power and inner cable shield
3	TPB-	Twisted-pair B, differential signals
4	TPB+	Twisted-pair B, differential signals
5	TPA-	Twisted-pair A, differential signals
6	TPA+	Twisted-pair A, differential signals
Shell	—	Outer cable shield

When the computer is on, the power pin provides a maximum voltage of 12.6 V (no load) and up to 7 W peak power. The power is shared with the USB port, which can use up to 2.5 W. The power available for FireWire is reduced by the power consumed by the USB ports.

Note
The maximum voltage on the FireWire power pin on the current iBook computer is lower than that of the previous model. ◆

Pin 2 of the 6-pin FireWire connector is ground for both power and the inner cable shield. If a 4-pin connector is used on the other end of the FireWire cable, its shell should be connected to the wire from pin 2.

The signal pairs are crossed in the cable itself so that pins 5 and 6 at one end of the cable connect with pins 3 and 4 at the other end. When transmitting, pins 3 and 4 carry data and pins 5 and 6 carry clock; when receiving, the reverse is true.

FireWire Device Programming

A generic driver for mass storage devices is included in the Mac OS ROM and in the FireWire Support extension. This driver is used only when a vendor-specific driver cannot be found. Apple recommends that users install vendor-provided drivers for maximum performance and functionality.

A driver for DV (digital video) is included in QuickTime 4.0 and later versions.

The iBook computer can boot from a FireWire storage device that implements SBP-2 (Serial Bus Protocol) with the RBC (reduced block commands) command set. Detailed information is available only under non-disclosure agreement; contact Developer Technical Support at dts@apple.com.

When connected to another computer by a FireWire bus, the iBook can operate as a mass storage device. See “Target Disk Mode” (page 18).

For additional information about the FireWire interface and the Apple APIs for FireWire device control, refer to the resources listed in “FireWire Interface” (page 72).

Ethernet Port

The iBook computer has a built-in 10/100 Mbps Ethernet port. The user can connect it to either a 10Base-T or a 100Base-TX hub; the port will automatically sense which type of hub is connected.

The connector for the Ethernet port is a shielded RJ-45 connector near the left rear corner of the computer. Table 3-3 shows the signals and pins on the connector.

Note
The RJ-45 Ethernet connector is designed so that an RJ-11 connector cannot be inserted into it. ◆

Table 3-3 Signals on the Ethernet connector

Pin	Signal name	Signal definition
1	TXP	Transmit (positive lead)
2	TXN	Transmit (negative lead)
3	RXP	Receive (positive lead)
4	–	Not used
5	–	Not used
6	RXN	Receive (negative lead)
7	–	Not used
8	–	Not used

When connecting two computers using Ethernet, a crossover cable is not required; circuits in the PHY detect the type of connection and switch the signal configuration as required. ◆

The Ethernet interface in the iBook computer conforms to the ISO/IEC 802.3 specification, where applicable.

Internal Modem

The iBook computer comes with a built-in modem.The connector for the modem is an RJ-11 connector on the left rear corner of the computer.

The modem has the following features:

- modem bit rates up to 56 Kbps (V.90 modem standards)
- fax modem bit rates up to 14.4 Kbps

The modem appears to the system as a serial port that responds to the typical AT commands. The modem provides digital sound output data to the Pangea IC for monitoring the progress of the modem connection.

AirPort Card Wireless LAN Module

The iBook computer supports the AirPort Card, an internal wireless LAN module. The AirPort Card is available as a build-to-order option or as a user-installable upgrade through The Apple Store.

By communicating wirelessly with a base station, the AirPort Card can be used for internet access, email access, and file exchange. A base station provides the connection to the internet or the bridge between the wireless signals and a wired LAN. Software included with the AirPort Card enables a Macintosh computer that has an AirPort Card installed to act as a base station. The user also has the option of purchasing an AirPort Base Station that can be connected to the wired LAN or to a telephone line by way of its built-in 56k hardware modem.

The AirPort Card transmits and receives data at up to 11 Mbps. It is also interoperable with some older wireless LANs, as specified in “Hardware Components”.

Data Security

Three features of the AirPort Card help to maintain the security of data transmissions.

- The system uses direct-sequence spread-spectrum (DSSS) technology that uses a multi-bit spreading code that effectively scrambles the data for any receiver that lacks the corresponding code.
- The system can use a table of authentic network client ID values to verify each client’s identity before granting access to the network.
- When communicating with a base station, the system encrypts the data using Wired Equivalent Privacy (WEP) with a 40-bit security key.

Hardware Components

The AirPort Card is a wireless LAN module based on the IEEE 802.11 standard and using direct-sequence spread-spectrum (DSSS) technology. It is interoperable with PC-compatible wireless LANs that conform to the 802.11 standard and use DSSS.

The AirPort Card contains a media access controller (MAC), a digital signal processor (DSP), and a radio-frequency (RF) section. The antennas are built into the computer's cover, on either side of the flat-panel display.

The MAC provides the data communication protocols and the controls for the physical layer.

The DSP provides the core physical layer functionality and controls the RF section. The DSP communicates with the MAC for data exchange, physical layer control, and parameter settings.

The RF section provides modulation and transmission of outgoing signals and reception and demodulation of incoming signals. Its power output when transmitting is nominally 31 mW.

When transmitting data, the DSP converts the outgoing data stream into a direct-sequence spread-spectrum (DSSS) signal and sends it to the RF section. When receiving data, the DSP accepts incoming DSSS data from the RF section and converts it to a normal data stream.

Two antennas are connected to the AirPort Card. One antenna is always used for transmitting. Either of the two antennas may be used for receiving. Using a diversity technique, the DSP selects the antenna that gives the best reception.

Software Components

Software that is provided with the AirPort Card includes

- AirPort Setup Assistant, a standalone assistant that takes users through the steps necessary to set up the AirPort Card, set up an AirPort Base Station, or set up a software base station.
- AirPort Application, an application that allows users to switch between wireless networks and to create and join peer-to-peer networks.
- AirPort Control Strip Module, which provides a signal strength indication and most of the functions of the AirPort Application.

- AirPort Utility, a utility for the advanced user. With it the user can edit the administrative and advanced settings for a hardware or software base station. It can also be used to determine the location for the base station that gives the best reception.

