



Developer Note

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# PowerBook Duo 270c



**Developer Note**

Developer Press

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# About This Note

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This note is a supplement to *Macintosh Developer Notes, Number 2, Macintosh Duo System*, APDA publication number R0457LL/A. It describes the design features of the PowerBook Duo 270c computer, which is basically a PowerBook Duo computer with an active-matrix color display, expanded hard disk capabilities, higher capacity batteries, and an integrated floating-point unit (FPU).

This note provides the hardware or software developer with the additional information needed to design hardware and software elements for the PowerBook Duo 270c computer. This publication assumes you are familiar with the functionality and programming requirements for Apple Macintosh computers. It contains the following three chapters and an appendix:

- Chapter 1, “Introduction to the PowerBook Duo 270c Computer”
- Chapter 2, “Hardware Modifications”
- Chapter 3, “Software Modifications”

The chapters and appendix are followed by an index.

## Conventions Used In This Book

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This developer note uses the following conventions:

**IMPORTANT**

A note like this contains information that is essential to an understanding of the text, and of the PowerBook Duo 270c computer. ▲

▲ **WARNING**

A note like this directs your attention to something that could cause injury to staff, damage to equipment, or loss of data. ▲

A slash in front of a signal name (/RESET) indicates an active low signal.

## P R E F A C E

The following common abbreviations are used in this note:

AM	active matrix
CCFL	cold cathode fluorescent lamp
CSC	color screen controller
DRAM	dynamic random-access memory
FPU	floating-point unit
FSTN	film super-twist nematic
K	1024
LCD	liquid crystal display
MB	megabyte
Mbit	megabit
ms	millisecond
MSC	main system controller
$\mu$ s	microsecond
ns	nanosecond
PCB	printed circuit board
RAM	random access memory
RMS	root mean square
SCSI	small computer system interface
SIMM	single inline memory module
TFT	thin-film transistor
TQFP	thin quad flat pack
VRAM	video RAM

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.

A distinction is made between boards and cards. Boards are a permanent part of the computer or expansion device. Cards may be inserted into the system and can be added or exchanged.

## Other Reference Material

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Related documentation includes:

- *Macintosh Developer Notes, Number 2, Macintosh Duo System*, APDA publication number R0457LL/A
- *Guide to the Macintosh Family Hardware*, second edition
- *Designing Cards and Drivers for the Macintosh Family*, third edition



- *Inside Macintosh, Volumes I through VI*
- *Macintosh Classic II, Macintosh PowerBook Family, and Macintosh Quadra Family Developer Notes, APDA publication number R0I43LL/A.*

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# P R E F A C E

# Introduction to the PowerBook Duo 270c Computer

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## Introduction to the PowerBook Duo 270c Computer

The Macintosh PowerBook Duo 270c computer is a member of the PowerBook Duo family of computers. It has all the basic features of the PowerBook Duo computer but also has certain new features which are described in this note. These features include

- an active-matrix (AM) thin-film transistor (TFT) 8-bit or 16-bit color display
- support for the color display via the color-screen controller (CSC) device, housed on the main logic board
- a 160 MB or a 240 MB hard drive (the 160 MB drive is not described separately in this note)
- integrated floating-point unit (FPU)
- higher capacity batteries
- an inverter/speaker board compatible with active matrix TFT color displays only
- software support for the color video and battery recharging
- modified system ROM

The computer uses the same 33 MHz 68030 microprocessor as the PowerBook Duo 230 computer. Chapter 2, "Hardware Modifications," describes the modifications made to the original PowerBook Duo computer to implement the PowerBook Duo 270c computer. Chapter 3, "Software Modifications," describes the changes made to the software to support the additional features.

This note is a supplement to the *Macintosh Duo System Developer Note, R0457LL/A*, which contains detailed information about the basic Macintosh PowerBook Duo computer.

## PowerBook Duo 270c Computer Features

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Features of the PowerBook Duo 270c computer are listed below. Items in boldface type are unique to the PowerBook Duo 270c computer and are described in more detail later in this note. All other items are discussed in detail in the *Macintosh Duo System Developer Note*.

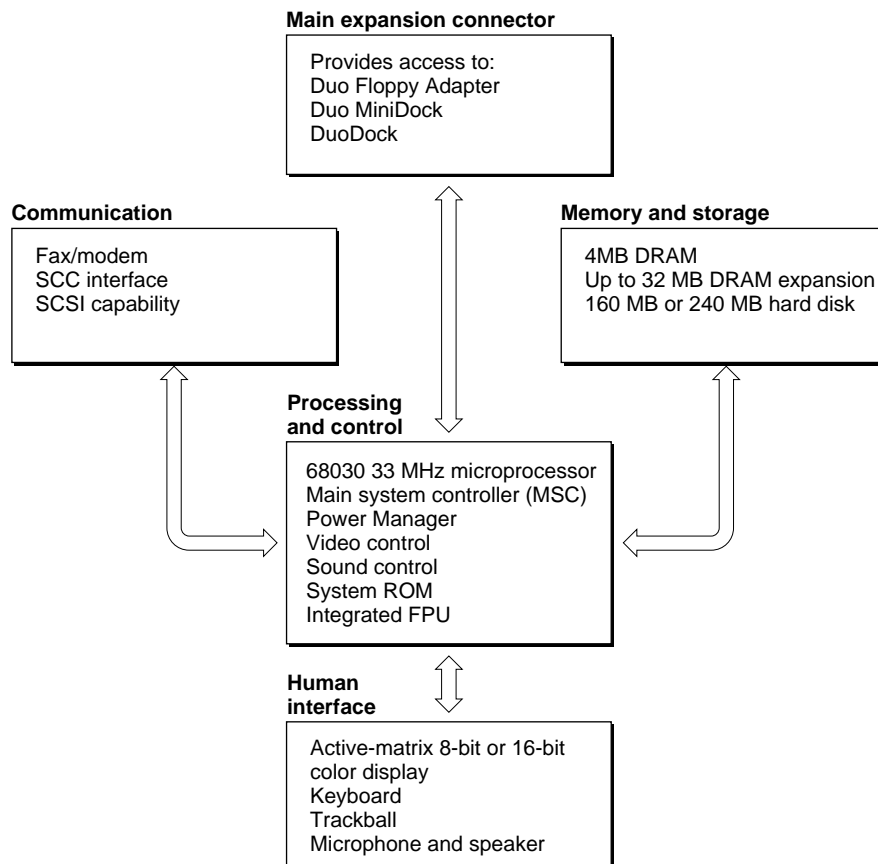
- main processor: 33 MHz 68030 microprocessor
- **integrated floating-point unit**
- main system controller (MSC): controls DRAM, ROM, built-in I/O, sound, and some power-saving features
- Power Manager: a custom microcontroller that provides intelligent power management
- integral hard disk: **160 MB or 240 MB capacity**
- 4 MB of DRAM (dynamic random access memory) on the main logic board
- 8 MB memory expansion card expands memory capacity up to 12 MB; third-party SIMM (single inline memory) card expands memory capacity up to 32 MB

