Developer Note

Power Macintosh G3 Computers

Includes Power Macintosh G3 All-in-one, desktop, and minitower computers

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PREFACE

About This Note

This developer note is a revision to the Power Macintosh G3 Developer Note dated 12/09/97. The primary difference between this note and the previous note is the incorporation of information about the new processor configurations, the All-in-one model, enhancements to the Power Macintosh G3 ROM and logic board, and a description of the features of the Apple DVD-Video and Audio/Video Card option.

This note describes the architecture and I/O features of the logic board and provides illustrations of all the currently supported enclosures for the Power Macintosh G3 family of computers. It also lists any features that are new or different from previous Power Macintosh G3 models.

This developer note is intended to help hardware and software developers design products that are compatible with the Macintosh products described here. If you are not already familiar with Macintosh computers or if you would simply like additional technical information, you may wish to read the related technical manuals listed in the section "Supplemental Reference Documents."

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■ on the World Wide Web at <http://developer.apple.com/techpubs/hardware/hardware.html>

■ on the Reference Library Edition of the Developer CD Series, which is distributed as part of the monthly mailing to registered developers

Topics Described In This Note

The information is arranged in four chapters and an index:

■ Chapter 1, "Introduction," gives a summary of the features of the logic board in the Power Macintosh G3 computers, describes the physical appearance of the supported enclosures, and lists the available configurations and options. This chapter also includes sections that describe the differences between the

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latest computer models and previous models and compatibility issues that hardware and software developers need to be aware of to take advantage of the features available with the Power Macintosh G3 computers.

■ Chapter 2, "Architecture," describes the internal organization of the computer. It includes a functional block diagram and descriptions of the main components of the logic board.

■ Chapter 3, "I/O Features," describes the built-in input/output (I/O) devices and the external I/O ports. It also describes the built-in support for external video monitors that can be used with the computer. In addition, power specifications are listed.

■ Chapter 4, "Expansion Features," describes the expansion slots on the Power Macintosh G3 logic board. This chapter provides guidelines for designing cards for the I/O expansion slots and brief descriptions of the expansion modules for the other slots.

Supplemental Reference Documents

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

PowerPC G3 Microprocessor

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

World Wide Web at

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

Mac OS

For a description of the version of the Mac OS that comes with the new models, developers should refer to the Technote for Mac OS 8.1. The technote is available on the Technote web site at

http://developer.apple.com/technotes/tn/tn1121.html

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

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

ATA Devices

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

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

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

The technotes are also available on the reference library issues of the developer CD.

PCI Expansion Cards

For information about PCI expansion cards, refer to
Designing PCI Cards and Drivers for Power Macintosh Computers.

3D Graphics

Developers interested in taking advantage of the 3D graphics acceleration features built into the Power Macintosh G3 logic board should have *3D Graphics Programming With QuickDraw 3D.*

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Apple Developer Connection Web Site

The Apple Developer Connection Web site is the one-stop source for finding technical and marketing information specifically for developing successful Macintosh-compatible software and hardware products. Developer World is dedicated to providing developers with up-to-date Apple documentation for existing and emerging Macintosh technologies. Developer Connection can be reached at

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

Introduction

The Power Macintosh G3 all-in-one, desktop, and minitower computers are designed around the third-generation PowerPC™ processor, referred to as the PowerPC G3 or PowerPC 750. The main logic board in all three enclosures has a mini-ATX form factor that supports the PowerPC™ G3 microprocessor module with a back-side second-level (L2) cache, three PCI card expansion slots, three SDRAM DIMM slots, one SO-DIMM connector for video RAM expansion, and a PERCH slot. The PERCH slot accepts three configurations of Apple Macintosh input/output cards that provide either standard Macintosh sound I/O or enhanced AV features (audio and video input and output)

This note provides a description of the features of the Power Macintosh G3 computers, the logic board architecture and expansion capabilities, and a brief description of the all-in-one, desktop and tower enclosures for the Power Macintosh G3 computer.

This note also provides a list of feature enhancements that were made to the main logic board, the Apple Audio, and the Apple Audio/Video I/O cards. In May '98 changes incorporated into the design of the all-in-one main logic board, consisting primarily of ROM updates and a graphics controller upgrade, were rolled across the entire Power Macintosh G3 product line.

The main logic board of the enhanced configurations is distinguished by the presence of the ATI RAGE PRO graphics controller or by accessing the ROM subversion number programmatically to get the values 0x45F1, or 0x45F2. Models began shipping with the 0x45F2 ROM in August 1998.

Throughout the remainder of this note those features that exist only in the enhanced configurations include a reference to the ROM subversions V4.5 F1 or V4.5 F2. The original Power Macintosh G3 logic board has a ROM subversion of 0x40F2 or V4.0 F2. Prototype sample code that shows how to access the ROM subversion value is provided in "Machine Identification" (page 33).

Power Macintosh G3 Computer Features

Here is a list of the hardware features of the Power Macintosh G3 computers.

■ Microprocessor: PowerPC G3 microprocessor running at a clock frequency of 233 MHz, 266 MHz, 300 MHz, and 333 MHz depending on model and configuration.

■ System bus speed: 66 MHz Apple RISC system bus

- RAM: 0 MB soldered on the main logic board; expandable to 768 MB using 64-bit (non-parity) 168-pin JEDEC-standard 3.3-volt unbuffered SDRAM (synchronous dynamic access memory) DIMM (dual inline memory module) cards. Three DIMM card slots are provided for DRAM expansion. A minimum of 32 MB of RAM is installed in one of the DIMM card slots. For additional information about supported SDRAM DIMMs, see "RAM DIMMs" (page 64).

- ROM: 4 MB on 160-pin DIMM; 64-bit ROM data bus width.

- Cache: 512 KB or 1 MB of back-side second-level (L2) cache on processor module (depending on model and configuration). The cache runs at one half the clock frequency of the microprocessor. For example, the cache would run at 166.5 MHz on a 333 MHz processor module.

- Video display modes supported on the desktop, minitower, and All-in-one external monitor port: 640 by 480, 800 by 600, and 832 by 624 at 32 bits per pixel; 1024 by 768, 1152 by 870, 1280 by 1024, 1600 by 1200, and 1920 by 1080 at 16 bits per pixel; 2 MB synchronous graphics RAM (SGRAM) frame buffer on the main logic board. Video memory can be expanded to 4 MB or 6 MB with an optional 2 MB or 4 MB SGRAM graphics memory module. For the complete list of display modes supported with 2 MB, 4 MB, and 6 MB of video memory installed, see Table 3-2 (page 58).

- Video display modes supported on the all-in-one built-in monitor: 640 by 480, 800 by 600, and 832 by 624 at 32 bits per pixel; 1024 by 768 at 16 bits per pixel; 2 MB synchronous graphics RAM (SGRAM) frame buffer on the main logic board. Video memory can be expanded to 4 MB or 6 MB with an optional 2 MB or 4 MB SGRAM graphics memory module. For the complete list of display modes supported with 2 MB, 4 MB, and 6 MB of video memory installed, see Table 3-1 (page 57).

- Built-in 2D and 3D hardware graphics acceleration using the ATI 3D RAGE II+DVD or ATI 3D RAGE PRO-PCI graphics controller. Software support through Macintosh QuickDraw 3D and QuickDraw 3D RAVE (rendering acceleration virtual engine) APIs. The ATI 3D RAGE II+DVD graphics controller is the graphics controller used in the original Power Macintosh G3 computer. The enhanced ATI 3D RAGE PRO-PCI graphics controller and 100 MHz graphics bus is incorporated into the logic boards in all Power Macintosh G3 models with the V4.5 F1 and V4.5 F2 ROM subversion number.

- Built-in YUV and MPEG scaler.

- PERCH slot: a 182-pin microchannel connector. The PERCH slot is a superset of the PCI specification, and does not accept standard PCI cards. The PERCH slot on the desktop and tower enclosures supports Apple Audio, Audio/Video, and DVD-Video and Audio/Video input/output cards. The All-in-one enclosure does not support the DVD-Video and Audio/Video Card. This note does not provide the electrical specification for the PERCH slot.

- Video input/output: video input and output feature on Apple Audio/Video and Apple DVD-Video and Audio/Video input/output card configurations allow video input and output through RCA or S-Video connectors.

- Sound: Apple Audio/Video, Audio, and Apple DVD-Video and Audio/Video input/output card configurations support 16 bits/channel stereo input and output, external jack for sound in, front jacks for headphones on all-in-one enclosures, rear jack for stereophonic speakers, one built-in speaker in tower and desktop enclosures, stereo speakers on all-in-one enclosure.

- Hard disks: one internal ATA hard disk. A SCSI bus for additional internal SCSI devices and an external SCSI port for additional SCSI devices. PIO, singleword DMA, and multiword DMA data transfers are supported.

- Expansion bay (enclosure dependent): no device expansion in all-in-one enclosures, the desktop enclosure has two bays which allow adding internal 3.5-inch SCSI devices. Minitower enclosures support the addition of either 5.25 or 3.5-inch SCSI, ATA, or ATAPI devices. Some models may include an optional Iomega Zip drive. ATA, ATAPI, and SCSI device expansion may require additional cables that are not included in the enclosure.

- Floppy disk: one internal 1.4 MB GCR/MFM SuperDrive.

- CD-ROM drive: internal 24X-speed ATAPI CD-ROM drive.

- DVD-ROM drive: optional DVD-ROM drive providing support for 20X-speed CD-ROM and 2x-speed DVD-ROM media, as well as DVD-Video playback when configured with an Apple DVD-Video and Audio/Video Card. The Apple DVD-Video and Audio/Video Card is not compatible with the All-in-one models.

- Zip drive: optional 100 MB SCSI or ATAPI Zip drive. The SCSI Zip drive is found in the Power Macintosh G3 All-in-one and the original Power Macintosh G3 computers. The ATAPI Zip drive is found in the Power Macintosh G3 desktop and tower enclosures with V4.5 F1 and V4.5 F2 ROM logic boards.

- Processor bus: 64-bit wide, 66 MHz, supporting split address and data tenures.

- Standard Macintosh I/O ports: two serial ports, 10BaseT RJ-45 Ethernet port, a SCSI port, and an ADB port.

- Modem slot: 112-pin connector on the Apple Audio and Audio/Video I/O cards accepts an optional modem interface. The interface is a subset of the type of communications slot found in the Power Macintosh 4400, 5500, and 6500 computers. It is strictly a modem interface and does not carry the PCI signals like the comm-slot II does.

- PCI card expansion slots: the modular and minitower enclosures accept three 12-inch PCI cards; three 15-watt cards or two 25-watt cards. The all-in-one enclosure accepts 6.88-inch PCI cards with the same electrical characteristics.

- Power switch: soft power controlled from keyboard.

- Voltage switch on desktop and minitower enclosures: allows selection of either 115 for voltages of 100–130 V or 230 for voltages of 200–230 V depending on the voltage which you will be connecting to. The voltage selection must be set manually for the desktop and minitower enclosures.

- Fan speed control: The speed of the fan is thermally controlled and is automatically set to the lowest possible speed to minimize noise. The fan speed varies according to the temperature inside the enclosure.

- Energy saving: sleep, startup, and shutdown scheduling can be controlled with an Energy Saver control panel.

Power Macintosh G3 All-in-one Features

This section lists the features incorporated into the design of the Power Macintosh G3 All-in-one since the first release of the Power Macintosh G3 computer.

The Power Macintosh G3 All-in-one computer is currently available only through the Apple North America Education channel and for distribution only in the United States and Canada.

The features introduced with the Power Macintosh G3 All-in-one computer are:

- New all-in-one enclosure design including tilt and swivel base for easy monitor positioning, stereo speakers, two 3.5mm mini-plugs on the front of the enclosure for stereo headphones, built-in 15-inch multisync display with digital geometry controls accessible through the Monitors & Sound control panel, and a front volume control.

- Mac OS 8.1 system software with extensions to support an all-in-one enclosure.

- An easy access pull-out tray for the logic board. See "Access to the Logic Board" (page 22) for additional information about accessing the logic board.

- Improved support for multifunction PCI cards.

- Support for the ATA Device 0/1 specification, which supports two ATA devices on a single ATA channel. Additional information about the ATA Device 0/1 specification and the Macintosh APIs that support it, can be found in the ATA Device 0/1 Developer Guide on the Developer CD and at the Apple Developer web site.

- ATI 3D RAGE PRO graphics controller; 100 MHz graphics memory bus.

- Addition of RGB signals on the Audio and Audio/Video input/output cards to support the built-in internal monitor. A ribbon cable is connected between the RGB output connector on the card and the internal monitor.

