



Developer Note

Apple iBook Computer



Developer Note

Technical Publications
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About This Developer Note

This developer note is a technical description of the Apple iBook computer. It has been updated to include information about the latest product 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 may wish to read the supplementary reference documents described in this preface.

Contents of This Note

The information in this note is arranged in five chapters and an appendix.

- 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.
- Chapter 5, “Software,” describes the system software that comes with the iBook, with emphasis on the new Open Firmware features.
- Appendix A is a list of the units of measure and other abbreviations used in this developer note.

Supplemental Reference Documents

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

PowerPC G3 Microprocessor

For more information about the PowerPC 750™ microprocessor used in the iBook, developers may wish to refer to the standard reference, *PowerPC 740/750 Microprocessor Implementation Definition Book IV*. Information about the PowerPC 750 and other G3 microprocessors is also available on the World Wide Web at

<http://www.mot.com/SPS/PowerPC/index.html>

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

RAM Expansion Modules

The mechanical characteristics of the RAM expansion module are given in JEDEC specification number JEDEC MO-190-C. The electrical characteristics of the RAM SO-DIMM are given in section 4.5.6 of the JEDEC Standard 21-C, release 7. These specifications are available from the Electronics Industry Association's web site at

<http://www.jedec.org/download/default.htm>

Mac OS

For a description of the version of the Mac OS that comes with the iBook, developers should refer to the Technote for Mac OS 9. The technote is available on the Technote web site at

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

ATA Devices

For information about the system software for ATA devices such as the IDE drive, see *ATA Device Software for Macintosh Computers*. That book is available on the reference library issue of the developer CD (June, 1999) and on the World Wide Web at

http://developer.apple.com/techpubs/hardware/DeviceManagers/ata/ata_ref/frameset.html

USB Devices

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/developers/index.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>

The NewWorld software architecture embodied in the new Mac OS software follows some of the standards defined by the Open Firmware IEEE 1274-1995 specification and the CHRP binding.

The basis for the bootinfo file format and use is the document *PowerPC™ Microprocessor Common Hardware Reference Platform (CHRP™) System binding to: IEEE Std 1275-1994 Standard for Boot (Initialization, Configuration) Firmware*. A bootinfo file contains Open Firmware script, a description, information for individual operating systems, icons, and other information. A bootinfo file can

P R E F A C E

be extended to contain non-Open Firmware information, such as “Trampoline” code and the ToolBox ROM Image.

Other Open Firmware references of possible interest include:

IEEE 1275-1994 Standard for Boot (Initialization, Configuration) Firmware: Core Requirements and Practices

IEEE Std 1275-1994 Standard for Boot (Initialization, Configuration) Firmware (Version 1.7)

Open Firmware Recommended Practice: Device Support Extensions (Version 1.0)

Open Firmware Recommended Practice: Interrupt Mapping (Version 0.9)

Introduction

Introduction

The iBook is Apple's portable computer for the consumer and education markets.

Note

This developer note has been updated to include information about the latest product configurations, which have faster clock speeds, more memory, and a larger hard disk than the original iBook. ♦

Features

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

- **Processor:** The iBook has a PowerPC G3 microprocessor running at a clock speed of 300 or 366 MHz. For more information, see “G3 Microprocessor” (page 22).
- **Cache:** The iBook has a backside L2 cache consisting of 512 KB of fast static RAM. The clock speed for the backside cache is half the clock speed of the microprocessor. See “Backside Cache” (page 22).
- **Memory:** The iBook has 64 MB of SDRAM installed on the main logic board and one standard SO-DIMM slot for memory expansion up to 320 MB total. See “RAM Expansion” (page 55).
- **Hard disk storage:** The iBook has a built-in hard disk drive with a capacity of 6 GB. For more information and developer guidelines for alternative hard drives, see “Hard Disk Drive” (page 37).
- **CD-ROM drive:** The iBook has a built-in CD-ROM drive with 24X speed. See “CD-ROM Drive” (page 42).
- **Display:** The iBook has a 12.1-inch TFT display with SVGA resolution (800 by 600 pixels). See “Flat Panel Display” (page 51).
- **Video RAM:** The display controller in the iBook includes 4 MB of video RAM, which supports millions of colors on the display. See “Flat Panel Display” (page 51).

- **Battery bays:** The iBook has one battery bay. The battery uses lithium ion cells and provides 3080 mAh at a nominal 14.2 V. Battery life under normal use is up to 6 hours.
- **USB port:** The iBook has one USB port for an external keyboard, a mouse, a hub, or other USB device, described in “USB Port” (page 30).
- **Modem:** The iBook has a built-in modem with 56 Kbps data rate. For more information, see “Internal Modem” (page 34).
- **Ethernet:** The iBook has a built in Ethernet port for 10Base-T and 100Base-TX operation. For more information, see “Ethernet Port” (page 33).
- **Wireless LAN:** An internal wireless LAN module is available as a build-to-order option or as a user-installable upgrade. For more information, see “AirPort Card Wireless LAN Module” (page 34).
- **Sound:** The iBook has a built-in speaker and a stereo headphone jack. See “Sound System” (page 52).
- **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 43).
- **Trackpad:** The integrated trackpad includes tap/double tap and drag features. For more information, see “Trackpad” (page 43).
- **Weight:** The iBook weighs 3.0 kg (6.6 pounds) with the battery installed.
- **Size:** The iBook is 34.4 cm (13.5 inches) wide and 29.4 cm (11.6 inches) deep. Its thickness varies from 3.1 to 5.2 cm (1.24 to 2.06 inches); the average thickness is 4.6 cm (1.8 inches).

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 iBook Battery is available separately as an additional or replacement battery.
- The iBook Power Adapter, which comes with the computer, is also available separately. The adapter can recharge the internal battery in four hours while the computer is running or in two hours while the computer is shut down or in sleep mode.

Compatibility Issues

While the iBook has many new features, there should be no compatibility problems with applications and peripherals that operate correctly with Apple PowerBook models, with the exceptions described in this section.

Legacy I/O Devices Not Present

The iBook does not have an ADB port, a serial port, a floppy disk drive, a SCSI port, a microphone, or a sound input jack. Any software designed to communicate directly with those hardware devices will not run properly. (It is possible that USB converters will be able to support some of those hardware devices.)

Software that communicates with the appropriate managers will be supported. For information about the managers, see “Legacy Drivers” (page 71).

USB Ports and Devices

The USB port takes the place of the ADB and serial I/O ports found on earlier Macintosh computers. Software shims have been added to allow existing applications designed to work with ADB mice and keyboards to work with the equivalent USB devices. See “USB Port” (page 30).

No Expansion Bay

The iBook does not have an expansion bay. Expansion bay modules designed for earlier PowerBook computers cannot be used in the iBook.