## Introduction to the PowerBook Duo 270c Computer

- 1 MB of ROM (read only memory): stores system and configuration data.
- **active-matrix TFT 8-bit or 16-bit color display**
- video components: a **color-screen controller (CSC) chip** and video RAM; the CSC controls the interface between the processor, the video RAM, and the display; the VRAMs store the data required to write and refresh the display
- **inverter/speaker board** compatible with both FSTN (film super-twist nematic) and AM displays
- **Combo chip**: includes the Serial Communication Controller (SCC) and Small Computer System Interface (SCSI) controller
- **enhanced sound chip**: supports 8-bit monaural sound input and output
- **integral microphone and speakers**
- **modem**: internal modem/fax card, referred to as the Express Modem
- **keyboard**: integral full-function keyboard with trackball
- **I/O**: one 152-pin connector for expansion devices, one mini-DIN 8-pin serial port, one modem port, and a power connector
- **nickel metal hydride battery**: 4.5-hour removable and rechargeable battery

Figure 1-1 shows a simplified block diagram of the PowerBook Duo 270c computer system

**Figure 1-1** Simplified block diagram of the PowerBook Duo 270c computer system



# Hardware Modifications

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## Hardware Modifications

This chapter describes hardware features of the PowerBook Duo 270cPowerBook Duo 270c computer that make it different from the Macintosh PowerBook Duo computer. These features include

- the active-matrix TFT color display
- the integrated floating point unit
- color screen controller
- the 160 MB or 240 MB hard disk drive (the 160 MB drive is not described separately in this note)
- the inverter/speaker board

This chapter also describes the hardware changes required to support these features:

- modified main logic board
- modified clamshell housing

## Active-Matrix TFT Color Display Features

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The PowerBook Duo 270c display is an active-matrix TFT color display. It is 3.8 millimeters thicker than the basic PowerBook Duo display, requiring the computer housing to be thicker than that of the original PowerBook Duo. (See the section “Clamshell Housing,” later in this chapter.)

The display can be driven in two modes. In what is termed 8-bit mode, with 8 bits per pixel, and a 640-pixel by 480-pixel display area, the PowerBook Duo 270c can display up to 256 different colors at a time. In what is termed 16-bit mode, but which is actually 15 bits per pixel, the PowerBook Duo 270c can display thousands (up to 32K) of colors on a 640-pixel by 400-pixel display area.

The system software allows you to select either mode by means of the Monitor control panel (see Chapter 3). Because the VRAM is a fixed size, 256K by 16 maximum, it can handle only a certain amount of data. If you select the 16-bit mode, to enable the VRAM to handle the thousands of colors, the system software resizes the display area down to 400 lines instead of 480, and centers the lines on the screen, leaving black bands of 40 lines each at the top and bottom of the screen.

Table 2-1 lists the features of the active-matrix TFT color display.

**Table 2-1** Features of the active-matrix TFT color display

Feature	Description
Display matrix	640 x 480 pixels, 8-bit color 640 x 400 pixels, 16-bit color
Active display area	171 mm x 130 mm
Display module dimensions	237.4 mm wide, 175.2 mm high, 8.7 mm deep



**Table 2-1** Features of the active-matrix TFT color display

<b>Feature</b>	<b>Description</b>
Standard display mode	Normally white
Contrast ratio	60:1 minimum
Pixel pitch	0.267 (high) by 0.270 (wide) = R+G+B = 1 pixel
Pixel configuration	R, G, B vertical stripes
Total pixel on/off switching speed or response time	<80 ms
Surface treatment	Antiglare polarizer at 2H pencil hardness
Backlight/CCFL	Integrated backlight system, with typical RMS operating values of 470 V <sub>rms</sub> at 5.5 mA

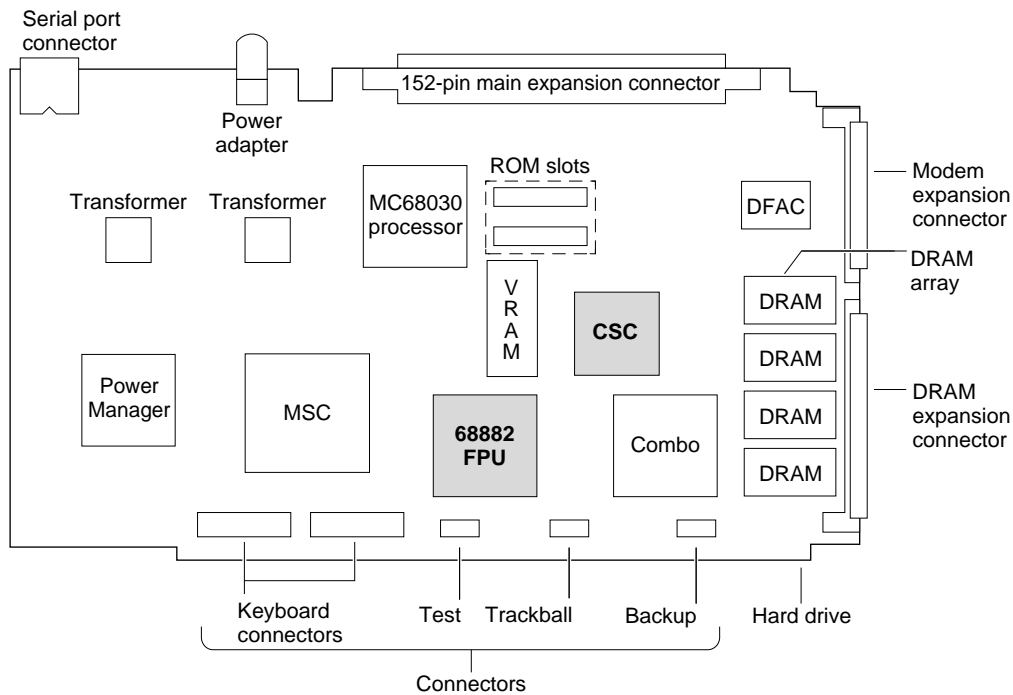
## Changes on Main Logic Board

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The outline of the PowerBook Duo 270c computer's main logic board is identical to the outline of the main logic board in the PowerBook Duo. However, there are several component changes, as described below. Figure 2-1 shows a view of the main logic board, with new components shaded.

