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# iMac

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# Introduction to iMac

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This developer note gives a technical description of the current two configurations of the iMac computer: 15" Pangea-based main IC and 17" Intrepid-based main IC. The note provides information about the computer's internal design, input-output features, and expansion capabilities. The Introduction chapter, Supplemental Reference Documents chapter, and both appendices are common to both configurations of the iMac computer. However, the 15" and 17" configurations have their own Architecture chapters, Devices and Ports chapters, and RAM Expansion chapters.

**Note:** This developer note describes the flat-panel models of the iMac computer. For a complete description of the CRT models, refer to the previous iMac developer notes.

This developer note is intended to help hardware and software developers design products that are compatible with the products described here. If you are not already familiar with Macintosh computers or if you would simply like additional technical information, you should refer to "[Supplemental Reference Documents](#)" (page 67)".

## Organization of This Document

The information in this note is arranged in four chapters.

- [Chapter 1, "Introduction"](#), (page 11) introduces both configurations of the iMac computer, describes the features, and mentions a few software issues of interest to developers.
- [Chapter 2, "Architecture of the 15" iMac"](#), (page 17) describes the internal organization of the 15" Pangea-based computer. It includes a functional block diagram and descriptions of the main components on the logic board.
- [Chapter 3, "Architecture of the 17" iMac"](#), (page 23) describes the internal organization of the 17" Intrepid-based computer. It includes a functional block diagram and descriptions of the main components on the logic board.
- [Chapter 4, "Devices and Ports on the 15" iMac"](#), (page 29) describes the I/O ports and the built-in I/O devices of the 15" Pangea-based computer.
- [Chapter 5, "Devices and Ports on the 17" iMac"](#), (page 43) describes the I/O ports and the built-in I/O devices for the 17" Intrepid-based computer.
- [Chapter 6, "RAM Expansion on the 15" iMac"](#), (page 59) includes development guidelines for the RAM expansion modules for the 15" Pangea-based computer.
- [Chapter 7, "RAM Expansion on the 17" iMac"](#), (page 63) includes development guidelines for the RAM expansion modules for the 17" Intrepid-based computer.
- [Appendix A, "Supplemental Reference Documents"](#), (page 67) tells where to find more information about specific technologies used in the iMac computer.

## INTRODUCTION

### Introduction to iMac

- [Appendix B, “Abbreviations”](#) (page 73) lists the standard units and abbreviations used in this developer note.

# Overview of iMac

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This chapter provides an overview of the hardware and software features of the current models of the iMac computer: the 15" Pangea-based configuration and the 17" Intrepid-based configuration. This chapter is structured such that information unique to each configuration is provided in different subsections. The 15" Pangea-based configuration will be referred to as the 15" iMac; the 17" Intrepid-based configuration will be referred to as the 17" iMac.

## 17" iMac New Features

New features are listed here with links to the sections that describe them. For a comparison of 15" iMac and 17" iMac features, see [Table 1-1](#) (page 14).

- **Processor and speed:** The microprocessor in the iMac computer is a PowerPC G4 with a clock speed of 1 GHz. For more information, see ["PowerPC G4 Microprocessor"](#) (page 24).
- **Memory:** The computer comes with 256 MB of DDR SDRAM installed in an internal standard 186-pin DIMM expansion slot, with a build-to-order option of 512 MB. A second user-accessible slot accepts an SO-DIMM with up to 512 MB. The maximum total memory is 1 GB. For more information, see ["The RAM Expansion Modules for Intrepid IC System"](#) (page 63).
- **Display:** The iMac has a built-in 17-inch, wide-screen, flat-panel display (measured diagonally). For more information, see ["Flat Panel Display"](#) (page 50).
- **System bus:** The speed of the system bus is 133 MHz. For more information, see ["Memory and I/O Device Controller"](#) (page 25).
- **Hard disk drive:** The iMac computer has an internal Ultra ATA /100, 7200 rpm, 80 GB hard disk. For more information, see ["Ultra ATA-100 Interface"](#) (page 27).
- **Graphics acceleration:** The graphics IC used in the iMac is an NVidia GeForce4 MX. For more information, see ["Intrepid IC Video Display Subsystem"](#) (page 26).
- **Video RAM:** The video hardware in the iMac includes 64 MB of DDR SDRAM, which supports 3D features and millions of colors in all resolutions. For more information, see ["Intrepid IC Video Display Subsystem"](#) (page 26).
- **External video monitor:** The external display connector supports mini-VGA, composite, S-video monitors and projectors, and television sets. A video adapter with composite and S-video connectors is available separately. For more information, see ["Video Monitor Port"](#) (page 51).
- **AirPort Extreme support (optional):** A 54 Mbps AirPort Extreme Card is available as a build-to-order option or as a user-installable upgrade. See ["AirPort Extreme Wireless Support \(optional\)"](#) (page 28).
- **Bluetooth support (optional):** Bluetooth support is available as a build-to-order option to enable short-range wireless connections between desktop and laptop computers and a host of other peripheral devices. For more information, see ["Bluetooth Technology"](#) (page 49).
- **Sound:** The iMac computer has external Apple Pro Speakers. For more information, see ["Sound System"](#) (page 55).

- **Audio line-in** Audio line-in port for self-powered microphones or other audio equipment. For more information, see [“Audio Line-in”](#) (page 56).

## 15” iMac Feature Set

Here is a complete list of the features of the 15” iMac computer. Each feature is described in more detail in a later section.

- **Processor and speed:** The microprocessor in the iMac computer is a PowerPC G4 with a clock speed of 800 MHz. For more information, see [“PowerPC G4 Microprocessor”](#) (page 18).
- **Cache:** The backside 256 MB L2 cache is included on the microprocessor IC and has the same clock speed as the microprocessor. For more information, see [“Level 2 Cache”](#) (page 18).
- **Memory:** The computer comes with 256 MB of SDRAM installed in an internal standard 168-pin DIMM expansion slot, with a build-to-order option of 512 MB. A second user-accessible slot accepts an SO-DIMM with up to 512 MB. The maximum total memory is 1 GB. For more information, see [“RAM Expansion Modules for Pangea IC System”](#) (page 59).
- **Hard disk storage:** The built-in hard disk drive is 7200 rpm with a capacity of 60 GB. For more information, see [“Hard Disk Drive”](#) (page 35).
- **Combo drive:** The 15” iMac has a combination CD-RW/DVD-ROM drive. For more information, see [“Combo \(CD-RW/DVD-ROM\) Drive”](#) (page 35).
- **Display:** The iMac has a built-in 15-inch flat-panel display (measured diagonally). For more information, see [“Flat Panel Display”](#) (page 35).
- **External video monitor:** The external display connector supports mini-VGA. A video adapter for VGA is available separately. For more information, see [“Video Monitor Port”](#) (page 36).
- **Graphics acceleration:** The video circuits in the iMac use an NVidia GeForce2 MX graphics IC. For more information, see [“Pangea IC Video Display Subsystem”](#) (page 20).
- **Video RAM:** The video hardware in the iMac includes 32 MB of DDR RAM, which supports 3D features and millions of colors in all resolutions. For more information, see [“Pangea IC Video Display Subsystem”](#) (page 20).
- **USB ports:** The iMac has five USB ports (two on the keyboard), described in [“USB Interface”](#) (page 21).
- **FireWire 400 ports:** The iMac computer has two IEEE-1394a FireWire 400 ports, which support transfer rates of 100, 200, and 400 Mbps. For more information, see [“FireWire 400 Ports”](#) (page 30).
- **Target Disk Mode:** The computer can act like a FireWire storage device connected to another computer. See [“Target Disk Mode”](#) (page 32).
- **Modem:** The iMac has a built-in V.92 modem with a 56 Kbps data rate. For more information, see [“Internal Modem”](#) (page 34).
- **Ethernet:** The iMac has a built in Ethernet port for a 10Base-T and 100Base-TX operation. For more information, see [“Ethernet Port”](#) (page 32).
- **AirPort support (optional):** An 11 Mbps AirPort Card is available as a build-to-order option or as a user-installable upgrade. For more information, see [“AirPort Wireless Support \(optional\)”](#) (page 22).
- **Sound:** The iMac has a built-in microphone and speaker, a stereo headphone jack, an Apple Speaker minijack, and external Apple Pro Speakers. For more information, see [“Sound System”](#) (page 39).

- **Keyboard:** The iMac comes with an Apple Pro Keyboard. The keyboard is also a USB hub with two USB ports. For more information, see [“Keyboard”](#) (page 37).
- **Mouse:** The iMac comes with an Apple Pro Mouse, a USB mouse with optical tracking. For more information, see [“Mouse”](#) (page 39).

## 17” iMac Feature Set

Here is a complete list of the features of the 17” iMac computer. Each feature is described in more detail in a later section.

- **Processor and speed:** The microprocessor in the iMac is a PowerPC G4 with a clock speed of 1 GHz. For more information, see [“PowerPC G4 Microprocessor”](#) (page 24).
- **Cache:** The backside 256 MB L2 cache is included on the microprocessor IC and has the same clock speed as the microprocessor. For more information, see [“Level 2 Cache”](#) (page 24).
- **Memory:** The computer comes with 256 MB of DDR SDRAM installed in an internal standard 186-pin DIMM expansion slot, with a build-to-order option of 512 MB. A second user-accessible slot accepts an SO-DIMM with up to 512 MB. The maximum total memory is 1 GB. For more information, see [“The RAM Expansion Modules for Intrepid IC System”](#) (page 63).
- **Hard disk storage:** The built-in hard disk is 7200 rpm with a capacity of 80 GB. For more information, see [“Hard Disk Drive”](#) (page 49).
- **SuperDrive:** The iMac has a SuperDrive (CD-RW/DVD-R) drive. For more information, see [“SuperDrive \(CD-RW/DVD-R\)”](#) (page 49).
- **Display:** The iMac has a built-in 17-inch, wide-screen, flat-panel display (measured diagonally). For more information, see [“Flat Panel Display”](#) (page 50).
- **External video monitor:** The external display connector supports mini-VGA, composite, S-video monitors and projectors, and television sets. A video adapter with composite and S-video connectors is available separately; and video adapter for VGA is available separately. For more information, see [“Video Monitor Port”](#) (page 51).
- **Graphics acceleration:** The video circuits in the iMac use an NVidia GeForce4 MX graphics IC. For more information, see [“Intrepid IC Video Display Subsystem”](#) (page 26).
- **Video RAM:** The video hardware in the iMac includes 64 MB of DDR RAM, which supports 3D features and millions of colors in all resolutions. For more information, see [“Intrepid IC Video Display Subsystem”](#) (page 26).
- **USB ports:** The iMac has five USB ports (two on the keyboard), described in [“USB Ports”](#) (page 43).
- **FireWire 400 ports:** The iMac computer has two IEEE-1394a FireWire 400 ports, which support transfer rates of 100, 200, and 400 Mbps. For more information, see [“FireWire 400 Ports”](#) (page 44).
- **Target Disk Mode:** The computer can act like a FireWire storage device connected to another computer. See [“Target Disk Mode”](#) (page 46).
- **Modem:** The iMac has a built-in V.92 modem with a 56 Kbps data rate. For more information, see [“Internal Modem”](#) (page 48).
- **Ethernet:** The iMac has a built in Ethernet port for a 10Base-T and 100Base-TX operation. For more information, see [“Ethernet Port”](#) (page 46).