RAM Expansion

For RAM expansion, the iBook accepts one standard SO-DIMM that uses SDRAM devices. For information, see “RAM Expansion” (page 55).

IMPORTANT

The RAM DIMM in the iBook must be an SO-DIMM that uses SDRAM devices. SO-DIMMs that use EDO devices will not work. ▲

System Software

Like the system software for the iMac and the 1999 Power Macintosh G3 computer, system software for the iBook has Open Firmware booting and Mac OS ROM in RAM. The system software is described in Chapter 5, “Software.”

The system software that comes with the iBook is Mac OS 9 with the addition of the extensions and control panels required for product-specific features. For a description of the general Mac OS 9 release, developers should refer to the Technote for Mac OS 9. The technote is available on the Technote web site at

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

Machine Identification

With the New World system software, it is no longer possible to use the Box Flag to identify the computer model. For guidelines about machine identification, see “Computer Identification” (page 67).

Architecture

This chapter describes the architecture of the iBook computer.

Block Diagram and Buses

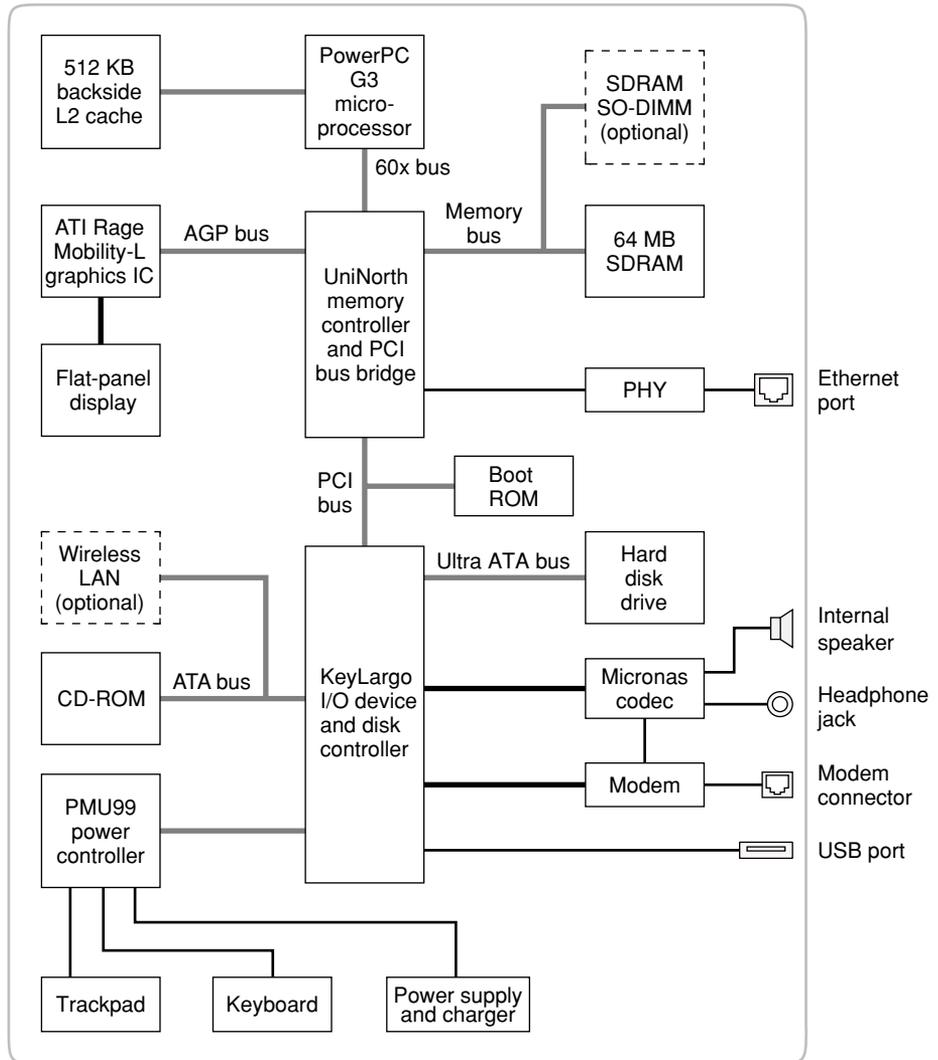
Figure 2-1 is a simplified block diagram of the iBook computer. The diagram shows the main ICs and the buses that connect them together.

The architecture of the iBook is designed around the PowerPC G3 microprocessor and two new custom ICs: the Uni-N memory controller and bus bridge, and the KeyLargo I/O device controller. The microprocessor and the two custom ICs occupy the center of the block diagram.

The PowerPC G3 microprocessor is connected to the Uni-N memory controller and bus bridge IC by a 60x bus with 64 data lines and a bus clock speed of 66 MHz. The Uni-N IC has other buses that connect with the KeyLargo IC, the main system RAM, the graphics IC, and the Ethernet PHY IC. The buses implemented by the Uni-N IC are summarized in Table 2-2, which is in the section “Memory Controller and Bus Bridge”.

The Uni-N IC is connected to the KeyLargo I/O controller IC by a 32-bit PCI bus that has a bus clock speed of 33 MHz. That PCI bus also connects to the Boot ROM. The KeyLargo IC has other buses that connect with the hard disk drive, the power controller (PMU99), the sound IC, the internal modem, the CD-ROM drive, and the optional wireless LAN module.

Figure 2-1 Block diagram



Microprocessor and Cache

The microprocessor communicates with the rest of the system by way of a 66-MHz, 64-bit 60x bus to the Uni-N IC. The microprocessor has a separate backside bus to its second-level cache.

G3 Microprocessor

The current family of PowerPC microprocessor designs is called “G3,” for “generation three.” The G3 microprocessors have several features that contribute to improved performance, including:

- large on-chip (L1) caches, 32 KB each for instruction cache and data cache
- a built-in cache controller and cache tag RAM for the L2 cache
- a separate backside bus for the L2 cache, providing faster clock speed and overlapped bus transactions
- a microprocessor core optimized for Mac OS applications

The G3 microprocessor in the iBook runs at a clock speed of 300 or 366 MHz.

Backside Cache

The data storage for the backside L2 cache consists of 512 KB of fast static RAM on the main logic board. The controller and the tag storage for the backside cache are built into the microprocessor chip. The cache controller includes bus management and control hardware that allows the cache to run at an independent sub-multiple of the processor’s clock speed, rather than at the

slower clock speed of the main system bus. In the iBook, the clock speed of the backside cache is related to that of the microprocessor as shown in Table 2-1.

Table 2-1 CPU and cache clock speeds

CPU clock	Cache clock	Ratio
300 MHz	150 MHz	2:1
366 MHz	146.4 MHz	5:2

Memory Controller and Bus Bridge

The Uni-N memory controller and bus bridge 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 interface, and the AGP port.