The changes to the board include

- an on-board floating-point unit
- replacement of the GSC with the CSC
- rearrangement of the on-board DRAM

**Figure 2-1** PowerBook Duo 270c main logic board

■ Components that are different for the Escher computer  
 The logic board contains 8 DRAMs - 4 on each side of the board

## Integrated Floating-Point Unit

The PowerBook Duo 270c computer has an integrated FPU mounted on the main logic board in a PLCC socket. The FPU is a 68882 device. Figure 2-1 shows the position of the FPU on the logic board.

## Color Control Chip (CSC)

The CSC replaces the PowerBook Duo's gray-scale controller (GSC). Figure 2-1 shows its position on the main logic board. The CSC is a 144-pin TQFP (thin quad flat pack) device. It supports FSTN and TFT LCD display panels, in color or monochrome/gray, in two raster matrix configurations: 640 x 480 and 640 x 400, in dual-drive and single-drive configurations. It supports the following color and grayscale modes:

- 1 bit per pixel (2 colors or grays), black-and-white monochrome
- 2 bits per pixel (4 colors or grays)
- 4 bits per pixel (16 colors or grays)
- 8 bits per pixel (256 colors or grays)
- 16 bits per pixel (32K colors or grays), with 640 x 400 display

## DRAM Configuration

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The PowerBook Duo 270c main logic board contains 8 DRAMs, which make up the 4 MB of on-board DRAM. Four of the DRAMs are located on the front of the main logic board, and four on the back of the board, whereas on the main logic board of PowerBook Duo computer, all eight DRAMs are on the front of the board.

## 240 MB Hard Disk Drive

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This section describes the 240 MB hard disk drive. It includes the following information about the drive:

- environmental specifications
- housing requirements
- interface requirements

### IMPORTANT

It is possible to mount a 160 MB hard disk drive in the PowerBook Duo 270c housing. The physical requirements for this drive are the same as for the 240 MB drive, and therefore the 160 MB drive is not described separately in this section. ▲

## Environmental Specifications

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Table 2-2 provides a summary of environmental specifications for the 240 MB hard disk drive.

**Table 2-2** Environmental specifications for 240 MB hard disk drive

Category	Condition	Specification
Temperature of ambient air inside a low airflow thermal chamber, non-condensing	Operating limits:	5 to 55 degrees C
	Nonoperating and storage:	-40 to 60 degrees C

## Hardware Modifications

**Table 2-2** Environmental specifications for 240 MB hard disk drive

Temperature gradient	Operating:	20 degrees C per hour
	Non-operating:	Below rate causing condensation
Relative humidity	Operating:	10-90%, noncondensing, maximum wet bulb 20 degrees C
	Non-operating:	Non-condensing, maximum wet bulb 35 degrees C
Altitude	Operating:	-200 to 15,000 feet
	Shipping:	-200 to 15,000 feet

## Housing Requirements

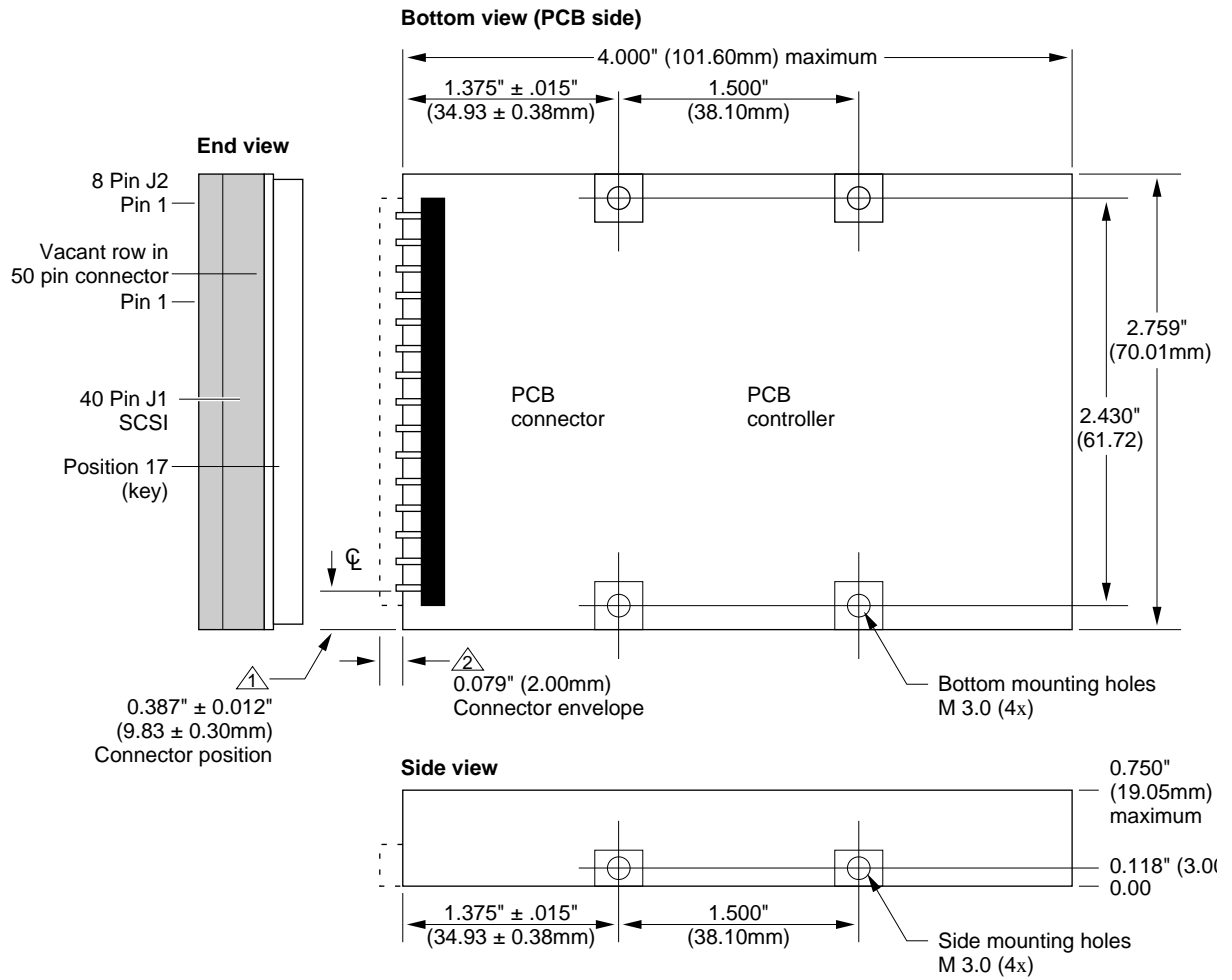
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The PowerBook Duo 270c computer accommodates either a 160 MB hard disk drive or a 240 MB drive. The hard disk drive is housed in the PowerBook Duo 270c clamshell housing.