- **AirPort Extreme support (optional):** A 54 Mbps AirPort Extreme Card is available as a build-to-order option or as a user-installable upgrade. For more information, see [“AirPort Extreme Wireless Support \(optional\)”](#) (page 28).
- **Bluetooth support (optional):** Fully-integrated Bluetooth support is available as a build-to-order option to enable short-range wireless connections between desktop and laptop computers and a host of other peripheral devices. For more information, see [“Bluetooth Technology”](#) (page 49).
- **Sound:** The iMac computer has external Apple Pro Speakers. For more information, see [“Sound System”](#) (page 55).
- **Audio line-in** The iMac computer has an audio line-in port for self-powered microphones or other audio equipment. For more information, see [“Audio Line-in”](#) (page 56).
- **Keyboard:** The iMac comes with an Apple Pro Keyboard. The keyboard is also a USB hub with two USB ports. For more information, see [“Keyboard”](#) (page 52).
- **Mouse:** The iMac comes with an Apple Pro Mouse, a USB mouse with optical tracking. For more information, see [“Mouse”](#) (page 55).

## Comparison of 15” and 17” iMac Features

Table 1-1 (page 14) provides a quick comparison of the features of the two configurations of the iMac computer.

**Table 1-1** Feature comparison

	15” iMac	17” iMac
CPU and speed	800 MHz PowerPC G4	1 GHz PowerPC G4
System bus speed	100 MHz	133 MHz
Main memory	256 MB, SDRAM expandable up to 1 GB	256 MB, DDR SDRAM expandable up to 1 GB
Display	Built-in 15-inch flat panel	Built-in 17-inch, wide-screen flat panel
Graphics IC	NVidia GeForce2 MX	NVidia GeForce4 MX
Graphics memory	32 MB DDR RAM	64 MB DDR RAM
Hard disk drive	60 GB Ultra ATA-66 7200 rpm	80 GB Ultra ATA-100 7200 rpm
Optical drive	Tray-load Combo drive	Tray-load SuperDrive
External monitor adapter	Mini-VGA	Mini-VGA or S-video/composite
Data ports	Five USB ports (two on keyboard); two FireWire 400 ports	Five USB ports (two on keyboard); two FireWire 400 ports
Communication features	10/100 Ethernet; 56K V.92 fax modem	10/100 Ethernet; 56K V.92 fax modem

	15" iMac	17" iMac
Wireless features	Optional 11 Mbps AirPort Card; Bluetooth via external, USB dongle	Optional 54 Mbps AirPort Extreme Card; optional internal Bluetooth
Sound features	Built-in speaker and microphone; stereo headphone jack and Apple Speaker minijack; external Apple Pro speakers	Built-in speaker and microphone; stereo headphone jack and Apple Speaker minijack; external Apple Pro speakers, audio line-in

## System Software

Both models of the iMac computer come with Mac OS X version 10.2.3 installed as the default system. For more information about Mac OS X, see the reference listed in “Mac OS X” (page 68).

### Machine Identification

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Apple Computer discourages the targeting of code to specific machine models. However, if it is necessary to identify a machine in order to determine the features of the machine, applications can use the IORegistry with Mac OS X. Or, in many cases, it is feasible to use Gestalt calls to test a machine for specific 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 15" Pangea-based iMac, the value of the string in the `compatible` property is `PowerMac4,2`. For the 17" Intrepid-based iMac, the value of the string in the `compatible` property is `PowerMac6,1`.

The string obtained from the `compatible` property cannot be displayed to the computer user. If it is 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.

### Velocity Engine Acceleration

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The Velocity Engine (an implementation of AltiVec) is the vector processing unit in the PowerPC G4 microprocessor. Some system software has been modified to take advantage of the accelerated processing that the Velocity Engine makes possible. System software has also been modified to support low-level operations using the Velocity Engine.

For complete information on the Velocity Engine, refer to the following Apple websites:

<http://developer.apple.com/hardwaredrivers/ve/index.html>

and

[http://developer.apple.com/documentation/Performance/Conceptual/vDSP/vDSP\\_Library.pdf](http://developer.apple.com/documentation/Performance/Conceptual/vDSP/vDSP_Library.pdf)

For more information, please see the references at “Velocity Engine (AltiVec)” (page 68).





# Architecture of the 15" iMac

This chapter describes the architecture of the 15" iMac computer. It includes information about the major components on the main logic board: the microprocessor, the other main ICs, and the buses that connect them to each other and to the I/O interfaces.

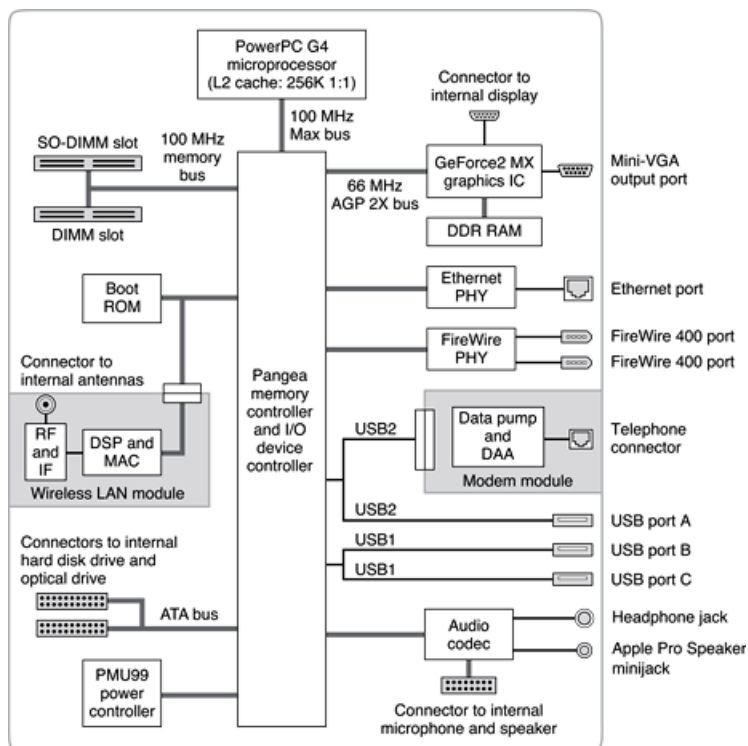
## Block Diagrams and Buses

This section is an overview of the major ICs and buses on the computer's main logic board. The 15" iMac uses the Pangea IC.

## Block Diagrams

Figure 2-1 (page 17) provides a simplified block diagram of the main IC and the buses that connect them together.

Figure 2-1 15" iMac block diagram



## Main ICs and Buses

---

The architecture of iMac computer is designed around the PowerPC G4 microprocessor and the Pangea memory and I/O device controller. The IC occupies the center of the block diagrams.

The PowerPC G4 microprocessor is connected to the Pangea IC by a MaxBus 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 hard disk drive, and the optical drive, the power controller IC, the sound IC, the internal modem module, and the optional wireless LAN module.

The Pangea I/O controller has a 32-bit PCI bus with a bus clock speed of 33 MHz. That bus also connects to the Boot ROM and the CardBus controller.

Each of the components listed here is described in one of the following sections.

## Microprocessor and Cache

The microprocessor runs at a clock speed 800 MHz. The microprocessor is a PowerPC G4 with a built-in 256 MB level 2 (L2) cache.

### PowerPC G4 Microprocessor

---

The PowerPC G4 microprocessor has many powerful features, including a pipelined system bus, called MaxBus, that is more efficient than the system bus on the PowerPC G3 microprocessors.

The PowerPC G4 used in the iMac computer has the following features:

- 32-bit PowerPC implementation
- superscalar PowerPC core
- Velocity Engine (AltiVec technology): 128-bit-wide vector execution unit
- high bandwidth MaxBus
- dual 32 KB instruction and data caches (level one)
- on-chip second level (L2) cache consisting of 256 KB with a clock speed ratio of 1:1

To find more information, see the reference at [“PowerPC G4 Microprocessor”](#) (page 18).

### Level 2 Cache

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

## Memory and I/O Device Controller

The Pangea IC combines several functions into a single IC. The IC contains the memory controller, the PCI bus bridge, the Ethernet and FireWire 400 interfaces, the USB interface, and the AGP interface.

In addition to the buses listed in [Table 2-1](#) (page 19), 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
MaxBus	Microprocessor	64 bits	100 MHz
Memory bus	System RAM	64 bits	100 MHz
AGP 2x bus	Graphics IC	32 bits	66 MHz
Ultra ATA bus	Hard drive and optical drive	16 bits	66 MHz

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

The Pangea IC has an interrupt controller (Open-PIC) that handles interrupts generated within the IC as well as external interrupts, such as those from the Ethernet and FireWire 400 controllers.

The following sections describe the subsystems that are connected to the Pangea IC.

### System RAM

The memory subsystem in the Pangea system supports two slots: one for a 168-pin DIMMs (dual inline memory module) and one for a 144-pin SO-DIMM. The data bus to the RAM and DIMM is 64 bits wide, and the memory interface is synchronized to the MaxBus interface at 100 MHz.

For more information on system RAM, see [“RAM Expansion Slots”](#) (page 59).

**Note:** Only the SO-DIMM slot is accessible by the user. See [“RAM Expansion Slots”](#) (page 59).

### Boot ROM

The boot ROM is a 1 M by 8 bit device connected to the Pangea IC by way of a CardBus interface.

## FireWire 400 Controller

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The Pangea IC includes an IEEE 1394a FireWire 400 controller with a data rate of 400 Mbits (50 MBps) and provides DMA (direct memory access) support for the FireWire 400 interface.

The controller IC implements the FireWire 400 link layer. A physical layer IC, called a PHY, implements the electrical signalling protocol of the FireWire 400 interface. The PHY supports two FireWire 400 ports by way of external connectors on the back of the enclosure.

**Important:** The FireWire PHY on the iMac does not operate with external bus power. As long as the computer is plugged into an active AC power outlet, the FireWire PHY is active and the FireWire bus remains connected. If AC power is interrupted, the PHY will not operate.

## 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 IC 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 more information, see ["Ethernet Port"](#) (page 32).

## Pangea IC Video Display Subsystem

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The display subsystem for the Pangea IC system consists of a graphics controller ASIC and 32 MB of DDR RAM on the main logic board. The graphics controller IC is an NVIDIA GeForce2 MX. It contains 2D and 3D acceleration engines, front-end and back-end scalers, a display controller, and an AGP 2x bus interface with bus master capability.

The graphics IC supports a display size of 1024 by 768 pixels. The graphics IC also has a scaling mode that displays a 640-by-480 or 800-by-600 pixel image on the full screen.

The display generated for the flat panel display is simultaneously available for an external monitor. See ["Video Monitor Port"](#) (page 36).

The interface between the graphics IC and the rest of the system is an AGP (accelerated graphics port) 2x bus on the Pangea IC. To give the graphics IC fast access to system memory, the AGP bus has separate address and data lines and supports deeply pipelined read and write operations. The AGP bus has 32 data lines and a clock speed of 66 MHz.

The graphics IC uses a graphics address remapping table (GART) to translate AGP logical addresses into physical addresses. The graphics driver software can allocate memory in both the dedicated DDR RAM and the main memory.

For information about the display and supported resolutions, see ["Flat Panel Display"](#) (page 35) and ["Video Monitor Port"](#) (page 36).