In addition to the four buses listed in Table 2-2, the Uni-N IC also has a separate interface to the physical layer (PHY) IC for Ethernet and an I²C interface that is used for configuring the memory subsystem.

Table 2-2 Buses supported by the Uni-N 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
PCI bus	KeyLargo IC and Boot ROM	32 bits	33 MHz
AGP port	Graphics IC	32 bits	66 MHz

Architecture

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 Uni-N IC.

System RAM

The memory subsystem in the iBook consists of 64 MB of SDRAM on the main logic board and one expansion slot for an SO-DIMM. (The original iBook had 32 MB of SDRAM and the slot.) 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 55).

Boot ROM

The boot ROM is connected to the Uni-N IC by way of the PCI bus plus three additional control signals: chip select, write enable, and output enable. The boot ROM is a 1 M by 8 bit device.

The boot ROM is a flash device and can be updated in the field.

Ethernet IC

The Ethernet link layer is built into the Uni-N IC. The physical layer is a 5201 IC made by Broadcom. The 5201 IC contains both the physical layer and the transceiver and filter circuits. The IC provides a dual-speed Ethernet controller, supporting both 10Base-T and 100Base-TX protocols.

Graphics IC

The graphics IC is a variation of the RAGE Mobility IC made by ATI. Certain features of the Mobility IC are not supported in this variation.

The graphics IC includes 4 MB of VRAM, which enables it to provide a display size of 800 by 600 at pixel depths of 8, 16, and 24 bits per pixel. The graphics IC also has a scaling mode that displays a 640-by-480 pixel image on the full screen.

Because it uses the AGP bus, the graphics IC 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 Uni-N IC uses a graphics address remapping table (GART) to translate a linear address space for AGP transactions into physical addresses in main memory.

I/O Device Controller

The I/O controller IC in the iBook is a custom IC called KeyLargo. It is an integrated I/O controller and DMA engine for use in Power Macintosh computers with a PCI bus.

The KeyLargo IC contains a PCI bus arbiter and an interrupt controller. It also provides the interface and control signals for the following devices:

Ultra ATA Hard Drive

The interface to the internal hard drive is an Ultra ATA bus on the KeyLargo IC.

ATA CD-ROM Drive

The interface to the CD-ROM drive is an E-IDE interface (ATA bus) on the KeyLargo IC. Digital audio from the CD-ROM drive goes through the KeyLargo IC and is sent to the sound IC.

USB Port

The KeyLargo IC provides a USB controller for the USB port. The external USB connector supports USB devices with data transfer rates of 1.5 Mbps and 12 Mbps. For more information, see “USB Port” (page 30).

The USB ports comply with the Universal Serial Bus Specification 1.1 Final Draft Revision. The USB register set complies with the Open Host Controller Interface (OHCI) specification.

Built-In Modem

The KeyLargo 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.

Sound IC

The sound IC is a DAC3550A made by Micronas-Intermetall (www.intermetall.de). The KeyLargo IC communicates with the sound IC using the I²S bus for digital data and the I²C bus for control signals. The digital audio is converted to analog by the sound IC and sent to the speaker and the headphone jack.

Modem progress audio is connected as an analog input to the sound IC and mixed into the sound output stream.

The iBook has no microphone or sound input jack. For information about sound system operation and outputs, see “Sound System” (page 52).

Power Controller IC

The power manager IC in the iBook 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 ADB interface to the built-in keyboard and trackpad

The iBook does not contain an Apple Desktop Bus; instead, the PMU99 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 the E-IDE interface (ATA bus) to the KeyLargo IC with the CD-ROM drive.

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 802.11 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 34).

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 Port

The iBook has a Universal Serial Bus (USB) port that can be used to connect additional I/O devices such as a USB mouse, printers, scanners, and low-speed storage devices.

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 "Supplemental Reference Documents" (page 9).

USB Connector

The USB port is located on the left side of the computer. It 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 port and connector

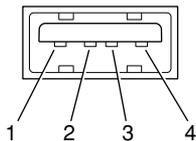


Table 3-1 Pin assignments on the USB port

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

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

The 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 iBook comes with version 1.3 of the Macintosh USB system software, which supports all four data transfer types defined in the USB specification.

USB Compatibility Issues

The following sections describe compatibility issues regarding legacy I/O (ADB and serial ports) as well as new functionality of the USB port.

ADB Compatibility

Apple is providing an ADB/USB shim to support processes that control ADB devices by making calls to the ADB Manager and the Cursor Device Manager. The ADB/USB shim makes it possible for processes that support an ADB keyboard to work with the USB keyboard equivalent.

Note

The iBook does not support the power-on key on the Apple USB keyboard. ♦

Keyboards other than the Apple USB keyboard can be used with the iBook, but they will be treated as having an ADB device ID of 2.

IMPORTANT

The ADB/USB shim does not support USB devices other than the keyboard and mouse. ▲

Note

The ADB/USB shim is built into the Mac OS ROM image on the iBook and on other Macintosh computers that have USB ports. For more information about the Mac OS ROM image, refer to Chapter 5, “Software.” ♦

Serial Port Compatibility

The latest release of the Mac OS USB DDK includes a universal Serial/USB shim that allows processes that use the Communications Toolbox CRM to find and use a USB modem device. The shim is called SerialShimLib and is available as part of the Mac OS 8.6 release. For more information about the shim, and a sample modem driver that shows how to use it, please refer to the Mac OS USB DDK, available from the Apple Developer Development Kits page on the World Wide Web, at

<http://developer.apple.com/sdk/index.html>

Apple also provides a USB Communication Class driver, so modem vendors whose devices comply with the USB Communication Class specification do not need to write their own vendor-specific USB class drivers. See “USB Drivers” (page 70).

Power Off During Sleep

The USB port can be completely powered down during Sleep mode. USB devices must be able to start up again when the computer wakes up from Sleep mode. This functionality is part of 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*.

Macintosh-To-Macintosh Connections

USB is a serial communications channel, but it does not replace LocalTalk functionality on Macintosh computers; you cannot connect two Macintosh computers together using the USB. The best method for networking iBook computers is through the built-in Ethernet port.

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 includes USB Mass Storage Support 1.3, a class driver that supports devices that meet the USB Mass Storage Class specification. See “USB Drivers” (page 70).

USB Controller

The iBook 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.

Ethernet Port

The iBook 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 on the left rear corner of the computer. Table 3-2 shows the signals and pins on the connector.

Table 3-2 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

Table 3-2 Signals on the Ethernet connector (continued)

Pin	Signal name	Signal definition
6	RXN	Receive (negative lead)
7	–	Not used
8	–	Not used

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

Internal Modem

The iBook 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 a sound output for monitoring the progress of the modem connection.