Hard Disk Drive

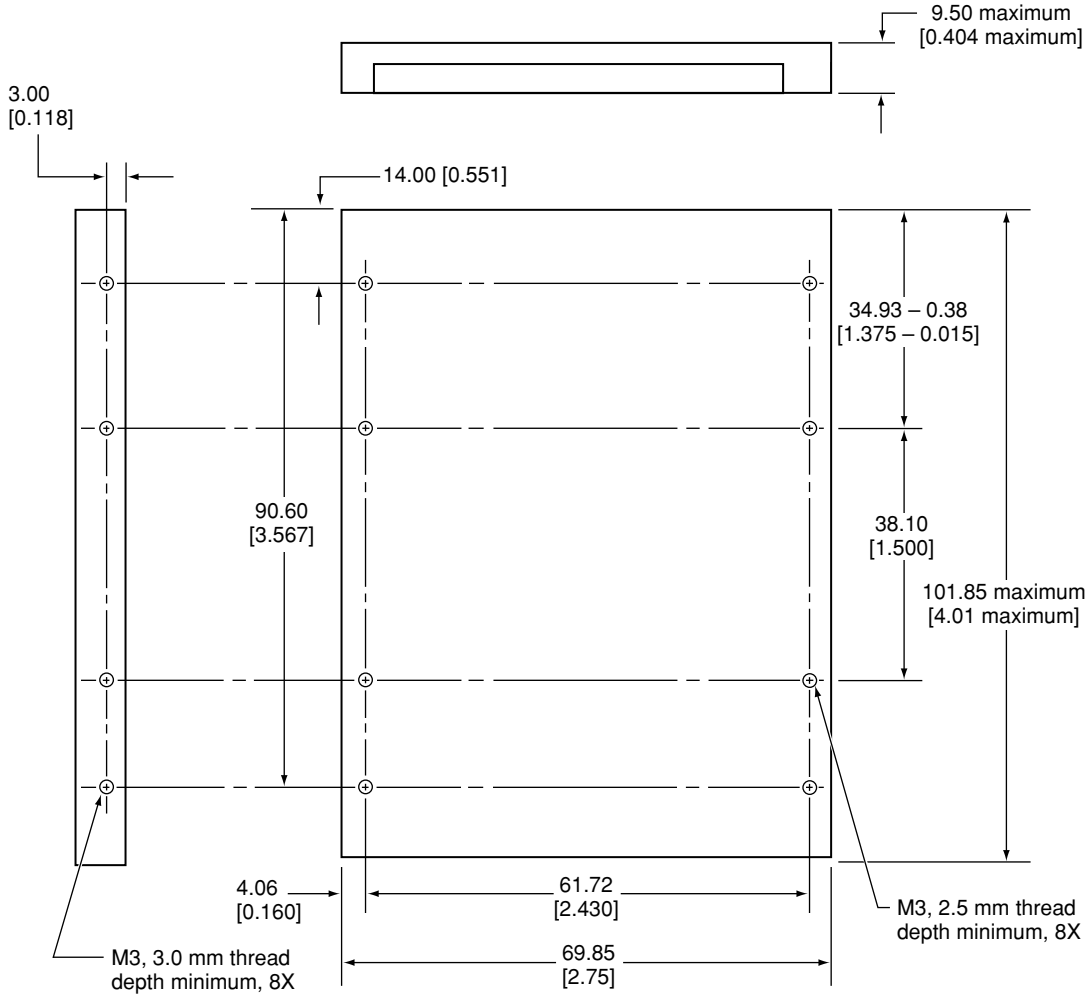
The storage capacity of the internal hard disk drive is 10 GB. The drive uses the Ultra DMA IDE (integrated drive electronics) interface, also called Ultra-DMA/33 and ATA-4, which is an improved version of the EIDE interface.

The software that supports the internal hard disk is similar to that in previous Macintosh PowerBook models with internal IDE drives and includes DMA support. For the information about that software, see the references in "ATA Devices" (page 72).

Hard Disk Dimensions

Figure 3-3 shows the maximum dimensions of the hard disk and the location of the mounting holes. The minimum clearance between any conductive components on the drive and the bottom of the mounting envelope is 0.5 mm.

Figure 3-3 Maximum dimensions of the internal hard disk

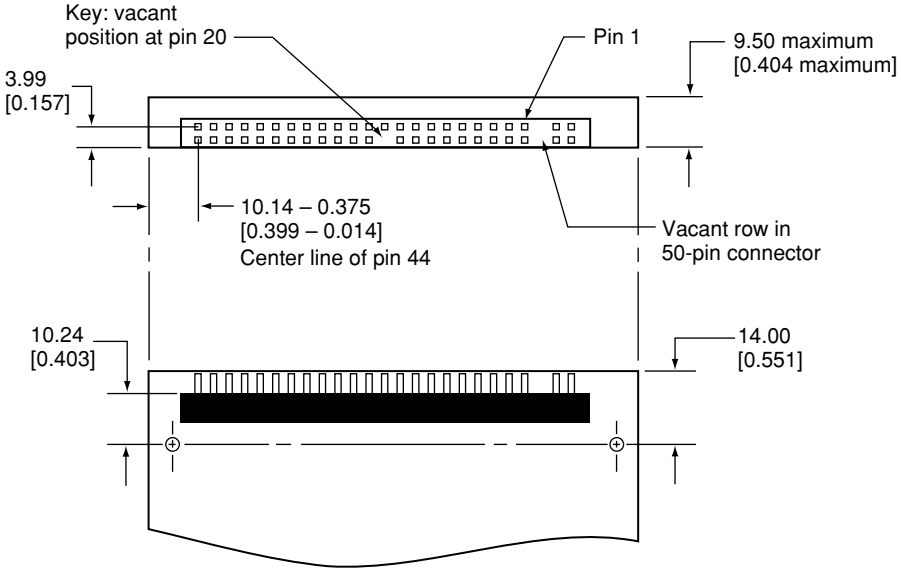


Note: Dimensions are in millimeters [inches].

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 3-4. The remaining pins are in two groups: pins 1–44, which carry the signals and power, and pins 45–48, 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 3-4 Hard disk connector and location



Signal Assignments

Table 3-4 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 3-4 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
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 MOTOR
43	GROUND	44	Reserved

NOTE CSEL, /DASP, /IOCS16, and /PDIAG are not used; see Table 3-5

ATA Signal Descriptions

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

Table 3-5 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 a 1 kilohm resistor).
/DIOR	I/O data read strobe.
/DIOW	I/O data write strobe.
/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.