- Display mirror output up to 1024 by 768 at 16 bits per pixel (thousands of colors) is supplied for external monitors on the DB-15 video port connector.

Power Macintosh G3 Design Enhancements

Many of the features incorporated into the logic board and Apple expansion modules that support the Power Macintosh G3 All-in-one computer are also incorporated into the logic board and expansion modules of the desktop and minitower computers that were built with the V4.5 F1 and V4.5 F2 ROM logic boards. The enhanced features include:

■ Improved support for PCI Multifunction cards.

■ Support for the ATA Device 0/1 specification, which supports two ATA devices on a single ATA channel. There are two ATA channels on the logic board of all Power Macintosh G3 computers.

■ ATI 3D RAGE PRO graphics controller; 100 MHz graphics memory bus providing improved graphics performance and support for higher resolution displays.

■ Configured with the same enhanced Apple Audio/Video and Audio input/output cards as those installed in the All-in-one computer configurations. Power Macintosh computers with the V4.5 F2 ROM on the MLB can be ordered with the Apple DVD-Video and Audio/Video Card option, which includes the card and DVD drive.

■ More build-to-order (BTO) options at the Apple Store.
<http://www.apple.com/store>

External Features

The Power Macintosh G3 computer is available in an all-in-one enclosure for the education market only, a desktop enclosure, and a minitower enclosure. This section describes the features of the three enclosures.

Front View of the All-in-one Enclosure

Figure 1-5 is a front view of the Power Macintosh G3 All-in-one enclosure. The front view shows the location of the openings for the CD-ROM drive, floppy disk, optional ZIP drive, the built-in monitor, the built-in microphone, the stereo speakers, the sound control button (with integrated power-on light), and the headphone jacks.

Figure 1-1   Front view of the enclosure
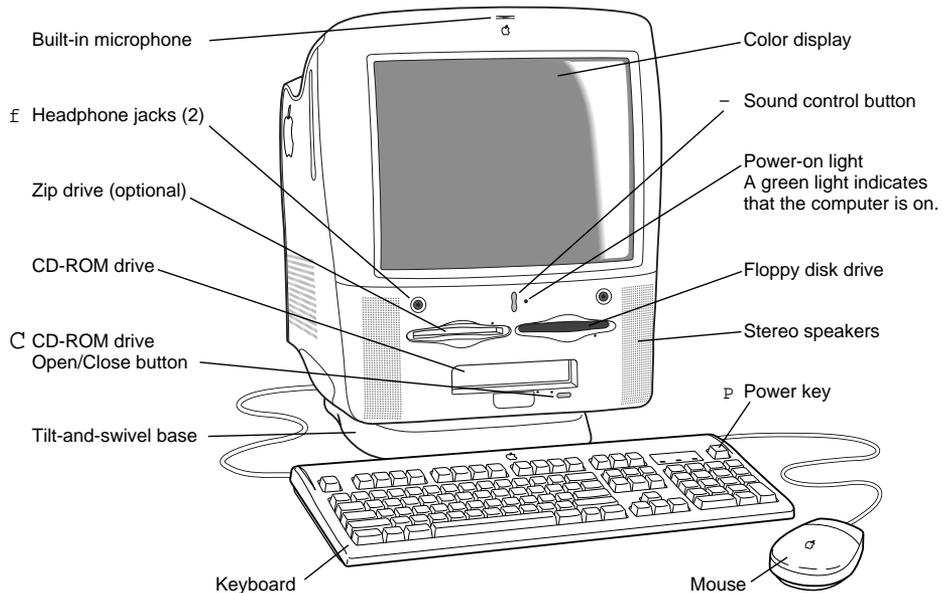
Back View of the Enclosure

The back panel includes the power input socket, the power switch, the I/O ports, the openings for PCI cards, and the opening for I/O access to the expansion features of the input/output cards in the PERCH slot.

Figure 1-6 shows the back view of the enclosure for the Power Macintosh G3 All-in-one computer.

Figure 1-2   Back view of the enclosure

Power switch

Power socket

[Printer port

V Apple Desktop Bus
(ADB) port

g SCSI port

G Ethernet port (10Base-T)

W External modem port
(This port is covered if an
internal modem is installed.)

F Security lock port

– Sound output port

Sound input port

Access covers for
expansion slots (3)

W Internal modem card
(optional)

™ External monitor port

Internal hard disk drive
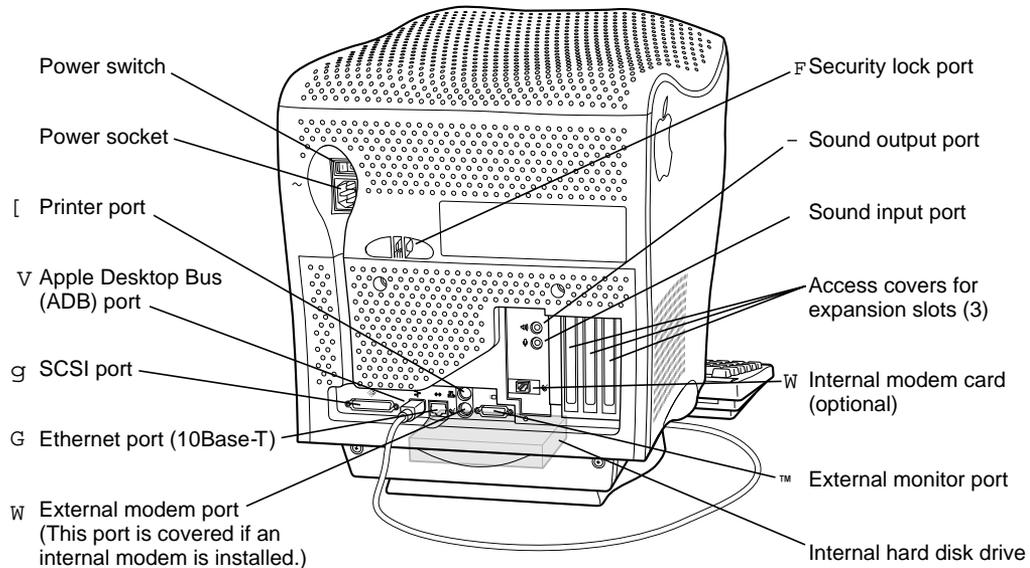
Note
The back view illustrations in Figures 1-2 and 1-3 show only the Audio I/O ports. The All-in-one enclosure also supports the Audio and Video I/O ports on the Apple Audio Video Card.

Access to the Logic Board

You can access the logic board to add expansion DRAM, expansion graphics memory, or PCI expansion cards by removing four captive screws and pulling the logic board tray out, as shown in Figure 1-7 and Figure 1-4.

Figure 1-3   Accessing the main logic board in pull-out tray

Remove these four screws
and pull the logic board
tray out until it stops.

Pull the logic board tray
out by grasping this handle.

Introduction
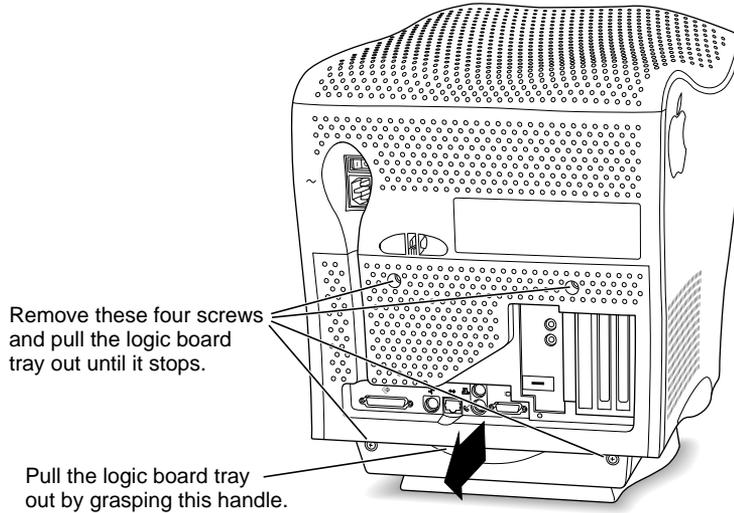
Figure 1-4 Logic board tray open

Reinstall the screw to secure the card in place.

Port access opening PCI slot

You may need to support the underside of the
logic board tray with your hand when you install PCI cards.
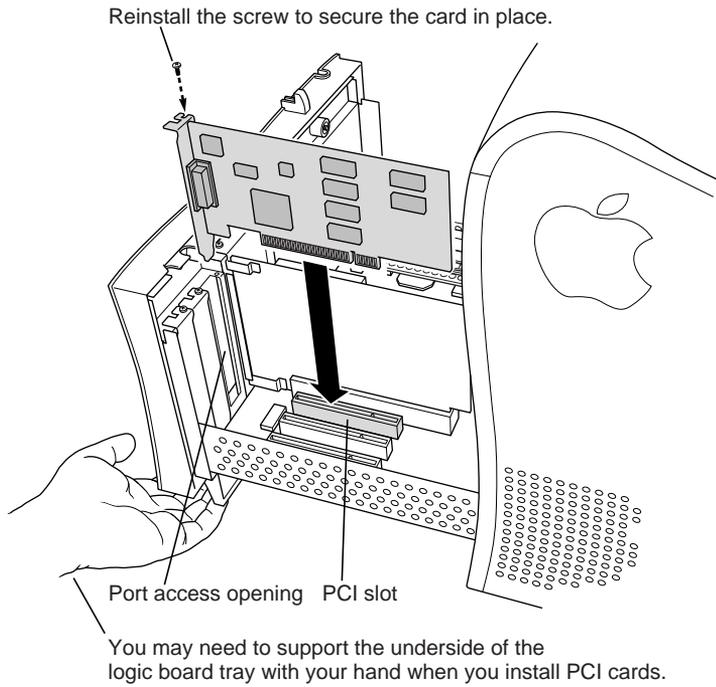
Front View of the Desktop Enclosure

Figure 1-5 is a front view of the Power Macintosh G3 desktop enclosure. The front view shows the location of the expansion bay, the openings for the CD-ROM drive, optional ZIP drive, floppy disk, the power button, and power-on light.

Figure 1-5   Front view of the desktop enclosure
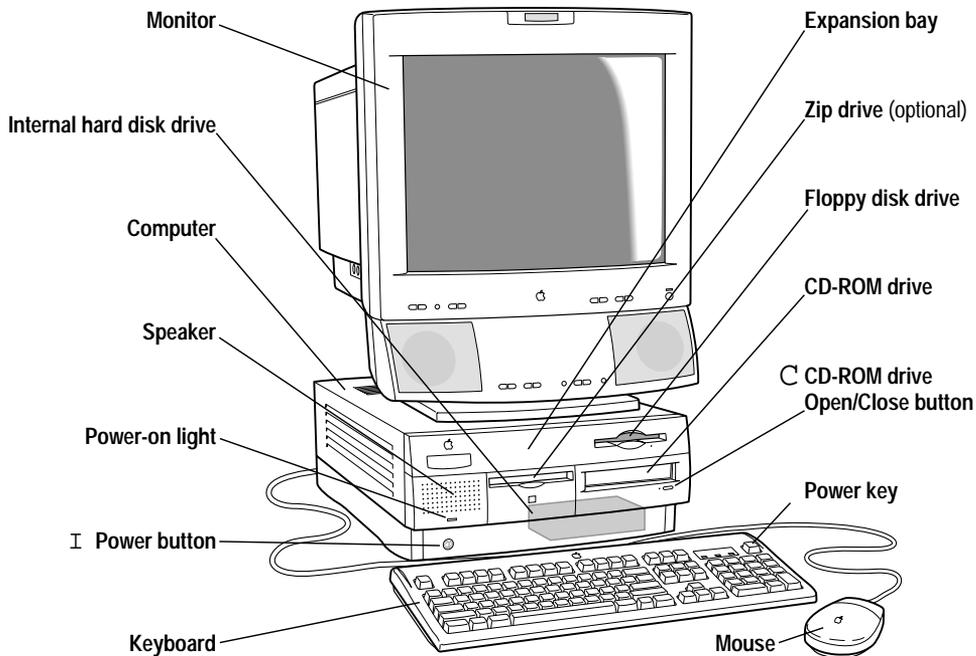
Back View of the Desktop Enclosure

The back panel includes the power socket, the monitor power socket, the reset button, the I/O ports, the openings for PCI cards, and the opening for I/O access to the expansion features of the input/output cards in the PERCH slot.

Figure 1-6 shows the back view of the desktop enclosure for the Power Macintosh G3 computer.