AirPort Card Wireless LAN Module

The iBook 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.

The AirPort Card can be used for internet access, email access, and file exchange.

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”.

Wireless connection to the internet or a wired LAN requires a base station as the connection to the internet or a 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 56k hardware modem.

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 case.

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 capacity of the internal hard disk drive has been increased from 3.2 to 6 GB. The drive uses the Ultra IDE (integrated drive electronics) interface, which is also referred to as the Ultra ATA interface. The implementation of the ATA interface on the iBook 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 similar to that in previous Macintosh PowerBook models with internal IDE drives and includes DMA support. For the latest information about that software, 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>

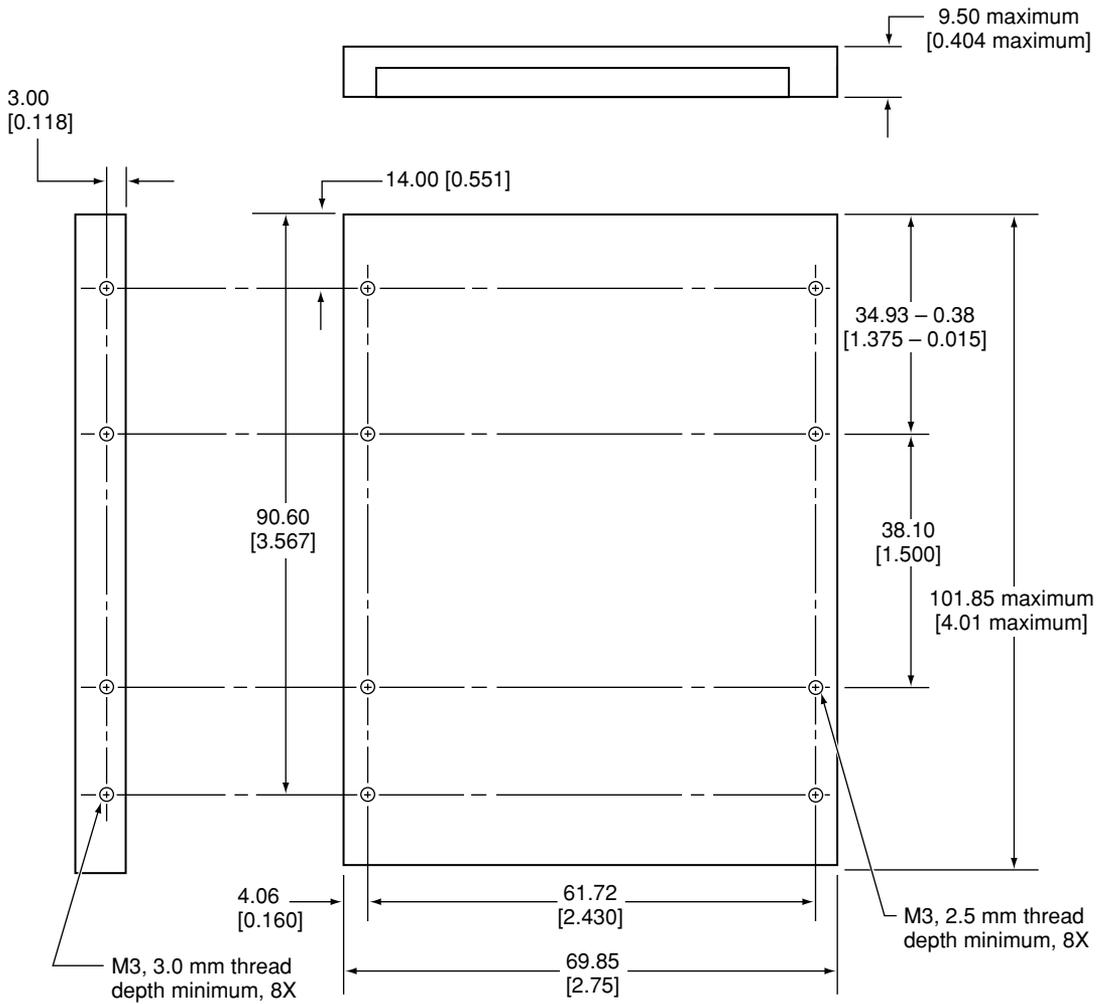
The web page for Technote #1098 includes a link to a downloadable copy of *ATA Device Software Guide*.

Hard Disk Dimensions

Figure 3-2 shows the maximum dimensions of the hard disk and the location of the mounting holes. The hard disk is physically smaller than the ones in previous PowerBook computers: only 9.5 mm (0.4 inches) high.

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

Figure 3-2 Maximum dimensions of the internal hard disk

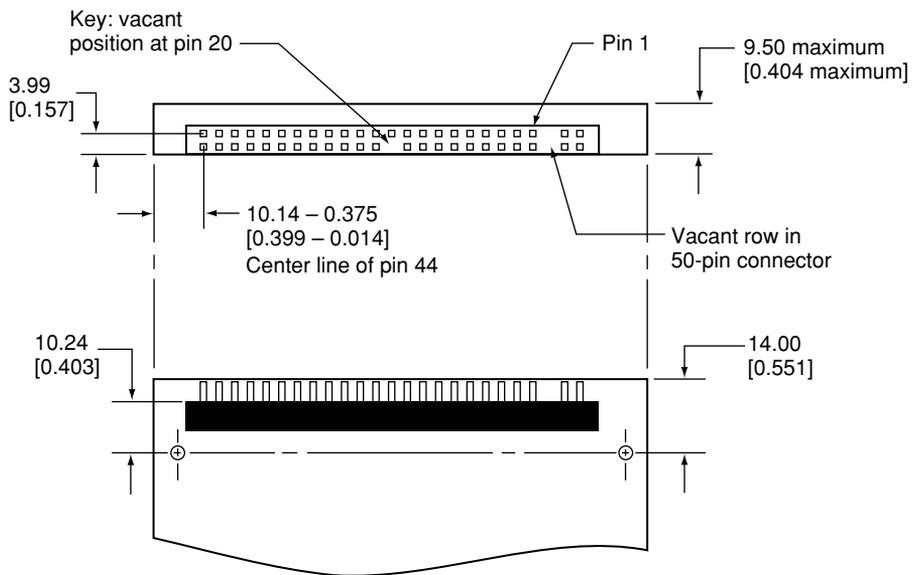


Note: Dimensions are in millimeters [inches].

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 3-3. 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 3-3 Hard disk connector and location



Signal Assignments

Table 3-3 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 3-3 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 3-4

ATA Signal Descriptions

Table 3-4 describes the signals on the ATA hard disk connector.

