
iBook

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Introduction to iBook

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. For additional technical information on Macintosh computers, refer to [“Supplemental Reference Documents”](#) (page 53).

Organization of This Document

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

- [Chapter 1, “Introduction”](#) (page 11) introduces the iBook computer and describes its features, with emphasis on the changes since the previous model.
- [Chapter 2, “Architecture”](#) (page 15) describes the internal logic of the iBook computer, including the main ICs that appear in the block diagram.
- [Chapter 3, “Devices and Ports”](#) (page 23) describes the standard I/O ports and the built-in I/O devices.
- [Chapter 4, “RAM Expansion”](#) (page 47) describes the RAM expansion module.
- [Appendix A, “Supplemental Reference Documents”](#) (page 53) tells where to find more information about specific technologies used in the iBook computer.
- [Appendix B, “Conventions and Abbreviations”](#) (page 57) lists the standard units and abbreviations used in this developer note.

Overview of iBook

The iBook computer is a portable computer for the consumer and education markets. This chapter lists the computer's features, with emphasis on the changes from the previous models.

New Features

The features that have changed are listed here along with references to the sections that describe them.

- **Processor speed** The clock speed of the Power PC G3 microprocessor is 800 or 900 MHz. See [“Power PC G3 Microprocessor”](#) (page 17).
- **Graphics IC** The display controller is an ATI Mobility Radeon 7500 with 32 MB of graphics DDR SDRAM. See [“Graphics IC”](#) (page 19).
- **Hard disk storage** The computer has a hard disk drive with a storage capacity of 30 or 40 GB (and CTO 60 GB). For more information and developer guidelines for alternative hard drives, see [“Hard Disk Drive”](#) (page 29).

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 Power PC G3 microprocessor is 800 or 900 MHz. See [“Power PC G3 Microprocessor”](#) (page 17).
- **Processor L2 cache** The L2 cache size is 512 KB. See [“L2 Cache”](#) (page 17).
- **Power stepping** This feature slows down the processor to conserve battery power when the computer is idle. For more information, see [“Power Stepping”](#) (page 13).
- **Cache** The microprocessor has a built-in L2 cache consisting of 512 KB of fast static RAM. The clock speed for the backside cache is the same as the clock speed of the microprocessor. See [“L2 Cache”](#) (page 17).
- **System RAM** The computer comes with 128 or 256 MB of RAM. The second 128 MB occupies the expansion slot. For more information, see [“RAM Expansion”](#) (page 47).
- **Hard disk storage** The computer has a hard disk drive with a storage capacity of 30 or 40 GB (and CTO 60 GB). For more information and developer guidelines for alternative hard drives, see [“Hard Disk Drive”](#) (page 29).
- **CD-ROM drive** One configuration of the 12.1-inch model has a built-in 24x-speed CD-ROM drive. See [“CD-ROM Drive”](#) (page 34).
- **Combination DVD-ROM/CD-RW drive** Two configurations have a combination DVD-ROM/CD-RW drive. For more information, see [“DVD-ROM/CD-RW Combo Drive”](#) (page 33).

- **Display** Two TFT display sizes are available: a 12.1-inch and a 14.1-inch. Both displays have XGA (1024 by 768) resolution. See [“Flat Panel Display”](#) (page 42).
- **External display connector** The external display connector supports VGA, composite, and S-video monitors and projectors. See [“External Display Port”](#) (page 42).
- **Graphics IC** The display controller is an ATI Mobility Radeon 7500 with 32 MB of graphics DDR SDRAM. See [“Graphics IC”](#) (page 19).
- **Microphone** The computer has a built-in microphone. See [“Sound System”](#) (page 44).
- **Battery** The computer has one battery bay. The battery in the 12.1-inch display models uses six lithium ion cells and provides up to 5 hours of operation under normal use. The battery in the 14.1-inch display model uses eight lithium ion cells and provides up to 6 hours of operation under normal use.
- **USB ports** The computer has two external USB ports. See [“USB Ports”](#) (page 23).
- **FireWire 400 port** The computer has an IEEE-1394a FireWire 400 high-speed serial port. See [“FireWire 400 Port”](#) (page 24).
- **Target disk mode** The computer can act like a FireWire storage device connected to another computer. See [“Target Disk Mode”](#) (page 14).
- **Modem** The computer has a built-in modem that supports 56 Kbps data rate with V.92 modem standards. See [“Internal Modem”](#) (page 27).
- **Ethernet** The computer has a built in Ethernet port for 10Base-T and 100Base-T operation. See [“Ethernet Port”](#) (page 26).
- **AirPort Card** An AirPort Card is available as a build-to-order option or as a user-installable upgrade. See [“AirPort Card”](#) (page 27).
- **Sound** The computer has a built-in microphone and stereo speakers; it provides stereo output signals on the audio minijack. See [“Sound System”](#) (page 44).
- **Keyboard** The keyboard has function keys and inverted-T arrow keys. Some of the function keys are used to control the brightness and sound and to eject a disk. The keyboard also includes an embedded numeric keypad. See [“Keyboard”](#) (page 34).
- **Trackpad** The integrated trackpad includes tap/double tap and drag features. See [“Trackpad”](#) (page 34).
- **Weight** With the battery installed, the 12.1-inch display models weigh approximately 2.2 kg (4.9 pounds) and the 14.1-inch display model weighs approximately 2.6 kg (5.9 pounds). The exact weight depends on the configuration.
- **Size** The 12.1-inch display models are 28.50 cm (11.2 inches) wide, depth 23.03 cm (9.06 inches) deep, and 3.42 cm (1.35 inches) thick. The 14.1-inch display model is 32.3 cm (12.7 inches) wide, 25.8 cm (10.2 inches) deep, and 3.42 cm (1.35 inches) thick.
- **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 less than 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 separately. The airline power cable should have a sense resistor of 24.3K ohms connected between the power plug's shell and ground. See also “[Power Control IC](#)” (page 20).
- A video adapter with composite and S-video connectors is available separately.
- A VGA adapter with a 15-pin VGA connector, included with the computer, is also available separately.
- Additional Apple Memory Module SO-DIMM SDRAM memory cards are available.

System Software

The iBook computer comes with Mac OS X v. 10.2.4 installed as the default system and is bootable into Mac OS 9. The Mac Classic software contains additional drivers for the graphics controller and CD-RW/Combo optical drives.

For more information about Mac OS X, see the reference listed in “[Mac OS X](#)” (page 54). For more information about Mac OS 9, see the reference listed in “[Mac OS 9.2.2](#)” (page 54).

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

Machine Identification

Current and recent Macintosh ROMs 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. On all these machines, a call to `gestaltMachineType` returns the value 406 (\$196).

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 computer, the `model` property value is `PowerBook4,3`.

The string obtained from the `compatible` property cannot be displayed to the computer user. If available, 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 require.