## USB Interface

---

The Pangea IC implements two independent USB controllers (root hubs), each with two ports. The internal modem and the external USB port nearest the mini-VGA connector are connected to one controller; the other two USB ports are connected to the other controller.

Each USB controller provides a 12 Mbps data transfer rate that is shared between the two devices connected to it. The two USB ports that are connected to separate controllers can support high data rate devices at the same time with no degradation of their performance. Thus, if a user connects a high-speed (12 Mbps) device to USB port 1 and another high-speed device to the port 2, both devices can operate at their full data rates.

All three external USB connectors support USB devices with data transfer rates of 1.5 Mbps or 12 Mbps. For more information about the connectors, see ["USB Ports"](#) (page 29).

USB devices connected to the iMac 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 70).

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

## Ultra ATA-66 Interface

---

The Pangea IC provides an Ultra ATA-66 channel with one connector to the internal hard disk drive and the optical drive. 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 optical drive is connected as device 1 (slave). The Ultra ATA-66 conforms to a subset of ATA/ATAPI-6 and -5 protocols. For more information, see ["Hard Disk Drive"](#) (page 35).

## Modem Support

---

One of the USB ports on the Pangea IC is used for the interface to the modem. The Pangea IC provide DB-DMA support for the modem interface. The modem provides digital call progress signals to the audio codec sound circuits.

The internal hardware modem is a separate module that contains the datapump and the interface to the telephone line (DAA). For more information about the modem, see ["Internal Modem"](#) (page 34).

## Sound Circuitry

---

The audio codec circuitry exchanges audio data with the main IC over a standard I2S bus and receives commands from the main IC over an I2C bus. The main IC provides DB-DMA (descriptor-based direct memory access) support for the I2S bus.

The sound circuitry includes a signal processing IC for equalization and volume control functions and a codec IC for A/D and D/A conversion.

The sound circuitry performs analog-to-digital conversion for the internal microphone and digital-to-analog conversion for the audio signals it sends to the internal speaker and the headphone jack. A switch-mode power amplifier drives the internal speaker and the Apple Pro Speaker minijack.

For a description of the features of the sound system, see ["Sound System"](#) (page 39).

## Power Controller

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The power management controller in the iMac is a custom IC called the PMU99. It supports several power-saving modes of operation, including idle, doze, and sleep.

## AirPort Wireless Support (optional)

---

Apple's internal wireless LAN module, the 11 Mbps AirPort Card, is available as a build-to-order option. The connector for the AirPort Card uses the CardBus interface. A separate connector is used for the cable to the antennas, which are built into the computer's enclosure. For information about operation, see ["AirPort Card"](#) (page 33).

# Architecture of the 17" iMac

This chapter describes the architecture of the 17" iMac computer. It includes information about the major components on the main logic board: the microprocessor, the other main ICs, and the buses that connect them to each other and to the I/O interfaces.

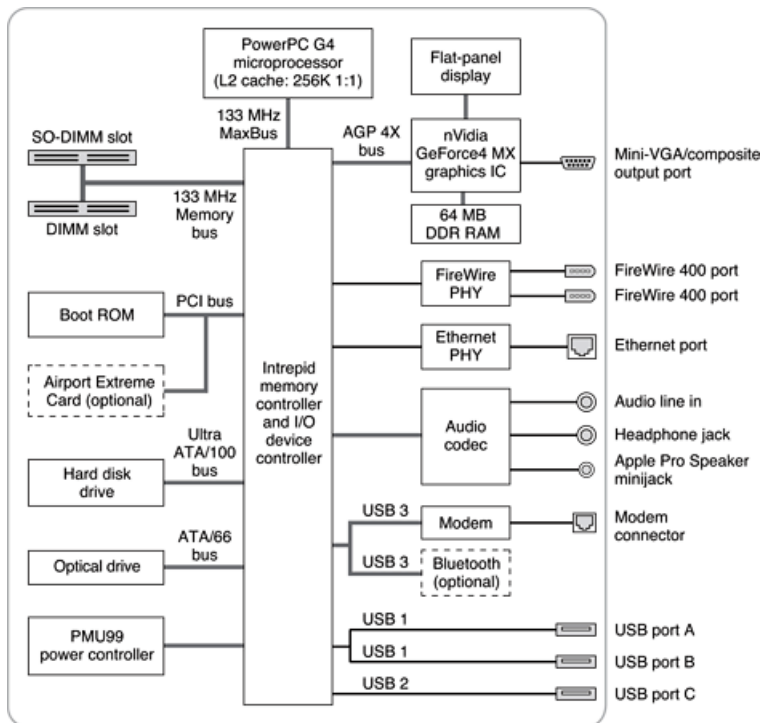
## Block Diagrams and Buses

This section is an overview of the major ICs and buses on the computer's main logic board. The 17" iMac uses the Intrepid IC.

### Block Diagrams

Figure 3-1 (page 23) provides a simplified block diagram of the Intrepid main logic board and the buses that connect them together.

Figure 3-1 Intrepid IC block diagram



## Main ICs and Buses

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The architecture of 17" iMac computer is designed around the PowerPC G4 microprocessor and the Intrepid memory and I/O device controller. The IC occupies the center of the block diagrams.

The PowerPC G4 microprocessor is connected to the Intrepid IC by a MaxBus bus with 128 data lines and a bus clock speed of 133 MHz. The Intrepid IC has other buses that connect with the boot ROM, the hard disk drive, and the optical drive, the power controller IC, the sound IC, the internal modem module, and the optional wireless LAN module.

The Intrepid I/O controller has a 32-bit PCI bus with a bus clock speed of 33 MHz.

Each of the components listed here is described in one of the following sections.

## Microprocessor and Cache

The microprocessor is a 1 GHz PowerPC G4 with a built-in 256 MB level 2 (L2) cache.

### PowerPC G4 Microprocessor

---

The PowerPC G4 microprocessor has many powerful features, including a pipelined system bus, called MaxBus, that is more efficient than the system bus on the PowerPC G3 microprocessors.

The PowerPC G4 used in the iMac computer has the following features:

- 32-bit PowerPC implementation
- superscalar PowerPC core
- Velocity Engine (AltiVec technology): 128-bit-wide vector execution unit
- high bandwidth MaxBus
- dual 32 KB instruction and data caches (level one)
- on-chip second level (L2) cache consisting of 256 KB with a clock speed ratio of 1:1

To find more information, see the reference at ["PowerPC G4 Microprocessor"](#) (page 24).

### Level 2 Cache

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



## Memory and I/O Device Controller

The Intrepid ICs combine several functions into a single IC. The IC contains the memory controller, the PCI bus bridge, the Ethernet and FireWire 400 interfaces, the USB interface, and the AGP interface.

In addition to the buses listed in [Table 3-1](#) (page 25), the Intrepid IC also has separate interfaces to the physical layer (PHY) ICs for Ethernet and FireWire 400 and an I2C interface that is used for configuring the memory subsystem.

**Table 3-1** Buses supported by the Intrepid IC

Name of bus	Destinations	Width of data path	Bus clock speed
MaxBus	Microprocessor	64 bits	133 MHz
Memory bus	System RAM	64 bits	133 MHz
AGP 4x bus	Graphics IC	32 bits	66 MHz
Ultra ATA -100 bus	Hard drive	16 bits	100 MHz
Ultra ATA-66 bus	Optical drive	16 bits	66 MHz

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

The following sections describe the subsystems that are connected to the Intrepid IC.

### System RAM

The memory subsystem in the Intrepid system consists of 256 MB of DDR266 (PC2100) SDRAM in the expansion slot. The data bus to the RAM and SO-DIMM is 64 bits wide, and the memory interface is synchronized to the MaxBus interface at 133 MHz.

For more information on system RAM, see [“RAM Expansion Slots”](#) (page 63).

**Note:** Only the SO-DIMM slot is accessible by the user. See [“RAM Expansion Slots”](#) (page 63)

### Boot ROM

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

## FireWire 400 Controller

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The Intrepid IC includes an IEEE 1394a FireWire 400 controller with a data rate of 400 Mbits (50 MBytes) per second and provide DMA (direct memory access) support for the FireWire 400 interface.

The controller IC implements the FireWire 400 link layer. A physical layer IC, called a PHY, implements the electrical signalling protocol of the FireWire 400 interface. The PHY supports two FireWire 400 ports by way of external connectors on the back of the enclosure.

**Important:** The FireWire PHY on the iMac does not operate with external bus power. As long as the computer is plugged into an active AC power outlet, the FireWire PHY is active and the FireWire bus remains connected. If AC power is interrupted, the PHY will not operate.

## Ethernet Controller

---

The Intrepid IC includes an ethernet media access controller (MAC) that implements the Link layer. As a separate channel connected directly to the IC logic, it can operate at its full capacity without degrading the performance of other peripheral devices. The Intrepid 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 more information, see [“Ethernet Port”](#) (page 46).

## Intrepid IC Video Display Subsystem

---

The display subsystem for the Intrepid IC system consists of a graphics controller ASIC and 64 MB of DDR RAM on the main logic board. The graphics controller IC is an NVidia GeForce4 MX. It contains 2D and 3D acceleration engines, front-end and back-end scalers, a display controller, and an AGP 4x bus interface with bus master capability.

The graphics IC supports a display size of 1440 by 900 pixels, with lesser resolutions scaled accordingly.

The display generated for the flat panel display is simultaneously available for an external monitor; see [“Video Monitor Port”](#) (page 51). Composite video and S-video signals can be displayed on either an NTSC display or a PAL display; see [“Video Display Adapter”](#) (page 52).

The interface between the graphics IC and the rest of the system is an AGP (accelerated graphics port) 4x bus on the Intrepid IC. To give the graphics IC fast access to system memory, the AGP bus has separate address and data lines and supports deeply pipelined read and write operations. The AGP bus has 32 data lines and a clock speed of 66 MHz running in 4x mode.

The graphics IC uses a graphics address remapping table (GART) to translate AGP logical addresses into physical addresses. The graphics driver software can allocate memory in both the dedicated DDR RAM and the main memory.

For information about the display and supported resolutions, see [“Flat Panel Display”](#) (page 50) and [“Video Monitor Port”](#) (page 51).

## USB Interface

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The Intrepid IC implements three independent USB controllers (root hubs). The internal modem and Bluetooth module are connected to one controller. Two external USB ports are connected to a second controller. A single external USB port is connected to the controller nearest the mini-VGA connector.

The USB controllers provide a 12 Mbps data transfer rate that is shared between the two devices connected to it. The USB ports that are connected to separate controllers can support high data rate devices at the same time with no degradation of their performance. Thus, if a user connects a high-speed (12 Mbps) device to one USB controller port another high-speed device to the port on the second USB controller, both devices can operate at their full data rates.

All three external USB connectors support USB devices with data transfer rates of 1.5 Mbps or 12 Mbps. For more information about the connectors, see ["USB Ports"](#) (page 43).

USB devices connected to the iMac 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 70).

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

## Ultra ATA-100 Interface

---

The Intrepid IC provides an Ultra ATA-100 channel that is connected to the internal hard disk drive. The Intrepid 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 Ultra ATA-100 conforms to a subset of ATA/ATAPI-6 and -5 protocols. For more information, see ["Hard Disk Drive"](#) (page 49).