Figure 1-6   Back view of the desktop enclosure

[**Printer port (GeoPort)**   **Monitor power socket**   **Power socket**   − **Sound output port**

W **External modem port (GeoPort)**   **Sound input port**

F **Security lock ports**   **Access covers for expansion slots (3)**

g **SCSI port**   W **Internal modem card** (optional)

V **Apple Desktop Bus (ADB) port**   G **Ethernet port (10Base-T)**   ™ **Monitor port**
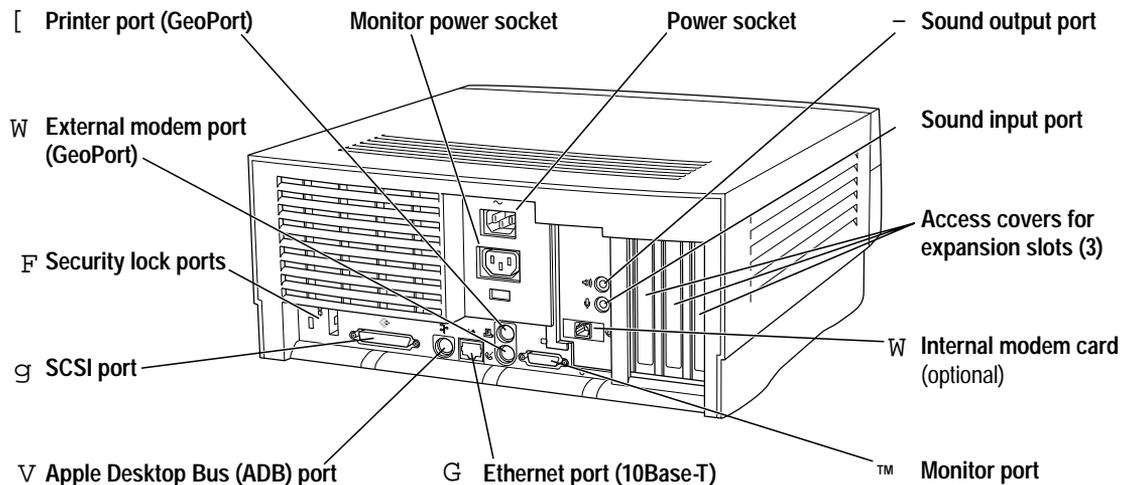
Note
The back view illustration of the desktop enclosure shows only the Audio I/O ports. The desktop enclosure also supports the Audio and Video I/O ports on the Apple Audio Video Card.

Access to the Logic Board in the Desktop Enclosure

You can access the logic board to add expansion DRAM, expansion graphics memory, or PCI expansion cards by removing the top of the case and swinging the sub chassis up, as shown in Figure 1-7.

Figure 1-7   Accessing the main logic board in desktop enclosure

Gently swing the top part of the chassis
up so that it rests on the support foot.

Support arm

Be sure that the support arm engages this hole on the floor of
the bottom chassis so that the top chassis is locked in place.
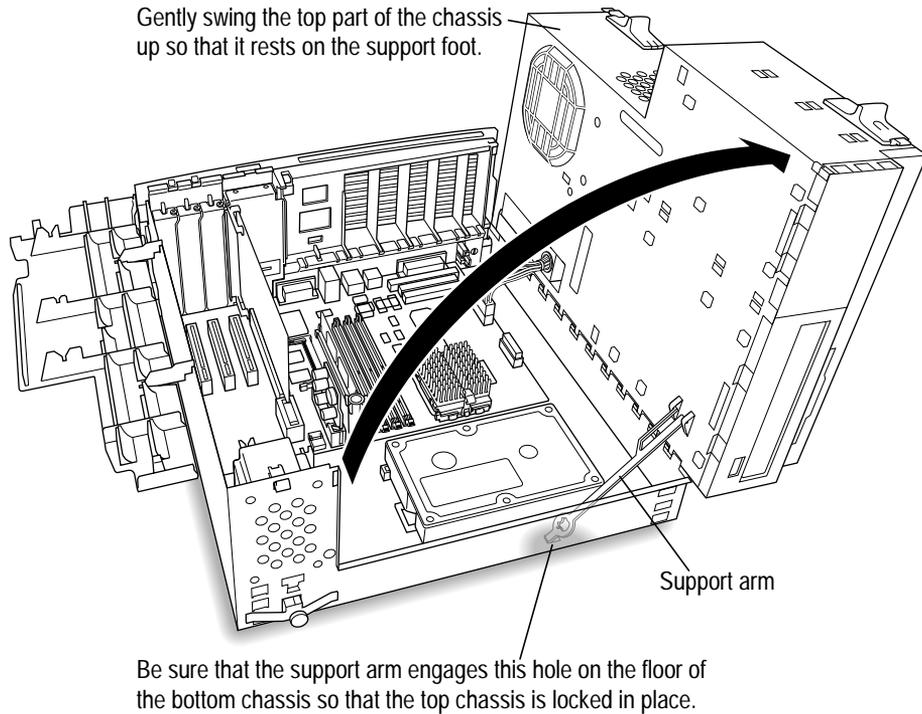
Front View of the Tower Enclosure

Figure 1-8 is a front view of the Power Macintosh G3 tower enclosure. The front view shows the location of the expansion bay, the openings for the CD-ROM drive, floppy disk and Zip drive, and the power-on light.

Figure 1-8   Front view of the tower enclosure

- Floppy disk drive
- CD-ROM drive
- Zip drive (optional)
- Expansion bay
- Power button/ Power-on light
- Speaker
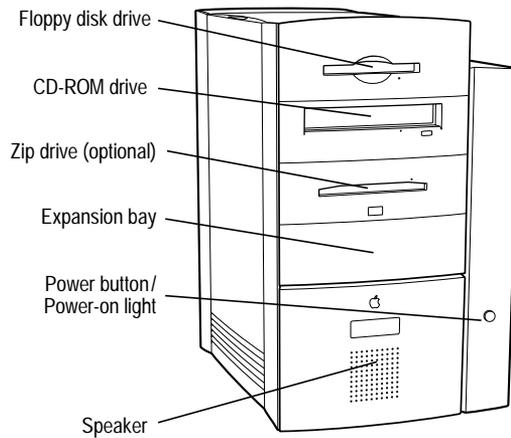
Back View of the Tower Enclosure

The back panel includes the power socket, the monitor power socket, the I/O ports, the openings for PCI cards, and the opening for I/O access to the AV expansion features of the input/output cards in the PERCH slot.

Figure 1-9 shows the back view of the tower enclosure for the Power Macintosh G3 computer.

Figure 1-9   Back view of tower enclosure

g **SCSI port**

V **Apple Desktop Bus (ADB) port**

G **Ethernet port (10Base-T)**

[**Printer port**

W **External modem port**

™ **Monitor port**

W **Internal modem card** (optional)

Æ æ **S-video ports (OUT and IN)**

– **Sound output port**

Sound input port

Â ~ **Composite video ports (OUT and IN)**

Optional AV ports

Internal hard disk drive

Lockable cover latch

Power socket

Monitor power socket

Sound input port

– **Sound output port**

F **Security lock port**

Access covers for expansion slots (3)

– **Audio output ports (left & right)**

– **Audio input ports (left & right)**

Optional Features

Several features of the logic board are implemented as plug-in modules available either as a configuration option at the time of purchase.

Video Input

The Apple Audio/Video Input/Output Card and Apple DVD-Video and Audio/Video Card accept video from an external source and display it in a window on the computer's display. In addition to AV support, the Apple DVD-Video and Audio/Video Card also plays video from DVD media in a DVD drive. The features of the video portion of the Apple Audio/Video and Apple DVD-Video and Audio/Video input/output cards are

■ acceptance of video input in NTSC, PAL, and SECAM formats

■ connectors for stereo sound, composite video, and S-video (Y/C)

■ video display in a 320-by-240 pixel window with scaling support for display at 640 by 480 (Apple Audio/Video Input/Output Card)

■ video display of NTSC format in a 640-by-480 pixel window without scaling (Apple DVD-Video and Audio/Video Card)

■ video display of PAL/SECAM format in a 768-by-576 pixel window without scaling (Apple DVD-Video and Audio/Video Card)

■ video overlay capability

■ YUV format for digital video input

■ a bi-directional digital audio video (DAV) connector for adding a video processor on a PCI expansion card (not available on the Apple DVD-Video and Audio/Video Card)

The Audio/Video Input/Output Card provides AV features for the Power Macintosh G3 computer. The Apple DVD-Video and Audio/Video Card provides AV features and DVD video media playback. The AV cards can accept video input from an external device, such as a VCR or camcorder. The external device can be connected to the cards through either the composite video connector or the S-video connector.

The default window size for the Apple Video Player software is 320 by 240 pixels; the user can resize the window up to 640 by 480 pixels.

The default DVD-video presentation window size for the Apple DVD Player software is 640 by 480 pixels; the user can select three predetermined window sizes or set the window to proportionally fill the entire screen of the current display. The Apple DVD Player software displays input from DVD media in the DVD drive; no other video input source can be viewed with the Apple DVD Player software

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Video can be recorded onto the hard drive from an external source at up to 30 frames per second at 320 by 240 pixels using the Apple Audio/Video Input/ Output Card. To capture video at 30 frames per second in a 320 x 240 pixel window, the G3 Video Input Update system extension must be installed. The Apple DVD-Video and Audio/Video Card supports video capture at 640 by 480 NTSC and 768 by 576 PAL and SECAM. Currently, it is not possible to capture video at 30 frames per second into a 640 by 480 pixel window without additional high-speed storage hardware.

The video input circuitry for the Power Macintosh G3 computer is provided by the Apple Audio/Video Input/Ouptut Card or the Apple DVD-Video and Audio/Video Card which plug into a dedicated PERCH slot on the main logic board. The PERCH slot connector is a 182-pin microchannel connector. The PERCH slot is a superset of the PCI specification, and it does not accept standard PCI cards.

IMPORTANT
You cannot record digital video onto the hard disk from a movie playing in DVD mode in a DVD drive.

Video Output

The Apple Audio/Video Input/Output Card and Apple DVD-Video and Audio/Video Card provide video output features for the Power Macintosh G3 computer. The video output features are

■ output of NTSC and PAL video formats

■ output connectors for composite and S-video output

Note
Viewing DVD movies requires the Apple DVD-Video and Audio/Video Card and a DVD-ROM drive.

Viewing DVD movies using the Apple DVD-Video and Audio/Video Card is optimized for monitors that support 800-by-600 pixel resolution or larger and display 256 or more colors. The optimum resolution for viewing DVD movies on a television is 720 by 480 pixels. If you are using an external monitor, you cannot view DVD movies on both the internal and external monitor at the same time.

The Apple DVD Player software supports viewing of DVD media designed to play in Region 1 (United States and Canada).

Audio Input and Output

The audio I/O features for Power Macintosh G3 computers are provided on the Apple DVD-Video and Audio/Video Card, Audio/Video Card, and Audio I/O Card when plugged into the PERCH slot on the main logic board. These cards include a line-level audio input port for a microphone or other line-level stereo input and an audio output port for use of headphones or amplified speakers. The Apple DVD-Video and Audio/Video Card and Apple Audio/Video Input/ Output Card also include RCA jacks for audio input and output. Connection to the front panel sound push buttons, on all-in-one enclosures configured with either the Audio/Video Input/Output Card or Audio Input/Output Card, provides for control of the sound output volume by pushing the volume control buttons on the front panel.

Note
The Apple DVD-Video and Audio/Video Card is not
supported in the Power Macintosh G3 All-in-one enclosure.

The sound specifications for the sound ports on AV configurations of the Power Macintosh G3 computers are

- 16-bit stereo input and output

- sample rates of 11.025, 22.05, and 44.1 kHz (Apple Audio/Video and Audio input/output cards)

- sample rate of 44.1 kHz (Apple DVD-Video and Audio/Video Card)

- input line level (Audio/Video and Audio input/output cards): 2 Vpp maximum into 10 kilohms impedance; nominal signal to noise (SNR) ratio 80 dB, 85 dB typical (A-weighted, 2 Vpp output, 1 kHz, digital record and playback, sound input port to sound output port); for the the Apple DVD-Video and Audio/Video Card the nominal A-weighted SNR is better than 90 dB

- frequency response (Audio/Video and Audio input/output cards): 20 Hz–18 kHz (+−3 dB relative to 1 kHz)

- frequency response (DVD-Video and Audio/Video Card) 20 Hz–18 kHz (+−1 dB relative to 1 kHz)

Stereo audio input for video audio is connected to the right audio channel (red) and left audio channel (white) RCA connectors. The composite video and S-video connectors use the same RCA audio connectors for video audio input.