Power Stepping

To conserve power when operating on battery power, the iBook computer supports two methods of power stepping to slow down the processor clock. One method is an inherent feature of the PowerPC G3 chip, called Dynamic Power Stepping (DPS) and cannot be adjusted by the user. DPS is controlled automatically by the system, stepping up the processor speed for performance-intensive applications and stepping down the processor speed for energy-efficient applications.

Under Mac OS X, users can manually step down the processor by adjusting the Energy Saving Settings, which are located under the Energy Saver panel of System Preferences. Users can select from preconfigured profiles including Automatic, Highest Performance, Longest Battery Life, DVD Playback, and Presentations, or customize their own energy settings. Highest Performance and Longest Battery Life profiles override the DPS feature. Highest Performance maintains the highest processor speed while Longest Battery Life caps the processor speed at 400MHz.

Target Disk Mode

The user has the option at boot time to put the iBook computer into a mode of operation called target disk mode (TDM). When the iBook computer is in target disk mode and connected to another Macintosh computer by a FireWire cable, the iBook computer 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 either Mac OS X (any version) or Mac OS 9 with FireWire software version 2.3.3 or later.

To put the iBook computer into target disk mode, restart the computer and hold down the T key until the FireWire icon appears on the display. Then connect a FireWire cable from the iBook computer to the other computer. When the other computer completes the FireWire connection, a hard disk icon appears on its desktop.

If the iBook computer is turned off or the FireWire cable is disconnected while in target disk mode, an alert appears on the other computer. Disconnecting while the disk is in use can cause loss of data on the target disk.

To dismount the iBook computer out of target disk mode, drag the hard disk icon of the targeted computer to the trash on the main computer. When the computer is fully dismounted, press the power button on the targeted computer.

Architecture

This chapter describes the architecture of the iBook computer.

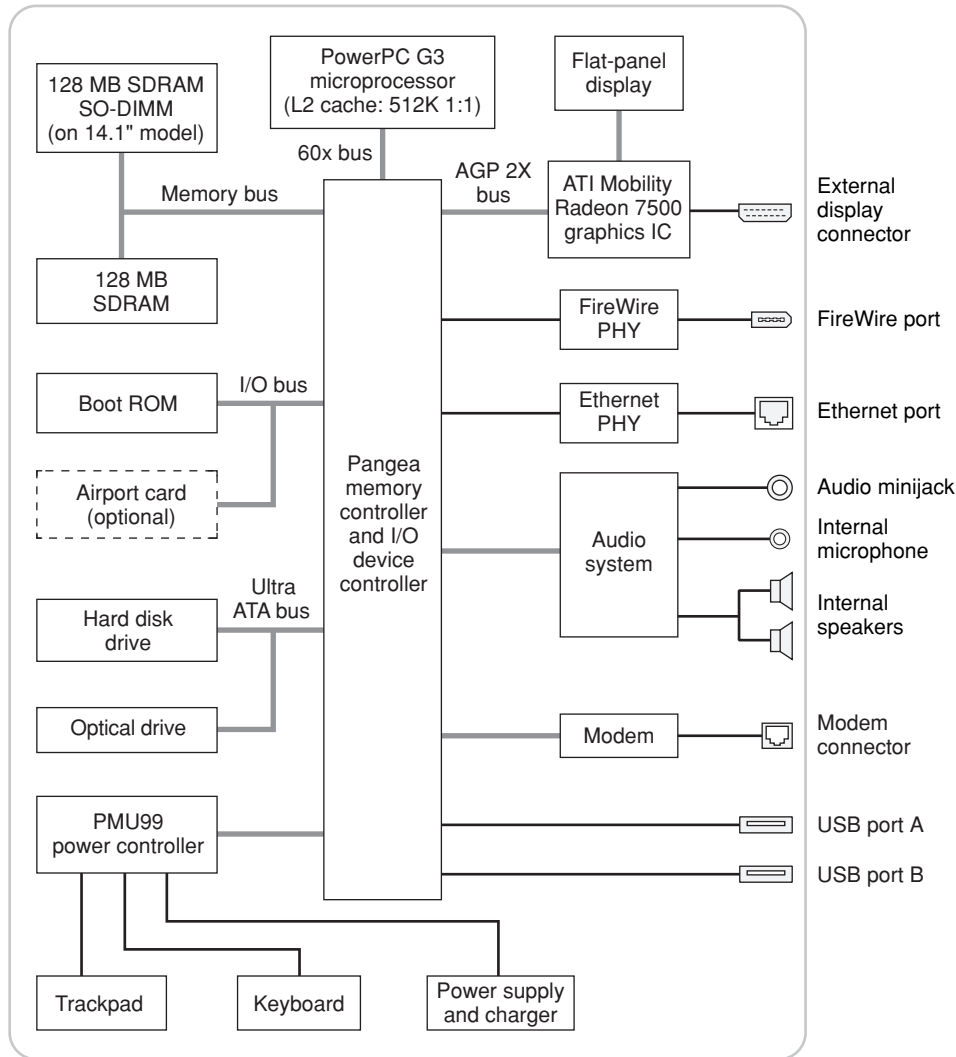
Block Diagram and Buses

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

Block Diagram

[Figure 2-1](#) (page 16) 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 the custom Pangea memory and I/O 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 100 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](#) (page 17), which is in the section “[Memory and I/O Device Controller](#)” (page 17).

Microprocessor and Cache

The microprocessor communicates with the rest of the system by way of a 100-MHz, 64-bit 60x bus to the Pangea IC. The backside cache is built into the microprocessor.

Power PC G3 Microprocessor

The microprocessor used in the iBook computer is a PowerPC G3. 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 512 KB with a clock speed ratio of 1:1
- a microprocessor core optimized for Mac OS applications

The G3 microprocessor in the iBook computer normally runs at a clock speed of 800 or 900 MHz. The Power Stepping feature slows the clock speed to save power when the computer is idle. See “Power Stepping” (page 13).

L2 Cache

The data storage for the L2 cache consists of 512 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](#) (page 17), the Pangea IC also has separate interfaces to the physical layer (PHY) ICs for Ethernet and FireWire and an I2C 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	100 MHz
Memory bus	System RAM	64 bits	100 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 DB-DMA 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 is described in its own section. The following sections describe the other subsystems that are connected to the Pangea IC.

System RAM

The memory subsystem in the iBook computer consists of 128 MB of SDRAM soldered on the main logic board and one expansion slot for an SO-DIMM (CTO expandable with 512 MB for a total of 640 MB). In some models, the expansion slot is occupied by a 128-MB SO-DIMM for a total of 256 MB of system RAM.

The data bus to the RAM and DIMM is 64 bits wide, and the memory interface is synchronized to the 60x bus interface at 100 MHz. See also [“RAM Expansion”](#) (page 47).

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 26).