Table 3-4 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 3-4 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

The iBook has an internal CD-ROM drive with a sliding tray to hold the disc. The drive features a mechanism that supports 4x, 8x, 12x, and 24x data transfer rates 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, and PhotoCD 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.

Trackpad

The pointing device in iBook 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 F4 and F5 function keys. Turning the screw 180° locks or unlocks the keyboard.

Note

The iBook 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 F8 and F9 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.
- The other function keys 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.

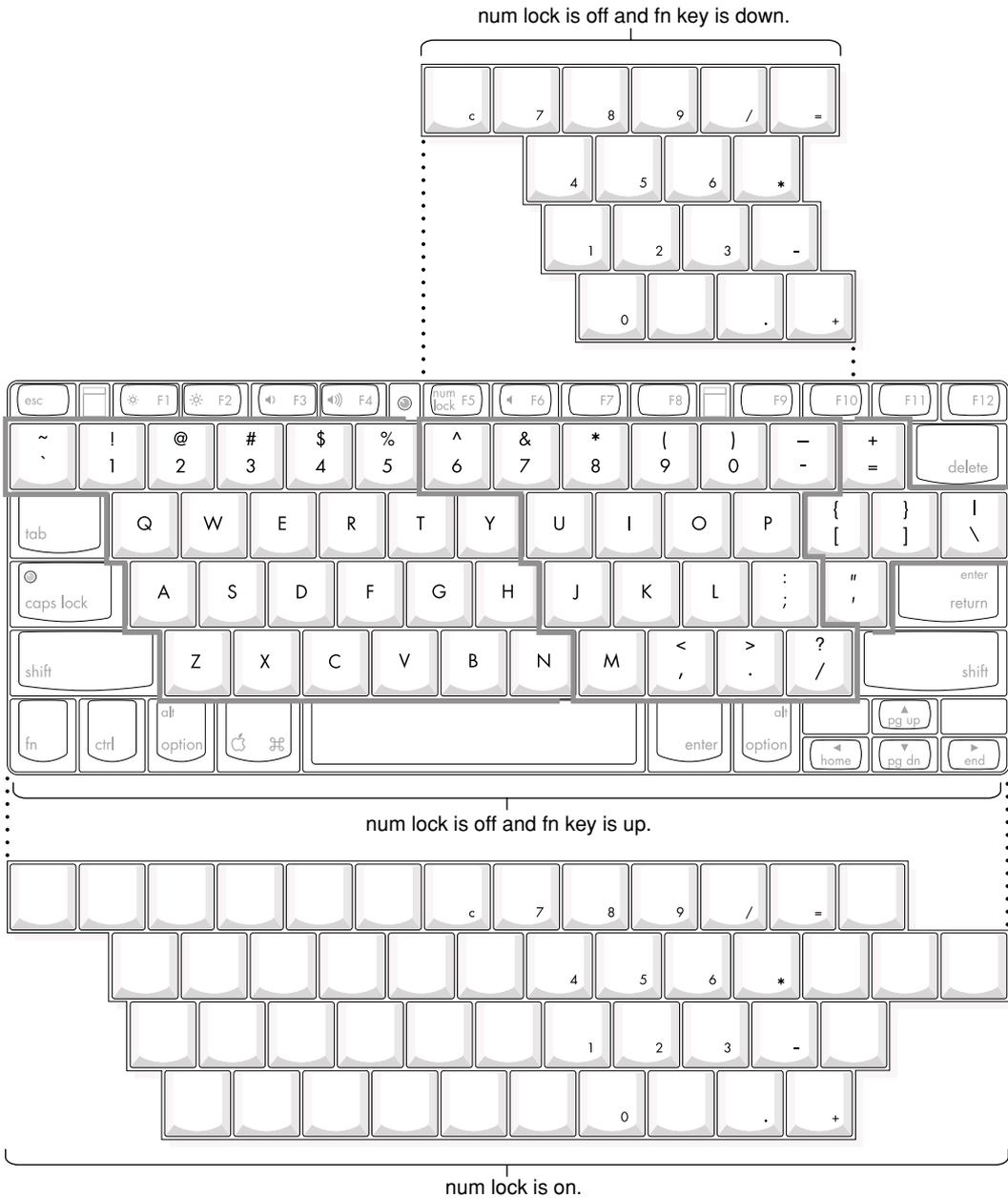
Keyboard Illustrations

Figure 3-4 shows the actual appearance of the keyboard. Figure 3-5 shows the alternate modes of operation of the function and control keys. Figure 3-6 shows the embedded numeric keypad.

Figure 3-4 Keyboard layout



Figure 3-6 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 3-6 and Figure 3-5. 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 3-7 and Figure 3-6.
- It changes certain control keys, including the cursor control keys, to page control keys, as shown in Table 3-8 and Figure 3-6.

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 3-7 and Figure 3-6.
- It makes the rest of the alphanumeric keys functionless (NOPs), as shown in Figure 3-6.

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 3-5 summarizes the checkbox settings and the operation of the Fn key. The operations of the individual function keys are shown in Table 3-6 and Figure 3-5.

Table 3-5 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 3-6 The function keys as control buttons

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

Operations of the Function Keys

Function keys F1 through F6 are used as control buttons for the display and sound; function keys F7 through F12 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 3-6 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 F12. 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 3-6 shows the keys making up the embedded keypad and Table 3-7 lists them.

Table 3-7 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 3-7 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 3-6. 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 3-8 is a list of these keys and their alternate functions. These control keys are also shown in Figure 3-6.

Table 3-8 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 has a built-in color flat panel display that is 12.1 inches in size, measured diagonally. The display contains 800 by 600 pixels and can show up to millions of colors. 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 ATI Rage Mobility graphics controller IC includes 4 MB of VRAM, which 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 24).

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

Sound System

The 16-bit stereo audio circuitry provides sound output through the built-in speaker and the headphone jack.

IMPORTANT

The iBook does not have a microphone or sound input jack. ▲

The sound system is implemented by a Micronas-Intermetall DAC3550A stereo digital-to-analog converter. It contains an output analog source selector, analog gain adjuster, and output amplifiers that system software configures as headphone drivers or internal speaker drivers. The sound system supports a sample rate of 44.1 kHz and sample sizes up to 16 bits.

The frequency response of the sound circuits, not including the speaker, has minus 3 dB points of 20 Hz and 20 kHz. Total harmonic distortion and noise is less than 0.03 percent. The signal-to-noise ratio (SNR) is 90 dB or better, with no audible discrete tones.

Headphone Jack

The headphone jack is located on the left side of the computer at the left palm rest. The headphone jack is configured to drive a pair of low-impedance stereo headphones. External powered speakers may also be connected to the headphone jack.