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Communications

The Apple DVD-Video and Audio/Video Card, Audio Input/Output Card, and Audio/Video Input/Output Card have a modem slot that allows the computer to support an internal modem communications module without occupying the PCI expansion slot.

Telephony audio is supported through the circuitry on the Apple DVD-Video and Audio/Video Card, Audio Input/Output Card, and Audio/Video Input/Output Card.

Internal Device Expansion Bays

The expansion bays in the desktop and tower enclosures include data and power connectors for adding additional devices. In system with the 4.0F2 ROM on the logic board there is only support for adding SCSI devices. In systems with the 4.5F1 ROM on the logic board, excluding the Power Macintosh G3 All-in-one, the internal SCSI cable is not provided. Instead there is an ATA cable with two connectors, one of which is connected to the ATAPI CD-ROM. If a ZIP drive is present, then the second ATA connector is connected to the Zip drive.

The three expansion bays in the tower enclosure are configured to support 1-inch-high 3.5-inch or 5.25-inch devices. The three expansion bays in the desktop enclosure support 1-inch-high 3.5-inch devices. Some configurations include an optional Zip drive in one of the expansion bays.

In the all-in-one enclosure an optional 100 MB ZIP drive can be placed in the left bay above the CD-ROM drive. There are no additional bays for device expansion available inside the all-in-one enclosure.

Compatibility Issues

The Power Macintosh G3 computers incorporate several changes from earlier desktop models. This section describes key issues you should be aware of to ensure that your hardware and software work properly.

Machine Identification

All of the Power Macintosh G3 computers have a machine ID value of 510 (hexadecimal 1FE). Applications can find out which computer they are running on by using the Gestalt Manager routines. *Inside Macintosh: Overview* describes the Gestalt Manager and tells how to use the `gestaltMachineType` value to obtain the machine name string.

It is possible to get the ROM subversion value to determine if the logic board is the original Power Macintosh G3 logic board with the V4.0 F2 ROM or an enhanced logic board with the V4.5 F1 or V4.5 F2 ROM. The following prototype example code can be used to get the ROM subversion number of the Power Macintosh G3 logic board.

```
#include <LowMem.h>
.
.

UInt16 GetROMSubversion(void)
{
    return *(UInt16*)((UInt32)LMGetROMBase() + 0x12);
}
```

Modem Slot

The modem slot in the Power Macintosh G3 computers is not a PCI bus compatible communications slot (comm slot II) like the comm slot in the Power Macintosh 5500 and 6500 computers. The modem slot is strictly for modem cards that do not require the use of the PCI signals. The modem slot is located on the Apple DVD-Video, Audio/Video, and Audio input/output cards rather than on the main logic board, as it is on previous Macintosh models that include a comm slot.

Expansion Slots

The three I/O expansion slots are PCI expansion slots that conform to the PCI V2.1 specification.

RAM Expansion

The logic board uses JEDEC-standard 64-bit (non-parity) 168-pin 3.3-volt unbuffered SDRAM DIMM cards. Because the maximum amount of devices supported on a DIMM is 16, 256 MB SDRAM DIMMs require 128 Mbit devices. For information about DRAM DIMM configurations supported on the Power Macintosh G3 logic board, see "RAM DIMMs" beginning on page 64.

RAM DIMM Height Dimensions

The maximum supported height of RAM DIMM cards depends on the enclosure. The maximum height of RAM DIMMs in the Power Macintosh G3 desktop enclosures is 1.15 inches. The maximum height of RAM DIMMs in the Power Macintosh G3 tower and all-in-one enclosures is 1.5 inches.

L2 Cache Expansion

The Power Macintosh G3 back-side L2 cache is integrated into the design of the microprocessor module. No cache expansion is possible.

CD-ROM Drive

The CD-ROM drive is an ATAPI CD-ROM drive, rather than a SCSI drive. The system software release includes version 4.0 of the ATA Manager and supports PIO, singleword DMA, and multiword DMA data transfers.

Power Supply

The power supply in and tower enclosures is not self-configuring for different input voltages. The voltage switch is delivered preconfigured for the input voltage of the region in which the unit is originally purchased. If the computer is moved to another location where the input voltage is different, a voltage switch must be adjusted to accommodate the voltage change. The switch has two positions that support voltage ranges of 100 to 130 V or 220 to 270 V.

The monitor power socket is not switched. Anytime power is connected to the power supply, power is available on the monitor power socket. A monitor that does not support energy saving features that is connected to the monitor power

socket will not power off when the computer is shut down. Monitors that do not support energy saving features have to be switched manually.

Video RAM Expansion

The Power Macintosh G3 computers include 2 MB of SGRAM on the main logic board. The video RAM can be expanded to 4 MB or 6 MB with an additional 2 MB or 4 MB of SGRAM on a 144-pin SO-DIMM (small outline dual inline memory module). The difference between supported display modes when using 4 MB or 6 MB of video memory is minimal, see Table 3-2 (page 58). However, 6 MB of SGRAM provides additional memory for storing 3D textures. The additional memory allocated for 3D texture storage results in increased 3D graphics performance for QuickDraw 3D aware applications.

The mechanical characteristics of the SGRAM expansion DIMM are given in the JEDEC specification for the 144-pin 8-byte graphics SO-DIMM. The devices on the DIMM must be 3.3 V, 100 MHz/10ns or faster, SGRAM devices. Additional information about memory devices and 144-pin SGRAM SO-DIMMs can be found at

<http://www.jedec.org/download/freestd/pub21/4_5_8-R8.PDF>

Built-in Video and Graphics Features

The Power Macintosh G3 computers have the following built-in video and graphics capabilities:

- ATI 3D RAGE II+DVD 64-bit graphics and multimedia accelerator on V4.0 F2 ROM logic boards or ATA 3D RAGE PRO-PCI 64-bit graphics and multimedia accelerator on V4.5 F1 and V4.5 F2 ROM logic boards

- 2 MB of synchronous graphic RAM (SGRAM)

- Hardware acceleration of 2D QuickDraw graphics and video to speed up scrolling text and graphics and screen redraw operations

- Hardware acceleration of video for full screen, full motion, TV-quality playback of Cinepak and MPEG1 QuickTime movies

- Bilinear hardware interpolation and scaling

- Accelerates 3D QuickDraw rendering up to 6 times that of software-only rendering

- Real-time 3D shaded object manipulation, animation, and virtual world navigation

- Includes 16-bit Z buffer for hidden texture surface removal

- Provides six perspectively correct texture mapping functions

- Alpha blending, transparency, and fog effects

- Flat and Gouraud shading

- Video textures and video lighting

The graphics acceleration features enhance the realism of 3D interactive application software and games.

For information about the supported display modes for video input and QuickDraw 2D and QuickDraw 3D acceleration capabilities, see "Video Input and Graphics Acceleration Display Modes" beginning on page 59.

Architecture

This chapter describes the architecture of the Power Macintosh G3 computers, which consists of a main logic board and one of two input/output cards installed in the PERCH connector. It describes the major components of the main logic board: the microprocessor, the custom ICs, and the display RAM. Input and output connectors are discussed in Chapter 3, "I/O Features."

Block Diagrams and Main ICs

The architecture of the main logic board is based on the PowerPC G3 microprocessor and two buses: the processor bus and the PCI bus. The processor bus connects the microprocessor, video, cache, and memory; the PCI bus connect the expansion slots and the I/O devices. The PCI interface on the Power Macintosh G3 computers conforms to PCI specification revision 2.1. Figure 2-1 shows the main logic board block diagram.

Figure 2-1   Main logic board block diagram
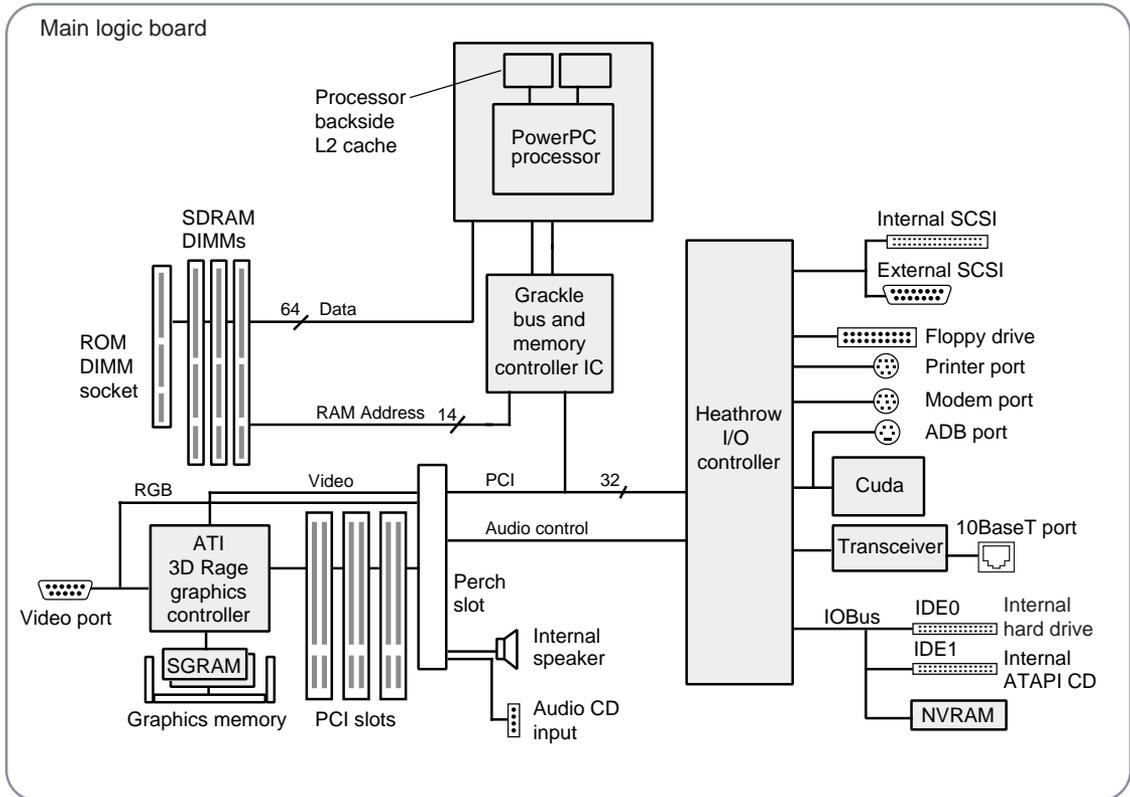
Audio Input/Output Card

The Audio input/output card, which is installed in the PERCH slot on the main logic board, provides sound input and output features for the Power Macintosh G3 computers. Figure 2-2 shows the Audio input/output card block diagram.

Figure 2-2   Audio input/output card block diagram
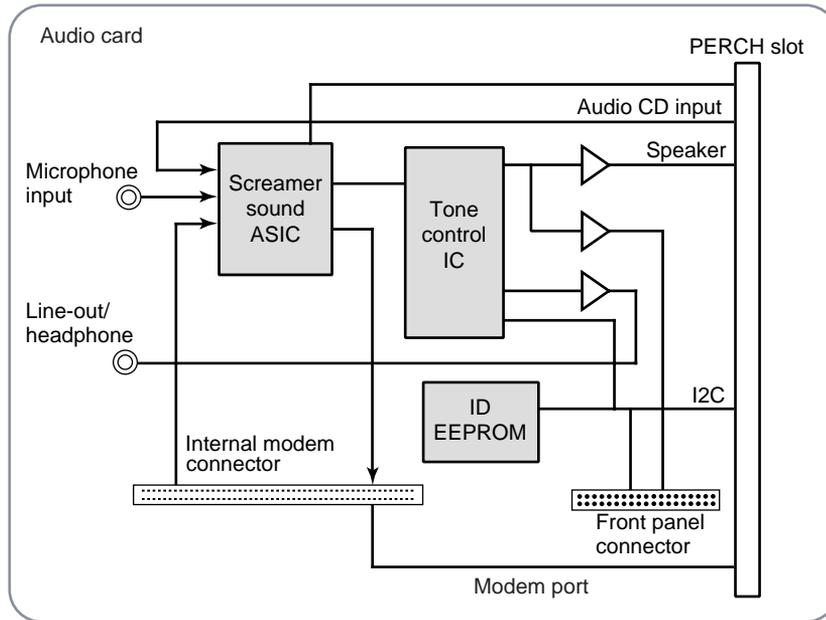
Audio/Video Input/Output Card

The Audio/Video input/output card, which is installed in the PERCH slot on the main logic board in AV configurations of the Power Macintosh G3 computers, provides the necessary circuitry for the audio and video input and output features. Figure 2-3 shows the Audio/Video input/output card block diagram.