Figure 2-2 shows the dimensions of the 240 MB hard disk. The height of the disk drive is critical, and it must not exceed 19mm (0.75) inches. Both drives are currently 19 millimeters tall, but eventually the 160 MB drive will be available in 12.5-millimeter and 17-millimeter versions.

The drive may be mounted through either side-mounting or bottom-mounting holes machined into the disk drive housing. A bracket, shown in Figure 2-3, is attached to the side of the hard disk and holds it in place in the PowerBook Duo 270c computer housing.

Figure 2-2 Hard disk drive housing



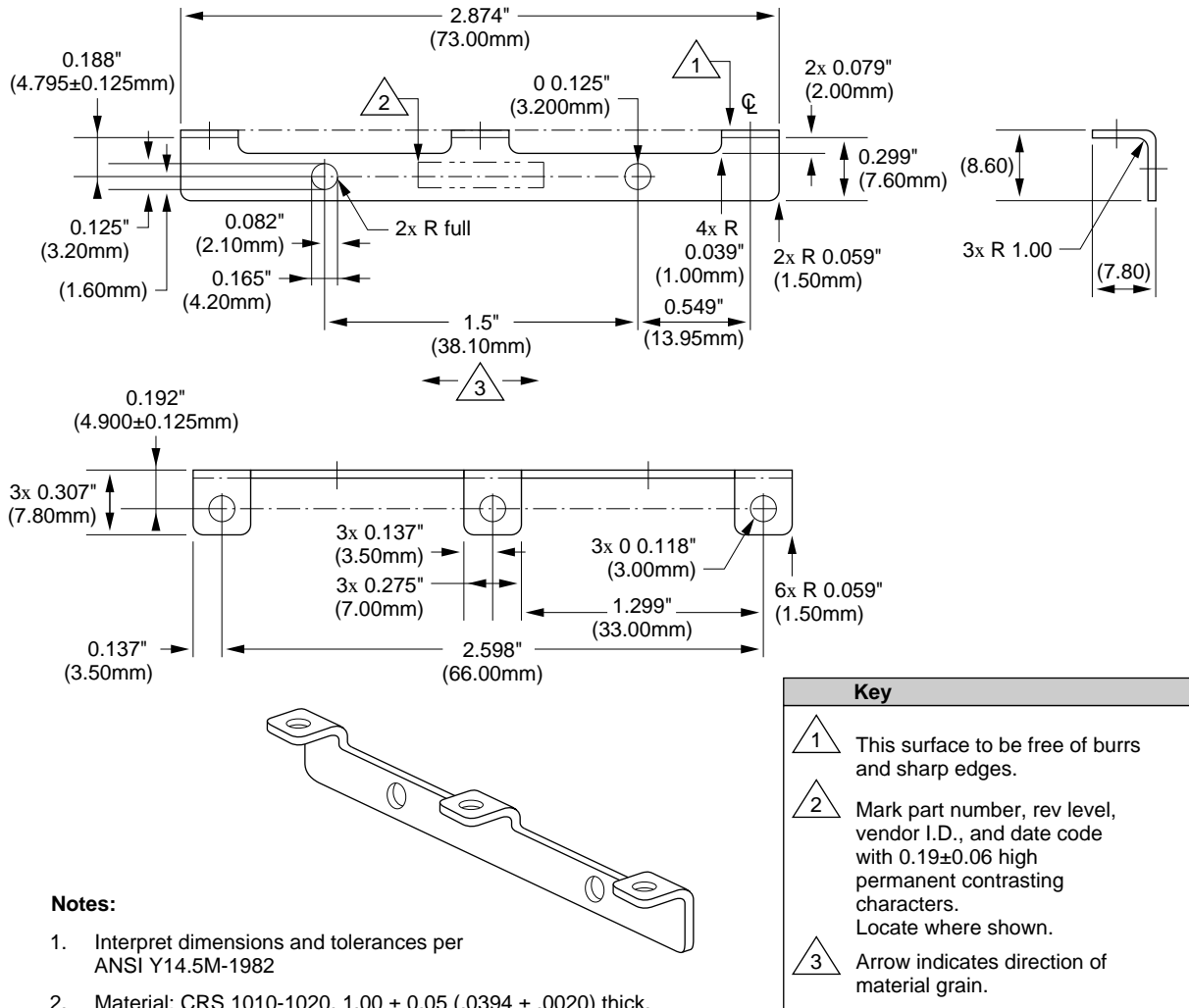
**Notes:**

1. All dimensions in inches (mm).
2. Tolerances (unless otherwise noted): .XX = +/-0.25mm (.XXX = +/- .010 inches).

**Key:**

- ① Connector position from edge of drive to center line of first connector pin (39).
- ② Connector envelope does not include flex cable or mating receptacle. Connector pins are to be flush with drive envelope dimensions.

**Figure 2-3** Bracket for the hard disk drive



**Notes:**

1. Interpret dimensions and tolerances per ANSI Y14.5M-1982
2. Material: CRS 1010-1020, 1.00 ± 0.05 (.0394 ± .0020) thick.
3. Finish: Zinc pre-plate per Mil.Spec. QQ-Z-325a Class 3 (0.00020) type II.
4. Maximum burr allowance is 15% of material thickness.
5. Starred (\*) dimensions and notes are critical control dimensions for Apple incoming quality control inspection
6. Tooling required to make this part to be property of Apple Computer, Inc. and shall be permanently marked with Apple's name and appropriate part number.
7. All dimensions apply after finish.

## Hard Disk Interface

This section describes the interface requirements for the 240 MB hard disk drive. It provides specifications and signal assignments for the SCSI connector.

## Interface Requirements

The interface to the hard disk is an ANSC X3T9.2 SCSI interface. It implements the Apple SCSI command protocol and diagnostic command set. Buffer size supports a 1:1 interleave. The drive supports the SCSI asynchronous information transfer. The transfer rate is 1.5 MB per second (minimum). An embedded controller provides error recovery algorithms, which include error check and correction (ECC), seek retry, head offset (for open-loop systems), and defect management. The SCSI interface provides a SCSI ID that can be detected by the hardware.

## SCSI Connectors

The disk drive SCSI connector comprises two segments, as shown in Figure 2-4. The first segment has 40 pins, arranged in two rows. It transfers SCSI signals between the CPU and the hard disk drive, and it also supplies power to the drive. The second segment of the connector accommodates the SCSI ID.