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

Signal name	Signal description
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 are connected to the I/O bus through bidirectional bus buffers.

CD-ROM Drive

One configuration of the iBook has an internal CD-ROM drive. The drive uses tray-loading of the disc. The drive features a mechanism that supports 24x data transfer rates using constant angular velocity (CAV) and a data buffer that further enhances performance.

The CD-ROM drive supports the worldwide standards and specifications for CD-ROM and CD-digital audio discs described in the Sony/Philips Yellow Book and Red Book. The drive can read CD-ROM, CD-ROM XA, CD-I, PhotoCD, and Video CD discs as well as play standard audio discs.

Digital audio from the CD-ROM drive can be played through the sound outputs under the control of the Sound Manager.

DVD-ROM Drive

One configuration of the iBook has an internal 8x-speed DVD-ROM drive. The drive has a tray for loading the disc. The drive is fully compatible with existing CD-ROM media; it supports CD-ROM at 24X speed maximum and DVD at 8X speed maximum using constant angular velocity (CAV). The DVD-ROM drive supports the following disc formats:

- DVD-ROM (one- or two-layer, one- or two-sided)
- CD-ROM (Modes 1 and 2) and CD-ROM XA (Mode 2, Forms 1 and 2)
- CD-Audio, Photo CD, CD-RW (read only), CD-R (read only), and CD-Extra
- CD-I (Mode 2, Forms 1 and 2), CD-I Ready, and CD-I Bridge
- Video CD

Digital audio signals from the DVD-ROM can be played through the sound outputs under the control of the Sound Manager.

DVD-ROM/CD-RW Drive

One configuration of the iBook has a combination DVD-ROM and CD-RW drive. The drive has a tray for loading the disc.

The drive can read DVD media and read and write CD media, as shown in Table 3-6. The DVD-ROM/CD-RW drive also provides DVD-Video playback with DVD MPEG2 decode.

Table 3-6 Types of media read and written by the DVD-ROM/CD-RW drive

Media type	Reading speed	Writing speed
DVD-ROM	6x (CAV)	–

Table 3-6 Types of media read and written by the DVD-ROM/CD-RW drive

Media type	Reading speed	Writing speed
CD-R	24x (CAV)	4x (CLV)
CD-RW	5.7x (PCAV)	4x (CLV)
CD or CD-ROM	24x (CAV)	–

Digital audio signals from the DVD-ROM/CD-RW drive can be played through the sound outputs under the control of the Sound Manager.

CD-RW Drive

An internal CD-RW drive is available as an option. The drive has a tray for loading the disc. The drive is capable of writing CD-R media at 8x speed and CD-RW media at 4x speed. It can read CD-ROM media at 24x speed (CAV).

Digital audio signals from the CD-RW drive can be played through the sound outputs under the control of the Sound Manager.

Trackpad

The pointing device in iBook computer is a trackpad. 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 digital signals.

A single button below the trackpad is used to make selections. Alternatively, the user can tap and double tap on the pad itself. 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 is a compact, low-profile design with a row of function keys and inverted-T cursor motion keys.

Removing the Keyboard

The keyboard is removable to allow access to the internal components and expansion connectors inside the computer. The keyboard is held in place by a locking screw and two latches.

To unlock the keyboard, the user turns a slotted screw that is part of the Num Lock LED, which is between the F5 and F6 function keys. Turning the screw 180° locks or unlocks the keyboard.

Note
The iBook computer leaves the factory with keyboard locking screw in the unlocked position. ◆

The two latches are between the ESC key and the F1 key and between the F11 and F12 keys. The user can release the latches by pulling them toward the front of the computer.

Changing the Operation of the Keyboard

Several of the keys on the keyboard have more than one mode of operation.

- Function keys F1–F6 can also control the display brightness, speaker volume, and the Num Lock function; function key F12 is also the media eject key.
- The function keys from F7 through F11 can be set by the user to open applications, documents, or AppleScripts.
- Certain control keys can be used as page-control keys.
- The keys on the right side of the keyboard can be used as a numeric keypad.

The next sections describe these groups of keys and the way their alternate modes of operation are selected by using the Fn key, the Num Lock key, and the Function Keys checkbox in the Keyboard control panel.

Keyboard Illustrations

Figure 3-5 shows the actual appearance of the keyboard. Figure 3-6 shows the alternate modes of operation of the function and control keys. Figure 3-7 shows the embedded numeric keypad.

Figure 3-5 Keyboard layout

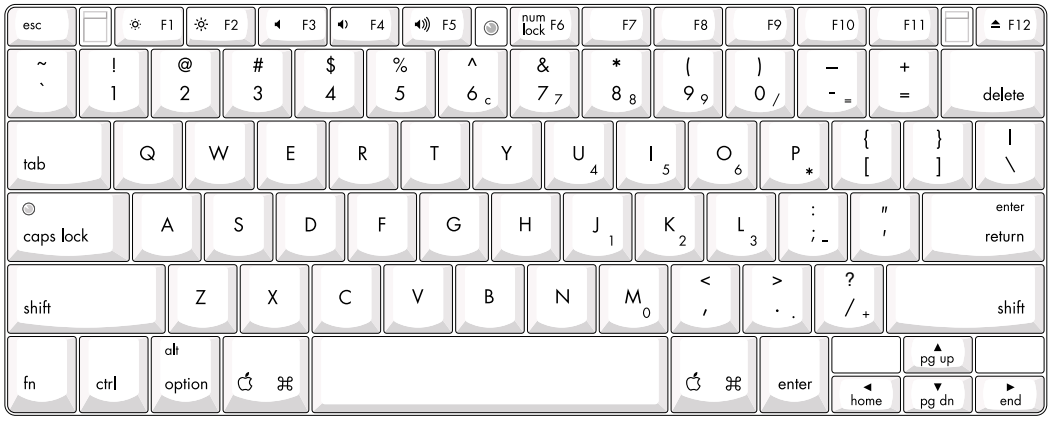


Figure 3-6 and Figure 3-7 include duplicate versions of some keys in order to show their alternate modes of operation. In some cases, the alternate key captions shown in the figures do not appear on the keyboard. For the actual appearance of the keyboard, refer to Figure 3-5.

