



Developer Note

Macintosh PowerBook 180c



Developer Note

Developer Press

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About This Developer Note

This document describes the Macintosh PowerBook 180c computer, emphasizing those features that are new or different from other Macintosh PowerBook computers. It is written primarily for experienced Macintosh hardware and software developers who want to create products that are compatible with these new computers. If you are unfamiliar with Macintosh computers or would simply like more technical information, you may want to read the related technical manuals listed in the following section.

Supplementary Documents

To supplement the information in this document, you might wish to obtain related documentation such as *Guide to the Macintosh Family Hardware*, second edition; *Designing Cards and Drivers for the Macintosh Family*, third edition; and *Inside Macintosh*. For detailed information about the Motorola 68030 microprocessor used in these computers, refer to the *MC68030 Enhanced 32-Bit Microprocessor User's Manual*. All of these documents are available through APDA.

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Conventions and Abbreviations

This developer note uses typographical conventions and abbreviations that are standard in Apple publications.

Typographical Conventions

Computer-language text—any text that is literally the same as it appears in computer input or output—appears in `Courier` font.

Standard Abbreviations

Standard units of measure used in Apple reference books include:

A	amperes	MB	megabytes
GB	gigabytes	MHz	megahertz
Hz	hertz	ms	milliseconds
K	1024	ns	nanoseconds
KB	kilobytes	V	volts
mA	milliamperes	W	watts

Standard abbreviations used in Apple reference books include:

$\$n$	hexadecimal value n
AC	alternating current
ADB	Apple Desktop Bus
ASC	Apple Sound Chip
ASIC	application-specific integrated circuit
CLUT	color look-up table
DAC	digital-to-analog converter
FSTN	film supertwist nematic (a type of LCD)
IC	integrated circuit
LCD	liquid crystal display
MMU	memory-management unit
PSRAM	pseudostatic RAM
RAM	random-access memory
RAMDAC	random-access memory, digital/analog converter
ROM	read-only memory
RGB	red-green-blue (a video display system used by Apple computers)

P R E F A C E

SCSI	Small Computer System Interface
SVGA	super VGA (a video display system used with PC-type computers)
SWIM	Super Woz Integrated Machine
TFT	thin film transistor (a type of LCD)
VGA	video graphics adapter (a video display system used with PC-type computers)
VRAM	video RAM

Macintosh PowerBook 180c

The Macintosh PowerBook 180c computer is a color version of the PowerBook 180 featuring a high-resolution 640 x 480 active matrix color display. With the exception of the display and its associated circuitry, the PowerBook 180c is identical to the PowerBook 180. From a software and hardware development perspective, the PowerBook 180c is more closely related to the PowerBook 165c.

This chapter lists the major features of the Macintosh PowerBook 180c computer, and describes the color LCD interface. Memory and modem expansion capabilities are also discussed.

IMPORTANT

Only the major differences between the PowerBook 180c and the PowerBook 180 are described in detail here. For a complete understanding of the PowerBook 180c computer, refer to the *Macintosh PowerBook 160 and Macintosh PowerBook 180 Developer Note*. ▲

Features

The major features of the Macintosh PowerBook 180c computer are:

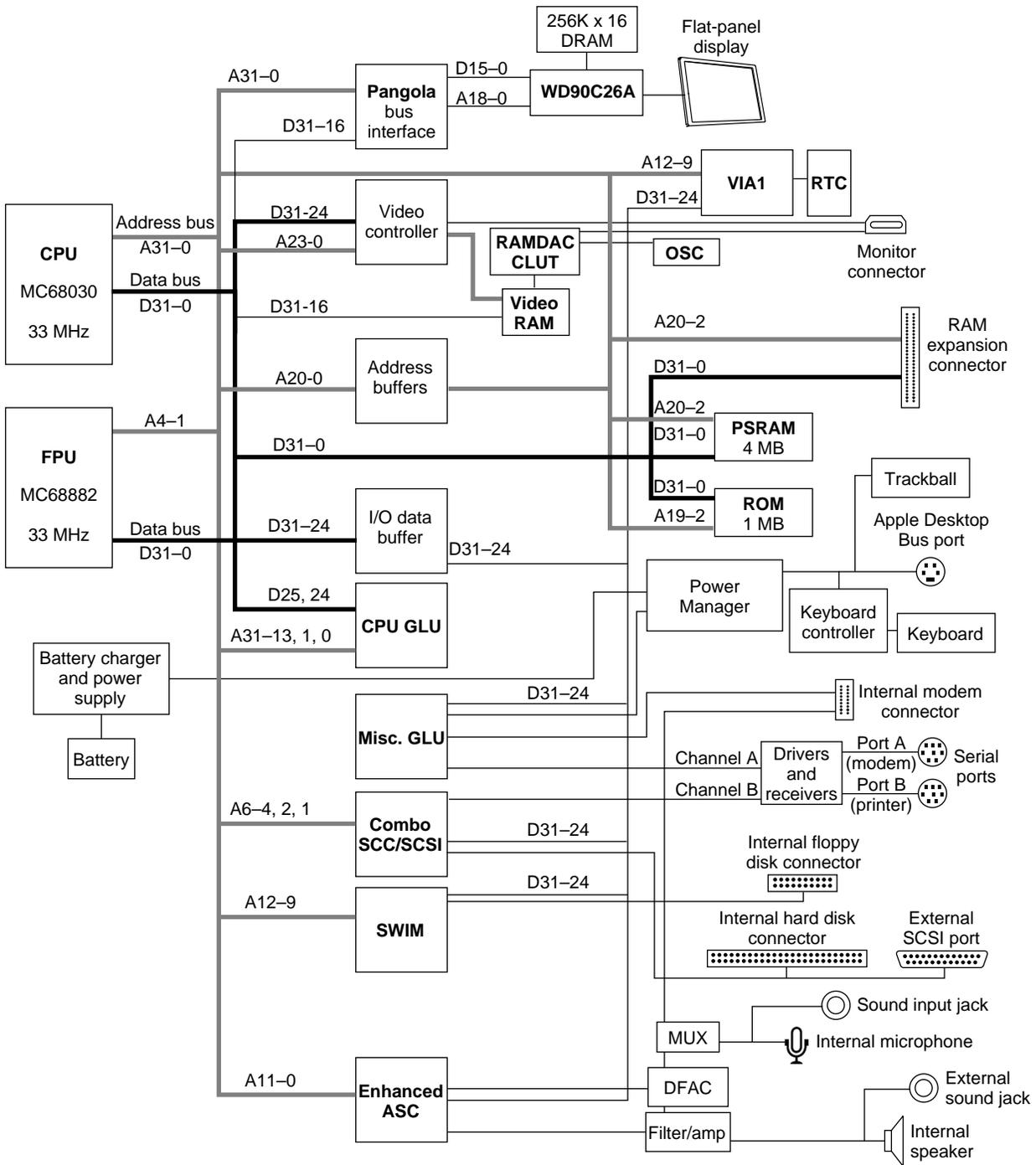
- Microprocessor: Motorola 68030 running at 33 MHz. A 16 MHz power saving mode can be selected by the user.
- Coprocessor: Motorola 68882 FPU running at 33 MHz.
- Read-only memory (ROM): 1 MB.
- Random-access memory (RAM): 4 MB of pseudostatic RAM (PSRAM).
- RAM expansion: a RAM expansion slot accommodates RAM expansion cards of up to 10 MB, for a total of 14 MB of RAM.
- Liquid crystal display: 8-bit color video circuitry supports 256 colors on the built-in 640 x 480 pixel thin film transistor (TFT) LCD. The display is backlit by two cold cathode fluorescent lamps.
- Video output: 8-bit color video output circuitry supports 256 colors on all Apple color monitors up to 16 inches in size, and 16 shades of gray on the Apple Portrait monitor. The video output circuitry is identical to that of the PowerBook 180, supporting both dual mode and video mirror mode. In dual mode, the LCD and external monitor are independent. In video mirror mode, the image on the external monitor is identical to what is displayed on the LCD.