Figure 2-3   Audio/Video input/output card block diagram
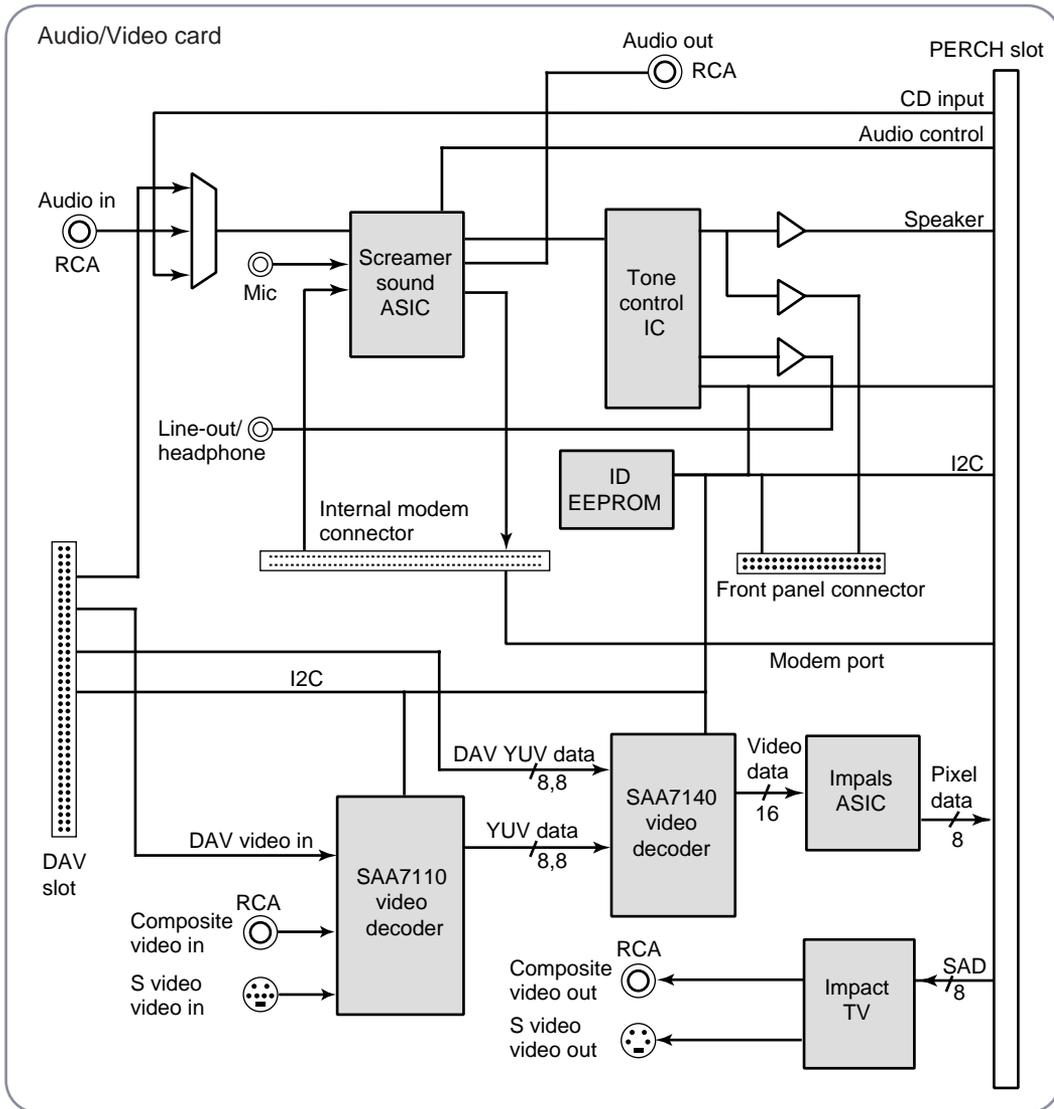
Apple DVD-Video and Audio/Video Card

The Apple DVD-Video and Audio/Video Card design is similar to the design of the Audio/Video input/output card. The Apple DVD-Video and Audio/Video Card differs from the Apple Audio/Video Card in that it does not include a DAV slot, uses a Burgundy sound ASIC, which provides improved sound performance, incorporates a higher-performance video capture IC, and includes additional circuitry to support the playback of DVD movies.

The Apple DVD-Video and Audio/Video Card uses a VPX3224 video capture IC that supports larger video capture frame sizes than the Apple Audio/Video Input/Output Card. Best overall results are achieved without vertical scaling.

Viewing DVD movies using the Apple DVD-Video and Audio/Video Card is optimized for monitors that support 800-by-600 pixel resolution or larger and display 256 or more colors. The optimum resolution for viewing DVD movies on a television is 720 by 480 pixels. If you are using an external monitor, you cannot view DVD movies on both the internal and external monitor at the same time.

Note
Viewing DVD movies requires the Apple DVD-Video and Audio/Video Card and a DVD-ROM drive.

PowerPC Microprocessor

The main logic board supports the third generation (G3) PowerPC 750 series of microprocessors running at 233 MHz, 266 MHz, 300 MHz, and 333 MHz. Apple refers to these processors as PowerPC G3 microprocessors.

The principal features of the PowerPC G3 microprocessor include

■ full RISC processing architecture

■ parallel processing units: load-store unit, two integer units, one complex integer unit, and one floating-point unit

■ a branch manager that can usually implement branches by reloading the incoming instruction queue without using any processing time

■ integrated L2 cache controller and Tag RAMs for high performance memory access

■ an internal memory management unit (MMU)

■ 64 KB of on-chip cache memory (32 KB each for data and instructions)

For complete technical details, see the Motorola PowerPC Library web page at <http://www.mot.com/SPS/PowerPC/library/library.html>.

The PowerPC G3 is located on a plug-in microprocessor card module which includes the L2 cache.

Memory Subsystem

The memory subsystem of the main logic board consists of RAM, ROM, and back-side second-level (L2) cache, in addition to the PowerPC microprocessor cache. The Grackle custom IC provides burst mode control to the ROM.

ROM

The ROM consists of 4 MB of ROM installed in a DIMM socket.

Second-Level Cache

The back-side second-level (L2) cache consists of 512 KB or 1 MB of SRAM. The cache is on the microprocessor card module. This cache runs at one half the speed of the microprocessor, a ratio of 2:1.

System RAM

The Power Macintosh G3 computers have 0 MB of DRAM memory soldered on the main logic board. All RAM expansion is provided by SDRAM devices on 64-bit 168-pin JEDEC-standard 3.3-volt unbuffered SDRAM DIMMs. Three DIMM sockets are used for memory expansion. Supported DIMM sizes are 8, 16, 32, 64, 128, and 256 MB. The DIMM sockets support both one-, two-, and 4-bank SDRAM DIMMs with no more than 16 memory devices on a DIMM. To accommodate the 16 device load limit, 256 MB SDRAM DIMM require 16M x 8 or higher density devices. The Grackle custom IC provides memory control for the system RAM.

For additional information about SDRAM DIMMs for Power Macintosh G3 computers, see "RAM DIMMs" (page 64).

Custom ICs

The architecture of the main logic board is designed around five large custom integrated circuits:

- the Grackle memory controller and PCI bridge

- the Heathrow I/O subsystem and DMA controller

- the Screamer sound processor (on Audio/Video and Audio input/output cards, not on the main logic board)

- the Cuda soft-power controller

- the ATI 3D RAGE video subsystem (an ATI 3D RAGE II+DVD graphics controller is used on systems with the V4.0F2 ROM, an ATI 3D RAGE PRO graphics controller is used on systems with the V4.5F1 and V4.5F2 ROM)

The computer also uses several standard ICs that are used in other Macintosh computers. This section describes only the custom ICs.

Grackle IC

The Grackle IC functions as the bridge between the PowerPC microprocessor bus and the I/O and graphics devices on the PCI bus. It provides buffering and address translation from one bus to the other.

The Grackle IC also provides the control and timing signals for ROM and RAM. The memory control logic supports byte, word, longword, and burst accesses to the system memory. If an access is not aligned to the appropriate address boundary, Grackle generates multiple data transfers on the bus.

Memory Control

The Grackle IC controls the system RAM and ROM and provides address multiplexing and refresh signals for the DRAM devices. For information about the address multiplexing, see "RAM Address Multiplexing" (page 66).

PCI Bus Bridge

The Grackle IC acts as a bridge between the processor bus and the PCI expansion bus, converting signals on one bus to the equivalent signals on the other bus. The PCI bridge functions are performed by two converters. One accepts requests from the processor bus and presents them to the PCI bus. The

other converter accepts requests from the PCI bus and provides access to the RAM and ROM on the processor bus.

The PCI bus bridge in the Grackle IC runs synchronously. The processor bus operates at a clock rate of 67 MHz, and the PCI bus operates at 30 or 33 MHz.

The PCI bus bridge generates PCI parity as required by the PCI bus specification, but it does not check parity or respond to the parity error signal.

Heathrow IC

The Heathrow IC is an I/O controller and DMA engine for Power Macintosh computers using the PCI bus architecture.

Heathrow also provides power-management control functions for energy saving features included on Power Macintosh computers. The Heathrow IC is connected to the PCI bus and uses the 30–33 MHz PCI bus clock.

The Heathrow IC includes circuitry equivalent to the Ethernet, IDE, SCC, SCSI, SWIM3, and VIA controller ICs. The functional blocks in the Heathrow IC include the following:

- gated clocks PCI bus arbiter

- system wide interrupt handling

- a SWIM3 floppy drive controller

- a MESH-based (Macintosh enhanced SCSI hardware) SCSI controller

- SCC serial I/O controller

- IDE hard disk interface controller

- sound control logic and buffers

- 10Base-T Ethernet controller

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

- ADB device controller

- VIA system interface to the Cuda IC

- Screamer sound input and output IC

- 8 KB nonvolatile RAM control

The SCSI controller cell in the Heathrow IC is an 8-bit MESH controller. The MESH cell supports data transfer rates of 5 MB per second.

The Heathrow IC also contains a serial interface and sound control logic for the Screamer sound IC on the Audio/Video and Audio input/output cards.

The 85C30 SCC cell in the Heathrow IC is an 8-bit device. The SCC circuitry supports serial and LocalTalk protocols.

Screamer Sound IC

The Screamer custom IC combines a waveform amplifier with a 16-bit digital sound encoder and decoder (codec). The Screamer IC supports all of the audio input and output features on the Audio/Video and Audio input/output cards. The Screamer IC provides improved audio performance over the AWACS IC used in previous Macintosh computers. For additional information about the audio features of the Audio/Video and Audio input/output cards, see "Sound" (page 52).

Burgundy Sound IC

The Burgundy custom IC combines a waveform amplifier with an internal 18-bit digital sound codec (only 16 bits supported for analog to digital/digital to analog sound capture and playback). The Burgundy IC supports all of the audio input and output features on the DVD-Video and Audio/Video Card. The Burgundy IC provides improved audio performance over the Screamer IC used on the Audio/Video and Audio input/output cards.

Cuda IC

The Cuda IC provides several system functions, including

- management of soft system resets; warm reset is controlled by the ADB cell in the Heathrow IC

- management of the real-time clock

- software control of the power supply

Graphics Controller

The ATI 3D RAGE graphics controller contains the logic for the video display. It includes the following functions:

■ architecture optimized to support high-speed SGRAM video memory

■ display memory controller, built-in drawing coprocessor, video scaler, color space converter, clock generator, and true color palette video DAC (digital-to-analog converter)

■ video CLUT (color lookup table)

■ hardware graphics acceleration with a 16-bit Z-buffer

■ accelerates QuickDraw 3D rendering up to 6 times that of software-only acceleration

■ true color palette DAC supporting pixel clock rates to 200 MHz for 1600 by 1200 resolution at 75 Hz

■ graphics and video line buffer for superior video scaling and playback quality

■ hardware cursor up to 64 x 64 x 2

■ DDC1 and DDC2B+ for plug-and-play monitor support

■ supports synchronous graphics RAM (SGRAM)

■ graphics control accessible through the QuickDraw, QuickDraw 3D, QuickDraw 3D RAVE, and QuickTime components APIs

A separate data bus handles data transfers between the ATI 3D RAGE graphics controller and the display memory. The display memory data bus is 64 bits wide, and all data transfers consist of 32 bits at a time. The ATI 3D RAGE IC breaks each 64-bit data transfer into several pixels of the appropriate size for the current display mode—4, 8, 16, 24, or 32 bits per pixel.