Figure 3-6 Alternate operations of function and control keys

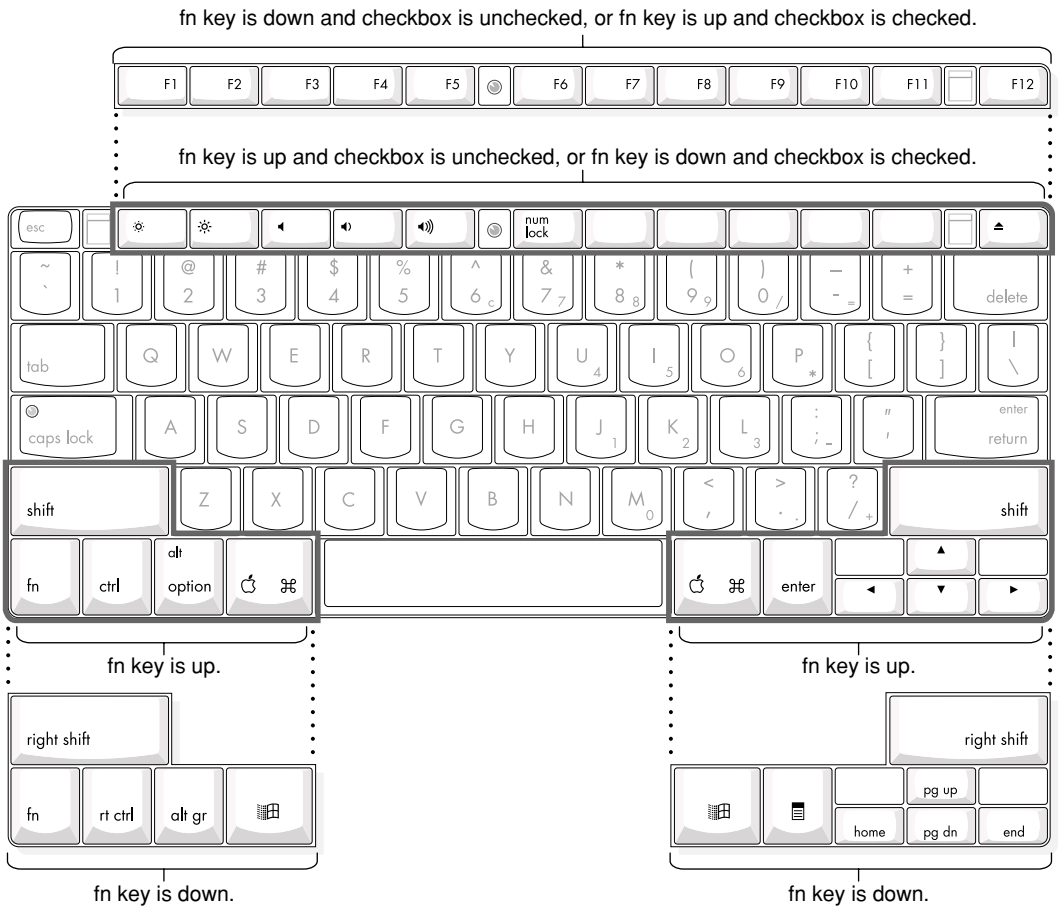
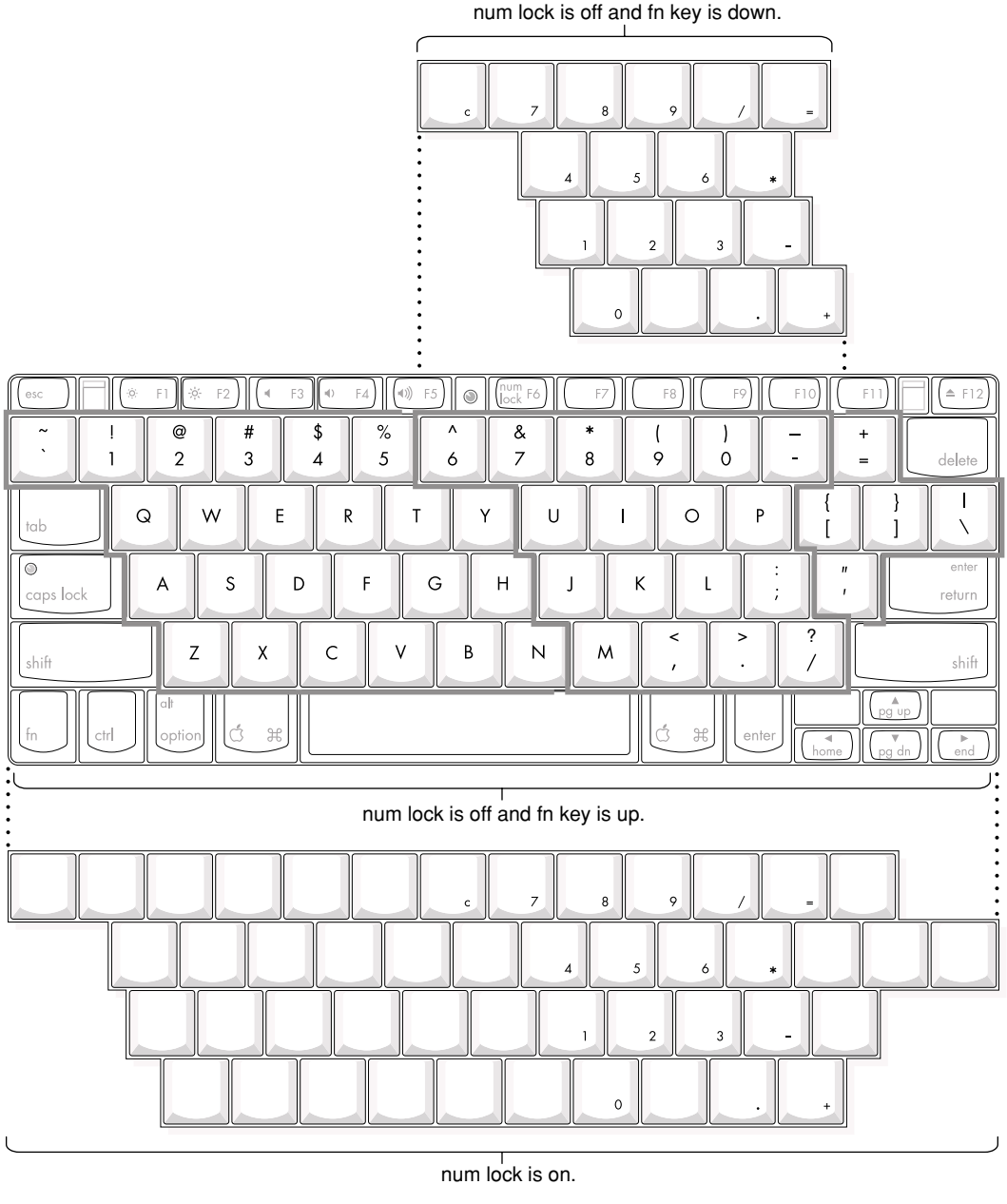


Figure 3-7 Embedded numeric keypad operation



Using the Fn Key

Pressing the Fn key affects three sets of keys: the function keys F1–F12, the embedded numeric keypad, and certain modifier keys.