The headphone jack has the following electrical characteristics:

- output impedance: 47 ohms each channel
- minimum recommended load impedance: 32 ohms each channel
- maximum level: 1.0 V rms(2.8 V P-P)

Internal Speaker

The computer has one speaker located between the keyboard and the display. The computer turns off the sound signal to the speaker when headphones are connected to the headphone jack.

Internal Modem

The sound system receives call progress audio from the internal modem so the user can hear the status of a dial-up modem connection. The level of the call progress audio is fixed.

CD-ROM Drive

Digital audio signals from the CD-ROM drive are sent to the Key Largo IC, which directs them through its I²S interface to the DAC3550A sound IC. The digital audio is converted to analog by the sound IC and sent to the speaker and the headphone jack.

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. Unplug the AC adapter from the computer.
2. Remove the battery from the computer.
3. Unlock the keyboard by turning the slotted screw that is part of the Num Lock LED, which is between the F4 and F5 function keys. Turning the screw 180° locks or unlocks the keyboard.

Note

The locking screw may already be in the unlocked position. ◆

4. 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 F8 and F9 keys. The user can release the latches by sliding them toward the front of the computer.
5. Lift the keyboard up and turn it over, without disconnecting the keyboard's membrane cable.
6. 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.
7. Using a Phillips head screwdriver, remove the two screws that secure the perforated metal RAM door. The screws are to the right of the wireless LAN module.

8. Slide the perforated metal RAM door 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.

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 must use SDRAM devices. If the user installs an SO-DIMM that uses EDO or SGRAM devices, the computer will beep several times when the user attempts to restart the computer. ▲

An SO-DIMM for the iBook can contain either 32, 64, 128, or 256 MB of memory. Total RAM capacity using devices currently available is 320 MB and is limited by the space available for the SO-DIMM. The slot can accommodate an SO-DIMM up to 1.35 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; it is available from the Electronics Industry Association's web site, at

<http://www.jedec.org/download/default.htm>

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 heights of 1.0 or 1.25 inches. It can accommodate an SO-DIMM up to 1.35 inches high, absolute maximum.

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. The specification is available from the Electronics Industry Association's web site, at

<http://www.jedec.org/download/default.htm>

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.

Because the SO-DIMM connector has only two clock lines, and each clock line is limited to only 4 loads, an SO-DIMM with more than 8 SDRAM devices must have buffers on the clock lines. The buffers must be zero-delay type, such as phase-lock loop (PLL), which regenerates the clock signals. For example, the computer can support a 128-MB SO-DIMM using 16 devices and a PLL clock buffer.

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. The first two columns show the memory size and configuration of the SO-DIMMs. The next two columns show the number and configuration of the SDRAM devices making up the memory modules.

Table 4-1 Sizes of RAM expansion modules and devices

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

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 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

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 (8 devices at 150 mA each)

Sleep 6 mA per bank

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, 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.

Software

Software

This chapter summarizes the ROM-in-RAM design of the software and describes the changes that have been made to support the iBook.

The Mac OS that comes with the iBook is Mac OS 9.

ROM in RAM

The system software in the iBook uses the ROM-in-RAM approach also used in the iMac and the 1999 Power Macintosh G3 computer. With the ROM-in-RAM approach, also called the NewWorld design, a small ROM contains the code needed to initialize the hardware and load an operating system. The rest of the system code that formerly resided in ROM is loaded into RAM from disk or from the network.

The small ROM that is needed for the computer's start-up activities, called the boot ROM, is only 1 MB in size. It includes the hardware specific code and tables needed to start up the computer, to run Open Firmware, to provide common hardware access services, and to load the Mac OS ROM image.

High level software resides in an image called the Mac OS ROM that is read into RAM before the Mac OS begins operation. Once the Mac OS begins operation, the Mac OS ROM image in RAM behaves in the same way that the corresponding code in ROM formerly did. Most of the changes are completely transparent to the Mac OS.

Aspects of the New Approach

Some aspects of the ROM-in-RAM approach are apparent in the operation of the system.

RAM Footprint

The iBook computer has its Mac OS ROM image stored in RAM. The area of RAM that contains the Mac OS ROM image is excluded from the available memory space and is marked as read-only. This removes approximately 3 megabytes of RAM from availability for other uses. In effect, a system with 32 megabytes of RAM appears to have only 29 megabytes available.

Startup Disk Control Panel

Setting the startup device from the Startup Disk control panel makes the changes to the boot process that are needed for the ROM-in-RAM approach. The Startup Disk control panel modifies the Open Firmware NV-RAM partition that contains the Open Firmware's configuration variables.

IMPORTANT

The previous API for controlling the startup device selection, using `_GetDefaultStartup` and `_SetDefaultStartup`, is not effective on computers that use the ROM-in-RAM approach. ▲

Data Structures and Files

The Mac OS ROM image is contained in a new file, named "Mac OS ROM", that is kept in the System Folder. The Mac OS ROM image is the same as it would be if it were an actual Mac OS ROM, containing the high-level software, the kernel software, and the 68K emulator.

Memory Mapping

With the ROM-in-RAM approach, memory is not mapped one-to-one as it has been for previous PCI-based Macintosh computers. This could be a compatibility issue with some software. Software that assumes the logical and physical addresses are the same will fail, even when virtual memory is not on. Well-behaved software—that is, software that always calls the `LogicalToPhysical` or `PrepareMemoryForIO` functions when it needs a physical memory address—will continue to work.

IMPORTANT

Designers of DMA device drivers should refer to *Designing PCI Cards and Drivers for Power Macintosh Computers* for information about using the `PrepareMemoryForIO` function to set up mapping for physical and logical addresses. The relevant section is on pages 219–229. For device drivers running with the NewWorld software, the sentence on page 227 that says "Certain DMA transactions require both mapping tables" should be interpreted to mean "All DMA transactions require both mapping tables." ▲

Boot Process

The boot process for the iBook is similar to that for other Macintosh computers that use the ROM-in-RAM approach.

Note

The iBook does not have the ability to start up in response to the power key on an external Apple USB keyboard. ♦

The PowerPC processor executes its reset vector as defined by the Hardware Initialization code. This code runs diagnostics tests, and when enough hardware initialization has been performed to run Open Firmware, the boot beep sound is played and Open Firmware begins executing. The Open Firmware module probes the system's I/O buses to determine the device configuration and builds a device tree describing the hardware it finds.

The boot device, selected by the user with the Startup Disk control panel, is stored in Open Firmware's NVRAM. Open Firmware attempts to locate that boot device (which may be a hard disk, CD, or network connection); if it is not found, Open Firmware searches for a suitable boot device according to a predetermined search order.

Once the boot device has been found, the Mac OS ROM image is loaded into memory, decompressed, and write-protected so that it behaves just like a ROM.

The user may interrupt Open Firmware's boot device selection by holding down the option key while booting. This invokes the OS Picker, an Open Firmware application that lets the user select an alternate operating system or boot device. The default OS is the Mac OS ROM image, loaded from the current startup device.