**Figure 2-4** Hard disk drive SCSI connector

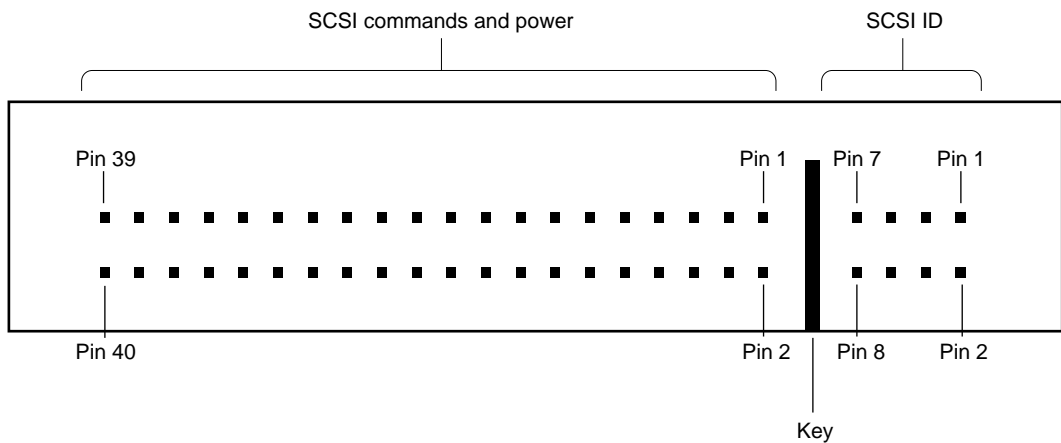


Table 2-3 lists and describes the interface signals for the 40-pin segment of the connector.

**Table 2-3** Hard disk drive SCSI connector signal assignments – SCSI and power

Pin	Signal name	Description
1, 2	+5V logic	+5 V power supply
3, 4	Logic return	+5 V return
5, 7, 9, 11, 13, 15, 19, 21, 23, 27, 31, 35	GND	Ground

**Table 2-3** Hard disk drive SCSI connector signal assignments – SCSI and power (continued)

Pin	Signal name	Description
6	/DB0	Data bus bit 0
8	/DB1	Data bus bit 1
10	/DB2	Data bus bit 2
12	/DB3	Data bus bit 3
14	/DB4	Data bus bit 4
16	/DB5	Data bus bit 5
17	KEY	Not connected; used as connector key
18	/DB6	Data bus bit 6
20	/DB7	Data bus bit 7
22	/PARITY	Data bus parity
24	TERM PWR	Terminator power; pulls up termination resistors for all signal lines
25	/ATN	Attention indicator
26	/BSY	Busy signal
28	/ACK	Acknowledge (handshake signal); asserted in response to a request for access (/REQ)
29	/RST	SCSI bus reset
30	/MSG	Message phase
32	/SEL	SCSI select
33	/I/O	Controls the direction of data movement: when this signal is low, data is output from the disk drive; when it is high, data is input
34	/C/D	Indicates whether data or control signals are on the SCSI bus: when this signal is low, data is on the bus; when it is high, control signals are on the bus
36	/REQ	Access request; the CPU asserts this signal to request access to the hard disk
37, 38	MOTOR RET	Return for +5 V power supply for motor
39, 40	+5V MOTOR	+5 V power supply for the motor



## Hardware Modifications

Table 2-4 lists and describes the interface signals for the 8-pin segment of the connector.

**Table 2-4** Hard disk drive SCSI connector signal assignments – SCSI ID

Pin	Signal name	Description
1, 2, 3, 4, 8	Unused	These pins are not used and are not connected electrically to the CPU
5	/ID1	SCSI ID 1
6	/ID2	SCSI ID 2
7	/ID4	SCSI ID 4

The internal hard disk is assigned a SCSI ID number (0-7). Pins 5-7 on the SCSI connector are encoded and allow the CPU to select the appropriate device. Table 2-5 shows how the ID signals are encoded.

**Table 2-5** SCSI ID encoding

ID1: Pin 5	ID2: Pin 6	ID4: Pin 7	SCSI ID
High	High	High	0
Low	High	High	1
High	Low	High	2
Low	Low	High	3
High	High	Low	4
Low	High	Low	5
High	Low	Low	6
Low	Low	Low	7

### Terminator

The hard disk has 1000-ohm termination resistors for all I/O signal lines. The lines are pulled up to through the resistors to termination power.

## Power Requirements

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Power drawn for the hard disk must be less than or equal to values shown in Table 2-6 for each mode. All measurements are under nominal environmental and voltage conditions. The limits include 1000-ohm pull-up resistors on all signal lines.

**Table 2-6** Power requirements for the 240 MB hard disk drive

Mode	Current (amps)	
	Mean	Maximum
Startup (1)		1.30
Random operation (2)	0.50	0.60
Idle	0.30	0.35

NOTE 1 Startup values are peak values during response time of Power On to Power Ready.

NOTE 2 Random operation values are RMS values with a 40% random seek, 40% write/read (1write in 10 reads) and 20% idle mode.

## Inverter/Speaker Board

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The inverter/speaker board is located in the clamshell housing, directly under the display. It interfaces between the basic CPU and the active-matrix display and performs the following basic functions for the PowerBook Duo 270c computer:

- It converts the DC power supplied by the computer's battery to the AC power required to drive the cold cathode fluorescent lamp (CCFL), that provides the backlighting for the active-matrix LCD display. Typical CCFL drive power is 400 VRMS (voltage root mean square) at 3mA, with maximum output of 2000V peak to peak at 6 mA.
- It provides pass-through circuitry for the data and timing signals, supplied by the CSC to the LCD display, and for the +5V from the power supply.
- It converts the DC voltage supplied by the computer's battery to +5 VDC level required for the LCD bias, which is typically +5 V at 200 mA.

### ▲ WARNING

You should not open or modify any of the circuitry associated with the inverter/speaker board. The PowerBook Duo 270c active-matrix display is assembled into the clamshell housing in a clean room environment. Opening up the equipment in any other environment could cause damage to the unit. The high-voltage inverter/speaker board may pose a risk if you are handling the board. The LCD display is susceptible to damage from electrostatic discharge (ESD). ▲