The ATI 3D RAGE graphics controller uses several clocks. Its transactions are synchronized with the PCI bus. Data transfers from the frame-buffer RAM are clocked by the MEM_CLK signal. Data transfers to the CLUT and the video output are clocked by the dot clock, which has a different rate for different display monitors.

The 2D graphics accelerator is a fixed-function accelerator for rectangle fill, line draw, polygon fill, panning/scrolling, bit masking, monochrome expansion, and scissoring.

Display RAM (Video RAM)

The display memory on the main logic board is separate from the main memory. The display memory consists of 2 MB of 100 MHz/10ns SGRAM devices configured to make a 64-bit data bus. The display memory can be expanded to 4 MB or 6 MB with a 2 MB or 4 MB SGRAM SO-DIMM card.

With the 2 MB of built-in video memory the display data generated by the computer can have pixel depths of 8, 16, or 32 bits for monitors up to 832 by 624 pixels, 8 or 16 bits for larger monitors up to 1152 by 870 pixels, and 8 bits for monitors supporting 1280 by 1024 pixels. Data from the video input module is always stored and transferred at 16 bits per pixel. The video frame buffers support live video in a 320-by-240 pixel frame at 30 frames per second. For a complete listing of the supported monitors and display resolutions, see "Video Input and Output" beginning on page 55.

The 100 MHz/10ns SGRAM SO-DIMM card specification provides suitable margins for compatibility with the Power Macintosh G3 computer architecture.

I/O Features

This chapter describes both the built-in I/O devices and the interfaces for external I/O devices. It also describes the types of external video monitors that can be used with the Power Macintosh G3 family of computers.

Serial I/O Ports

The main logic board has two standard Macintosh 9-pin mini-DIN serial ports, one for a printer and one for a modem. Both serial ports accept either 8-pin or 9-pin mini-DIN plugs. Both serial ports support the AppleTalk serial protocols.

ADB Port

The Apple Desktop Bus (ADB) port on the logic board is functionally the same as on other Macintosh computers.

The ADB is a single-master, multiple-slave serial communications bus that uses an asynchronous protocol and connects keyboards, graphics tablets, mouse devices, and other devices to the computer. The custom ADB microcontroller drives the bus and reads status from the selected external device. A 4-pin mini-DIN connector connects the ADB to the external devices. For more information about the ADB, see *Guide to the Macintosh Family Hardware,* second edition.

Note
The total current available for all devices connected to the +5 V pins on the ADB and the modem port is 500 mA. Each device should use no more than 100 mA. ◆

Disk Drives

The Power Macintosh G3 computers have a connector for one GCR/MFM internal high-density floppy disk drive, an ATA hard disk drive, an internal ATAPI CD-ROM drive, and internal and external SCSI devices. The modular

desktop and tower enclosures also provide expansion bays with power and data connectors for the addition of other SCSI devices.

Floppy Disk Drive

The logic board supports one high-density floppy disk drive (Apple SuperDrive). The drive is connected to a 20-pin connector on a cable that is connected to the main logic board.

ATA Hard Disk

The logic board supports an internal hard disk that uses the standard ATA-2 interface. The implementation of the ATA interface on the Power Macintosh G3 computers is a subset of the ATA interface specification, ANSI proposal X3T9.2/ 90-143, Revision 3.1.

The internal hard disk has a standard 40-pin ATA connector and a separate 4-pin power connector. The 40-pin connector cable is attached to the main logic board. The power cable is attached directly to the power supply.

ATAPI CD-ROM Drive

The Power Macintosh G3 computers have a 24X-speed internal ATAPI CD-ROM drive. The CD-ROM drive supports the worldwide standards and specifications for CD-ROM and CD-digital audio discs described in the Sony/ Philips Yellow Book and Red Book. The drive can read CD-ROM, CD-ROM XA, CD-I, and PhotoCD discs as well as play standard audio discs.

The CD-ROM drive has a sliding tray to hold the disc. The drive features a mechanism that supports 4X, 8X, 12X, and 24X data transfer rates and a data buffer that further enhances performance.

Zip Drive

A Zip drive is available as a build-to-order option at the time of purchase. In the Power Macintosh G3 All-in-one and original Power Macintosh G3 computers, the Zip drive was a SCSI device connected to the internal 50-pin SCSI connector on the main logic board. In Power Macintosh G3 desktop and tower computer configurations with ROM subversions V4.5 F1 or V4.5 F2, the Zip drive is an

ATAPI drive and is connected in a Device 0/1 configuration on one of the two ATA channels of the main logic board.

SCSI Bus

The Power Macintosh G3 computers have a SCSI bus for an additional internal SCSI devices, and one or more external SCSI devices. Additional internal SCSI devices receive power directly from the power supply.

SCSI Connectors

The SCSI connector for the internal SCSI devices is a 50-pin connector with the standard SCSI pin assignments. It attaches to a cable that is connected to the main logic board by the internal chassis connector. The external SCSI connector is a 25-pin D-type connector with the same pin assignments as the external SCSI connectors on previous Macintosh models. The external connector supports a maximum data transfer rate of 5 MB per second. The internal and external SCSI connectors share the same SCSI bus.

SCSI Bus Termination

The internal end of the SCSI bus is terminated by an active terminator. The terminator circuitry is located on the main logic board.

Sound

The sound system for the Power Macintosh G3 computers is implemented entirely on the Apple DVD-Video and Audio/Video Card, Apple Audio Input/Ouput Card, or Apple Audio/Video Input/Output Card. Each supports 16-bit stereo sound output and input, available simultaneously.

Like other AV class Macintosh computers, the sound circuitry on the Apple DVD-Video and Audio/Video, Audio, and Audio/Video input/output cards and system software can create sounds digitally and either play the sounds through speakers inside the enclosure or send the sound signals out through

the sound output jacks. The Power Macintosh G3 computers also record sound from several sources: a microphone connected to the line-level sound input jack, the sound in ports on the video input module, analog sound from an optional modem card connected to the internal modem connector, a compact disc in the CD-ROM player, or analog sound from a cross-platform card in a PCI slot. With each sound input source, sound playthrough can be enabled or disabled.

The Apple DVD-Video and Audio/Video Card does not support the all-in-one enclosure, nor does it support analog sound from cross-platform PCI cards.

Sound Output

All of the sound output features for Power Macintosh G3 computers are provided by the Apple DVD-Video and Audio/Video Card, Audio Input/ Output Card, or Audio/Video Input/Output Card. The Audio Input/Output Card provides one mini jack for sound output on the back of the enclosure. The DVD-Video and Audio/Video Card and Audio/Video Input/Output Card each provide three sound output connectors, two RCA jacks for right and left sound out, and one 3.5-mm mini jack for a stereophonic phone plug. The All-in-one model has an additional pair of 3.5-mm mini jacks for headphones on the front of the enclosure.

The output jacks are connected to the sound amplifier; the mini jacks are intended for connecting a pair of headphones or amplified external speakers. Inserting a plug into the sound output mini jack disconnects the internal speaker. The modular desktop and tower enclosures have one built-in speaker. All-in-one enclosures have a pair of front-firing stereo speakers and sound output jacks at the front and rear. In the all-in-one enclosure, the internal speakers are turned off when the rear jack is used for external speakers.

The Screamer IC provides the stereo sound output to both the internal speakers and the sound output jacks in configuration with the Apple Audio/Video and Apple Audio input/output cards. The Burgundy IC provides the stereo sound output to both the internal speakers and the sound output jacks in configurations with the Apple DVD-Video and Audio/Video Card.

Sound Input

The DVD-Video and Audio/Video, Audio/Video, and Audio input/output cards provide a stereo sound input jack on the back of the enclosure for connecting an external PlainTalk microphone or other sound source. The sound

input jack accepts a standard 3.5-mm stereophonic phone plug (two signals plus ground). The DVD-Video and Audio/Video and Audio/Video input/output cards provide an additional pair of RCA jacks for right and left sound input for an external source, such as a TV, VCR, or VTR.

The Power Macintosh G3 All-in-one computer has a built-in microphone for sound input located near the top of the enclosure.

The 3.5-mm sound input jack accepts either the Apple PlainTalk line-level microphone or a pair of line-level signals.

Note
The Apple PlainTalk microphone requires power from the main computer, which it obtains by way of an extra-long, 4-conductor plug that makes contact with a 5-volt pin inside the sound input jack. ◆

IMPORTANT
The microphone for the Macintosh LC and LC II does not work with the Audio or Audio/Video input/output cards; the cards require the line-level signal provided by the Apple PlainTalk microphone. ▲

Sound Input Specifications

The sound input jack has the following electrical characteristics:

■ input impedance: 10 kΩ

■ maximum input level: 2 V peak to peak (Vpp) maximum

Digitizing Sound

The sound circuitry digitizes and records sound as 16-bit samples. The computer can use any one of three sampling rates: 11.025K samples per second, 22.050K samples per second, or 44.100K samples per second. In the case of the Apple DVD-Video and Audio/Video Card sound is always sampled at 44.100kHz and the host performs sample rate conversion for output sample rates not equal to 44.100kHz.

The preferred sound sampling rate for output is specified in the Monitors and Sound control panel when the sound input is not in use. The preferred output

sampling rate is overridden by the setting of the input sampling rate, because the input and output sampling rates are physically locked together.

When recording sound from a microphone, applications that are concerned about feedback should disable sound playthrough by calling the Sound Manager APIs.

The Screamer IC on the Apple Audio and Audio/Video card configurations provides separate sound buffers for input and for stereo output so that the computer can record and send digitized sound to the sound outputs simultaneously. The Burgundy IC provides the sound buffers on Power Macintosh G3 configurations with the Apple DVD-Video and Audio/Video Card.

Video Input and Output

The Apple DVD-Video and Audio/Video Card and Apple Audio/Video Input/Output Card supports video input and output of composite and S-video signals. The cards support input of NTSC, PAL, and SECAM video formats, and output of NTSC and PAL video formats.

Viewing of DVD movies with the Apple DVD-Video and Audio/Video Card is optimized for monitors that are 800-by-600 pixels or larger and display 256 or more colors.

S-Video Connectors

The Apple DVD-Video and Audio/Video Card and Apple Audio/Video Input/Output Card have two S-video (Y/C) connectors, a standard 4-pin S-video connector for video output, and a 7-pin S-video connector for video input. The signal assignments on the 4-pin and 7-pin S-video connectors are the same as those earlier Power Macintosh computer S-video output and input connectors.

Composite Video Connectors

Composite video input and output are available on a pair of RCA-type connectors. The video input or output is connected to the center pin, and the outer shell is connected to video return.

Built-in Display Video

The built-in video circuitry in modular desktop and mini-tower configurations with the ATI 3D RAGE+DVD graphics controller supports pixel display sizes of 512 by 384, 640 by 480, 800 by 600, 832 by 624, 1024 by 768, 1152 by 870, 1280 by 960, 1280 by 1024, and 1600 by 1200.

The built-in video circuitry in modular desktop and mini-tower configurations with the ATI 3D RAGE PRO-PCI graphics controller supports pixel display sizes of 512 by 384, 640 by 480, 800 by 600, 832 by 624, 1024 by 768, 1152 by 870, 1280 by 960, 1280 by 1024, 1600 by 1200, and 1920 by 1080.

The built-in video circuitry in all-in-one configurations with the ATI 3D RAGE PRO-PCI graphics controller supports pixel display sizes of 512 by 384, 640 by 480, 800 by 600, 832 by 624, and 1024 by 768.

When power is applied, the monitor is initially set for a display size of 640 by 480 pixels. With a multisync monitor the user can switch the monitor resolution on the fly from the Monitor BitDepth and Monitor Resolution modules in the Control Strip or from the Monitors & Sound control panel.

External Video Connector

The cable from the external monitor plugs into a DB-15 video port located on the enclosure's rear panel. The pin assignments for the external video connector are the same as those for the Power Macintosh 5500 and 6500 computers.

External Video Monitors

This section includes two tables; Table 3-1 provides a list of display modes supported on the external video connector of the All-in-one enclosure, and Table 3-2 lists the display modes supported on the external video connector of the modular desktop and mini-tower enclosures. The display resolution values listed in Table 3-1 and 3-2 are supported on AppleVision monitors or DDC enabled monitors with the proper cable.

All-in-one Display Resolution Modes

The Power Macintosh G3 All-in-one can drive several sizes of external video monitors in display mirror mode. Table 3-1 shows the display resolution, vertical refresh, horizontal refresh, and maximum pixel depths supported by the Power Macintosh G3 All-in-one display graphics subsystem.