FireWire 400 Controller

The Pangea IC includes an IEEE 1394a FireWire 400 controller with a maximum data rate of 400 Mbits (50 MBytes) per second. The Pangea IC provides DMA (direct memory access) support for the FireWire400 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 400 Port”](#) (page 24).

Graphics IC

The graphics IC is an ATI Mobility Radeon 7500. It provides video for both the internal flat panel display and an external video display. The signals to the external display can be either VGA, composite video, or S-video; for more information, see [“External Display Port”](#) (page 42).

The Mobility Radeon IC includes 32 MB of DDR SDRAM. The graphics IC supports a display size of 1024 by 768 pixels and also has a scaling mode that displays a 640-by-480 or 800-by-600 pixel image on the full screen.

The Mobility Radeon 7500 IC also has a 3D graphics engine for fast rendering of 3D objects.

The signal generated for the flat panel display is simultaneously available for an external display. The external display mirrors the built-in display. For more information, see [“External Display Port”](#) (page 42).

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-5, 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 side 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 23).

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 55).

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 internal modem is connected to an internal USB port. The Pangea IC provides DB-DMA support for the modem interface. The modem provides digital call progress signals to the sound circuitry.

The internal modem is a separate module that contains the datapump IC and the interface to the telephone line (DAA). The controller functions are performed by the main processor. See [“Internal Modem”](#) (page 27).

Sound Circuitry

The iBook computer has sound circuitry that is connected to the Pangea IC by a standard I2S bus. The Pangea IC provides DB-DMA (descriptor-based direct memory access) support for the I2S 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 sound circuitry performs digital-to-analog conversion for the audio signals to the internal speakers and the headphone mini-jack. The sound 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 computer 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 44).

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
- keeping track of real time clock operations, including date and time

The iBook computer can operate from a 15-volt power outlet on an airliner, however for safety reasons the computer will not allow battery charging. In order for the computer to detect the connection to airline power, the airline power cable should have a sense resistor of 24.3K 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

The AirPort Card shares the 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 other 802.11b-standard systems that operate at 2 or 1 Mbps and with Apple's AirPort Extreme system. For information about its operation, see ["AirPort Card"](#) (page 27).

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 55).

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](#) (page 23) is an illustration of a Type A USB port. [Table 3-1](#) (page 23) shows the pin assignments.

Figure 3-1 USB Type A connector

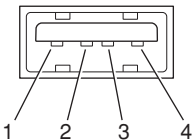


Table 3-1 Pin assignments on the USB port

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

The iBook computer 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 Technology

The USB ports include power saving modes, support of USB mass-storage devices, and an OHCI 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

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 55).

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 400 Port

The iBook computer has one external FireWire 400 IEEE 1394a port. The FireWire 400 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 or the power adapter is connected.
- supports booting the system from a mass storage device
- supports target disk mode (TDM)

The FireWire 400 hardware and software provided with the iBook computer are capable of all asynchronous and isochronous transfers defined by IEEE standard 1394.

FireWire 400 Connector

The FireWire 400 connector has six contacts, as shown in [Figure 3-2](#) (page 25). The connector pin assignments are shown in [Table 3-2](#) (page 25).

Figure 3-2 FireWire 400 connector

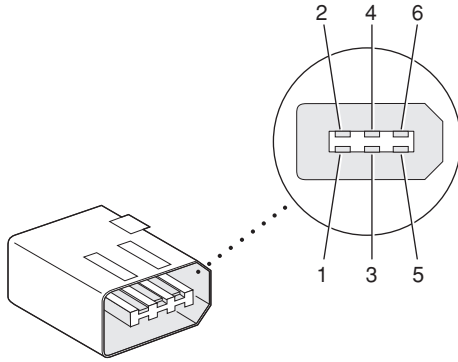


Table 3-2 Pin assignments on the FireWire 400 connector

Pin	Signal name	Description
1	Power	Unregulated DC; 12.0–16.8 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 or the power adapter is connected, the power pin provides a maximum voltage of 16.8 V (no load) and up to 7 W peak power.

Pin 2 of the 6-pin FireWire 400 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 400 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 400 Device Programming

A generic driver for mass storage devices is included in the system software. 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 400 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 400 bus, the iBook computer can operate as a mass storage device. See [“Target Disk Mode”](#) (page 14).

For additional information about the FireWire 400 interface and the Apple APIs for FireWire 400 device control, refer to the resources listed in [“FireWire 400 Interface”](#) (page 56).

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-T 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](#) (page 26) shows the signals and pins on the connector.

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.92 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.

Note: Apple's implementation of V.92 does not support outgoing Modem On Hold. By default, PCM stream is turned off.

AirPort Card

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 or both. The AirPort Base Station and AirPort Extreme Base Station have connectors for a wired LAN, a DSL or cable modem, and a standard telephone line using the built-in 56 Kbps modem that is available on some base stations.

AirPort transmits and receives data at speeds up to 11 Mbps, comparable to wired networking speeds. AirPort is Wi-Fi Certified, which means it is fully compatible with other devices that follow the IEEE 802.11b standard, including PC's. For more information about Wi-Fi and compatibility, see the reference at ["Wireless Networks"](#) (page 56).

Data Security

AirPort has several features designed to maintain the security of the user's data.

- 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 an Access Control List of authentic network client ID values (wireless and MAC Addresses) to verify each client's identity before granting access to the network.
- When communicating with a base station, AirPort uses up to 128-bit encryption to encode data while it is in transit.
- The AirPort Base Station can be configured to use NAT (Network Address Translation), protecting data from would-be Internet hackers.

- The AirPort Base Station can authenticate users by their unique Ethernet IDs, preventing unauthorized machines from logging into the network. Network administrators can take advantage of RADIUS compatibility, used for authenticating users over a remote server. Smaller networks can offer the same security using a local look-up table located within the base station.

AirPort Hardware

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 802.11b standard and use DSSS.

Two AirPort antennas are built into the computer's cover, on either side of the flat-panel display. One antenna is always used for transmitting. Either of the two antennas may be used for receiving. Using a diversity technique, the AirPort Card selects the antenna that gives the best reception.

AirPort Software

Software that is provided with the AirPort Card includes

- AirPort Setup Assistant, an easy-to-use program that guides users through the steps necessary to set up the AirPort Card or set up an AirPort Base Station.
- Users can switch between wireless networks and can create and join peer-to-peer networks. In Mac OS X, these functions are accessed via System Preferences or the AirPort status menu (which first must be activated in System Preferences). In Mac OS 9, these functions are available through the AirPort application and the menu bar.
- AirPort Admin Utility, a utility for advanced users and system administrators. With it the user can edit the administrative and advanced settings needed for some advanced configurations.