## Clamshell Housing

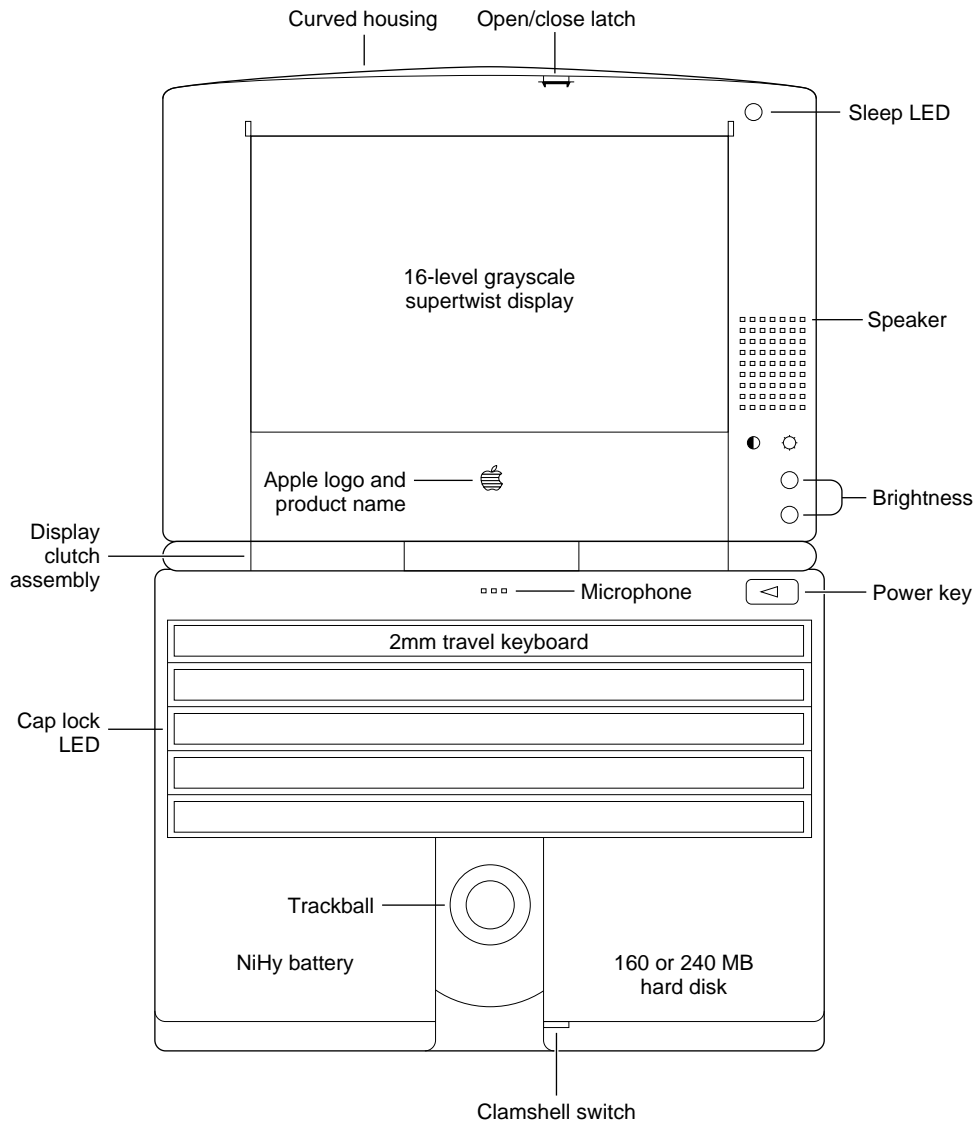
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The PowerBook Duo 270c computer is housed in a clamshell case. Since the display is 3.8 millimeters (0.149 inches) thicker than the original PowerBook Duo display, the overall housing is also thicker than the original PowerBook Duo housing. When the case is closed, it measures 203.2 millimeters by 274.32 millimeters (8 inches by 10.8 inches), and is 36.8 millimeters (1.449 inches) deep. Figure 2-7 shows an open view of the clamshell.

**IMPORTANT**

Since the clamshell case is slightly deeper than the case of the original PowerBook Duo, if you plan to use the PowerBook Duo 270c computer with the Duo Dock, you cannot use a standard Duo Dock. The slot is not deep enough to accommodate the PowerBook Duo 270c clamshell case. There are two solutions. You may upgrade the top shell of an existing Duo Dock to enlarge the slot. Future Duo Docks will accommodate the deeper case, and will not require modification. ▲

**Figure 2-5** The PowerBook Duo 270c computer housing in open position



# Software Modifications

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## Software Modifications

This chapter describes the software modifications required to support the PowerBook Duo 270c computer. The changes are associated with

- the System ROM and Enabler
- battery reconditioning
- the control panels

## System ROM

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The 1 MB ROM used in the PowerBook Duo 270c system is a universal ROM and supports all existing products based on the 68020, 68030, and 68040 microprocessors. Additions to the ROM code support the following PowerBook Duo 270c features:

- built-in color video
- the internal floating-point unit
- refresh operation for up to 32 MB of DRAM
- extended power management capabilities
- improved support for the AppleTalk network
- diagnostic support for the FPU and the CSC chip registers

The ROM also supports several docking station features, such as an external cache, and enhancements to the docking process.

The PowerBook Duo 270c system Enabler, known as Figeac, is designed to be compatible with the entire family of PowerBook Duo products. The Enabler resides in the System Folder, and it enables you to add system enhancements.

The PowerBook Duo 270c ROM version number is \$27, the CPU ID bits are A55A 1002, the box flag is 71, and the Gestalt ID is 77.

## Video Support

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This section describes the software support provided for both 8-bit and 16-bit color. The basic techniques used are similar to those used in other Macintosh color monitors. However, certain software modifications are required to support the LCD display, as opposed to the CRT displays used with Apple desktop computers. *Inside Macintosh, Volume VI*, Chapters 16 through 19, and *Inside Macintosh: Imaging With QuickDraw*, provide additional background information on video color.

One basic difference between the PowerBook Duo 270c LCD display and Apple CRT displays is that while the CRT display uses a digital-to-analog interface to achieve the colors represented in the color lookup table, the LCD display uses a digital-to-digital interface.