Macintosh PowerBook 180c

- Floppy disk: one internal 1.4 MB Apple SuperDrive with Super Woz Integrated Machine (SWIM) interface.
- Hard disk: one internal 2.5-inch SCSI hard disk drive. Disk capacities of 80 and 160 MB are offered.
- SCSI disk mode: by connecting an HDI-30 SCSI Disk Adapter cable, users can access the PowerBook's internal hard disk from another Macintosh.
- I/O (input/output): one HDI-30 connector for external SCSI devices, one 4-pin mini-DIN ADB port, two 8-pin mini-DIN serial ports, audio input and output jacks, and a custom video output connector with adapter for attaching standard Apple video cables.
- Sound: enhanced Apple Sound Chip (ASC) audio circuitry provides sound input and output through the built-in microphone and speaker. Stereo sound output can be heard through the headphone jack.
- Keyboard: built-in keyboard with integral 30-mm trackball.
- Modem: internal 20-pin connector for an optional modem card. This slot supports the Macintosh PowerBook Express Modem, the Macintosh PowerBook Fax/Data Modem, and compatible third-party serial modems.
- Battery: a rechargeable NiCad battery is included. A 3 V lithium battery provides backup power for the real-time clock and parameter RAM when the main battery is removed.
- Power supply: a new 24 W external wall-mounted recharger/power adapter is included. This charger can be used safely with PowerBook models 100–180 and the Macintosh PowerBook Battery Recharger.
- Security connector: a connector on the back panel allows users to attach a security device.
- Weight: 7 pounds.
- Size: 11.3 inches wide, 9.3 inches deep, and 2.3 inches high.

The block diagram shown in Figure 1 on page 4 illustrates the major hardware components of the PowerBook 180c computer.

Figure 1 Block diagram of the PowerBook 180c computer



Compatibility Issues

Because the Macintosh PowerBook 180c is identical in most respects to the Macintosh PowerBook 165c computer, most hardware and software designed for that model will operate without modification on the PowerBook 180c. This section highlights key areas you should investigate in order to ensure that your products work properly with the PowerBook 180c.

Color Display

The PowerBook 180c is the first PowerBook computer to use a 640 x 480 pixel LCD. This change is transparent to applications that follow the guidelines in *Inside Macintosh*.

The internal display controller is optimized for 8-bit color mode. Although 1-, 2-, and 4-bit modes are supported for compatibility, they provide no significant improvement in display performance.

The external video interface of the Macintosh PowerBook 180c computer is identical to the PowerBook 160/180 in all respects.

See the section “Color LCD Interface” on page 9 for more information about the internal display hardware and LCD screen.

Note

MacsBug version 6.2.2 does not properly restore the LCD frame buffer on the Macintosh PowerBook 180c. The screen can be restored by forcing a redraw. This problem will be corrected in future MacsBug versions. ♦

RAM Expansion Slot

The RAM expansion card specification for the PowerBook 180c is identical to the PowerBook 165c. Cards meeting Apple design specifications for the PowerBook 180 and earlier models are also compatible with the PowerBook 180c. See the section “RAM Expansion Interface” on page 10 for more information about designing RAM expansion cards.

Identifying the PowerBook 180c

The correct method for software to identify the Macintosh model it is running on is by using the Gestalt Manager routines described in *Inside Macintosh*.

The `gestaltMachineType` value returned by the PowerBook 180c is 71. This value can be used to obtain the machine name string as described in *Inside Macintosh*. Applications should not make decisions based on the machine type, but should use the appropriate Gestalt Manager routines to determine what features are available at runtime.

Hardware Overview

This section discusses the hardware differences between the Macintosh PowerBook 180c and the Macintosh PowerBook 160/180 computers.