## Ultra ATA-66 Interface

---

The Intrepid IC provides an Ultra ATA-66 SuperDrive connected as device 0 (master). For more information, see ["SuperDrive \(CD-RW/DVD-R\)"](#) (page 49).

## Modem Support

---

One of the USB ports on the Intrepid IC is used for the interface to the modem. The Intrepid IC provides DB-DMA support for the modem interface. The modem provides digital call progress signals to the audio codec sound circuits.

The internal hardware modem is a separate module that contains the datapump and the interface to the telephone line (DAA). For more information about the modem, see ["Internal Modem"](#) (page 48).

## Bluetooth Technology

---

Bluetooth is available as an internal build-to-order option in the 17" iMac. Bluetooth is an open specification that enables short-range wireless connections between desktop and laptop computers and a host of other peripheral devices. For more information on Bluetooth technology, refer to ["Bluetooth Technology"](#) (page 49).

## Sound Circuitry

---

The audio codec circuitry exchanges audio data with the main IC over a standard I2S bus and receives commands from the main IC over an I2C bus. The main IC provides DB-DMA (descriptor-based direct memory access) support for the I2S bus.

The sound circuitry includes a signal processing IC for equalization and volume control functions and a codec IC for A/D and D/A conversion.

The sound circuitry performs analog-to-digital conversion for the internal microphone and digital-to-analog conversion for the audio signals it sends to the internal speaker and the headphone jack. A switch-mode power amplifier drives the internal speaker and the Apple Pro Speaker minijack.

For a description of the features of the sound system, see ["Sound System"](#) (page 55).

## Power Controller

---

The power management controller in the iMac is a custom IC called the PMU99. It supports several power-saving modes of operation, including idle, doze, and sleep.

## AirPort Extreme Wireless Support (optional)

---

Apple's internal wireless LAN module, the 54 Mbps AirPort Extreme Card, is available as a build-to-order option. The proprietary connector for the AirPort Extreme Card uses the PCI bus. A separate connector is used for the cable to the antennas, which are built into the computer's enclosure. For information about operation, see ["AirPort Extreme Card"](#) (page 47).

# Devices and Ports on the 15" iMac

This chapter describes both the built-in I/O devices and the ports for connecting external I/O devices on the 15" iMac. Each of the following sections describes an I/O port or device.

## USB Ports

The iMac has five Universal Serial Bus (USB) ports that are used for connecting the keyboard and mouse as well as additional I/O devices such as printers, scanners, and low-speed storage devices. Three USB ports are on the iMac itself; two more are on the keyboard.

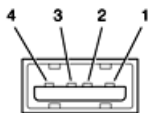
The first USB port (the one nearest the mini-VGA connector) and the internal modem share one USB root hub; the second and third USB ports share a second USB hub. Each hub provides a 12 Mbps data transfer rate that is shared between the devices connected to it. See ["USB Interface"](#) (page 70).

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 70).

## USB Connectors

The USB ports use USB Type A connectors, which have four pins each. Two of the pins are used for power and two for data. [Figure 4-1](#) (page 29) is an illustration of a Type A port; [Table 4-1](#) (page 29) shows the signals and pin assignments.

**Figure 4-1** USB Type A port and pins



**Table 4-1** Signals on the USB port

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

The iMac provides 5-volt power to the USB ports. The maximum current available is 500 mA on each port.

The USB ports support both low-speed and high-speed data transfers, at up to 1.5 Mbps per second and 12 Mbps per second, respectively. High-speed operation requires the use of shielded cables.

The Macintosh USB system software supports all four data transfer types defined in the USB specification.

## USB Features

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Features of the USB ports are listed in the following paragraphs.

### Wake Up From Sleep

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USB devices can provide a remote wakeup function for the computer. The USB root hub in the computer is set to support remote wakeup whenever a device is attached to or disconnected from the bus. The keyboard that comes with the computer uses this method to wake the computer on a key press.

### 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.

### USB Storage Devices

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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 iMac supports the USB Mass Storage specification.

### USB Controller

---

The iMac 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 Ports

The iMac has two external FireWire 400 IEEE 1394a ports. The features of the FireWire 400 ports are:

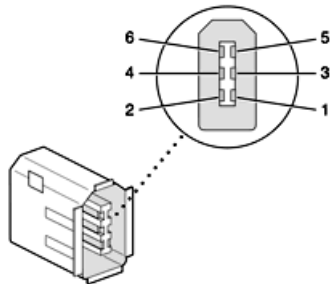
- Support serial I/O at 100, 200, and 400 Mbps (megabits per second)
- Share 8 watts of power when the computer system is on
- Support up to 62 devices

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

## FireWire 400 Connector

The FireWire 400 connector has six contacts, as shown in [Figure 4-2](#) (page 31). The connector signals and pin assignments are shown in [Table 4-2](#) (page 31).

**Figure 4-2** FireWire 400 connector



**Table 4-2** Signals on the FireWire 400 connector

Pin	Signal name	Description
1	Power	regulated, 12 VDC
2	Ground	Ground return for power and inner cable shield
3	TPB-	Twisted-pair B, differential signals
4	TPB+	Twisted-pair B, differential signals
5	TPA-	Twisted-pair A, differential signals
6	TPA+	Twisted-pair A, differential signals
Shell	—	Outer cable shield

When the computer is on, the power pin provides a regulated voltage of 12 V and 8 W for each connector for a total of 16 W. Zero voltage is present at the power pin when the computer is off.

**Important:** The FireWire PHY on the iMac does not operate from external bus power. As long as the computer is plugged into an active AC power outlet, the FireWire PHY is active and the FireWire bus remains connected. If AC power is interrupted, the PHY will stop operating and data on the bus cannot be repeated.

Pin 2 of the 6-pin FireWire 400 connector is ground for both power and 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.

For additional information about the FireWire 400 interface and the Apple APIs for FireWire 400 device control, developers should refer to the resources listed in [“FireWire 400 Interface”](#) (page 70).

## Target Disk Mode

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The user has the option at boot time to put the computer into a mode of operation called Target Disk Mode (TDM).

When the iMac is in Target Disk Mode and connected to another Macintosh computer by a FireWire 400 cable, the iMac operates like a FireWire mass storage device with the SBP-2 (Serial Bus Protocol) standard. Target Disk Mode has two primary uses:

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

The iMac computer can operate in Target Disk Mode as long as the other computer has a FireWire 400 port and either Mac OS X (any version) or Mac OS 9 with FireWire 400 software version 2.3.3 or later.

To put the iMac into Target Disk mode, you restart the iMac and hold down the T key until the FireWire icon appears on the display. You then connect a FireWire 400 cable from the iMac to the other computer. When the other computer completes the FireWire connection, a hard disk icon appears on its desktop.

If you disconnect the FireWire cable or turn off the iMac while in Target Disk Mode, an alert appears on the other computer.

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

## Ethernet Port

The iMac 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 an RJ-45 connector located on the I/O panel. [Table 4-3](#) (page 32) shows the signals and pin assignments on the connector.

**Table 4-3** 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



Pin	Signal name	Signal definition
8	–	Not used

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

## AirPort Card

The 15" iMac 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 has connectors for a wired LAN, a DSL or cable modem, and a standard telephone line using its built-in 56k modem.

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 70).

## AirPort Data Security

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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 Internet hackers.
- The AirPort Base Station can authenticate users by their unique Ethernet IDs, preventing unauthorized computers from logging into your 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.

As an additional data security measure, VPN can be used in conjunction with the AirPort data security

## AirPort Hardware

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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 flat-panel display, one on either side. 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

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Software that is provided with the AirPort Card includes

- AirPort Setup Assistant, an easy-to-use program that guides you 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. These functions are accessed via the AirPort status menu.
- 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.

## Internal Modem

The iMac comes with a built-in modem. The telephone connector for the modem is an RJ-11 connector on the I/O panel.

The modem has the following features:

- modem bit rates up to 56 Kbps (supports V.92 and K56flex modem standards)
- Group 3 fax modem bit rates up to 14.4 Kbps

The modem appears to the system as a USB device that responds to the typical AT commands. The modem provides an analog sound output for monitoring the progress of the modem connection.

## Bluetooth Technology

In the 15" iMac, the Bluetooth option requires an external third-party adapter 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 71).

## Hard Disk Drive

The internal hard disk drive has a storage capacity of 60 GB, uses the Ultra ATA-66 interface, and spins at 7200 rpm. The internal hard disk drive conforms to a subset of ATA/ATAPI-6 and -5 protocols and is connected as device 0 (master) in an ATA Device 0/1 configuration.

The software that supports the internal hard disk is similar to that in previous Macintosh models with internal IDE drives and includes DMA support. To obtain information about that software and about the ANSI standard for the Ultra DMA IDE interface, see ["ATA Interface"](#) (page 69).

## Combo (CD-RW/DVD-ROM) Drive

The 15" iMac computer has a combination CD-RW and DVD-ROM drive. The combination drive has a tray for loading the disc.

The drive can read DVD media and read and write CD media, as shown in [Table 4-4](#) (page 35). The Combo drive also provides DVD-Video playback with DVD MPEG2 decode.

**Table 4-4** Types of media used in the Combo (CD-RW/DVD-ROM) drive

Media type	Reading speed	Writing speed
DVD-ROM	8x (CAV)	–
DVD-R	4x max (CAV)	–
CD-R	32x (CAV)	32x max
CD-RW	24x (CAV)	10x (CLV)
CD or CD-ROM	32x (CAV)	–

Digital audio signals from the Combo drive can be played through the sound outputs under the control of the Sound Manager in System Preferences.

The Combo drive uses the ATA-4 protocol and is device-select jumpered as Device 1 (slave) in an ATA Device 0/1 configuration.

## Flat Panel Display

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

The display is 15 inches, measured diagonally. The display contains 1024 by 768 pixels (XGA) and can show up to millions of colors.

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 1024x768, 800 x600, or 640 x480 pixels.

The graphics subsystem uses an NVIDIA GeForce2 MX with 32 MB of DDR RAM. It supports 3D acceleration and display depths up to 24 bits per pixel at all screen resolutions. When more graphics storage is needed, the graphics IC can also use part of main memory. For more information, see [“Pangea IC Video Display Subsystem”](#) (page 20).

## Video Monitor Port

The iMac computer has a port for an external video monitor. The external monitor shows the same information as the built-in display, a mode sometimes called hardware video mirroring. The external monitor supports only the display sizes that are available on the internal monitor; the sizes and refresh rates are shown in [Table 4-5](#) (page 36).

**Table 4-5** Display sizes and refresh rates

Display size	Refresh rate
640 by 480	60 Hz
800 by 600	75 Hz
1024 by 768	75 Hz

## Monitor Connector

The connector for the analog video monitor is a custom 14-pin connector. The pins and signals are listed in [Table 4-6](#) (page 36). An adapter is available for use with monitors with VGA 15-pin miniature D-type connectors.

**Table 4-6** Signals on the monitor connector

Pin	Signal name	Pin	Signal name
1	GND	8	DDC_VCC_5
2	/VSYNC	9	ANALOG_BLU
3	/HSYNC	10	VGA_EIC_DAT
4	RED_RTN	11	VGA_EIC_CLK
5	ANALOG_RED	12	GND
6	GRN_RTN	13	MON_DETECT

Pin	Signal name	Pin	Signal name
7	ANALOG_GRN	14	BLU_RTN

## Keyboard

The iMac comes with an Apple Pro Keyboard. It is a USB compatible full-size keyboard with 15 function keys and separate groups of numeric keypad and editing keys.