### 8-Bit Color

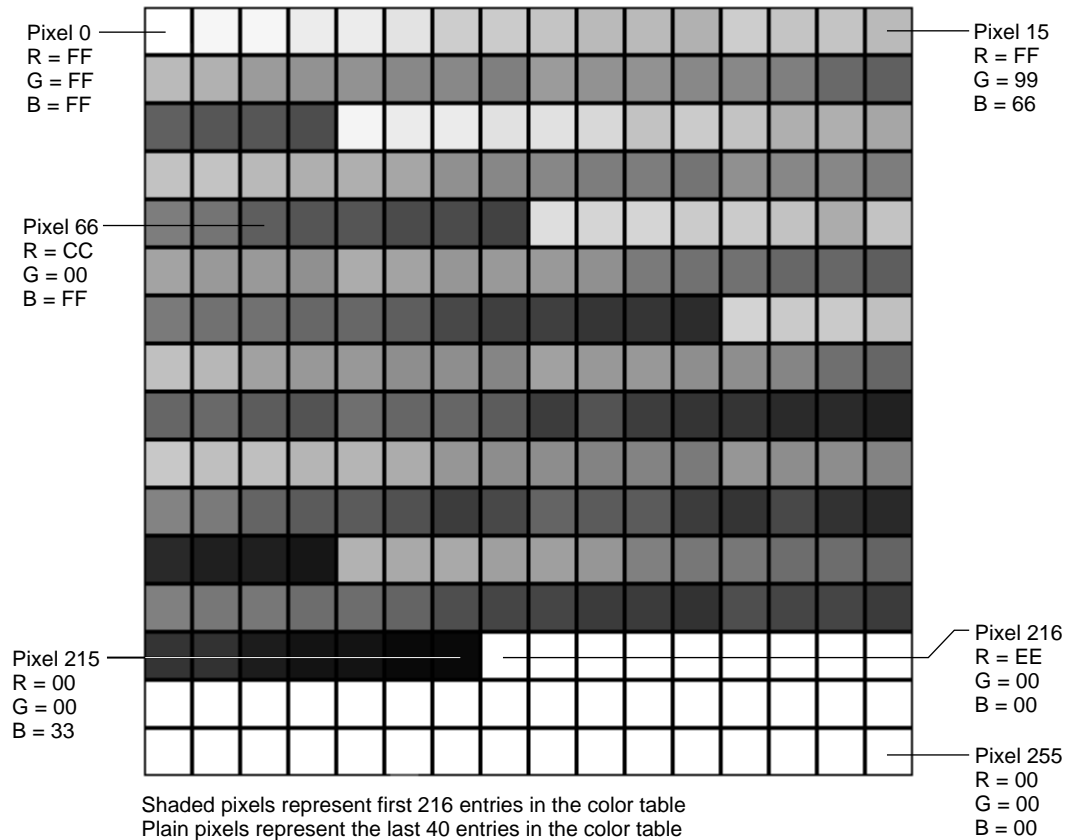
The CSC video driver resides in the slot 0 configuration (declaration) ROM (part of the system ROM on the main logic board). The driver supports 8-bit color on a 640-by-480-pixel screen.

The 8-bits-per-pixel configuration produces 256 colors. Figure 3-1 shows the color lookup table with values for sample indexes (pixels). You are advised to select colors from first 215 entries in the color table. The values of the entries are based upon combinations of 00, 33, 66, 99, CC, and FF.

The last 40 entries in the table are assigned to shades of pure red, green, blue, and gray, and are based upon combinations of 00, 11, 22, 44, 55, 77, 88, AA, BB, and EE. These entries are ramped and dithered, to produce the various shades. Dithering, which may be implemented spatially or temporally, mixes primary colors to produce the effect of a range of different shades.

Appendix A, “Color Lookup Table,” provides a complete listing of the 256 indexes and their values.

**Figure 3-1** PowerBook Duo 270c color lookup table



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## 16-Bit Color

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You may select 16-bit color from an option in the Monitor control panel. If you select this option, the image area on the LCD display is reduced to 640 x 400 pixels and narrow black bands appear at the top and bottom of the screen. With 16-bit color, you have access to thousands of different colors.

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## Support for Internal FPU

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The PowerBook Duo 270c computer contains an internal FPU. When the PowerBook Duo 270c is installed in a Duo Dock or attached to the Duo MiniDock or Duo Floppy Adapter, an external FPU may also be installed on the main logic board of the dock or the adapter. The external FPU takes priority over the internal FPU, and the default power-on procedure disables the internal FPU to prevent a possible conflict. The startup sequence has been modified to detect the presence of an external FPU. If there is no external FPU, the PowerBook Duo 270c computer's internal FPU is enabled.

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## Support for Extended DRAM

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The memory system controller (MSC) installed on the PowerBook Duo 270c computer's main logic board supports up to 40 MB of self-refreshing DRAM. Currently, PowerBook Duo 270c hardware provides decoding for up to 32 MB of DRAM.

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## Extended Power Management Capabilities

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The latest release of the Power Manager code, which resides in the PowerBook Duo 270c ROM, allows you to modify the system time without impacting the battery-charging algorithm. Firmware features added for the PowerBook Duo 270c computer also support a sleep LED, version dependent code, 4/5A Panasonic battery support, and battery conditioning.

The Power Manager section of the PowerBook Duo 270c ROM provides a standard set of routines that you may access. All other routines are private.

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## Network Support

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The latest version of AppleTalk is included in both the PowerBook Duo 270c ROM and the System Disk. The new version of AppleTalk is more efficient in remembering network settings when the PowerBook Duo 270c computer is being docked or undocked. AppleTalk resources are removed from the System Enabler file. The Installer application installs AppleTalk files directly into the System file when needed.

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## Diagnostic Support

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The PowerBook Duo 270c ROM enables diagnostic testing for the FPU, the CSC chip registers, and the VRAM by means of the CSC.



## Battery Reconditioning

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The PowerBook Duo 270c computer is powered either by a main wall supply or by its battery unit. When the computer is plugged in, it can decide whether power is supplied by the wall supply or by the battery. This feature makes it easier to initiate a battery reconditioning cycle. All you need to do is initiate the Recondition application and proceed through a number of informational dialog boxes. After you have approved all stages by clicking the OK button, the application configures the Power Manager to perform the reconditioning process.

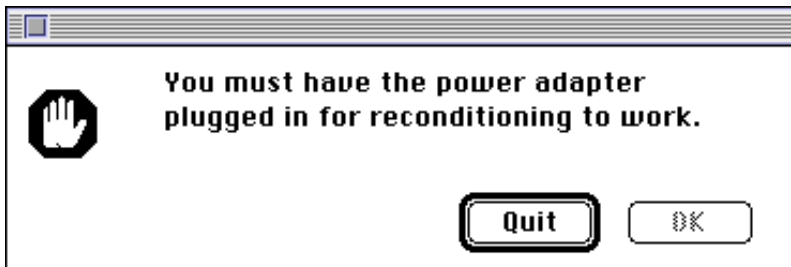
When reconditioning starts, the Power Manager is placed in forced discharge mode. In this mode, the Power Manager switches the external power adapter off and ignores all the low power levels, including hardware shutdown. It disables the battery charging circuit, although it turns it on once every second to read the battery voltage. The Power Manager stays in this forced discharge mode until Battery Recondition clears it. This occurs either when the battery has been reconditioned or when you abort the process.

### Before Reconditioning

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To recondition the battery, you must plug the PowerBook Duo 270c power adapter into the main power supply. If the adapter is not plugged in when you initiate the Recondition application the dialog box shown in Figure 3-2 appears on the screen. The OK button is not available until you plug in the adapter. If you unplug the power adapter while the battery is being reconditioned, the application terminates and no further dialog boxes are displayed.