- It toggles the function keys between their control-button operation and their F1–F12 functions, as shown in Table 3-8 and Figure 3-6. The user selects the default modes of operation of those keys as described in the section "The Function-Keys Checkbox".
- It selects the embedded numeric keypad on the right portion of the alphanumeric keys, as shown in Table 3-9 and Figure 3-7.
- It changes certain control keys, including the cursor control keys, to page control keys, as shown in Table 3-10 and Figure 3-7.

Using the Num Lock Key

Pressing the Num Lock key affects two sets of keys: the embedded keypad and the rest of the alphanumeric keys.

- It selects the embedded numeric keypad, as shown in Table 3-9 and Figure 3-7.
- It makes the rest of the alphanumeric keys functionless (NOPs), as shown in Figure 3-7.

The Function-Keys Checkbox

The Fn key lets the user switch the mode of operation of the function keys at any time. The user selects the default mode of the function keys by means of the Function-keys checkbox in the Keyboard Control Panel.

The Function-keys checkbox lets the user choose whether the function key operations are primary or secondary. "Function keys primary" means the function keys are normally in their F1–F12 mode of operation and pressing the Fn key selects their control-button mode. "Function keys secondary" means the function keys are normally in their control-button mode and pressing the Fn key selects their function-key mode.

In other words, pressing the Fn key reverses the mode of operation of the function keys from the default mode set by the checkbox. Table 3-7 summarizes the checkbox settings and the operation of the Fn key. The operations of the individual function keys are shown in Table 3-8 and Figure 3-6.

Table 3-7 Setting the default behavior of the function keys

Make Function Keys Primary checkbox	Operations of function keys	
	Fn key up	Fn key down
Checked	F1–F12 functions	Control buttons
Not checked	Control buttons	F1–F12 functions

Table 3-8 The function keys as control buttons

Key name	Control button
F1	Decrease display brightness
F2	Increase display brightness
F3	Mute the speaker
F4	Decrease speaker volume
F5	Increase speaker volume
F6	Num Lock
F7	User definable
F8	User definable
F9	User definable
F10	User definable
F11	User definable
F12	Media Eject

Operations of the Function Keys

Function keys F1 through F6 are used as control buttons for the display and sound and F12 is used for media eject; function keys F7 through F11 are open for the user to define. The operations of the function keys are controlled by the Function keys checkbox and the Fn key. Table 3-8 is a list of the function keys and their operations as control buttons. The Keyboard Control Panel allows the user to assign operations to function keys F7 through F11. Operations that can be assigned include

- opening an application
- opening a document
- evoking an AppleScript
- logging on to a FileServer by way of an alias

The Embedded Keypad

A certain group of alphanumeric keys can also function as an embedded keypad. The user selects this mode by using the Fn key or the Num Lock key. Figure 3-7 shows the keys making up the embedded keypad and Table 3-9 lists them.

Table 3-9 Embedded keypad keys

Key name	Keypad function
6	Clear
7	7
8	8
9	9
0	/ (divide)
-	= (equals)
U	4
I	5
O	6

Table 3-9 Embedded keypad keys (continued)

Key name	Keypad function
P	* (multiply)
J	1
K	2
L	3
;	– (subtract)
M	0
,	NOP
.	. (decimal)
/	+ (add)

When the embedded keypad is made active by the Num Lock key, the other alphanumeric keys have no operation (NOP), as shown in Figure 3-7. The affected keys include certain special character keys: plus and equal sign, right and left brackets, vertical bar and backslash, and straight apostrophe.

Other Control Keys

The cursor control keys can also be used as page control keys. Other control keys can take on the functions of certain keys on a PC keyboard, for use with PC emulation software. The Fn key controls the modes of operation of this group of keys. Table 3-10 is a list of these keys and their alternate functions. These control keys are also show in Figure 3-7.

Table 3-10 Control keys that change

Key name	Alternate function
Shift	Right shift key
Control	Right control key
Option	Alt gr (right Alt key)
Command	Windows® key
Enter	Menu key (for contextual menus)
Left arrow	Home
Up arrow	Page up
Down arrow	Page down
Right arrow	End

Flat Panel Display

The iBook computer has a built-in color flat panel display. The display is backlit by a cold cathode fluorescent lamp (CCFL). The display uses TFT (thin-film transistor) technology for high contrast and fast response.

The display is 12.1 inches in size, measured diagonally. The display contains 1024 by 768 pixels (XGA) and can show up to millions of colors.

The graphics controller IC is an ATI Rage Mobility M128. The graphics IC has 8 MB of video RAM on the chip. It supports 3D acceleration and display depths up to 24 bits per pixel. When more graphics storage is needed, the graphics IC can also use part of main memory. For more information, see “Graphics IC” (page 27).

The graphics IC includes a scaling function that expands smaller-sized images to fill the screen. By means of the scaling function, the computer can show full-screen images at 1024 by 768, 800 by 600, or 640 by 480 pixels.

Composite Video Output

The combined audio and video output jack (A/V/ jack) on the iBook computer provides a composite video signal for a TV monitor. The video output mirrors the flat panel display: internal and external video share the same buffer, and the hardware sends the image to both displays.

The A/V jack is located on the left side of the computer at the left palm rest. The jack accepts a special mini-plug with an additional contact ring that carries the composite video output signal; see "A/V Jack" (page 59). An adaptor cable with separate RCA-type connectors for stereo audio and composite video outputs is available.

Display sizes supported are 640 by 480, 800 by 600, and 1024 by 768 pixels. The composite video can be displayed on either an NTSC monitor or a PAL monitor. When a monitor is connected by way of the A/V jack, the computer detects the presence of the A/V mini-plug and enables the composite video output. The settings for the display sizes and standards (NTSC or PAL) are then selectable in the Monitor control panel or control strip.