Some of the Mac OS ROM boot code is written in 68K code. In order to run the 68K ROM, the PowerPC Nanokernel is loaded, and the emulator task is started. The emulator begins executing code in the 68K ROM. This code uses the device tree provided by Open Firmware to install device drivers, Macintosh OS Services (referred to as Toolbox Managers), and finally the ROM loads the rest of the operating system from the startup device.

Boot ROM Contents

The boot ROM image serves as the container for the CPU specific software required for loading the Mac OS.

Hardware Initialization Code

The hardware initialization portion of the ROM contains calls to a series of Power-On Self Test (POST) routines. The principle features are a ROM checksum test, memory testing, detection of the manufacturing test pin, and test manager support. These diagnostics run in native Power PC code.

The hardware initialization code on the iBook is different from that on existing PowerBook models because of the new ICs (Uni-N and KeyLargo). Additional diagnostics are run out of the ROM in emulation.

Functions of the hardware initialization code include

- Initialization of the Uni-N memory controller IC
- Memory sizing using I²C presence detect on the memory module
- Memory timing setup with support for fast SDRAM devices
- L2 cache detection and sizing
- Initialization of the KeyLargo I/O controller IC
- Generating diagnostic sounds, including the boot chord that is emitted when hardware initialization has been successfully completed

The firmware in the boot ROM sets up and sizes memory, then stores the information in the device tree where it is available to the OS. The firmware obtains information about the memory by way of the Serial Presence Detect mechanism of the SO-DIMM that is used for memory expansion. The JEDEC standard for the SO-DIMM mandates that all SO-DIMMs include a ROM with information about the memory. The Uni-N IC reads that information from the ROM by way of the I²C bus.

Open Firmware

Open Firmware is a boot environment developed using the Forth programming language. The purpose of Open Firmware is to provide a machine independent mechanism for loading operating systems from a variety of boot devices. Open Firmware probes the PCI bus looking for devices and possible Open Firmware drivers for those devices. These drivers can either be built into the Open Firmware module or located in the external device, thus providing plug and play capabilities for new boot devices. Open Firmware is capable of using these drivers to load an operating system from the device.

Software

Functions of the Open Firmware code include

- Configuration of the Uni-N and KeyLargo ICs
- Construction of the device tree
- ATI Rage Mobility video driver
- Selection of the boot device

On the iBook, the Open Firmware code has been extended so that the device tree describes the new hardware features of the computer. The Open Firmware code also includes FCode drivers for the new UltraDMA66 and USB hardware channels.

Open Firmware normally starts up using the default device and operating systems. The user can interrupt Open Firmware by holding down the Command, Option, O, and F keys. Open Firmware responds by providing a command line interface using the keyboard and built-in display. Using this interface, users can change the stored parameters used by Open Firmware.

Interrupts

The interrupt layout is determined by information in the device tree. An interrupt tree overlays the other information in the device tree and determines how the interrupts are configured.

Mac OS ROM Image File

The Mac OS ROM image file (also called the bootinfo file) is named Mac OS ROM. It includes:

- A Mac OS Loader program
- A compressed Mac OS ROM image including:
 - 68K code Macintosh Toolbox code and data resources
 - PowerPC shared libraries
 - Nanokernel, the Mac OS 9 kernel
 - 68LC040 Emulator
 - drivers and libraries needed during OS boot

Software

The Nanokernel and the 68LC040 Emulator are low-level Mac OS initialization components that were part of BootPowerPC code in previous CPU ROMs. They are now included in the Mac OS ROM Image.

Complementarily, CPU-specific hardware initialization code has been relocated into the boot ROM as described in the previous section.

System Software Modifications

The following sections describe the parts of the Mac OS ROM Image that have been changed for the Mac OS 9 release to support features of the iBook.

Computer Identification

All ROMs based on NewWorld 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 BoxFlag 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 `PowerBook2,1`.

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.

Software

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.

Power Saving Modes

The iBook meets the following energy saving standards:

- Energy Saver
- Energy Star (US)

To meet those standards, the default configuration of the computer must draw less than 7 watts in Sleep mode and less than 5 watts in off mode, while plugged into the AC adapter and with the battery removed.

The power manager has been redesigned to reduce power consumption in Sleep mode. The new version, Power Manager 2.0, is a native Mac OS manager designed to implement common power management policy across all Macintosh models by means of the new Power Plugin component.

With the new power management architecture, the following operating modes are defined:

- **Run Single:** One processor is running at maximum processing capacity.
- **Idle One:** The system is idling. All clocks are running and the system can return to running code within a few nanoseconds. In a single processor system, the main processor is stopped in DOZE mode. Cache coherency is maintained in this level of idle.
- **Idle Two:** The system is in power saving mode. This mode is entered only when a system has been in Idle one state for a substantial period of time (a half second or so) with no activity. In a single processor system, the main processor cache is flushed, and the processor is put into sleep mode—the external processor bus clock is stopped. The delay in coming out of this state is on the order of a millisecond. Cache coherency is maintained by the flush on entry.
- **Sleep:** The system is completely shut down, with only the DRAM state preserved for quick recovery. All processors are powered off with their state preserved in DRAM. All clocks in the system are suspended except for the 32.768Khz timebase crystal on the PMU99 IC.

Software

The computer automatically enters Idle Two mode after several seconds of inactivity. This mode easily meets the requirement of less than 7 watts of power consumption. While the computer is in either Idle mode, if it is attached to a network, it is able to respond to service requests and other events directed to the computer.

Idle mode is not the same as Sleep mode. To allow the computer to respond to network activity when it is in Sleep mode, the user must select the Wake on LAN option in the Advanced Settings of the Energy Saver control panel.

Although the current public Power Manager interfaces will be maintained for application compatibility, this is a major revision that may affect developers. Information about the API changes for Power Manager 2.0 is available in a technote, which can be obtained from the web site at

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

Suspend and Resume

Suspend and resume provides a way for the computer to shut off or lose power and then, once power returns, restore the system to the state before the power loss. The Suspend feature saves the computer's RAM contents on the hard disk before turning off the power. The difference between the Suspend state and normal power off is the presence of the saved RAM contents, along with some other hardware information, on the hard disk.

IMPORTANT

Drivers are required to save whatever is necessary to restore state after a loss of power. ▲

The Energy Saver control panel has a checkbox that lets the user specify whether or not to save memory before the system goes into Sleep mode. The default is yes.

When the user presses the power key, the computer starts up and automatically reloads the RAM contents from the hard disk. The computer goes through a process similar to a normal boot, but it does not display the startup screen or the extension icons. It restores the prior state and resumes execution of whatever application was active at the time the system shut down.