IMPORTANT

Memory sizes, addresses, and other data are specific to each type of Macintosh computer and are provided for informational purposes only. To ensure that your application software maintains compatibility across the Macintosh line and to allow for future hardware changes, you are strongly advised to use the Macintosh Toolbox and Operating System routines wherever provided. In particular, never use absolute addresses to access hardware, because these addresses are not the same for all models. ▲

Memory Map

Like all Macintosh PowerBook computers that use the 68030 microprocessor, the PowerBook 180c always operates in 32-bit addressing mode. To maintain compatibility with software that uses 24-bit addressing conventions, the memory management unit (MMU) in the 68030 is used to map 24-bit addresses to their 32-bit equivalent.

In 32-bit mode, the 68030 supports a 4 GB address space. In 24-bit mode, however, the upper 8 address bits are ignored, and the maximum address space is limited to 16 MB. The MMU remaps addresses so that RAM, ROM, VRAM, and I/O all appear within this 16 MB range. Although the address translation is transparent to software, it has the effect of limiting the amount of addressable RAM to 8 MB.

Figure 2 shows the 32-bit memory map of the PowerBook 180c. Figure 3 on page 8 compares the 24-bit and 32-bit memory maps.

ROM

The Macintosh PowerBook 180c uses the same ROM as the PowerBook 160, 165c, and 180 computers. The ROM chips are located on a RAM/ROM board as in the PowerBook 165c.

A 32K x 8-bit declaration ROM appears in NuBus™ slot \$C address space and provides firmware support for the color LCD.

ROM Wait States

ROM accesses by the CPU require 4 processor wait states (7 clock cycles at 33 MHz), which is equivalent to 180 ns per access.