Bluetooth Technology

In the iBook computer, the Bluetooth option requires an external, third-party dongle connected via the USB bus. Bluetooth is an open specification that enables short-range wireless connections between desktop and laptop computers and a host of other peripheral devices. Bluetooth support is built into Mac OS X and compliant with Bluetooth specification v1.1. It operates on a globally available 2.4 GHz frequency band (ISM band) for worldwide compatibility and has a maximum throughput of 1Mbps.

The Bluetooth technology supports the following profiles:

- synchronization —enables synchronization of devices over Bluetooth
- serial —provides a wireless serial connection to other Bluetooth devices
- dial-up networking (DUN) — enables a mobile phone to act as a modem
- object push —enables the transfer of files between Bluetooth devices

For more information on Bluetooth technology, refer to [“Bluetooth”](#) (page 56).

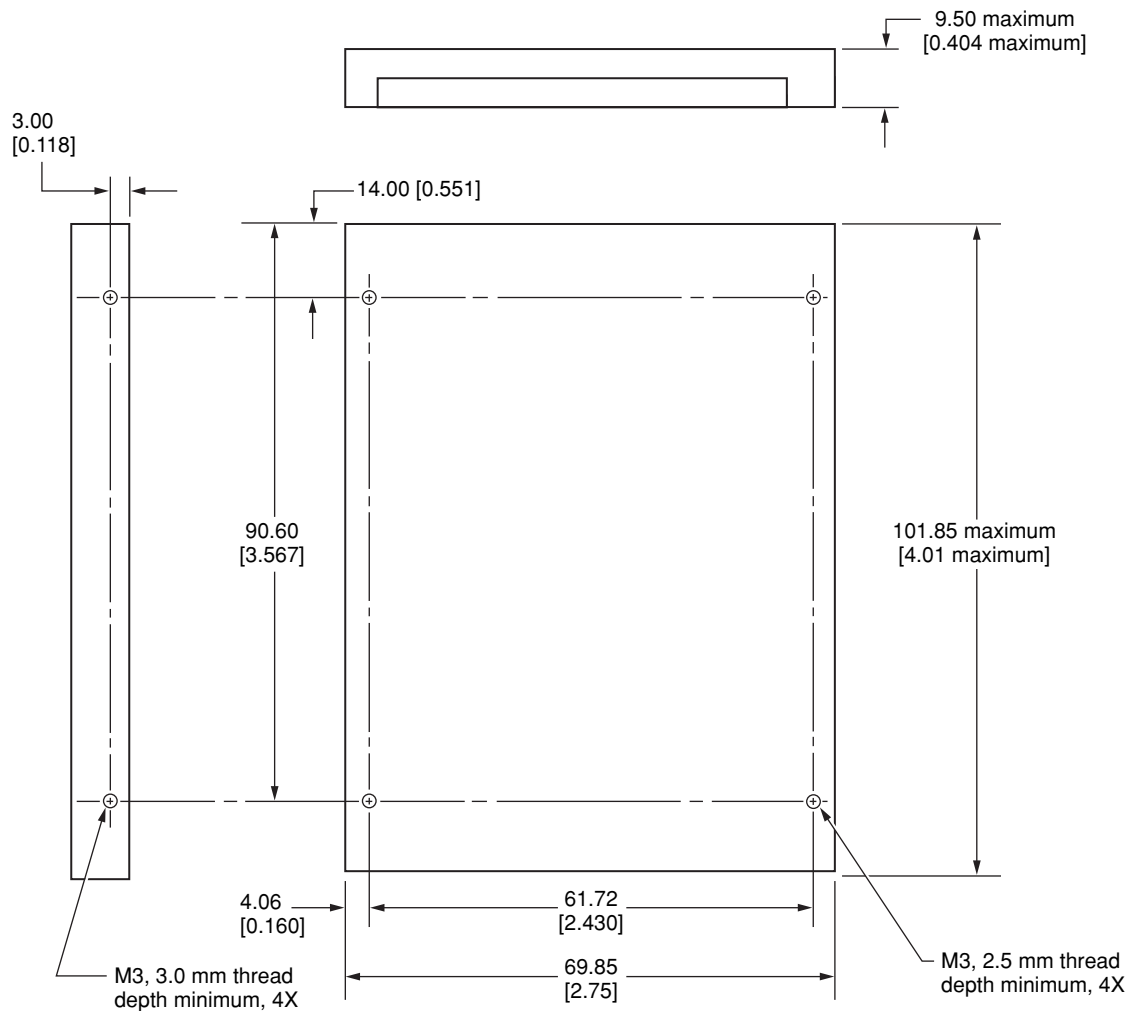
Hard Disk Drive

The storage capacity of the internal hard disk drive is 30 GB on the CD-ROM model and 40 GB on models with Combo drive. A 60 GB drive is available as an option. The drive uses the Ultra DMA IDE (integrated drive electronics) interface and is ATA-5 compatible. Current Data Transfer Mode for the drive is UDMA-33.

The software that supports the internal hard disk is similar to that in previous models with internal IDE drives and includes DMA support. For the information about that software, see the references in [“ATA Devices”](#) (page 55).

Hard Disk Dimensions

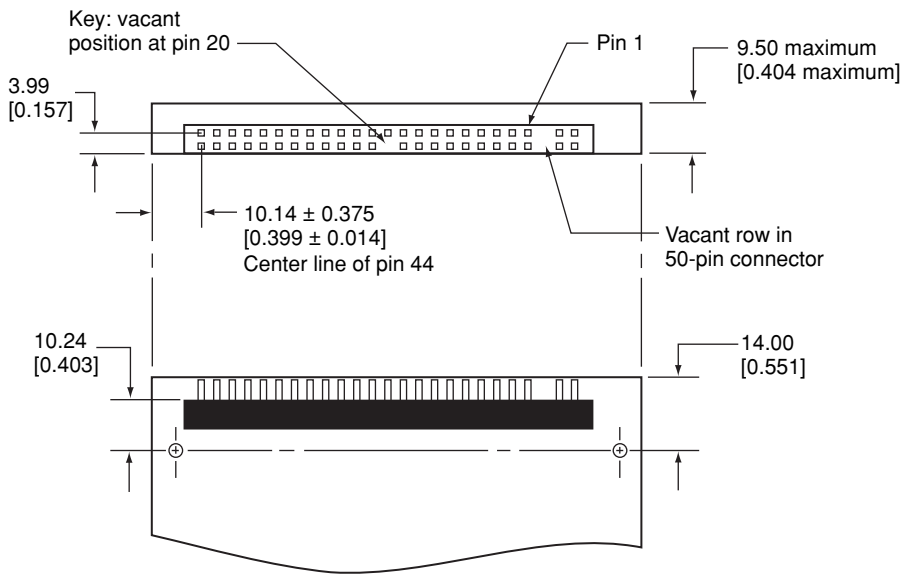
[Figure 3-3](#) (page 30) shows the maximum dimensions of the hard disk and the location of the mounting holes. The minimum clearance between any conductive components on the drive and the bottom of the mounting envelope is 0.5 mm.