RGB Video Output

The iBook computer has an output port for connecting an RGB video monitor. The computer detects when a monitor is plugged in and configures the display appropriately.

The RGB display operates in mirror mode, which duplicates the display on the internal flat panel. Display sizes supported are 640 by 480, 800 by 600, and 1024 by 768 pixels.

RGB Video Connector

The connector is a 14-pin rectangular connector, Hosiden TCX3143. The signal assignments are shown in Figure 3-8 and Table 3-11.

Figure 3-8 RGB connector

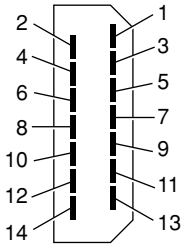


Table 3-11 Signal assignments on the RGB connector

Pin	Signal name	Pin	Signal name
1	Ground	8	+5 volts
2	VSync	9	Blue video
3	Hsync	10	DDC data
4	Red return	11	DDC clock
5	Red video	12	n.c.
6	Green return	13	/Cable detect
7	Green video	14	Blue return

The cable detect function on pin 13 is implemented by connecting pin 13 to ground in the monitor cable.

The RGB connector is compliant with the VESA specification (DDC version 3).

An adapter is available for use with monitors with VGA 15-pin miniature D-type connectors.

RGB Monitors Supported

The computer supports RGB monitors that use the DDC (display data channel) standard for identification. Older monitors that do not support the DDC standard are not supported. The following Apple monitors are not supported:

- Multiple Scan 17
- Multiple Scan 20
- AudioVision 14
- Apple Hi-Res RGB
- Apple 16" Color
- Apple Hi-Res Monochrome
- Macintosh 12" RGB

Sound System

The 16-bit stereo audio circuitry provides sound input through the built-in microphone and the USB port and sound output through the built-in stereo speakers and the A/V jack.

All audio is handled digitally inside the computer, including audio data from the CD or DVD drive, the modem, and devices connected to the USB and FireWire ports. Sound data is converted to analog form only for output to the internal speakers and the A/V jack.

The sound circuitry handles audio data as 44.1 kHz 16-bit samples. If audio data sampled at a lower rate on another computer is played as output, the Sound Manager transparently upsamples the data to 44.1 kHz prior to sending the audio data to the Tumbler sound circuitry.

A/V Jack

The A/V jack is located on the left side of the computer at the left palm rest. The jack accepts either a stereo mini-plug or a special plug that has an additional contact ring that carries the composite video output signal. See also “Composite Video Output” (page 57).

The stereo audio signals at the jack are configured to drive a pair of low-impedance stereo headphones. External powered speakers may also be connected to the A/V jack.

The audio signals on the A/V jack have the following electrical characteristics:

- output impedance: 47 ohms each channel
- minimum recommended load impedance: 32 ohms each channel
- maximum level: 0.7 V rms (2.0 V P-P)

Internal Microphone

The computer has a built-in microphone located at the upper right hand corner of the display.

Internal Speakers

The computer has a stereo pair of speakers located between the keyboard and the display. The Tumbler sound system provides parametric equalization for the speakers. The computer turns off the sound signal to the speakers when headphones are connected to the A/V jack.

Internal Modem

The Pangea IC receives call progress audio from the internal modem as digital data and sends it to the sound system so the user can hear the status of a dial-up modem connection. The level of the call progress audio is fixed.

CD Audio

Digital audio data from the CD, CD-RW, or DVD drive is processed by the Sound Manager. The data is then transferred by DMA through the I^2S interface of the Pangea IC to the Tumbler sound system, where the digital data is converted to analog signals and sent to the speaker and the A/V jack.

CHAPTER 4

RAM Expansion

This chapter tells how to gain access to the RAM expansion slot in the iBook computer and then describes the RAM expansion module.

The RAM Expansion Slot

The iBook computer has one RAM expansion slot. To get access to the RAM expansion slot, the user must open up the computer by performing the following operations.

IMPORTANT
The user should be reminded to observe the usual precautions to avoid damage to the electronic components due to static electricity. ▲

1. Shut down the computer.
2. Unplug the AC adapter from the computer.
3. Remove the battery from the computer.
4. Unlock the keyboard by turning the slotted screw that is part of the Num Lock LED, which is between the F5 and F6 function keys. Turning the screw 180° locks or unlocks the keyboard. (The locking screw may already be in the unlocked position.)
5. Release the two latches located at the top of the keyboard. One latch is between the ESC key and the F1 key; the other is between the F11 and F12 keys. You can release the latches by sliding them toward the front of the computer.
6. Pulling only on the latches (not on the keys), lift the keyboard up and turn it over, without disconnecting the keyboard's membrane cable.
7. Remove the wireless LAN module, if present, by unlatching the formed wire holder on the module, then pulling the flex tab to remove the module. The antenna cable should remain attached to the module.
8. Using a Phillips head screwdriver, remove the two screws that secure the metal RAM shield plate. The screws are to the right of the wireless LAN module.
9. Slide the metal RAM shield plate toward the rear of the computer, then lift it up and out of the computer.

Once the RAM expansion module has been installed in the slot, the user must close up the computer by performing these steps in reverse order. Be careful to replace the shield plate properly so that the LAN card will fit properly.

IMPORTANT
If AC and battery power are removed for longer than ten minutes, the user may need to reset the computer's clock (using the Data and Time control panel) when the computer is turned back on. ▲

The RAM Expansion Module

The RAM expansion slot accommodates a standard SO-DIMM (small outline, dual inline memory module) that uses SDRAM devices.

IMPORTANT
A RAM expansion SO-DIMM for the iBook computer must use SDRAM devices. If the user installs an SO-DIMM that uses EDO or SGRAM devices, the computer will beep twice when the user attempts to restart the computer. ▲

An SO-DIMM for the iBook computer can contain either 32, 64, 128, 256, or 512 MB of memory. Total RAM capacity using devices currently available is 640 MB (576 MB on the CD-ROM model) and is limited by the space available for the SO-DIMM. The slot can accommodate an SO-DIMM up to 1.25 inches high.

Mechanical Design of the RAM SO-DIMM

The mechanical characteristics of the RAM expansion module are given in the JEDEC specification for the 144-pin 8-byte DRAM SO-DIMM. The specification number is JEDEC MO-190-C. To find out how to obtain the specification, see "RAM Expansion Modules" (page 71).