### Keyboard Features

---

Here is a list of the features of the Apple Pro Keyboard.

- Slope settable to either 0 or 6 degrees by a flip-out foot
- 108 keys (on the ANSI versions)
- 15 function keys, programmable by the user
- 6 editing keys (Page Up, Page Down, Home, End, Forward Delete, and Help)
- USB multi-media control keys (Volume Up, Volume Down, and Mute)
- Media eject key
- Full travel, standard pitch keys on alphanumeric, editing, and keypad sections, including function keys and cursor position keys
- Localized worldwide: 33 versions, 3 standard layouts (ANSI, JIS, ISO)
- LED indicators in the Caps Lock and Num Lock keys
- USB hub functionality with two Type A USB bus-powered ports

**Note:** There is no power key on this keyboard.

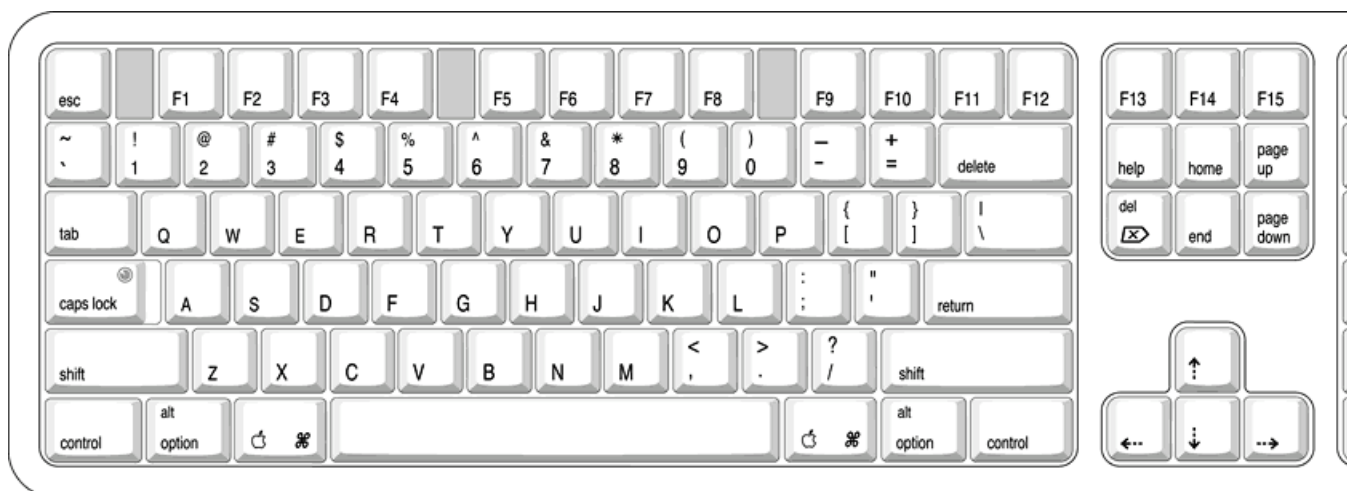
### Keyboard Layout

---

There are localized versions of the Apple Pro Keyboard for use in different parts of the world. The three standards used are ANSI (US and North America), JIS (Japan), and ISO (Europe). [Figure 4-3](#) (page 38) shows the keyboard layout for the ANSI keyboard. Applications can determine which type of keyboard is connected by calling the Gestalt Manager and checking for the corresponding value of the `gestaltKeyboardType` selector:

- `gestaltUSBAndyANSIKbd` (value = 204)
- `gestaltUSBAndyISOKbd` (value = 205)
- `gestaltUSBAndyJISKbd` (value = 206)

Figure 4-3 ANSI keyboard layout



## Programming the Function Keys

The function keys (F1–F15) can be programmed by the user through the Keyboard Control Panel. Operations that can be assigned include

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

## Multi-Media Control Keys

The keyboard has four multi-media keys: Volume Up, Volume Down, Mute, and Eject. They provide direct control of those features on the computer by way of the USB.

## Keyboard and USB

The Apple Pro Keyboard is designed to work with the iMac by way of the USB ports. The keyboard has a captive cable with a USB Type A connector. The keyboard is a bus-powered USB hub with two USB Type A ports.

**Warning:** A bus-powered hub does not provide enough power to support a second bus-powered hub. To use a second bus-powered hub with an iMac, connect it to the second USB port on the computer, not to a port on the Apple USB keyboard.

The standard NMI and reset key combinations are available, but the keys are decoded in software and may not be available under some crashed conditions.

Apple provides a HID class driver for the Apple USB keyboard, which supports the USB boot protocol. Other keyboards intended for use on the Macintosh platform must support the HID boot protocol, as defined in the USB Device Class Definition for Human Interface Devices (HIDs). For information about the USB HID definition, see the HID reference in ["USB Interface"](#) (page 70).

## Mouse

The iMac comes with an Apple Pro Mouse. The Apple Pro Mouse uses optical tracking in place of the traditional rolling ball. It works on almost any surface, though non-reflective, opaque surface without repetitive patterns work best.

## Sound System

The sound system provides sound input and output through the built-in microphone and speaker. The user can also connect external input and output devices by way of the headphone jack, the Apple Pro Speaker minijack, and the USB ports. The iMac includes Apple Pro Speakers.

To maintain the highest fidelity when digital audio program material from CDs or DVDs is played, the audio data is kept in digital form until just before being sent to the sound output jack or the headphone jack. A switch mode power amplifier provides the power for the external speaker.

The sound system supports sample sizes up to 24 bits and sample rates of up to 48 kHz.

### Sound Inputs

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The sound system accepts inputs from four sources:

- the built-in microphone
- digital audio from the internal optical drive
- call progress audio from the internal modem
- USB audio devices connected to the USB ports

### Built-in Microphone

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The iMac has a built-in microphone located at the bottom of the display. The analog signal from the microphone is converted to a digital signal by the audio circuitry.

The nominal SNR of the internal microphone is 65 dB.

### Sound Outputs

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The sound system sends computer-generated sounds to four destinations:

- internal speaker
- Apple Pro Speaker minijack
- stereo headphone jack
- USB audio devices connected to the USB ports

#### Internal Speaker


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The iMac computer has a single internal speaker that operates when no external speakers are connected. The internal speaker uses a monaural mix of the left and right channels.

#### Apple Pro Speaker Minijack

---

The Apple Pro Speaker minijack is a 2.5-mm stereo minijack. It has a smaller diameter than the headphone jack so that the user cannot inadvertently plug typical headphones into it.

 **Warning:** Many cell phones, along with some types of headphones and other audio devices, have a 2.5-mm plug. The user must not plug such devices into the Apple Pro Speaker minijack. Doing so could cause damage to the devices.

The Apple Pro Speakers include an internal ROM that enables the computer to identify the speakers. Speakers other than the Apple Pro Speakers should not be connected to the Apple Pro Speaker minijack.

#### Headphone Jack

---

The iMac has a 3.5 mm minijack for stereo sound output. The headphone jack is suitable for connecting a pair of headphones or amplified external speakers. When a plug is inserted into the headphone jack, the internal speaker and the Apple Pro Speaker minijack are disconnected.

The sound output through the headphone jack has the following electrical characteristics:

- output level 4.0 V peak-to-peak (1.4 V RMS), open circuit
- source impedance 44 ohms
- signal-to-noise (SNR) 90 dB unweighted (typical)
- total harmonic distortion (THD) 0.03% or less

### Sound Specifications

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The frequency response of the sound circuits, not including the microphone and speakers, is within plus or minus 1 dB from 20 Hz to 20 kHz.

Total harmonic distortion plus noise (THD+N) as a percentage of full scale are shown in [Table 4-7](#) (page 41).



**Table 4-7** Distortion specifications

Connector and level	THD+N
Headphone jack, open circuit	0.03%
Headphone jack, 32-ohm headphones	0.5%

The signal-to-noise ratios (SNR) for various inputs and outputs are shown in [Table 4-8](#) (page 41). The values shown are unweighted.

**Table 4-8** SNR specifications

Connector	Signal-to-noise ratio
Microphone	65 dB
Headphone jack	90 dB
Internal CD or DVD	90 dB



# Devices and Ports on the 17" iMac

This chapter describes both the built-in I/O devices and the ports for connecting external I/O devices on the 17" iMac. Each of the following sections describes an I/O port or device.

## USB Ports

The iMac has five Universal Serial Bus (USB) ports that are used for connecting the keyboard and mouse as well as additional I/O devices such as printers, scanners, and low-speed storage devices. Three USB ports are on the iMac itself; two more are on the keyboard.

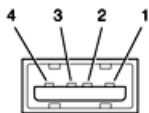
The 17" iMac has three independent USB controllers. The internal modem and Bluetooth module are connected to one controller. Two external USB ports are connected to a second controller. A single external USB port is connected to the controller nearest the mini-VGA connector. See "USB Interface" (page 70).

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 70).

## USB Connectors

The USB ports use USB Type A connectors, which have four pins each. Two of the pins are used for power and two for data. [Figure 5-1](#) (page 43) is an illustration of a Type A port; [Table 5-1](#) (page 43) shows the signals and pin assignments.

**Figure 5-1** USB Type A port and pins



**Table 5-1** Signals on the USB port

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

The iMac provides 5-volt power to the USB ports. The maximum current available is 500 mA on each port.

The USB ports support both low-speed and high-speed data transfers, at up to 1.5 Mbps per second and 12 Mbps per second, respectively. High-speed operation requires the use of shielded cables.

The Macintosh USB system software supports all four data transfer types defined in the USB specification.

## USB Features

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Features of the USB ports are listed in the following paragraphs.

### Wake Up From Sleep

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USB devices can provide a remote wakeup function for the computer. The USB root hub in the computer is set to support remote wakeup whenever a device is attached to or disconnected from the bus. The keyboard that comes with the computer uses this method to wake the computer on a key press.

### Connect and Resume

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The Intrepid 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.

### USB Storage Devices

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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 iMac supports USB Mass Storage specification.

### USB Controller

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The iMac 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 Ports

The iMac has two external FireWire 400 IEEE 1394a ports. The features of the FireWire 400 ports are:

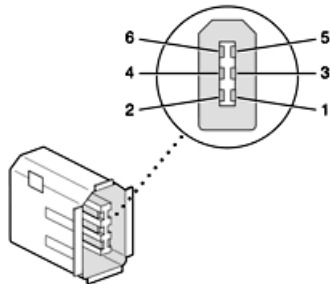
- Support serial I/O at 100, 200, and 400 Mbps (megabits per second)
- Share 8 watts of power when the computer system is on
- Support up to 62 devices

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

## FireWire 400 Connector

The FireWire400 connector has six contacts, as shown in [Figure 5-2](#) (page 45). The connector signals and pin assignments are shown in [Table 5-2](#) (page 45).

**Figure 5-2** FireWire 400 connector



**Table 5-2** Signals on the FireWire 400 connector

Pin	Signal name	Description
1	Power	regulated, 12 VDC
2	Ground	Ground return for power and inner cable shield
3	TPB-	Twisted-pair B, differential signals
4	TPB+	Twisted-pair B, differential signals
5	TPA-	Twisted-pair A, differential signals
6	TPA+	Twisted-pair A, differential signals
Shell	—	Outer cable shield

When the computer is on, the power pin provides a regulated voltage of 12 V and 8 W for each connector for a total of 16 W. Zero voltage is present at the power pin when the computer is off.