Figure 2 32-bit memory and detailed I/O map

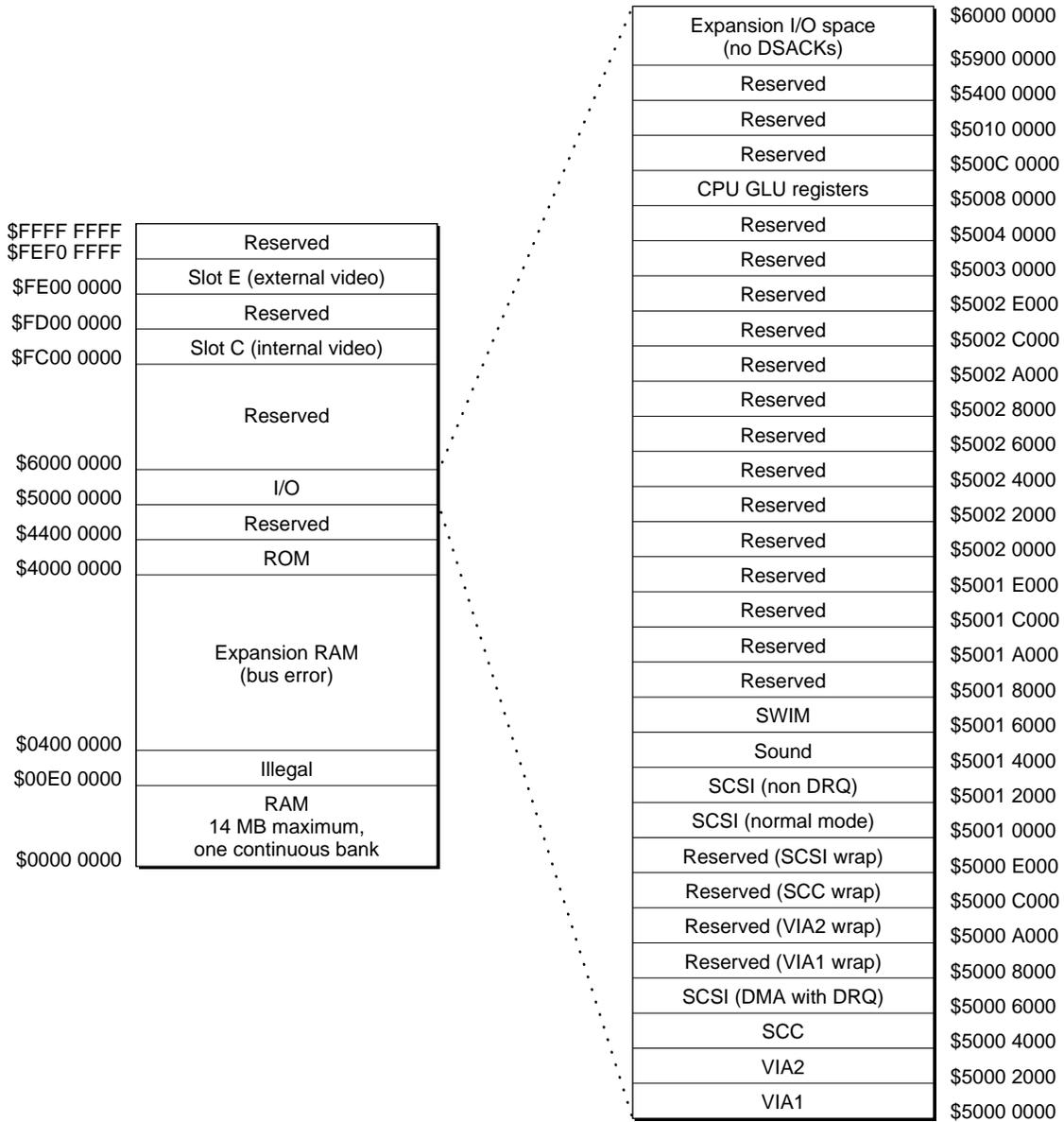
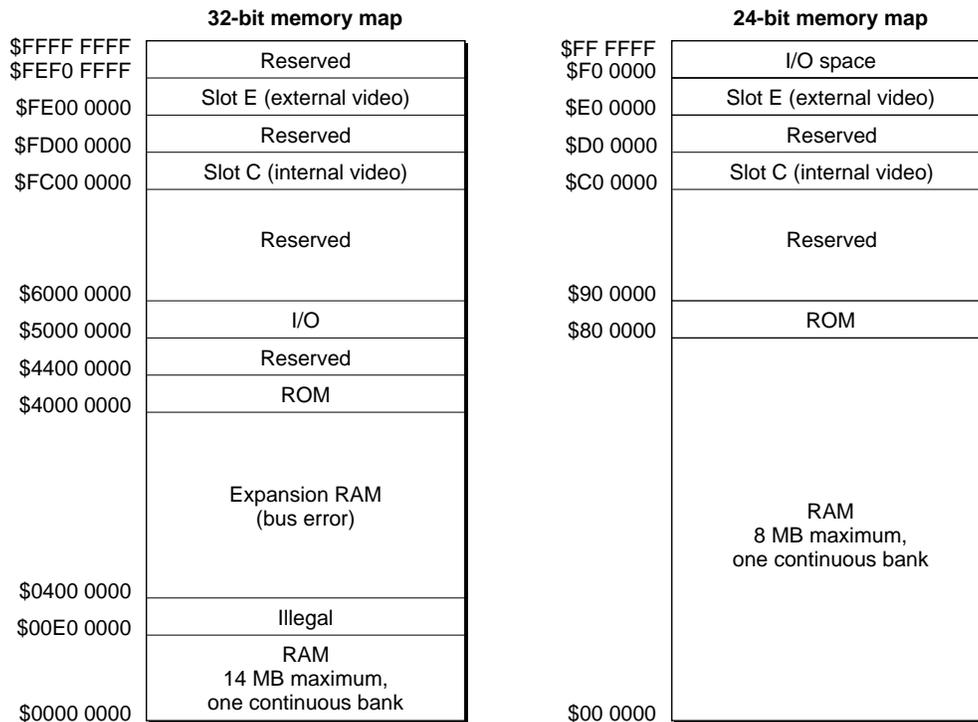


Figure 3 32-bit and 24-bit memory map comparison



RAM

The PowerBook 180c includes 4 MB of 85 ns pseudostatic RAM, consisting of eight 512K x 8-bit chips. The RAM chips are located on the RAM/ROM board to provide room for the color display circuitry on the secondary logic board.