The specification defines SO-DIMMs with nominal heights of 1.0, 1.25, 1.5, or 2.0 inches. The iBook can accommodate standard SO-DIMMs with a height of 1.0 or 1.25 inches.

The JEDEC specification defines the maximum depth or thickness of an SO-DIMM as 3.8 mm. That specification is also a maximum: Modules that exceed the specified thickness can cause reliability problems.

Electrical Design of the RAM SO-DIMM

The electrical characteristics of the RAM SO-DIMM are given in section 4.5.6 of the JEDEC Standard 21-C, release 7. To find out how to obtain the specification, see "RAM Expansion Modules" (page 71).

The specification defines several attributes of the DIMM, including storage capacity and configuration, connector pin assignments, and electrical loading. The specification supports SO-DIMMs with either one or two banks of memory.

The JEDEC specification for the SO-DIMM defines a Serial Presence Detect (SPD) feature that contains the attributes of the module. SO-DIMMs for use in the iBook are required to have the SPD feature. Information about the required values to be stored in the presence detect EEPROM is in section 4.1.2.5 and Figure 4.5.6–C (144 Pin SDRAM SO–DIMM, PD INFORMATION) of the JEDEC standard 21-C specification, release 7.

SDRAM Devices

The SDRAM devices used in the RAM expansion modules must be self-refresh type devices for operation from a 3.3-V power supply. The speed of the SDRAM devices must be 66 MHz or greater, corresponding to a cycle time of 15 ns or less.

Note
The computer may have 100-Mhz parts installed. This is normal, and does not indicate that the memory bus is running faster than the specified 66 MHz. ◆

The devices are programmed to operate with a CAS latency of 2. At that CAS latency, the access time from the clock transition must be 7 ns or less. The burst length must be at least 4 and the minimum clock delay for back-to-back random column access cycles must be a latency of 1 clock cycle.

Configuration of RAM SO-DIMMs

Table 4-1 shows information about the different sizes of SO-DIMMs used in the iBook computer. The first three columns show the memory size, configuration,

and number of banks in the SO-DIMMs. The other three columns show the number, density, and configuration of the SDRAM devices making up the memory modules.

Table 4-1 Sizes of RAM expansion DIMMs and devices

SO-DIMM			SDRAM Devices		
Size	**Configuration**	**Banks**	**Number**	**Density**	**Configuration**
16 MB	2 M x 64	1	2	64 Mbit	2 M x 32
32 MB	4 M x 64	1	4	64 Mbit	4 M x 16
32 MB	4 M x 64	2	4	64 Mbit	2 M x 32
64 MB	8 M x 64	1	8	64 Mbit	8 M x 8
64 MB	8 M x 64	2	8	64 Mbit	4 M x 16
64 MB	8 M x 64	1	4	128 Mbit	8 M x 16
128 MB	16 M x 64	1	8	128 Mbit	16 M x 8
128 MB	16 M x 64	2	8	128 Mbit	8 M x 16
256 MB	16 M x 64	2	16	128 Mbit	16 M x 8
256 MB	16 M x 64	2	8	256 Mbit	16 M x 16
256 MB	32 M x 64	1	8	256 Mbit	32 M x 8
256 MB	32 M x 64	2	8	256 Mbit	16 M x 16
512 MB	64 M x 64	2	16	256 Mbit	32 M x 8

Address Multiplexing

Signals A[0] – A[12] and BA[0] – BA[1] on each RAM SO-DIMM make up a 15-bit multiplexed address bus that can support several different types of SDRAM devices. Table 4-2 lists the types of devices that can be used in the iBook by size, configuration, and sizes of row, column, and bank addresses.

IMPORTANT
The iBook computer supports only the types of SDRAM devices specified in Table 4-2. Other types of DRAM devices should not be used with this computer. ▲

Table 4-2 Types of DRAM devices

Device size	Device configuration	Row address bits	Column address bits
64 Mbits	2 M x 8 x 4*	12	9
64 Mbits	1 M x 16 x 4	12	8
64 Mbits	512 K x 32 x 4	11	8
128 Mbits	4 M x 8 x 4	12	10
128 Mbits	2 M x 16 x 4	12	9
128 Mbits	1 M x 32 x 4	12	8
256 Mbits	8 M x 8 x 4	13	10
256 Mbits	4 M x 16 x 4	13	9

NOTE The use of 8x4 device configurations leads to excessive loading and so is not recommended; see "RAM SO-DIMM Electrical Limits".

RAM SO-DIMM Electrical Limits

Each RAM SO-DIMM must not exceed the following maximum current limits on the +3 V supply:

Active	1.2 A (maximum of 8 devices per bank, 150 mA per device)
Sleep	12 mA (total for all banks)

The maximum current specified for active operation generally rules out the use of 4-bit-wide SDRAM devices in a RAM expansion module. Such a module would have 16 such devices per bank, and the 1.2 A maximum current would allow only about 75 mA per device. To stay within the current limits, RAM expansion modules should use only 8-bit or 16-bit SDRAM devices.

APPENDIX A

Supplemental Reference Documents

For more information about the technologies mentioned in this developer note, you may wish to consult some of the following references.

For information about older models of Macintosh computers, refer to the developer notes archive at:

http://developer.apple.com/techpubs/hardware/hardware2.html

You should also have copies of the relevant books describing the system software for Macintosh computers available in technical bookstores and on the World Wide Web at

http://developer.apple.com/techpubs/mac/mac.html

Apple Technotes

Apple Technotes answer many specific questions about the operation of Macintosh computers and the Mac OS. The technotes are available on the Technote website at

http://developer.apple.com/technotes/

3D Graphics

Developers of 3D graphics for games should know about OpenGL for Macintosh®, a new version of SGI's application programming interface (API) and software library for 3D graphics.