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](#) (page 31). 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

Note: Dimensions are in millimeters [inches].

Signal Assignments

Table 3-4 (page 31) 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

Pin number	Signal name	Pin number	Signal name
23	/DIOW, /STOP	24	GROUND
25	/DIOR, /HDMARDY, HSTROBE	26	GROUND
27	IORDY, /DDMARDY, DSTROBE	28	CSEL
29	/DMACK	30	GROUND
31	INTRQ	32	/IOCS16
33	/DA1	34	/PDIAG, /CBLID
35	/DA0	36	/DA2
37	/CS0	38	/CS1
39	/DASP	40	GROUND
41	+5V LOGIC	42	+5V MOTOR
43	GROUND	44	Reserved
/IOCS16 is not used; see Table 3-5			

ATA Signal Descriptions

Table 3-5 (page 32) 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.
/CBLID	The host checks this signal after Power On or hardware reset to detect whether an 80-conductor cable is present.
/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.).

Signal name	Signal description
/DDMARDY	Drive ready to receive Ultra DMA data.
/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.
DSTROBE	Strobe for Ultra DMA data transfers to host.
/HDMARDY	Ultra DMA data ready.
HSTROBE	Strobe for Ultra DMA data transfers from host.
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).
DMARQ	Asserted by the device when it is ready to transfer data to or from the host.
INTRQ	Interrupt request. This active high signal is used to inform the computer that a data transfer is requested or that a command has terminated.
/PDIAG	Asserted by device 1 to indicate to device 0 that it has completed the power-on diagnostics; not available on this computer (n.c.).
/RESET	Hardware reset to the drive; an active low signal.
/STOP	Stop request; 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.

DVD-ROM/CD-RW Combo Drive

The computer 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](#) (page 33). The DVD-ROM/CD-RW Combo 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	Maximum reading speed	Maximum writing speed
DVD-ROM	8x (CAV)	–
CD-R	24x (CAV)	24x (CLV) Zone

Media type	Maximum reading speed	Maximum writing speed
CD-RW	24x (PCAV)	10x (CLV)
CD or CD-ROM	24x (CAV)	–

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

CD-ROM Drive

One configuration of the iBook computer has an internal CD-ROM drive. The drive has a tray for loading the disc. The drive supports a maximum 24X data transfer rates using constant angular velocity (CAV) and a data buffer, and writes to constant linear velocity (CLV).

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 signals from the CD-ROM 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, depending on the trackpad settings in System Preferences. 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

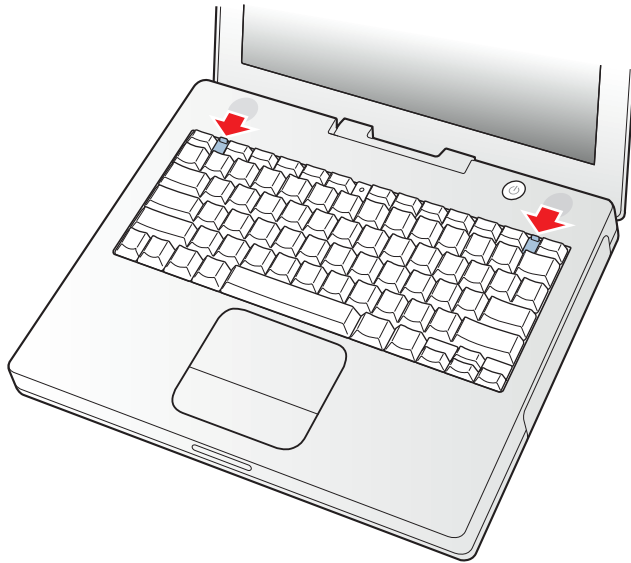
The keyboard is removable to allow access to the internal components and expansion connectors inside the computer. The keyboard is held in place by a locking screw and two latches.

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.

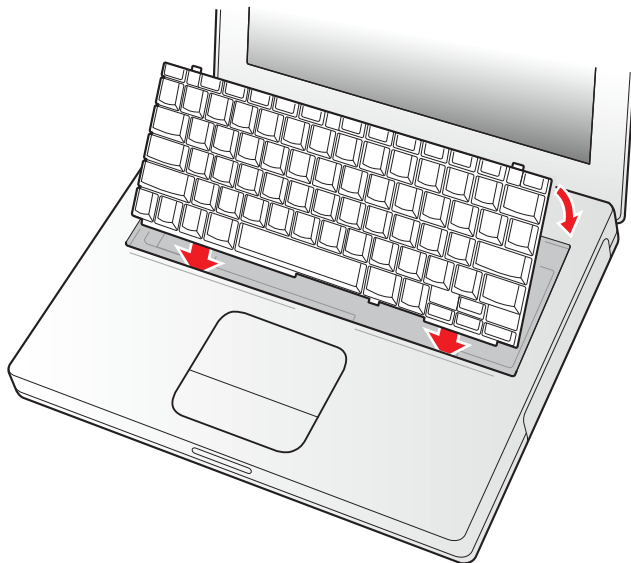
The two latches are between the ESC key and the F1 key and between the F11 and F12 keys. The user can release the latches by pulling them toward the front of the computer; see [Figure 3-5](#) (page 35).

Figure 3-5 Unlocking the keyboard



Important: When replacing the keyboard, make sure the latches at the top line up with the corresponding slots in the case and that the bottom tabs are aligned correctly and completely seated before tilting the keyboard into place. See [Figure 3-6](#) (page 35).

Figure 3-6 Replacing the keyboard



Getting access to the AirPort Card and memory card in the RAM expansion slot takes further steps. For a full description, see “The RAM Expansion Slot” (page 47).

Keyboard Illustrations

Figure 3-7 (page 36) shows the appearance of the keyboard. Figure 3-8 (page 37) shows the alternate modes of operation of the function and control keys. Figure 3-9 (page 38) shows the embedded numeric keypad.

Figure 3-7 Keyboard layout



Figure 3-8 (page 37) and Figure 3-9 (page 38) 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 basic appearance of the keyboard, refer to Figure 3-7 (page 36).