Table 3-1   Supported display resolutions for all-in-one enclosure

Display resolution	Vertical refresh	Horizontal refresh	Maximum pixel depth 2 MB	Maximum pixel depth 4 MB	Maximum pixel depth 6 MB
512 by 384	70 Hz	31.488 kHz	32	32	32
640 by 480	60 Hz	31.469 kHz	32	32	32
640 by 480	67 Hz	35.00 kHz	32	32	32
640 by 480	72 Hz	37.861 kHz	32	32	32
640 by 480	75 Hz	37.500 kHz	32	32	32
640 by 480	85 Hz	43.269 kHz	32	32	32
640 by 870	75 Hz	68.85 kHz	16	32	32
800 by 600	56 Hz	35.156 kHz	32	32	32
800 by 600	60 Hz	37.879 kHz	32	32	32
800 by 600	72 Hz	48.077 kHz	32	32	32
800 by 600	75 Hz	46.875 kHz	32	32	32
800 by 600	85 Hz	53.674 kHz	32	32	32
832 by 624	74.5 Hz	49.725 kHz	32	32	32
1024 by 768	60 Hz	48.363 kHz	16	32	32
1024 by 768	70 Hz	56.476 kHz	16	32	32

Modular Desktop and Mini-tower Display Resolution Modes

Table 3-2 shows the display resolution, vertical refresh, horizontal refresh, and maximum pixel depths supported by the Power Macintosh G3 display graphics subsystem in modular desktop and mini-tower enclosures. New modes

supported by the graphics subsystem with the ATI 3D RAGE PRO-PCI graphics controller are indicated with an asterisk*.

Table 3-2   Supported display resolutions for desktop and mini-tower

Display resolution	Vertical refresh	Horizontal refresh	Maximum pixel depth 2 MB	Maximum pixel depth 4 MB	Maximum pixel depth 6 MB
512 by 384	70 Hz	31.488 kHz	32	32	32
640 by 480	60 Hz	31.469 kHz	32	32	32
640 by 480	67 Hz	35.00 kHz	32	32	32
640 by 480	72 Hz	37.861 kHz	32	32	32
640 by 480	75 Hz	37.500 kHz	32	32	32
640 by 480	85 Hz	43.269 kHz	32	32	32
640 by 870	75 Hz	68.85 kHz	16	32	32
800 by 600	56 Hz	35.156 kHz	32	32	32
800 by 600	60 Hz	37.879 kHz	32	32	32
800 by 600	72 Hz	48.077 kHz	32	32	32
800 by 600	75 Hz	46.875 kHz	32	32	32
800 by 600	85 Hz	53.674 kHz	32	32	32
832 by 624	74.5 Hz	49.725 kHz	32	32	32
1024 by 768	60 Hz	48.363 kHz	16	32	32
1024 by 768	70 Hz	56.476 kHz	16	32	32
1024 by 768 (VESA)	75 Hz	60.023 kHz	16	32	32
1024 by 768 (19" RGB)	75 Hz	60.241 kHz	16	32	32
1024 by 768	85 Hz	68.677 kHz	16	32	32
1152 by 870	75 Hz	68.681 kHz	16	32	32
1280 by 960	75 Hz	75.000 kHz	8	16	32

Table 3-2   Supported display resolutions for desktop and mini-tower (continued)

Display resolution	Vertical refresh	Horizontal refresh	Maximum pixel depth 2 MB	Maximum pixel depth 4 MB	Maximum pixel depth 6 MB
1280 by 1024	60 Hz	63.981 kHz	8	16	32
1280 by 1024	75 Hz	79.976 kHz	8	16	32
1280 by 1024	85 Hz	91.146 kHz	8	16	32
1600 by 1200	60 Hz	75 kHz	8	16	16
1600 by 1200	65 Hz	81.250 kHz	8	16	16
1600 by 1200	70 Hz	87.500 kHz	8	16	16
1600 by 1200	75 Hz	93.750 kHz	8	16	16
1920 by 1080*	60 Hz	70.313 kHz	8	16	16
1920 by 1080*	71 Hz	84.375 kHz	8	16	16

Video Input and Graphics Acceleration Display Modes

Table 3-3 shows the display modes for video input and QuickDraw 2D and QuickDraw 3D acceleration.¬

Table 3-3   Video input and graphics acceleration display modes

Display resolution	Pixel depth	Vertical scan rate	Video input	QuickDraw 2D acceleration	QuickDraw 3D acceleration
512 by 384	8	70 Hz	Yes	Yes	No
512 by 384	16, 32	70 Hz	Yes	Yes	Yes
640 by 480	8	60 Hz, 67 Hz, 72 Hz, 75 Hz, 85 Hz	Yes	Yes	No
640 by 480	16	60 Hz, 67 Hz, 72 Hz, 75 Hz, 85 Hz	Yes	Yes	Yes
640 by 480	32	60 Hz, 67 Hz, 72 Hz, 75 Hz, 85 Hz	Yes	Yes	Depends on application window size

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Table 3-3   Video input and graphics acceleration display modes (continued)

Display resolution	Pixel depth	Vertical scan rate	Video input	QuickDraw 2D acceleration	QuickDraw 3D acceleration
640 by 870	16	75 Hz	Yes	Yes	No
800 by 600	8, 32	56 Hz, 60 Hz, 72 Hz, 75 Hz, 85 Hz	Yes	Yes	No
800 by 600	16	56 Hz, 60 Hz, 72 Hz, 75 Hz, 85 Hz	Yes	Yes	Depends on application window size
832 by 624	8, 32	75 Hz	Yes	Yes	No
832 by 624	16	75 Hz	Yes	Yes	Depends on application window size
1024 by 768	8, 16	60 Hz, 70 Hz, 75 Hz	Yes	Yes	No
1152 by 870	16	75 Hz	Yes	Yes	No
1280 by 980	8	75 Hz	Yes	Yes	No
1280 by 1024	8	60 Hz, 75 Hz	Yes	Yes	No

Power Specifications and Device Power Requirements

The power specifications for the Power Macintosh G3 computer are listed in this section.

AC Line Input

- Line voltage: 100–120 volts alternating current (V AC) and 200–240 V AC, RMS, single phase, manually set by voltage selector switch

- Frequency: 50–60 Hz

- Power: 960 volt-amperes (VA) maximum continuous; 1070 VA peak input

AC Line Output

- Output receptacle: 100–120 V AC; 3 amperes (A) maximum, or 200–240 V AC; 1.5 amperes (A) maximum (determined by actual input voltage)

DC Power

- Continuous output: 161 W

- Peak output (for 12 seconds at startup): 210 W

Output voltage	Maximum current [1]
+5 V	18.3 A[2]
+5 V (trickle)	0.1 A
+3.3 V	12.5 A[2]
+12 V	6.2 A
–12 V	0.4 A

1. Total continuous power output cannot exceed 161 W.

2. Not more than 104 W total combined power.

Device Power Requirements

This section lists the power requirements for ADB devices, audio and telecommunications devices, PCI expansion cards, and internal storage devices.

Apple Desktop Bus (ADB)

- The mouse draws up to 10 milliamperes (mA).

- The keyboard draws 25–80 mA (varies with keyboard model used).

- The maximum current available for all ADB devices is 500 mA.

The ADB port can support up to three ADB devices.

Audio and Telecommunications Devices

The following table shows power allowances for external devices connected to input ports.

Device	Voltage	Current	Power
Microphone	+5 V	20 mA	100 mW
A device connected to the printer port or modem port	+5 V	500 mA	2.5 W

Expansion Cards and Internal Storage Devices

If you add an expansion card or a 3.5-inch storage device to your computer, make sure the component's power requirements don't exceed the maximum power allowances allocated to it by the computer.

The maximum power allowances for expansion cards in your computer can accommodate three 15-watt cards, two 25-watt cards, or one 15-watt card and one-25 watt card. Some detailed guidelines are presented in the following table.

Device	Voltage	Current	Power
Expansion card (15 watts)[1]	+5 V	3 A	15 W
	+12 V	0.500 A	6 W
	−12 V	0.100 A	1.2 W
	+3.3 V	2 A	6.6 W
Expansion card (25 watts)[2]	+5 V	5 A	25 W
	+12 V	0.500 A	6 W
	−12 V	0.100 A	1.2 W
	+3.3 V	2 A	6.6 W
Storage devices (such as a hard disk)	+5 V	3 A	15 W
	+12 V	2.3 A	27.6 W
	+12 V	6.2 A peak[3]	

1 15-watt expansion cards should not consume more than 15 watts of total power.

2 25-watt expansion cards should not consume more than 25 watts of total power.

3 Peak power is for startup only and must not occur in normal operation.

Expansion Features

This chapter describes the expansion features of the Power Macintosh G3 logic board: the RAM expansion slot, the PCI expansion slot, and the DAV connector on the Audio and Audio/Video input/output cards, and the communications slot on the Apple DVD-Video and Audio/Video, Audio I/O, and Audio/Video input/output cards. This chapter also provides minimum specifications for adding auxiliary cooling fans in the tower enclosure.

Note
Apple does not support development of third-party cards for the PERCH slot. ◆

RAM DIMMs

The logic board has three DRAM expansion slots. The DRAM expansion slots accept 3.3 volt unbuffered 8-byte (x64 non-parity) SDRAM DIMMs. The 8-byte 168-pin DIMM has a 64-bit-wide data bus per bank. One of the slots contains a factory installed SDRAM DIMM.

The mechanical design of the SDRAM DIMM is defined by the JEDEC MO-161 specification.

The JEDEC MO-161 specification can be found at

<http://www.jedec.org/download/freestd/pub95/mo161c.pdf>

The electrical characteristics of the SDRAM DIMM are defined by the JEDEC standard 21-C section 4.5.4 release 8. The specification can be found at

<http://www.jedec.org/download/freestd/pub21/4_5_4-R8.PDF>

The minimum bank size supported by the Grackle IC is 2 MB, and the largest is 64 MB; the largest DIMM supported is a 4-bank DIMM of 256 MB using

128 Mbit SDRAM devices. Table 4-1 shows the DIMM configurations and sizes for a range of SDRAM device sizes that are supported on the logic board.

Table 4-1   Memory configurations and sizes for SDRAM DIMMS

Device size	Device configuration	Devices per bank	DIMM size per bank	Maximum DIMM size
16 Mbits	256K x 32 x 2	2	4 MB	16 MB
16 Mbits	2 Mbits x 4 x 2	16	32 MB	32 MB
16 Mbits	1 Mbits x 8 x 2	8	16 MB	32 MB
16 Mbits	512K x 16 x 2	4	8 MB	32 MB
64 Mbits	1 Mbits x 32 x 2	2	16 MB	64 MB
64 Mbits	512K x 32 x 4	2	16 MB	64 MB
64 Mbits	8 Mbits x 4 x 2	16	128 MB	128 MB
64 Mbits	4 Mbits x 4 x 4	16	128 MB	128 MB
64 Mbits	4 Mbit x 8 x 2	8	64 MB	128 MB
64 Mbits	2 Mbits x 16 x 2	4	32 MB	128 MB
64 Mbits	1 Mbits x 16 x4	4	32 MB	128 MB
128 Mbits	4 Mbits x 8 x 4	8	64 MB	256 MB
128 Mbits	16 Mbits x 8	4	64 MB	256 MB

The SDRAM DIMMs can be installed one or more at a time. The Power Macintosh G3 logic board supports only linear memory organization; therefore no performance gains are seen when two DIMMs of the same size are installed. Any supported size DIMM can be installed in either DIMM slot, and the combined memory of all of the DIMMs installed will be configured as a contiguous array of memory.

The modular desktop enclosure accommodates SDRAM DIMMs of 1.15 inches in height. The All-in-one and tower enclosures accommodate RAM DIMMs of 1.5 inches in height. ▲

Presence Detect EEPROM

The presence detect serial EEPROM specified in the JEDEC standard is required and must be set properly. Details about the required values for each byte on presence detect EEPROM can be found in sections 4.5.4 and 4.1.2.5 of the JEDEC standard 21-C, release 7 specification.

RAM DIMM Connectors

The RAM DIMM connector accommodates 3.3 volt unbuffered 168-pin SDRAM DIMM cards as defined in the JEDEC specification.

RAM Address Multiplexing

Signals A[0–13] on each SDRAM DIMM make up a 14-bit multiplexed address bus that can support several different types of DRAM devices. Table 4-2 shows the address multiplexing modes used with SDRAM types of DRAM devices. The devices are characterized by their bit dimensions: for example, a 1 M by 16-bit device has 1 M addresses and stores 16 bits at a time.