Information is available on the World Wide Web at

www.apple.com/opengl

Developer support and documentation is available at

http://developer.apple.com/opengl/

PowerPC G3 Microprocessor

For more information about the PowerPC 750CX microprocessor used in the iBook computer, developers may wish to refer to the standard reference, *PowerPC 740/750 Microprocessor Implementation Definition Book IV.* Information about the PowerPC 750CX microprocessor is available on the World Wide Web at

http://www.chips.ibm.com/products/powerpc/

Mac OS 9

For a description of the version of the Mac OS that comes with the new models, developers should refer to the technote for Mac OS 9. Other technotes contain information about the New World software architecture and the API changes for Power Manager 2.0. The technotes are available on the Technote web site at

http://developer.apple.com/technotes/

Developers should also have copies of the relevant books describing the system software for Macintosh computers available in technical bookstores and on the World Wide Web at

http://developer.apple.com/techpubs/mac/mac.html

ROM-in-RAM Architecture

The system software in all current Macintosh computers uses a ROM-in-RAM approach, also called the New World architecture. For more information about this architecture, see Technote 1167, *NewWorld Architecture,* available on Apple's technote website at

http://developer.apple.com/technotes/tn/tn1167.html

Open Firmware

Three Technotes provide an introduction to Open Firmware on the Macintosh platform. They are:

TN 1061: Open Firmware, Part I, available on the Technote web site at

http://developer.apple.com/technotes/tn/tn1061.html

TN 1062: Open Firmware, Part II, available on the Technote web site at

http://developer.apple.com/technotes/tn/tn1062.html

TN 1044: Open Firmware, Part III, available on the Technote web site at

http://developer.apple.com/technotes/tn/tn1044.html

Another Technote tells how to debug open firmware code. Please refer to *TN 2004: Debugging Open Firmware Using Telnet*, available on the Technote web site at

http://developer.apple.com/technotes/tn/tn2004.html

RAM Expansion Modules

The mechanical characteristics of the RAM SO-DIMM are given in JEDEC specification number JEDEC MO190-C. The specification can be found by using the search string MO190-C on the Electronics Industry Association's website at

http://www.jedec.org/DOWNLOAD/default.cfm

The electrical characteristics of the RAM SO-DIMM are given in JEDEC Standard 21-C. The specification can be found by using the search string JESD21-C on the Electronics Industry Association's website at

http://www.jedec.org/DOWNLOAD/default.cfm

ATA Devices

For information about the system software for ATA devices such as the IDE drive, see *Technote #1098, ATA Device Software Guide Additions and Corrections*, available on the world wide web at

http://developer.apple.com/technotes/tn/tn1098.html

The web page for Technote #1098 includes a link to a downloadable copy of *ATA Device Software Guide*.

USB Interface

For more information about USB on Macintosh computers, you should refer to Apple Computer's *Mac OS USB DDK API Reference*. Information is also available on the World Wide Web, at

http://developer.apple.com/techpubs/hardware/DeviceManagers/usb/usb.html

USB game controllers are supported by the InputSprocket component of the Apple Games Sprockets software architecture. InputSprocket software and information about the InputSprocket APIs can be found at

http://developer.apple.com/games/

For full specifications of the Universal Serial Bus, you should refer to the USB Implementation Forum on the World Wide Web, at:

http://www.usb.org/

FireWire Interface

For additional information about the FireWire IEEE 1394 interface and the Apple APIs for FireWire software, refer to the resources available on the Apple FireWire web site at:

http://developer.apple.com/hardware/FireWire/index.html

The IEEE 1394 standard is available from the IEEE. Ordering information can be found on the World Wide Web at

http://standards.ieee.org/catalog/bus.html

You may also find useful information at the 1394 Trade Association's web site:

http://www.1394ta.org/

APPENDIX A

Supplemental Reference Documents

Abbreviations

Standard units of measure used in this note include:

A	amperes	MB	megabytes
dB	decibels	Mbps	megabits per second
GB	gigabytes	Mbit	megabits
Hz	hertz	MHz	megahertz
KB	kilobytes	mm	millimeters
kg	kilograms	ns	nanoseconds
kHz	kilohertz	V	volts
mA	milliamperes	VDC	volts direct current
mAh	milliampere-hours		

Other abbreviations used in this note include:

10Base-T	an Ethernet standard for data transmission at 10 Mbits per second
100Base-TX	an Ethernet standard for data transmission at 100 Mbits per second
ADB	Apple Desktop Bus
AGP	accelerated graphics port
AIM	ATA Interface Module
AP	access point, for a wireless LAN
API	application programming interface
ASIC	application-specific integrated circuit
ATA	AT attachment
ATAPI	AT Attachment Packet Interface
CAS	column address strobe, a memory control signal
CAV	constant angular velocity
CD	compact disc

CD-ROM	compact disc read-only memory
CLV	constant linear velocity
CPU	central processing unit
DAA	data access adapter (a telephone line interface)
DAC	digital-to-analog converter
DDC	display data channel
DIMM	Dual Inline Memory Module
DMA	direct memory access
DSP	digital signal processor
DSSS	direct-sequence spread-spectrum
EDO	extended data out
G3	Generation 3, the third generation of PowerPC microprocessors
GND	ground
HFS	hierarchical file system
HID	human interface device, a class of USB devices
I^2C	inter IC control bus
I^2S	inter IC sound bus
IC	integrated circuit
IDE	integrated device electronics
IIC	inter IC control bus (same as I^2C)
IIS	inter IC sound bus (same as I^2S)
I/O	input and output
ISO	International Organization for Standardization
JEDEC	Joint Electron Device Engineering Council
L1	level 1 or first level, a type of CPU cache
L2	level 2 or second level, a type of CPU cache
LAN	local area network
LED	light emitting diode
MAC	media access controller
Mac OS	Macintosh Operating System

modem	modulator-demodulator, a data communications interface for use with analog telephone lines
NMI	nonmaskable interrupt
NOP	no operation
NTSC	National Television System Committee; the standard system used for broadcast TV in North America and Japan
NV-RAM	nonvolatile random-access memory
OHCI	Open Host Controller Interface
OS	operating system
PAL	Phase Alternate Lines; the standard for broadcast TV in most of Europe, Africa, South America, and southern Asia
PCAV	partial constant angular velocity (CLV at small radius, CAV at large radius)
PCI	Peripheral Component Interconnect
PHY	physical layer
PLL	phase-locked loop
POST	power-on self test
RAM	random-access memory
RF	radio frequency
rms	root mean square
ROM	read-only memory
SCC	Serial Communications Controller
SCSI	Small Computer System Interface
SDRAM	synchronous dynamic RAM
SNR	signal to noise ratio
SO-DIMM	small outline dual inline memory module
SPD	Serial Presence Detect, a feature of the SO-DIMM
USB	Universal Serial Bus
TDM	Target Disk Mode
VCC	positive supply voltage (voltage for collectors)
WEP	Wired Equivalent Privacy
WLAN	wireless LAN

APPENDIX B

Abbreviations

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