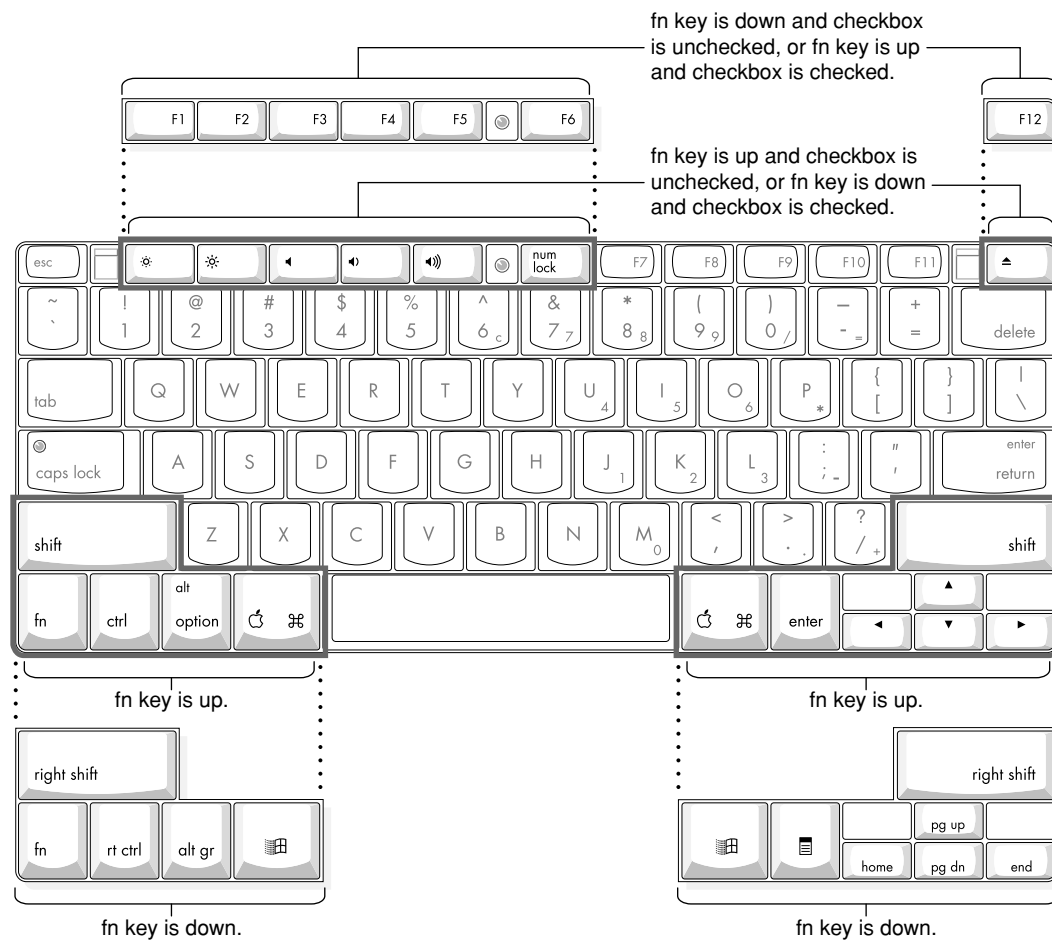
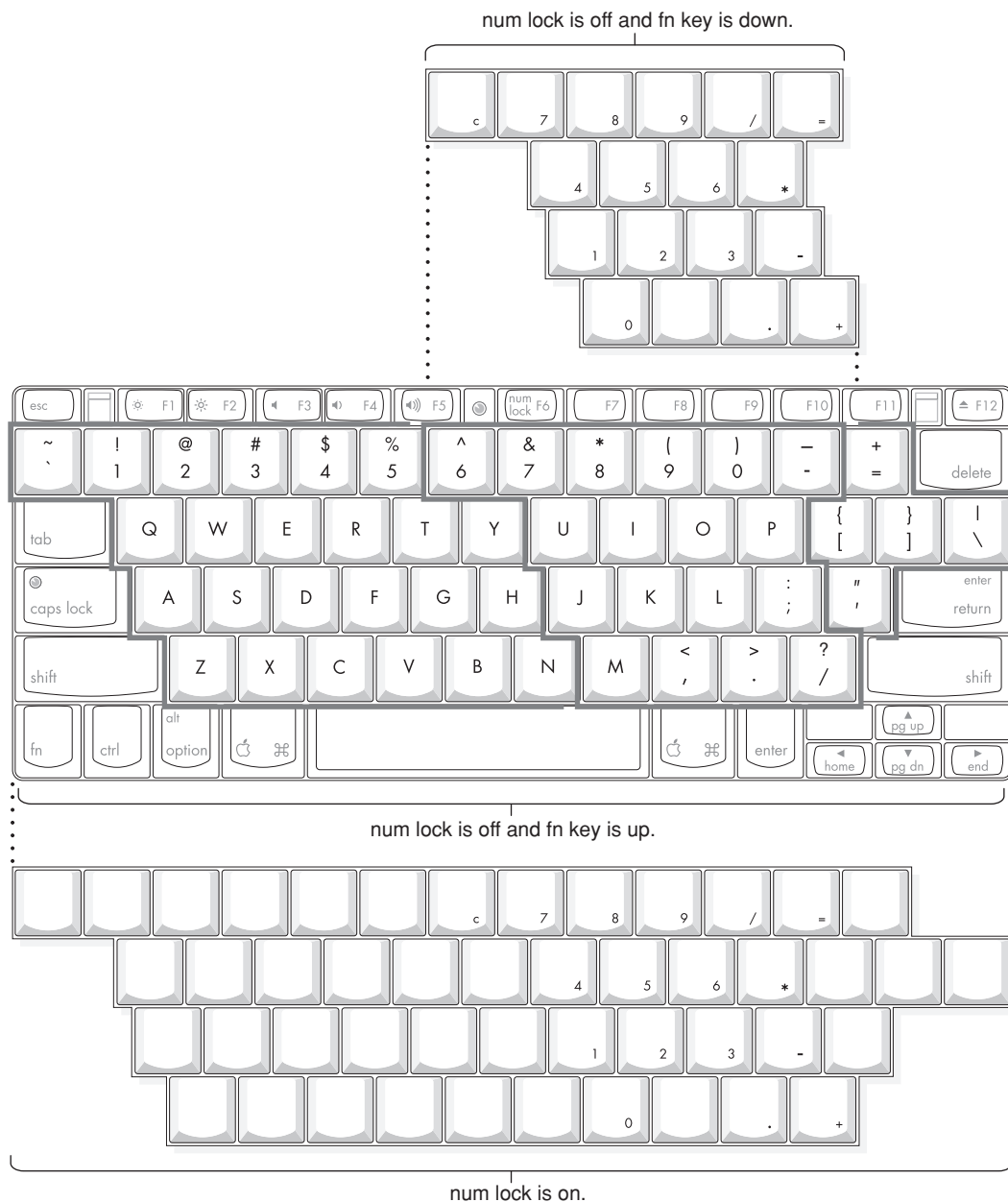
Figure 3-8 Alternate operations of function and control keys

Figure 3-9 Embedded numeric keypad operation

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.
- 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.

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](#) (page 40) and [Figure 3-8](#) (page 37). In Mac OS 9, the user selects the default modes of operation of those keys as described in the section “[The Function-Keys Checkbox](#)” (page 39).
- It selects the embedded numeric keypad on the right portion of the alphanumeric keys, as shown in [Table 3-9](#) (page 40) and [Figure 3-9](#) (page 38).
- It changes certain control keys, including the cursor control keys, to page control keys, as shown in [Table 3-10](#) (page 41) and [Figure 3-9](#) (page 38).