The RAM expansion slot is located on the RAM/ROM board, and supports up to 10 MB of PSRAM, for a total of 14 MB. See the section “RAM Expansion Interface” on page 10 for information about designing RAM expansion cards.

RAM is always contiguous because only one size of RAM chip (4 Mbits) is used. As a result, software does not have to “stitch” memory. The RAM array is located in the system memory map between addresses \$0000 0000 and \$00DF FFFF, except following a system reset or sleep cycle, when it is overlaid by system ROM. However, the overlay is removed following access to normal ROM space, and the RAM space is then accessible. Both RAM and ROM memory spaces provide DSACK signals to the processor even if memory is not actually installed. The RAM data path is 32 bits wide.

RAM Wait States

RAM accesses require 2 wait states when using 85 ns PSRAM exclusively. Installing 100 ns expansion RAM causes the memory controller to insert an additional wait state in all memory accesses (both main and expansion).

Battery Backup

Both main and expansion RAM are backed up when the computer is in the sleep state, as long as the battery is charged or the power adapter is plugged in. RAM contents are not maintained when the computer is turned off or when the battery is removed.

Color LCD Interface

The color display circuitry in the Macintosh PowerBook 180c emulates a NuBus video card installed in slot \$C. This circuitry includes the LCD controller chip set, 512 KB of DRAM, and a declaration ROM. The PowerBook 180c is compatible with software that uses QuickDraw and the Palette Manager. Color table animation is also supported.

The LCD controller chip set consists of a Western Digital WD90C26A controller and an Apple custom ASIC named Pangola that translates signals between the WD90C26A and the 68030 bus. Pangola also handles the frame buffer conversion necessary to support 1-, 2-, and 4-bit color modes with the Western Digital controller.

The WD90C26A contains a 256-entry CLUT, RAMDAC, frame buffer controller, and flat panel control circuitry. Although the CLUT supports a palette of 262,143 colors, many of the possible colors do not look acceptable on the display. Due to the nature of LCD technology, some colors are dithered or exhibit noticeable flicker. Apple has developed a new gamma table for this display that minimizes flicker and optimizes available colors. With this gamma table in place, the effective range of the CLUT is 110,592 colors.

The frame buffer appears to the 68030 as a continuous RAM array of 512 KB beginning at \$FC04 0000. The data path is 16 bits wide and byte addressable. The frame buffer is controlled by the WD90C26A, which allocates 1 byte per pixel in all color modes. Because the WD90C26A manages its frame buffer differently than QuickDraw expects, Pangola must perform byte packing and unpacking to support color modes other than 8-bit.

For example, in 1-bit mode QuickDraw expects that each byte in the frame buffer represents eight pixels. For every byte QuickDraw writes to the frame buffer in 1-bit mode, Pangola unpacks the bits and sends 8 bytes to the WD90C26A. Similarly, Pangola must pack 8 bytes into 1 byte each time QuickDraw reads a byte from the frame buffer in 1-bit mode.

Because the WD90C26A is optimized for 8-bit color mode, there is little advantage to selecting a reduced bit depth. Apple recommends that application developers use 8-bit mode whenever possible on the Macintosh PowerBook 180c.

Applications that manipulate the frame buffer directly must do so at a consistent bit depth because Pangola always interprets pixel data based on the current video mode. For example, attempting to write 8-bit data to the frame buffer while in 1-bit mode will corrupt the frame buffer because Pangola will unpack each byte as described above. Sending 1-bit data to the buffer while in 8-bit mode produces similar results because Pangola will not perform the necessary conversion.