**Important:** The FireWire PHY on the iMac does not operate from external bus power. As long as the computer is plugged into an active AC power outlet, the FireWire PHY is active and the FireWire bus remains connected. If AC power is interrupted, the PHY will stop operating and data on the bus cannot be repeated.

Pin 2 of the 6-pin FireWire 400 connector is ground for both power and 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.

For additional information about the FireWire 400 interface and the Apple APIs for FireWire 400 device control, developers should refer to the resources listed in [“FireWire 400 Interface”](#) (page 70).

## Target Disk Mode

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The user has the option at boot time to put the computer into a mode of operation called Target Disk Mode (TDM).

When the iMac is in Target Disk Mode and connected to another Macintosh computer by a FireWire 400 cable, the iMac operates like a FireWire mass storage device with the SBP-2 (Serial Bus Protocol) standard. Target Disk Mode has two primary uses:

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

The iMac computer can operate in Target Disk Mode as long as the other computer has a FireWire 400 port and either Mac OS X (any version) or Mac OS 9 with FireWire 400 software version 2.3.3 or later.

To put the iMac into Target Disk mode, you restart the iMac and hold down the T key until the FireWire icon appears on the display. You then connect a FireWire 400 cable from the iMac to the other computer. When the other computer completes the FireWire 400 connection, a hard disk icon appears on its desktop.

If you disconnect the FireWire 400 cable or turn off the iMac while in Target Disk Mode, an alert appears on the other computer.

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

## Ethernet Port

The iMac 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 an RJ-45 connector located on the I/O panel. [Table 5-3](#) (page 46) shows the signals and pin assignments on the connector.

**Table 5-3** 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

Pin	Signal name	Signal definition
8	–	Not used

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

## AirPort Extreme Card

The 17" iMac computer supports the AirPort Extreme Card, an internal wireless LAN module. The AirPort Extreme 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 Extreme 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 Extreme Base Station has connectors for a wired LAN, a DSL or cable modem, and a standard telephone line using the optional 56K modem that is built-in on some models.

AirPort Extreme transmits and receives data at speeds up to 54 Mbps. AirPort Extreme is compatible with other devices that follow the IEEE 802.11b and 802.11g standards, including PC's. For more information about Wi-Fi and compatibility, see the reference at "[Wireless Networks](#)" (page 70).

**Note:** As is the case with the existing IEEE 802.11b standard, actual data throughput speeds will be lower than the indicated maximum connection speeds. Inherent in wireless LAN systems, bandwidth overhead is required for wireless routing, scrambling, security, error correction, and other processes.

## AirPort Extreme Data Security

AirPort Extreme 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 multibit 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 Extreme uses up to 128-bit encryption to encode data while it is in transit.
- The AirPort Extreme Base Station can be configured to use NAT (Network Address Translation), protecting data from would-be Internet hackers.
- The AirPort Extreme Base Station can authenticate users by their unique Ethernet IDs, preventing unauthorized computers from logging into a 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.

As an additional data security measure, VPN can be used in conjunction with the AirPort Extreme data security.

## AirPort Extreme Hardware

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The AirPort Extreme Card is a wireless LAN module based on the IEEE draft specification of the 802.11g standard using both OFDM (orthogonal frequency-division multiplexing) and DSSS technologies. Using DSSS, AirPort Extreme is interoperable with PC-compatible wireless LANs that conform to the 802.11b standard at speeds of 11 Mbps, 5.5 Mbps, 2 Mbps, and 1 Mbps. Using OFDM, AirPort Extreme is compatible with all 802.11g draft standard speeds.

Two AirPort Extreme antennas are built into the computer's enclosure. One antenna is always used for transmitting. Either of the two antennas may be used for receiving. Using a diversity technique, the AirPort Extreme Card selects the antenna that gives the best reception. AirPort Extreme shares the antennas with Bluetooth.

The AirPort Extreme wireless LAN is on the PCI bus.

## AirPort Extreme Software

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Software that is provided with the AirPort Extreme Card includes

- AirPort Extreme Setup Assistant, an easy-to-use program that guides the user through the steps necessary to set up the AirPort Extreme Card or set up an AirPort Extreme Base Station.
- Users can switch between wireless networks and can create and join peer-to-peer networks. These functions are accessed via the AirPort Extreme- Menu-Extra pulldown in System Preferences.
- AirPort Extreme 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.

## Internal Modem

The iMac comes with a built-in modem. The telephone connector for the modem is an RJ-11 connector on the I/O panel.

The modem has the following features:

- modem bit rates up to 56 Kbps (supports V.92 and K56flex modem standards)
- Group 3 fax modem bit rates up to 14.4 Kbps

The modem appears to the system as a USB device that responds to the typical AT commands. The modem provides an analog sound output for monitoring the progress of the modem connection.



## Bluetooth Technology

Bluetooth is an internal build-to-order option in the 17" iMac. 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

In the 17" iMac, Bluetooth is available as a build-to-order option which is installed by Apple at the time of purchase as a fully integrated module. Accessing the Bluetooth capabilities without purchasing the integrated module will require a third-party dongle.

For more information on Bluetooth technology, refer to ["Bluetooth"](#) (page 71).

## Hard Disk Drive

The internal hard disk drive has a storage capacity of 80 GB, uses the Ultra ATA-100 interface, and spins at 7200 rpm. The internal hard disk drive conforms to a subset of ATA/ATAPI-6 and -5 protocols and is connected as device 0 (master) in an ATA Device 0/1 configuration.

The software that supports the internal hard disk is similar to that in previous Macintosh models with internal IDE drives and includes DMA support. To obtain information about that software and about the ANSI standard for the Ultra DMA IDE interface, see ["ATA Interface"](#) (page 69).

## SuperDrive (CD-RW/DVD-R)

The 17" iMac computer has a tray-loading, combination DVD-R and CD-RW SuperDrive.

The drive can read and write DVD media and CD media, as shown in [Table 5-4](#) (page 49). The SuperDrive also provides DVD-Video playback with DVD MPEG2 decode.

**Table 5-4** Types of media read and written by the SuperDrive

Media type	Reading speed	Writing speed
DVD-R	2x	4x, 2x, 1x depending on media
DVD-ROM	8x max (single layer), 2x (dual layer)	–

Media type	Reading speed	Writing speed
DVD-RW	2x	2x, 1x depending on media
CD-R	32x max	16x
CD-RW	32x max	8x, 4x depending on media
CD or CD-ROM	32x max	–

Digital audio signals from the SuperDrive can be played through the sound outputs under the control of the Sound Manager in System Preferences.

The SuperDrive uses the ATA-4 protocol and is device-select jumpered as Cable Select (CS) in an ATA Device 0/1 configuration.

## Flat Panel Display

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

The display is 17 inches, measured diagonally. The display contains 1440x900 pixels and can show up to millions of colors.

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 the resolutions listed in Table 5-5.

**Table 5-5** Resolutions on the flat-panel display

Resolution	Aspect ratio	Notes
640 by 480	4:3	
640 by 480	4:3	stretched to fit full screen
800 by 500	16:10	
800 by 600	4:3	
800 by 600	4:3	stretched to fit full screen
1024 by 640	16:10	
1024 by 768	4:3	
1024 by 768	4:3	stretched to fit full screen
1152 by 720	16:10	
1440 by 900	16:10	

The graphics subsystem uses an NVIDIA GeForce4 MX with 64 MB of DDR RAM. It supports 3D acceleration and display depths up to 24 bits per pixel at all screen resolutions. For more information, see “[Intrepid IC Video Display Subsystem](#)” (page 26).

## Video Monitor Port

The iMac computer has a port for an external video monitor and supports video mirroring mode. Video mirroring mode displays the same information on both monitors, enabling the control of a presentation on one display, while allowing an audience to watch the presentation on a second display or projector.

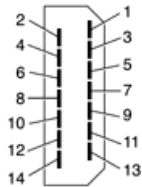
Due to display mirroring, the external monitor could have black borders during mirroring, depending on the supported timings between the two displays and on the monitor’s selection algorithm. Both displays show full-sized images only when the display resolution for the second monitor is set to the first display’s native resolution: 1440 by 900.

The external monitor supports user-selectable display sizes up to 1600 by 1200 at 75 Hz.

## Monitor Connector

The video display connector is a 14-pin rectangular connector, Hosiden TCX3143, or compatible. The connector accepts either a VGA adapter or a composite adapter. The system requires a composite adapter to use composite output over this connector. The connector pins are identified in [Table 5-3](#) (page 46).

**Figure 5-3** Video display connector



The pins and signals are listed in Table 5-6. An adapter is available for use with monitors with VGA 15-pin miniature D-type connectors.

**Table 5-6** Video signals for a VGA R-G-B 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

Pin	Signal name	Pin	Signal name
6	Green return	13	/Cable detect
7	Green video	14	Blue return

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

The video display connector is compliant with the VESA specification.

## Video Display Adapter

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The iMac 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 when the composite adapter is attached are shown in [Table 5-7](#) (page 52).

**Table 5-7** 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

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 composite adapter, the computer detects this configuration and enables the composite and S-video outputs. The settings for the resolutions and standards (NTSC or PAL) are then selectable in System Preferences.

## Keyboard

The iMac comes with an Apple Pro Keyboard. It is a USB compatible full-size keyboard with 15 function keys and separate groups of numeric keypad and editing keys.

## Keyboard Features

---

Here is a list of the features of the Apple Pro Keyboard.

- Slope settable to either 0 or 6 degrees by a flip-out foot
- 108 keys (on the ANSI versions)
- 15 function keys, programmable by the user
- 6 editing keys (Page Up, Page Down, Home, End, Forward Delete, and Help)
- USB multi-media control keys (Volume Up, Volume Down, and Mute)
- Media eject key
- Full travel, standard pitch keys on alphanumeric, editing, and keypad sections, including function keys and cursor position keys
- Localized worldwide: 33 versions, 3 standard layouts (ANSI, JIS, ISO)
- LED indicators in the Caps Lock and Num Lock keys
- USB hub functionality with two Type A USB bus-powered ports