Note: User-programmable function key assignments are supported in Mac OS 9. In Mac OS X, the user must provide a third-party utility to enable the feature.

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](#) (page 40) and [Figure 3-9](#) (page 38).
- It makes the rest of the alphanumeric keys functionless (NOPs), as shown in [Figure 3-9](#) (page 38).

The Function-Keys Checkbox

The Function-keys checkbox is supported in Mac OS 9. 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](#) (page 40) summarizes the checkbox settings and the operation of the Fn key. The operations of the individual function keys are shown in [Table 3-8](#) (page 40) and [Figure 3-8](#) (page 37).

Note: The F12 key will remain the primary function even when the secondary function is enabled.

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

Operations of function keys		
Make function keys primary checkbox	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
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 (hold down F12 button for one or 2 seconds). The operations of the function keys are controlled by the Function keys checkbox and the Fn key. [Table 3-8](#) (page 40) is a list of the function keys and their operations as control buttons.

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 3-9](#) (page 38) shows the keys making up the embedded keypad and [Table 3-9](#) (page 40) lists them.

Table 3-9 Embedded keypad keys

Key name	Keypad function
6	Clear
7	7

Key name	Keypad function
8	8
9	9
0	/ (divide)
-	= (equals)
U	4
I	5
O	6
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 3-9](#) (page 38). 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](#) (page 41) is a list of these keys and their alternate functions. These control keys are also shown in [Figure 3-9](#) (page 38).

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)

Key name	Alternate function
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.

Depending on the model, the display is either 12.1 or 14.1 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 Mobility Radeon 7500. The graphics IC has 32 MB of video DDR SDRAM 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 19).

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.

External Display Port

The iBook computer has a video output port for connecting an external video monitor or projector. The port supports both VGA and TV signals by means of adapters. The port detects the type of adapter connected to it and programs the graphics IC to provide the appropriate type of video signals, as shown in the table below.

Table 3-11 Display adapters

Adapter type	Video signals	Connector type(s)
VGA	RGB	VGA 15-pin miniature D-type
Video	Composite and S-video TV signals	RCA and S-video

Resolutions supported are 640 by 480, 800 by 600, and 1024 by 768 pixels. When either type of display adapter is connected, the settings for the resolutions are selectable in the Monitor control panel or control strip.

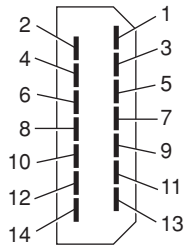
Composite video and S-video signals can be displayed on either an NTSC display or a PAL display. When a display is connected by way of the video adapter, the computer detects the type of adapter and enables the composite and S-video outputs. The settings for the resolutions and standards (NTSC or PAL) are then selectable in the monitor control panel or control strip.

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.

Video Display Connector

The video display connector is a 14-pin rectangular connector, Hosiden TCX3143, or compatible. The connector pins are identified in [Figure 3-10](#) (page 43).

Figure 3-10 Video display connector



The iBook computer detects the type of display adapter that is plugged in and programs the graphics IC to route the appropriate video signals to the connector. The signal assignments on the video connector are shown in [Table 3-12](#) (page 43). The signal assignments for the video adapter are shown in [Table 3-13](#) (page 44).

Table 3-12 Video signals for a VGA display

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	Ground
6	Green return	13	/Cable detect
7	Green video	14	Blue return

Table 3-13 Video signals for a TV display

Pin	Signal name	Pin	Signal name
1	Ground	8	+5 volts
2	n.c.	9	Composite video
3	n.c.	10	DDC data
4	Ground	11	DDC clock
5	S-video C	12	Ground
6	Ground	13	Ground (for /Cable Detect)
7	S-video Y	14	Ground

The cable detect function on pin 13 is implemented by connecting pin 13 to ground in the display cable. The computer detects the video adapter by reading its EDID (Extended Display Identification Data) via DDC.

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

Older Monitors Not Supported

The computer supports current video monitors. Some older monitors are not supported, including the following Apple monitors:

- 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 audio minijack.

All audio is handled digitally inside the computer, including audio data from the DVD-ROM/CD-RW Combo drive or CD-ROM 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 audio minijack.

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 sound circuitry.

Audio Minijack

The audio minijack is located on the left side of the computer at the left palm rest. The jack accepts a standard stereo mini-plug.

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 audio minijack.

The audio signals on the audio minijack have the following electrical characteristics:

- output impedance: 16 ohms each channel
- minimum recommended load impedance: 32 ohms each channel
- maximum level: 1.0 V rms (2.8 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 sound system provides parametric equalization for the speakers. The computer turns off the sound signal to the speakers when headphones are connected to the audio mini-jack and when USB speakers are active.

Sound effects and output from other audio sources can be specified in the System Preferences Sound panel. An output device is displayed on the Sound panel when the computer detects that it is plugged in. The system default setting is the internal audio controller. Once the default is changed to a different device, it will remain the default as long as the device is plugged in.

Note: Unlike Mac OS 9, Mac OS X does not automatically switch to USB audio when the device is attached.

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 or Combo drive is read using the ATA interface, processed by the audio software, and then transferred by DMA through the I2S interface of the Pangea IC to the sound system or sent to USB speakers.

RAM Expansion

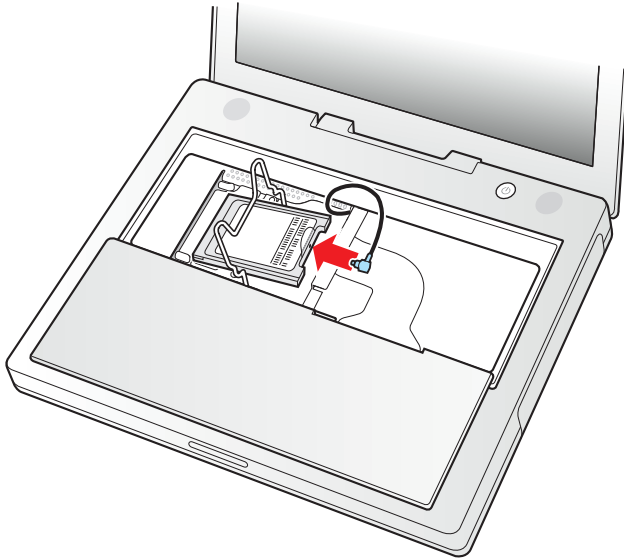
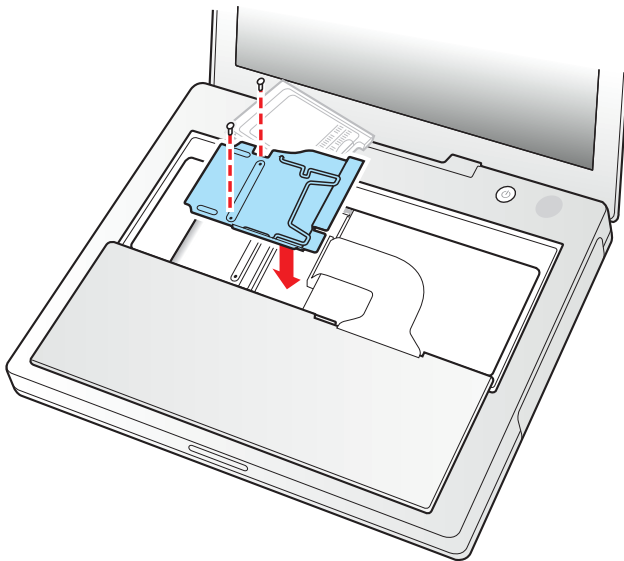
This chapter tells how to gain access to the RAM expansion slot in the iBook computer and then describes the RAM expansion module.