LCD Screen

The PowerBook 180c uses a high-contrast 640 x 480 pixel active matrix color display with .27 mm dot pitch. The display is backlit by two CCFL bulbs located at the top and bottom of the panel.

The inherent differences between LCD and CRT technologies make it a challenge to precisely match colors displayed on the LCD with those on an external monitor. The PowerBook 180c gamma table provides good color matching while minimizing flicker. Developers should use the supplied gamma table unless there is a specific need to replace it. Using a gamma table developed for RGB systems will produce poor results.

RAM Expansion Interface

The PowerBook 180c accommodates RAM expansion cards from 2 MB to 10 MB in capacity, for a total of 14 MB of RAM. The RAM expansion interface is physically and electrically identical to that of the PowerBook 165c.

The RAM expansion slot is located on the RAM/ROM board, in the same position as the PowerBook 165c. Figure 4 shows the location of the RAM expansion connector.

Figure 4 Location of the RAM expansion connector

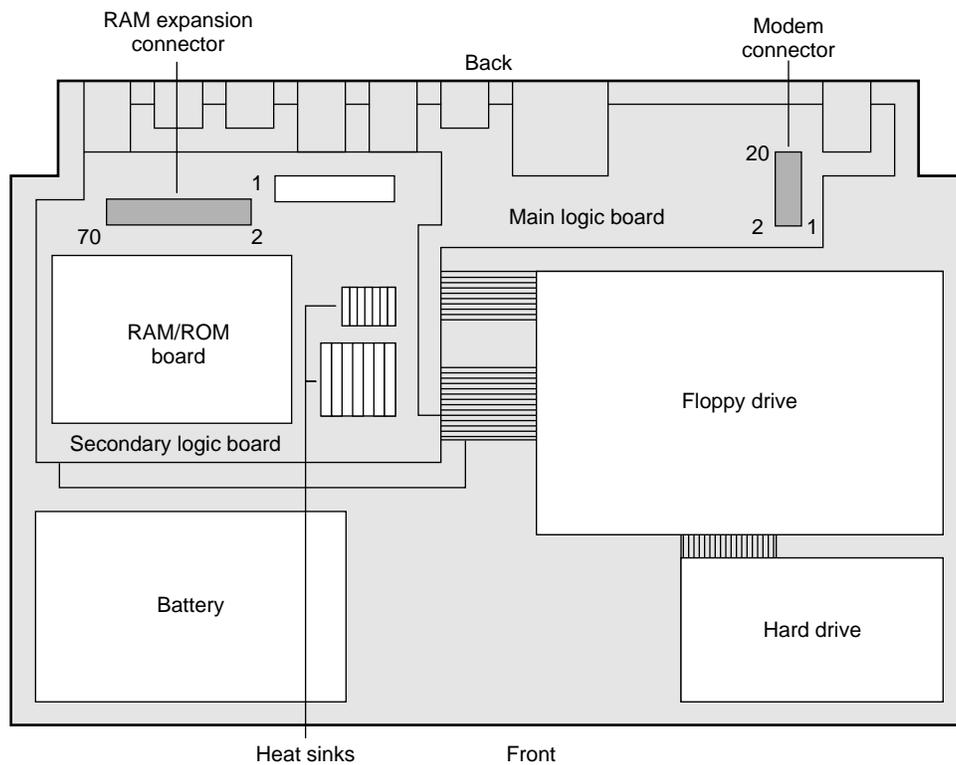
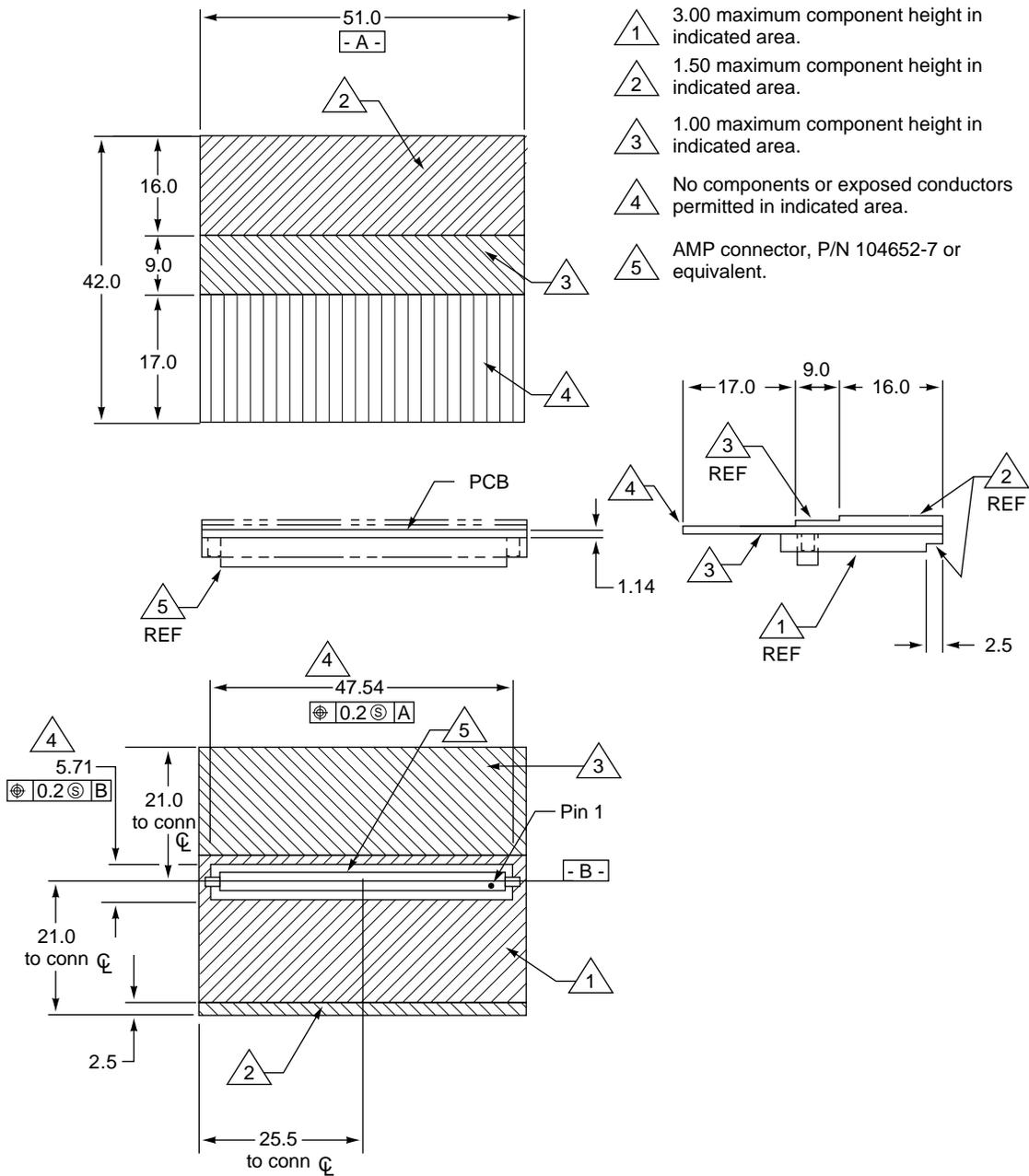


Figure 5 shows the mechanical design guide for PowerBook 165c/180c RAM expansion cards. Refer to the *Macintosh PowerBook 160 and Macintosh PowerBook 180 Developer Note* for electrical design guidelines.

Figure 5 RAM expansion card design guide



Dimensions are in millimeters.

▲ **WARNING**

Do not exceed the design guidelines shown in Figure 5. Cards that exceed these specifications may damage the computer and void the warranty. ▲

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