Sleep and wake queues are executed for Suspend and Resume.

ATA Manager 4.0

Mac OS 9 includes ATA Manager 4.0, which has a modular design similar to that of SCSI Manager 4.3. This modularity provides the flexibility to have multiple ATA controllers working at the same time—for example, those for the Ultra ATA and ATA interfaces. ATA Manager 4.0 supports both controllers together by including ATA Interface Modules (AIMs) for both.

With this new modular design, the ATA Manager and the ATA Interface Modules (AIMs) divide the responsibilities. The ATA Manager is responsible for

- registering ATA plug-ins
- routing each request to the appropriate plug-in
- calling completion routines for asynchronous calls

ATA Interface Modules are responsible for

- handling each request
- error handling
- returning errors

USB Drivers

A USB Services Library layer provides hardware abstraction. Below it is the UIM (USB Interface Module) that communicates with the USB hardware in the KeyLargo IC. Above it are the device drivers that are loaded dynamically when new devices are plugged onto the bus.

USB class drivers are software components that are able to communicate with similar 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.

USB Mass Storage Support 1.3 includes the following class drivers:

- Audio Class driver: Supports USB audio devices such as speakers and microphones.
- Mass Storage Class driver: Supports booting from a USB storage device that follows the USB Mass Storage Class specification. Mass Storage Class drivers do not support CD, CD-R, or other read-only media types.

Software

- Communication Class driver: Supports USB communication devices that support the Abstract Control Model subclass.
- Printer Class driver: Supports USB printers. The LaserWriter 8 driver can communicate through this driver to any Postscript-based printer.
- HID driver: Provides support in InputSprockets for all HID-class devices (such as joysticks and game controllers) and for most force feedback devices.
- Keyboard and Mouse driver: Supports all USB keyboards and mouse devices that support boot protocol (HID Class, SubClass 1).
- HUB Class driver: Supports all USB compliant hubs.

Version 1.3 of the Macintosh USB system software supports all four data transfer types defined in the USB specification.

Other New Drivers

The system software includes new drivers for the Ethernet port and the AirPort Card wireless LAN module.

The new Ethernet driver supports 100Base-T operation. The Ethernet driver uses the Open Transport Data Link Provider Interface (DLPI). The Ethernet driver also supports Wake on LAN.

The driver for the AirPort Card wireless LAN module is not part of the Mac OS ROM image but resides in the Extensions folder.

Legacy Drivers

The absence of serial ports, SCSI port, IRTalk, floppy drive, internal microphone, and stereo speakers, and the addition of the USB port, may affect the behavior and appearance of various system components. Modifications for such changes are in Mac OS 9 itself.

Some managers and drivers remain in the system to support existing applications that depend on those older devices. New applications are expected to use the new I/O channels such as USB.

Floppy Disk Legacy

The iBook has no built-in floppy disk drive, so the existing “.Sony” driver has been disabled using the same techniques as in the iMac software. MFM Floppy disks can be supported by a USB-based LS-120 disk drive developed by a third party.

ADB Legacy

The iBook has no ADB ports. The ADB Manager, however, will still be present to retain compatibility with programs that require it.

The system software in the iBook has an ADB shim layer to allow USB keyboards and mice to appear as legacy ADB devices. The PMU99 provides the interfaces to the keyboard and mouse and communicates with the system by simulating ADB packets that are interpreted by the ADB Manager.

For external USB mice and keyboards to be fully compatible and interoperate seamlessly with the built-in keyboard and trackpad, an ADB shim is used to convert USB mouse and keyboard events into ADB packets.

Note

The built-in trackpad and keyboard also appear to the system as ADB devices, as described in the section “Power Controller IC” (page 26). ♦

SCSI Legacy

Although there is no SCSI connector on the iBook, the high-level SCSI interfaces will remain in the system. That allows for possible future support for SCSI devices using a USB to SCSI adapter. Such an adapter would take the USB commands coming from the USB port and convert them into SCSI commands to send to the drive. A SCSI driver would also need to be written that would take the SCSI commands coming from the system and embed them in USB commands that would be sent to the device through the adapter.

Note

The iBook doesn't have SCSI disk mode. To transfer files to and from another computer, the user should connect the machines using Ethernet. ♦

Other New Features

The system software for the iBook supports several other new features.

Sound Software Components

The I²S-based sound system in the iBook is the first such implementation on any Macintosh computer. To support this new hardware, a Sound HAL (hardware abstraction layer) has been written. In addition to the HAL, a port handler has been written to describe the hardware capabilities.

Note

The Sound Manager API has not been changed. ♦

Keyboard and Key Caps

The built-in keyboard has several new features. Several of the keys on the keyboard have more than one mode of operation. The function keys can also control the display and speakers; the keys on the right side of the keyboard can also be used as a numeric keypad; and certain control keys can also be used as page-control keys. The Keyboard Control Panel has been changed to support these new features, as described in the section “Keyboard” (page 43).

External keyboards connected using USB will work. The image displayed by Key Caps toggles when input from a new keyboard is detected.

Onscreen Display

The iBook uses on-screen display meters for its sound and display control buttons. There are separate on-screen display meters for display brightness, sound volume, and mute.

Wireless LAN Module

A software driver for the AirPort Card wireless LAN module is included in the Extensions folder. For more information, please see “Software Components” (page 36).

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:

\$n	hexadecimal value n
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
BIOS	basic input/output system
CAS	column address strobe, a memory control signal

A P P E N D I X A

Abbreviations

CD	compact disc
CD-ROM	compact disc read-only memory
CHRP	Common Hardware Reference Platform
CPU	central processing unit
CRM	Communications Resource Manager
DAA	data access adapter (a telephone line interface)
DAC	digital-to-analog converter
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 ² C	inter IC control bus
I ² S	inter IC sound bus
IC	integrated circuit
IDE	integrated device electronics
IEC	International Electrotechnical Commission
IIC	inter IC control bus (same as I ² C)
IIS	inter IC sound bus (same as I ² S)
I/O	input and output
IR	infrared
IrDA	Infrared Data Association
ISO	International Organization for Standardization
JEDEC	Joint Electron Device Engineering Council
JIS	Japanese Industrial Standards
L1	level 1 or first level, a type of CPU cache

A P P E N D I X A

Abbreviations

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
NV-RAM	nonvolatile random-access memory
OHCI	Open Host Controller Interface
OS	operating system
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
RTAS	run-time abstraction services
SCC	Serial Communications Controller
SCSI	Small Computer System Interface
SDRAM	synchronous dynamic RAM
SGRAM	synchronous graphics 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
VCC	positive supply voltage (voltage for collectors)

A P P E N D I X A

Abbreviations

VIA	versatile interface adapter
WEP	Wired Equivalent Privacy
WLAN	wireless LAN

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