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. Release the latches by sliding them toward the front of the computer. See [Figure 3-5](#) (page 35).
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 AirPort Card, if present, by unlatching the formed wire holder on the card, then pulling the flex tab to remove the module. The antenna cable should remain attached to the card. See [Figure 4-1](#) (page 48).
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 AirPort Card. See [Figure 4-2](#) (page 48).
9. Slide the metal RAM shield plate toward the rear of the computer, then lift it up and out of the computer.
10. If this is a 256-MB configuration, remove the 128-MB SO-DIMM currently occupying the memory expansion slot.

Figure 4-1 The AirPort Card and antenna cable**Figure 4-2** The RAM shield plate

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 AirPort Card will fit.

Important: When replacing the keyboard, make sure the latches at the top line up with the corresponding slots in the case.

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 128, 256, or 512 MB of memory. Maximum total RAM capacity using devices currently available is 640 MB and is limited by the space available for the SO-DIMM.

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 55).

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 55).

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 100 MHz or greater, corresponding to a cycle time of 10 ns or less.

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 (page 18) 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

Size of SO-DIMM	Configuration of SO-DIMM	Number of banks	Number of devices	Device density	Device configuration
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** (page 50) 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** (page 50). 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
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 (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.

Supplemental Reference Documents

This section contains additional information about the technologies mentioned in this developer note by providing references to helpful websites.

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

<http://developer.apple.com/documentation/HardwareDrivers/index.html>

Apple Technical Notes

Apple Technical Notes answer many specific questions about the operation of Macintosh computers and the Mac OS. The technical notes are available on the 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.

General information on OpenGL is available on the World Wide Web at

<http://www.opengl.org>

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 X

Mac OS X version 10.2.4 is installed by default on the iBook computer. For access to Apple's developer documentation for Mac OS X, see the Apple Developer Connection (ADC) website at

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

O'Reilly & Associates publishes a series of books about Mac OS X development. The books in this series have been technically reviewed by Apple engineers and are recommended by the Apple Developer Connection.

Mac OS 9.2.2

Mac OS 9.2.2 is also included with the iBook computer. Programming information about Mac OS 9 is available in technical bookstores and (for free download) on the World Wide Web at

<http://developer.apple.com/documentation/Carbon/Carbon.html>

You can find additional information in Apple Technical Notes at

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

Open Firmware

The following technical notes provide an introduction to Open Firmware on the Macintosh platform:

TN1061: Open Firmware, Part I, available on the technical note web site at

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

TN1062: Open Firmware, Part II, available on the technical note web site at

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

TN1044: Open Firmware, Part III, available on the technical note web site at

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

TN2001: Running Files from a Hard Drive in Open Firmware, at

<http://developer.apple.com/technotes/tn/tn2001.html>

Another technical note tells how to debug open firmware code. Please refer to *TN2004: Debugging Open Firmware Using Telnet*, available on the technical note 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

ATA (AT Attachment), also referred to as integrated drive electronics (IDE), is a standard interface used with storage devices such as hard disk drives. For more information on ATA, refer to the following Apple website at

<http://developer.apple.com/documentation/Darwin/Darwin.html>

and

<http://developer.apple.com/documentation/Hardware/DeviceManagers/ata/ata.html>

Information about the ATA standards is available at the Technical Committee T13 AT Attachment website, at

<http://www.t13.org/>

USB Interface

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

<http://developer.apple.com/hardwaredrivers/usb/index.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, refer to the USB Implementation Forum on the World Wide Web, at:

<http://www.usb.org/developers/docs>

FireWire 400 Interface

For additional information about the FireWire 400 IEEE 1394a interface and the Apple APIs for FireWire software, refer to the resources available on the Apple FireWire web site at:

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

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

<http://shop.ieee.org/store>

Useful information is also available at the 1394 Trade Association's web site:

<http://www.1394ta.org/>

Target Disk Mode

For more information about target disk mode, see the section "Target Mode" in *TN1189: The Monster Disk Driver Technote*. The technical note is available on the website at

<http://developer.apple.com/technotes/tn/tn1189.html>

Wireless Networks

More information about Wi-Fi and wireless networks using the IEEE 802.11 standard is available on the web site of the Wireless Ethernet Compatibility Alliance, at

<http://www.wirelessethernet.org/OpenSection/>

Bluetooth

For more information regarding Bluetooth technology, refer to the following locations on the World Wide Web.

Bluetooth specification:

<http://www.bluetooth.com/>

Bluetooth SIG:

<http://www.bluetooth.org>

Bluetooth developer tools on the Apple web site at:

<http://developer.apple.com/hardwaredrivers/bluetooth/>

Conventions and Abbreviations

This developer note uses the following typographical conventions and abbreviations.

Typographical Conventions

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

Important: A note like this contains important information that you should read before proceeding.

Abbreviations

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

Here are the standard units of measure used in developer notes:

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 developer notes include these:

10Base-T	an Ethernet standard for data transmission at 10 Mbits per second
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100Base-TX	an Ethernet standard for data transmission at 100 Mbits per second
ADB	Apple Desktop Bus
ADC	Apple Display Connector
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
DDR	double data rate, a type of SDRAM where data is clocked on rising and falling clock edges
DIMM	Dual Inline Memory Module
DMA	direct memory access
DSP	digital signal processor
DSSS	direct-sequence spread-spectrum
EDID	Extended Display Identification Data
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
I2C	inter IC control bus
I2S	inter IC sound bus
IC	integrated circuit
IDE	integrated device electronics
IIC	inter IC control bus (same as I2C)
IIS	inter IC sound bus (same as I2S)
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
RADIUS	Remote Authentication Dial-In User Service
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)
VESA	Video Electronics Standards Association
VGA	video graphics adapter
WEP	Wired Equivalent Privacy
Wi-Fi	Logo used by the Wireless Ethernet Compatibility Alliance for certification of interoperability of 802.11 products
WLAN	wireless LAN