**Note:** There is no power key on this keyboard.

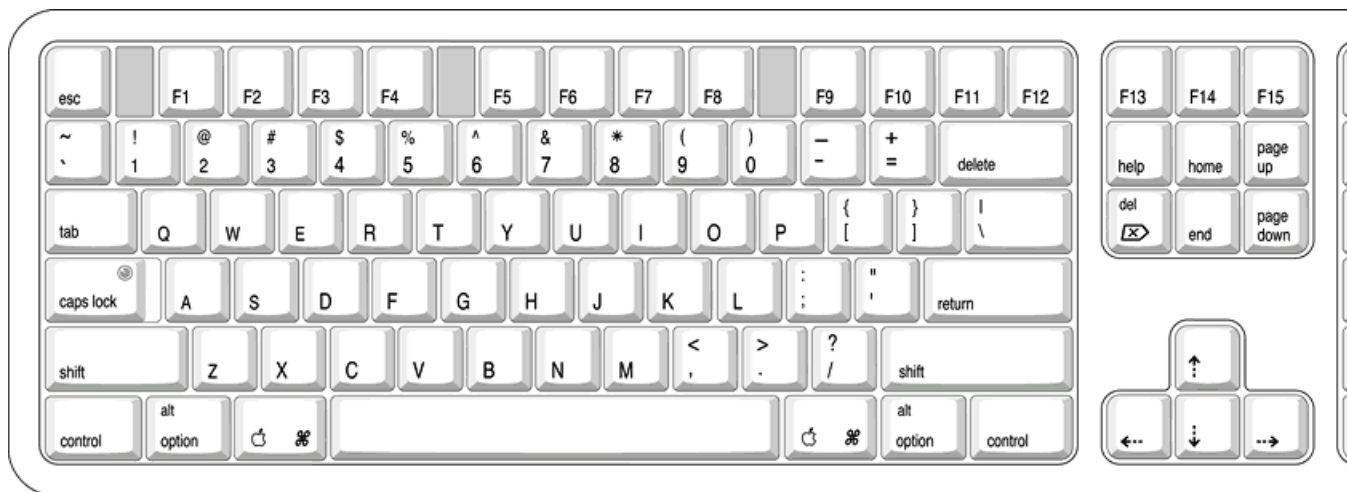
## Keyboard Layout

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There are localized versions of the Apple Pro Keyboard for use in different parts of the world. The three standards used are ANSI (US and North America), JIS (Japan), and ISO (Europe). [Figure 5-4](#) (page 54) shows the keyboard layout for the ANSI keyboard. Applications can determine which type of keyboard is connected by calling the Gestalt Manager and checking for the corresponding value of the `gestaltKeyboardType` selector:

- `gestaltUSBAndyANSIKbd` (value = 204)
- `gestaltUSBAndyISOKbd` (value = 205)
- `gestaltUSBAndyJISKbd` (value = 206)

Figure 5-4 ANSI keyboard layout



## Programming the Function Keys

The function keys (F1–F15) can be programmed by the user through the Keyboard Control Panel. Operations that can be assigned include

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

## Multi-Media Control Keys

The keyboard has four multi-media keys: Volume Up, Volume Down, Mute, and Eject. They provide direct control of those features on the computer by way of the USB.

## Keyboard and USB

The Apple Pro Keyboard is designed to work with the iMac by way of the USB ports. The keyboard has a captive cable with a USB Type A connector. The keyboard is a bus-powered USB hub with two USB Type A ports.

**Warning:** A bus-powered hub does not provide enough power to support a second bus-powered hub. To use a second bus-powered hub with an iMac, connect it to the second USB port on the computer, not to a port on the Apple USB keyboard.

The standard NMI and reset key combinations are available, but the keys are decoded in software and may not be available under some crashed conditions.

Apple provides a HID class driver for the Apple USB keyboard, which supports the USB boot protocol. Other keyboards intended for use on the Macintosh platform must support the HID boot protocol, as defined in the USB Device Class Definition for Human Interface Devices (HIDs). For information about the USB HID definition, see the HID reference in ["USB Interface"](#) (page 70).

## Mouse

The iMac comes with an Apple Pro Mouse. The Apple Pro Mouse uses optical tracking in place of the traditional rolling ball. It works on almost any surface, though non-reflective, opaque surface without repetitive patterns work best.

## Sound System

The sound system provides sound input and output through the built-in microphone and speaker. The user can also connect external input and output devices by way of the headphone jack, the Apple Pro Speaker minijack, the USB ports, and audio line-in.

To maintain the highest fidelity when digital audio program material from CDs or DVDs is played, the audio data is kept in digital form until just before being sent to the sound output jack or the headphone jack. A switch mode power amplifier provides the power for the external speaker.

The sound system supports sample sizes up to 24 bits and sample rates of up to 48 kHz.

### Sound Inputs

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The sound system accepts inputs from the following sources:

- the built-in microphone
- digital audio from the internal optical drive
- call progress audio from the internal modem
- USB audio devices connected to the USB ports
- audio line-in

### Built-in Microphone

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The iMac has a built-in microphone located at the bottom of the display. The analog signal from the microphone is converted to a digital signal by the audio circuitry.

The nominal SNR of the internal microphone is 65 dB.

## Audio Line-in

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The iMac has a stereo audio line-in jack on the base. Low level consumer products operating below -10 dbu require a pre-amp.

The audio inputs are designed to accept high-level audio signals: 2 Vrms or +8 dBu, which is the standard output level from CD and DVD players. The output level of some consumer audio devices is lower, often 0.1 Vrms or -10 dBu. Sound recordings made on the iMac with such low-level devices have more noise than those made with high-level devices. The user may obtain better results by connecting an amplifier between the low-level device and the computer's audio input jack.

The audio input jack is a 3.5 mm miniature phone jack with the signals connected as follows:

Tip	Left-channel audio
Ring	Right-channel audio
Sleeve	Audio ground

The sound input jack has the following electrical characteristics:

- maximum input signal amplitude 2 Vrms (5.65 Vpp), +8 dbu peak
- input impedance at least 47 kilohms
- channel separation greater than 60 dB
- recommended source impedance 2 kilohms or less
- ground noise rejection greater than 40 dB
- frequency response 5 Hz to 20 kHz, +0.0, -0.5 dB
- distortion below -80 dB
- signal to noise ratio (SNR) greater than -85 dB (unweighted)

## Sound Outputs

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The sound system sends computer-generated sounds to the following destinations:

- internal speaker
- Apple Pro Speaker minijack
- stereo headphone jack
- USB audio devices connected to the USB ports

## Internal Speaker

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The iMac computer has a single internal speaker that operates when no external speakers are connected. The internal speaker uses a monaural mix of the left and right channels.



## Apple Pro Speaker Minijack

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The Apple Pro Speaker minijack is a 2.5-mm stereo minijack. It has a smaller diameter than the headphone jack so that the user cannot inadvertently plug typical headphones into it.

 **Warning:** Many cell phones, along with some types of headphones and other audio devices, have a 2.5-mm plug. The user must not plug such devices into the Apple Pro Speaker minijack. Doing so could cause damage to the devices.

The Apple Pro Speakers include an internal ROM that enables the computer to identify the speakers. Speakers other than the Apple Pro Speakers should not be connected to the Apple Pro Speaker minijack.

## Headphone Jack

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The iMac has a 3.5 mm minijack for stereo sound output. The headphone jack is suitable for connecting a pair of headphones or amplified external speakers. When a plug is inserted into the headphone jack, the internal speaker and the Apple Pro Speaker minijack are disconnected.

The sound output through the headphone jack has the following electrical characteristics:

- output level 4.0 V peak-to-peak (1.4 V RMS), open circuit
- source impedance 44 ohms
- signal-to-noise (SNR) 90 dB unweighted (typical)
- total harmonic distortion (THD) 0.03% or less

## Sound Specifications

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The frequency response of the sound circuits, not including the microphone and speakers, is within plus or minus 1 dB from 20 Hz to 20 kHz.

Total harmonic distortion plus noise (THD+N) as a percentage of full scale are shown in [Table 5-8](#) (page 57).

**Table 5-8** Distortion specifications

Connector and level	THD+N
Headphone jack, open circuit	0.03%
Headphone jack, 32-ohm headphones	0.5%

The signal-to-noise ratios (SNR) for various inputs and outputs are shown in [Table 5-9](#) (page 57). The values shown are unweighted.

**Table 5-9** SNR specifications

Connector	Signal-to-noise ratio
Microphone	65 dB

Connector	Signal-to-noise ratio
Headphone jack	90 dB
Internal CD or DVD	90 dB
Line-in jack	$\geq 85$ dB SNR

# RAM Expansion on the 15" iMac


This chapter tells how to gain access to the expansion slots in the 15" iMac computer and describes the RAM expansion modules.

## RAM Expansion Slots

The 15" iMac has two RAM expansion slots off the PC100 bus. One of the slots accepts a standard, unbuffered PC133 168-pin DIMM (512 MB with minimum latency 3.0) and is occupied by the factory-installed RAM. The other slot accepts a standard PC133 144-pin SO-DIMM and is normally used for added RAM.

**Note:** Only the SO-DIMM slot is accessible by the user. (The access panel is on the bottom of the computer.)

**Important:** The user should be reminded to observe the usual precautions to avoid damage to the electronic components due to static electricity.

 **Warning:** The computer must be turned off before RAM modules are removed or inserted. To remind the user, a red LED is visible in the access door. If the red LED is on, power is on, and must be turned off before changing RAM modules.

## RAM Expansion Modules for Pangea IC System

The 15" iMac computer uses two types of RAM expansion modules: one 168-pin DIMM and one 144-pin SO-DIMM. Both expansion modules for the iMac are 3.3 volt, unbuffered, 8-byte, non-parity, and PC133 compliant. The speed of the SDRAM devices must be rated at 125 MHz (8 ns) or faster.

A DIMM for the Pangea system can contain either 128, 256, or 512 MB of memory; an SO-DIMM can contain either 64, 128, 256, or 512 MB of memory.

**Important:** RAM expansion DIMMs must be PC133 compliant and use SDRAM devices. If the user installs a DIMM that uses EDO or SGRAM devices, the computer will beep several times when the user attempts to restart the computer.

The sections that follow describe the 144-pin SO-DIMM for the user-accessible expansion slot. Because the 168-pin DIMM slot is not accessible to the user, its specifications are not given here.

## Mechanical Design of the SO-DIMM

The mechanical characteristics of the SO-DIMM 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 for Pangea IC System”](#) (page 59).

The specification defines SO-DIMMs with nominal heights of 1.0, 1.25, 1.5, or 2.0 inches. The iMac can accommodate standard SO-DIMMs with any height up to the maximum specified.

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 SO-DIMM

The SO-DIMM is required to be PC133 compliant. For information about the PC133 SDRAM specification, see the references at [“RAM Expansion Modules”](#) (page 69).

The electrical characteristics of the RAM SO-DIMM are given in section 4.5.6 of the JEDEC Standard 21-C, release 7. To obtain a copy of the specification, see the references listed at [“RAM Expansion Modules”](#) (page 69).

The JEDEC and PC133 specifications define several attributes of the DIMM, including storage capacity and configuration, connector pin assignments, and electrical loading. The specifications support 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 Macintosh computers 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.

Capacitance of the data lines must be kept to a minimum. Individual DRAM devices should have a pin capacitance of not more than 5 pF on each data pin.

## Configuration of DDR SDRAM Devices

[Table 6-1](#) (page 60) shows information about the different sizes of DIMMs used in the iMac computer. The first three columns show the memory size, configuration, and number of banks in the DIMMs. The other three columns show the number, density, and configuration of the DDR SDRAM devices making up the memory modules.

**Table 6-1** Sizes of RAM expansion DIMMs and devices for Pangea

Size of DIMM	Configuration of DIMM	Number of banks	Number of devices	Device density	Device configuration
128 MB	16 M x 64	1	4	256 Mbit	16 M x 16
256 MB	32 M x 64	2	8	256 Mbit	32 M x 8
512 MB	64 M x 64	2	16	256 Mbit	32 M x 8

## SDRAM Devices in the SO-DIMM

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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.