Table 4-2   Address multiplexing modes for SDRAM devices

Device size	Device configuration	Number of banks	Size of row address	Size of column address
16 Mbits	2 M x 4 x 2	2	11	10
16 Mbits	1 M x 8 x 2	2	11	9
16 Mbits	512K x 16 x 2	2	11	8
64 Mbits	8 M x 4 x 2	2	13	10
64 Mbits	4 M x 4 x 4	4	12	10

Table 4-2   Address multiplexing modes for SDRAM devices (continued)

Device size	Device configuration	Number of banks	Size of row address	Size of column address
64 Mbits	4 M x 8 x 2	2	13	9
64 Mbits	2 M x 8 x 4	4	12	9
64 Mbits	2 M x 16 x 2	2	13	8
64 Mbits	1 M x 16 x 4	4	12	8
64 Mbits	1 M x 32 x 2	2	13	7
64 Mbits	512K x 32 x 4	4	12	7

SDRAM Devices

The memory controller in the Grackle IC supports 1 M, 4 M, 8 M, 16 M, and 64 M SDRAM devices. The speed of the SDRAM devices is 100 MHz/10ns or faster. The devices are programmed to run with a CAS latency of 3. The access time from clock at CAS latency of 3 should be 7 ns or faster. Burst length should be at least 4 and the minimum clock delay, back to back random column accesses should be a latency of 1 clock.

RAM Refresh

The Grackle IC provides a CAS-before-RAS refresh cycle every 15.6 μs. DRAM devices must be compatible with this refresh cycle; for example, this cycle will refresh 2K-refresh parts within 32 milliseconds.

Compatible SDRAM DIMMs

Table 4-3 lists some vendors and part numbers for SDRAM DIMMs that have been qualified as compatible with the Power Macintosh G3 architecture.

Table 4-3   Compatible SDRAM DIMMs for the Power Macintosh G3 computer

Vendor name	SDRAM DIMM part number
Hyundai	HY57V168010A TC-10, HYM7V64400TFG-10
LG Semicon	GM72V1681BT 10K, GMM2642233BL TG-10K 7042S
Samsung	KMM366S104BTN, KMM366S403BT2, KMM366S3323T

Video RAM SO-DIMMs

The Power Macintosh G3 computers include 2 MB of SGRAM on the main logic board. The video RAM can be expanded to 4 MB or 6 MB with an additional 2 MB or 4 MB of SGRAM on a 144-pin SO-DIMM (small outline dual inline memory module). The mechanical design of the SGRAM SO-DIMM is defined by the JEDEC MO-190 specification. The SGRAM SO-DIMM specification can be downloaded at

<http://www.jedec.org/download/freestd/pub21/4_5_8-R8.PDF>

The devices on the DIMM must be 3.3 V, 100 MHz/10ns or faster, SGRAM devices.

Expanding Video RAM

Increasing the size of the installed video RAM from 2 MB to either 4 MB or 6 MB increases the maximum color depth allowed at specific monitor resolutions. The only additional display mode supported by using 6 MB instead of 4 MB of video memory is 32-bit color at 1280 by 1024 at 60 hz. Supported display modes are listed in Table 3-2. Any additional video RAM that isn't used for the current display mode is available to QuickDraw 3D applications for more data storage, such as textures, which results in faster 3D graphics performance. A more

detailed explanation of video RAM and QuickDraw 3D graphics performance can be found in Chapter 5 of the Power Macintosh 5500/6500 Developer Note, where the use of the video frame buffer for front frame buffer, back frame buffer, optional Z buffer, and available texture memory are described.

Compatible SGRAM modules

Table 4-4 lists the vendor and part number for SGRAM modules that are compatible with the Power Macintosh G3 computer.

Table 4-4   Compatible SGRAM SO-DIMMs for the Power Macintosh G3 computer

Vendor name	SO-DIMM part number
Samsung Semiconductor	KMM966G512AQN-G0

The specification for the Samsung Semiconductor SGRAM SO-DIMM can be found on the World Wide Web at

<http://www.sec.samsung.com/Products/dram/mo_index.html>

PCI Expansion Slots

The Power Macintosh G3 logic board uses the industry-standard peripheral component interconnect (PCI) bus for an I/O expansion bus. The PCI bus is a 32-bit multiplexed address and data bus. The PCI expansion slots have a 33.33 MHz clock frequency.

PCI I/O expansion cards are mounted vertically in PCI expansion slots on the main logic board.

A total of 15 watts of power is provided for each of the PCI expansion slots. Both 5 volts and 3.3 volts are supplied; the total power consumed by both voltages must not exceed the 15-watt maximum.

The Power Macintosh G3 logic board requires that PCI cards use the 5-volts signaling standard described in the *PCI Local Bus Specification*, Revision 2.1.

The logic board accepts standard 6.88-inch and 12.283-inch PCI cards as defined by the *PCI Local Bus Specification*, Revision 2.1. The cards are required to use the standard ISA fence described in the specification.

The PCI slots support all the required PCI signals and certain optional PCI signals. The PCI slots on the logic board do not support the optional 64-bit bus extension signals or cache support signals.

For more information about the PCI expansion slot, refer to *Designing PCI Cards and Drivers for Power Macintosh Computers.*

The DAV Connector

The Audio/Video Input/Output Card has a separate connector called the DAV (digital audio video) connector. The DAV connector provides access to the Audio/Video card's 4:2:2 unscaled YUV video input data bus and associated control signals. By means of a 60-pin cable to the DAV connector, a PCI expansion card can gain access to the digital video bus on the Audio/Video Input/Output Card and use it to transfer real-time video data to the computer. Such a PCI expansion card can contain a hardware video compressor or other video processor.

The DAV connector accepts YUV video and analog sound from the PCI expansion card.

The 60-pin DAV connector is located at the top edge of the Audio/Video Input/Output Card. A PCI expansion card that uses the DAV interface can be connected to the Audio/Video Input/Output Card with a 7-inch 60-conductor flat-ribbon cable.

The Apple DVD-Video and Audio/Video Card does not include the DAV interface.

The Modem Slot

The Apple DVD-Video and Audio/Video Card, Apple Audio/Video Card, and Apple Audio Input/Output Card all have a separate slot for an optional fax/modem card. The modem slot is not a PCI bus–based communications slot

(comm slot II) like that in the Power Macintosh 5500 and 6500, and it does not accept comm slot II cards that use any of the PCI signals.

Auxiliary Cooling Fans

The Power Macintosh G3 tower enclosure includes a baffle above the PCI card slots for the addition of one or two cooling fans. This feature is provided for VARS or developers that plan to configure the tower enclosure with PCI cards that require additional cooling. Figure 4-1 shows the baffle where the fans can be installed.

Figure 4-1   Location for auxiliary cooling fans

These two groups of four screw posts indicate where either one or two auxilliary fans may be mounted.

The fan must be positioned so that air is pulled into the computer, not pushed out.

Screws used to attach an auxiliary fan to the computer must be installed so that they do not extend down into the space where PCI cards or cables may be present.
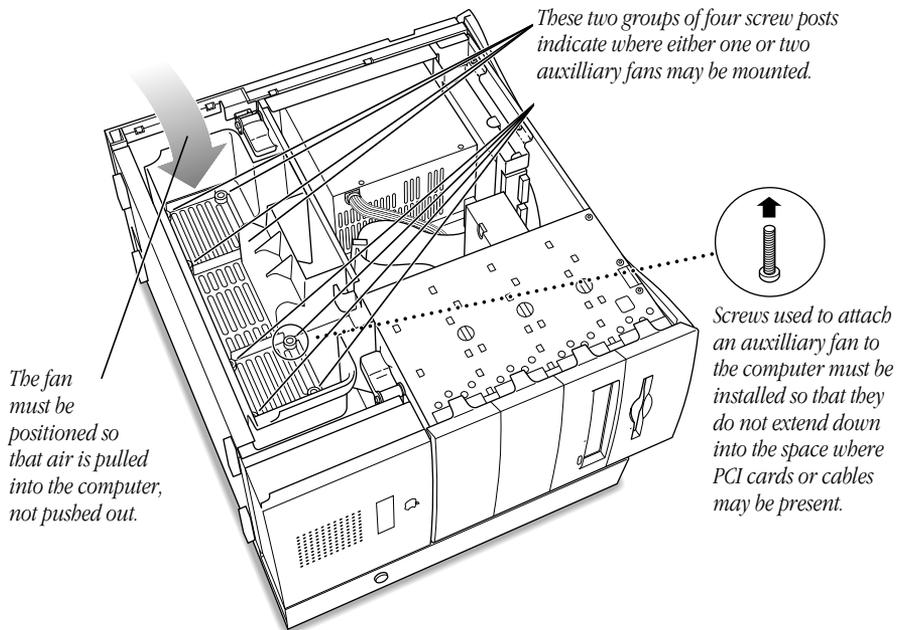
Power for the fans can be obtained from one of the peripheral power connectors, or a Y termination harness can be used if a connector is not available. The fan or fans power consumption must be figured in with the PCI expansion card power budget. The maximum allowable current per fan as +12 V is .2 amps (2.4 watts per fan). The Yellow wire on the peripheral connector provides +12 V and either of the Black wires provides power supply ground.

The baffle is designed to accommodate a 60mm square fan frame with a depth up to 25mm.

IMPORTANT

VARs and developers installing fans in the enclosure are responsible for routing and securing the wiring properly from the baffle to the power source. The VAR or developer is responsible for safety compliance within the country or countries where the fan configuration of the Power Macintosh G3 tower enclosure will be sold. This includes providing finger guards, testing compliance and agency submittal. If the fan assembly is provided as a kit, the VAR or developer is responsible for the installation instructions and safety compliance. ▲

Conventions and Abbreviations

This developer note uses the following typographical conventions and abbreviations.

Typographical Conventions

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

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

Abbreviations

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

Here are the standard units of measure used in this developer note:

A	amperes	mA	milliamperes
dB	decibels	μA	microamperes
GB	gigabytes	MB	megabytes
Hz	hertz	MHz	megahertz
in.	inches	mm	millimeters
k	1000	ms	milliseconds
K	1024	μs	microseconds
KB	kilobytes	ns	nanoseconds
kg	kilograms	Ω	ohms

kHz	kilohertz	sec.	seconds
kΩ	kilohms	V	volts
lb.	pounds	W	watts

Other abbreviations used in this note include:

$n	hexadecimal value n
ADB	Apple Desktop Bus
ATA	advanced technology attachment
ATAPI	advanced technology attachment packet interface
ATX	a compact logic board design
AV	audiovisual
AWACS	audio waveform amplifier and converter for sound
CAS	column address strobe
CD-ROM	compact disc read-only memory
CLUT	color lookup table
DAC	digital to analog converter
DAV	digital audio video
DDC	display data channel
DIMM	dual inline memory module
DIN	Deutsche Industrie Norm
DMA	dynamic memory access
DRAM	dynamic random-access memory
DVD	digital video disc, also referred to as digital versatile disc
EDO	extended data out DRAM device type
EMI	electromagnetic interference
GCR	group code recording
IC	integrated circuit
IDE	integrated device electronics
IIC	inter-integrated circuit (an internal control bus)
I/O	input/output
IR	infrared

JEDEC	Joint Electronics Devices Engineering Council
L2	level 2, used in reference to level of cache
MESH	Macintosh enhanced SCSI hardware
MMU	memory management unit
MPEG	Motion Picture Experts Group
NTSC	National Television Standards Committee (the standard system used for broadcast TV in North America and Japan)
PAL	Phase Alternating Line system (the standard for broadcast TV in most of Europe, Africa, South America, and southern Asia)
PCI	Peripheral Component Interconnect
PGA	pin grid array
PIO	parallel input output
RAM	random-access memory
RAS	row address strobe
RAVE	Rendering Acceleration Virtual Engine
RGB	a video signal format with separate red, green, and blue components
RISC	reduced instruction set computing
ROM	read-only memory
SCSI	Small Computer System Interface
SCC	serial communications controller
SDRAM	synchronous dynamic random access memory
SECAM	the standard system used for broadcast TV in France and the former Soviet countries
SIMM	single inline memory module
SGRAM	synchronous graphics random access memory
SO-DIMM	small outline dual inline memory module
SRAM	static random access memory
S-video	a type of video connector that keeps luminance and chrominance separate; also called a Y/C connector
SWIM	Super Woz Integrated Machine, a custom IC that controls the floppy disk interface

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Conventions and Abbreviations

VRAM	video RAM; used for display buffers
Y/C	a type of video connector that keeps luminance and chrominance separate; also called an S-video connector
YUV	a video signal format with separate luminance and chrominance components

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S

T, U

V, W, X

Y, Z