The devices are programmed to operate with a CAS latency of 3. At that CAS latency, the access time from the clock transition must be 6 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-DIMM

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[Table 6-2](#) (page 61) shows information about the different sizes of SDRAM devices used in the SO-DIMM. 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 6-2** Sizes of RAM expansion modules and devices for Pangea system

SO-DIMM size	SO-DIMM configuration	Number of devices	Device configuration	Number of banks
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
512 MB	64 M x 64	16	32 M x 8	2

## SO-DIMM Address Multiplexing

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Signals A[0] – A[12] and BA[0] – BA[1] on each SO-DIMM make up a 15-bit multiplexed address bus that can support several different types of SDRAM devices. [Table 6-3](#) (page 62) lists the types of devices that can be used in the SO-DIMM slot by size, configuration, and sizes of row, column, and bank addresses.

**Important:** The SO-DIMM slot supports only the types of SDRAM devices specified in [Table 6-3](#) (page 62). Other types of devices should not be used.

**Table 6-3** Types of DRAM devices for Pangea system

Device size	Device configuration	Size of row address	Size of column address
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 Expansion on the 17" iMac


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This chapter tells how to gain access to the expansion slots in the 17" iMac computer and describes the RAM expansion modules.

## RAM Expansion Slots

The 17" iMac has two RAM expansion slots: one for an SO-DIMM and one for a DIMM, which is preloaded by the factory. The Intrepid configuration has standard 184-pin, 8-byte, DDR266B (PC2100) SO-DIMM (small outline, dual inline memory module) that uses DDR SDRAM devices.

**Important:** The user should be reminded to observe the usual precautions to avoid damage to the electronic components due to static electricity.

 **Warning:** The computer must be turned off before RAM modules are removed or inserted. To remind the user, a red LED is visible in the access door. If the red LED is on, power is on, and must be turned off before changing RAM modules.

## The RAM Expansion Modules for Intrepid IC System

The RAM expansion slot accommodates a standard DDR266B (PC2100) SO-DIMM (small outline, dual inline memory module) that uses DDR SDRAM devices.

**Important:** A RAM expansion SO-DIMM for the iMac computer must use DDR SDRAM devices. If the user installs an SO-DIMM that uses single data rate (SDR), SGRAM, or non-DDR SDRAM devices, the computer will beep twice when the user attempts to restart the computer.

An SO-DIMM for the iMac 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 RAM SO-DIMM

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The mechanical characteristics of the RAM expansion module are given in the JEDEC specification JESD95 for the 184-pin 8-byte DRAM SO-DIMM. To find out how to obtain the specification, see ["RAM Expansion Modules"](#) (page 69).

The specification defines SO-DIMMs with nominal heights of 1.0, 1.25, 1.5, or 2.0 inches. The iMac 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 4 mm. That specification is also a maximum: Modules that exceed the specified thickness can cause reliability problems.

## Electrical Design of 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 (JESD-21C). To find out how to obtain the specification, see [“RAM Expansion Modules”](#) (page 69).

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 iMac 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 (200-pin DDR SDRAM SO-DIMM, PD INFORMATION) of the JEDEC standard 21-C specification, release 7.

## Configuration of DDR SDRAM Devices

The DDR SDRAM devices used in the RAM expansion modules must be self-refresh type devices for operation from a 2.5 V power supply. The speed of the DDR SDRAM devices must be 133 MHz or greater. The preloaded DIMM is 186-pin DDR266B (PC2100).

The devices are programmed to operate with a CAS latency of 2.5. At these CAS latencies, the access time from the clock transition must be 7.5 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.

[Table 7-1](#) (page 64) shows information about the different sizes of DIMMs used in the iMac computer. The first three columns show the memory size, configuration, and number of banks in the DIMMs. The other three columns show the number, density, and configuration of the DDR SDRAM devices making up the memory modules.

**Table 7-1** Sizes of RAM expansion DIMMs and devices for Intrepid

Size of DIMM	Configuration of DIMM	Number of banks	Number of devices	Device density	Device configuration
128 MB	16 M x 64	1	4	256 Mbit	16 M x 16
256 MB	32 M x 64	2	8	256 Mbit	32 M x 8
512 MB	64 M x 64	2	16	256 Mbit	32 M x 8
1GB	128 M x 64	2	16	512 Mbit	64 M x 8



## Configuration of RAM SO-DIMMs

Table 7-2 (page 65) shows information about the different sizes of SO-DIMMs used in the iMac 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 DDR SDRAM devices making up the memory modules.

**Table 7-2** Sizes of RAM expansion SO-DIMMs and devices for Intrepid

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	32 M x 64	2	16	128 Mbit	16 M x 8
256 MB	32 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
*1GB	128 M x 64	2	16	512 Mbit	32 M x 16
* 1 GB dual die package is not supported.					

## 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 DDR SDRAM devices. (page 14)Table 7-3 lists the types of devices that can be used in the iMac by size, configuration, and sizes of row, column, and bank addresses.

**Important:** The iMac computer supports only the types of DDR SDRAM devices specified in Table 7-3. Other types of DRAM devices should not be used with this computer.

**Table 7-3** Types of DDR SDRAM devices for Intrepid

Device size	Device configuration (bytes x bits x banks)	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
256 Mbits	8 M x 8 x 4	13	10
256 Mbits	4 M x 16 x 4	13	9

## CHAPTER 7

### RAM Expansion on the 17" iMac

Device size	Device configuration (bytes x bits x banks)	Row address bits	Column address bits
512 Mbits	16 M x 8x 4	13	10

# Supplemental Reference Documents

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

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

<http://developer.apple.com/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 technotes are available on the Technical Note website at

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

## 3D Graphics

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

Information is available on the World Wide Web at

<http://www.apple.com/opengl>

Developer support and documentation is available at

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

## PowerPC G4 Microprocessor

Information about the PowerPC G4 microprocessor is available on the World Wide Web at

<http://www.freescale.com/webapp/sps/site/homepage.jsp?nodeId=0162468rH3bTdG>

## Velocity Engine (AltiVec)

Velocity Engine is Apple's name for the AltiVec vector processor in the PowerPC G4 microprocessor. Apple provides support for developers who are starting to use the Velocity Engine in their applications. Documentation, development tools, and sample code are now available on the World Wide Web, at

<http://developer.apple.com/hardware/drivers/ve/index.html>

and

[http://developer.apple.com/documentation/Performance/Conceptual/vDSP/vDSP\\_Library.pdf](http://developer.apple.com/documentation/Performance/Conceptual/vDSP/vDSP_Library.pdf)

*AltiVec Technology Programming Environments Manual* (AltiVec PEM) is a reference guide for programmers. It contains a description for each instruction and information to help in understanding how the instruction works. You can obtain a copy of the AltiVec PEM through the Motorola AltiVec site on the World Wide Web, at

<http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02VS0181285Nf2>

## Mac OS X

Mac OS X version 10.2.3 is installed by default on the iMac 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.

## Open Firmware

The software architecture implemented on current Macintosh computers follows the standard defined by the Open Firmware IEEE 1274-1994 specification. Three Technical Notes provide an introduction to Open Firmware on the Macintosh platform. They are:

TN1061: Open Firmware, Part I, available at

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

TN1062: Open Firmware, Part II, available at

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

TN1044: Open Firmware, Part III, available at

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

Other Technical Notes provide additional information about Open Firmware on the Macintosh.

TN2000: PCI Expansion ROMs and You, at

<http://developer.apple.com/technotes/tn/tn2000.html>

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

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

TN2004: Debugging Open Firmware Using Telnet, available at

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

## RAM Expansion Modules

The 15" iMac uses a 168-pin SDRAM DIMM and a 144-pin SO-DIMM (PC133) for memory expansion. The 17" iMac uses a 184-pin, 8-byte, DDR266B (PC2100) SO-DIMM.

The mechanical characteristics of the DIMM are given in the JEDEC specification number JESD-95. The specification can be found by using the search string JESD-95 on the Electronics Industry Association's website at

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

The electrical characteristics of the DIMM and the SO-DIMM are given in JEDEC Standard 21-C, release 7 (JESD-21C). 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>

Information about the PC133 specification is available from Intel's web site, at

<http://developer.intel.com/technology/memory/>

## ATA Interface

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/Hardware/DeviceManagers/ata/ata.html>

ATA Manager 4.0 supports driver software for internal IDE drives and includes DMA support. For the latest information about ATA Manager 4.0, see Technical Note TN1098, 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 Technical Note TN1098 includes a link to a downloadable copy of ATA Device Software Guide.

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 on the World Wide Web, at

<http://developer.apple.com/documentation/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 API 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/docs>

## FireWire 400 Interface

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

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

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

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

## Wireless Networks

More information about Wi-Fi and wireless networks using the IEEE 802.11 standard is available on the website 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/>





# Abbreviations

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Standard units of measure used in this developer note include:

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

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
A/D	analog to digital
ADB	Apple Desktop Bus
AGP	accelerated graphics port
AIM	ATA Interface Module
ANSI	American National Standards Institute
API	application programming interface
ATA	Advanced Technology Attachment
ATAPI	ATA Packet Interface
BIOS	basic input/output system
CAS	column address strobe

## Abbreviations

CD	compact disc
CD-R	compact disc-recordable
CD-ROM	compact disc read-only memory
CD-RW	compact disc-rewritable
CPU	central processing unit
CRM	Communications Resource Manager
D/A	digital to analog
DAA	data access adapter
DBDMA	descriptor-based direct memory access
DIMM	Dual Inline Memory Module
DMA	direct memory access
DDR	double data rate, a type of SDRAM
DSSS	direct-sequence spread-spectrum
DV	digital video
DVD	digital video disc
DVD-R	digital video disc-recordable
DVD-ROM	digital video disc read-only memory
DVD-RW	digital video disc-rewritable
EDO	extended data out
EEPROM	electrically erasable programmable ROM
G3	Generation 3, the third generation of PowerPC microprocessors
G4	Generation 4, the fourth generation of PowerPC microprocessors
GART	graphics address remapping table
GND	ground
HFS	hierarchical file system
HID	human interface device, a class of USB devices
IC	integrated circuit
IDE	integrated device electronics

## APPENDIX B

### Abbreviations

IEC	International Electrotechnical Commission
I/O	input and output
IR	infrared
ISO	International Organization for Standardization
JEDEC	Joint Electron Device Engineering Council
L1	level 1 or first level
L2	level 2 or second level
LAN	local area network
LED	light emitting diode
MAC	media access controller
Mac OS	Macintosh Operating System
MPEG	Motion Picture Experts Group
modem	modulator-demodulator
NMI	nonmaskable interrupt
NV-RAM	nonvolatile random-access memory
OHCI	Open Host Controller Interface
OS	operating system
PCI	Peripheral Component Interconnect
PLL	phase-locked loop
POST	power-on self test
RADIUS	Remote Authentication Dial-In User Service
RAM	random-access memory
RCA	Radio Corporation of America
rms	root mean square
ROM	read-only memory
RTAS	run-time abstraction services
SCC	Serial Communications Controller
SCSI	Small Computer System Interface

## APPENDIX B

### Abbreviations

SDRAM	synchronous dynamic RAM
SGRAM	synchronous graphics RAM
SNR	signal to noise ratio
SPD	Serial Presence Detect
THD	total harmonic distortion
THD+N	total harmonic distortion plus noise
USB	Universal Serial Bus
VCC	positive supply voltage (voltage for collectors)
VIA	versatile interface adapter
Wi-Fi	Logo used by the Wireless Ethernet Compatibility Alliance for certification of interoperability of 802.11 products