**Figure 3-2** Power adapter warning



**IMPORTANT**

In all dialog boxes associated with reconditioning the battery, you have to make a conscious decision to recondition the battery. All defaults cause the application to terminate. This is important for a variety of reasons: the reconditioning process takes about two hours, and you do not want to enter the process inadvertently; you should not recondition the battery more frequently than every 30 days; and when you initiate the Recondition application, all other applications shut down. ▲

## Reconditioning Dialog Boxes

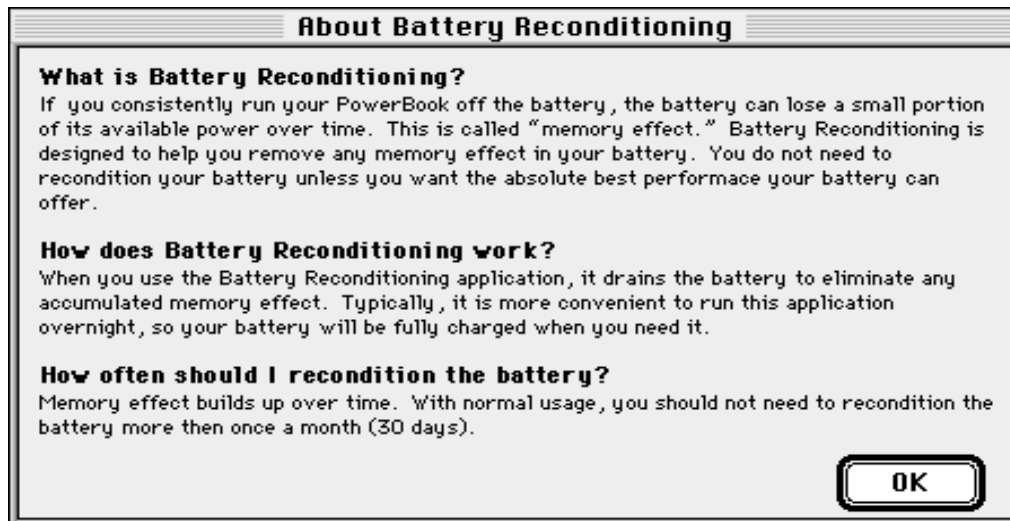
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The Recondition application has several levels of informational dialog box. The first level, shown in Figure 3-3 contains general information. You open this dialog box if you want to initiate the application to see what it does. The dialog box briefly explains the battery memory effect and the reconditioning process. It summarizes the information found in the user's manual.

**IMPORTANT**

As you proceed through the reconditioning process, the default button in each dialog box is Quit. If you hit the Enter or Return key while a dialog box is displayed on the screen, the Recondition application automatically quits. To initiate or proceed with the reconditioning process, you have to click OK or Recondition. ▲

**Figure 3-3** Initial information dialog box

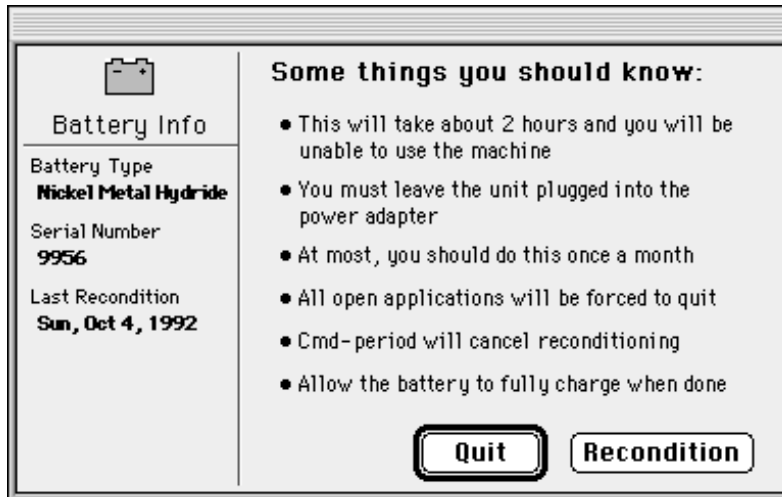


The only control in the initial information dialog box is the OK button. When you click this button you proceed to the Main Informational dialog box, shown in Figure 3-4. This box displays specific information about the battery, including battery type, serial

## Software Modifications

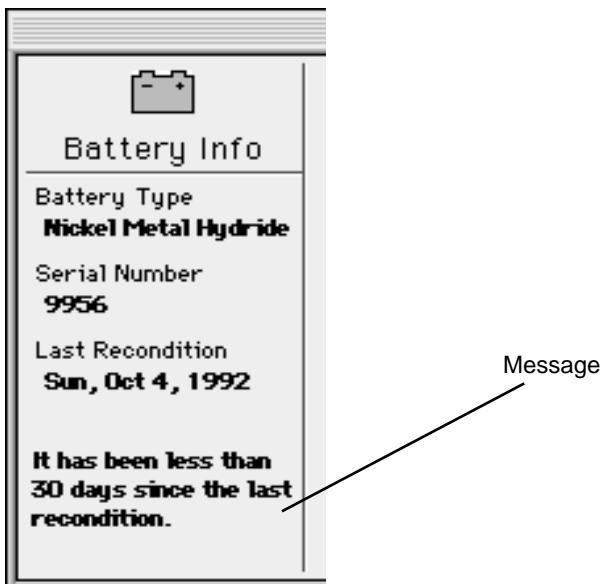
number, and the date the battery was last reconditioned. The default control for this dialog is the Quit button. You have to click the Recondition button to start reconditioning.

**Figure 3-4** Main informational dialog box



If it has been less than 30 days since the battery was last reconditioned, the message shown in Figure 3-5 is displayed as part of the main informational dialog box.

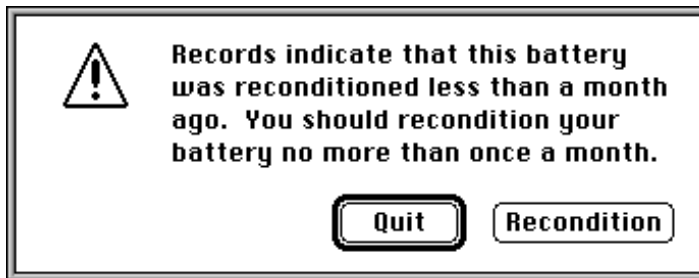
**Figure 3-5** Less-than-30-days message



## Software Modifications

If you decide to proceed with reconditioning, and have reconditioned the battery within the last 30 days, the dialog box shown in Figure 3-6 appears on the screen. It warns you not to recondition the battery but gives you the option of proceeding.

**Figure 3-6** Final confirmation: less than 30 days



Once you have decided to go ahead and recondition the battery, the Power Manager is reconfigured to forced discharge, all open applications, including the Finder, are closed, and the screen is blanked. The Recondition application code enters a loop as it waits for the battery to reach the required voltage. During this wait period, the symbol shown in Figure 3-7 is displayed on the screen to let you know that the machine is still running. If you wish to terminate the Recondition application, you may press Command and period.

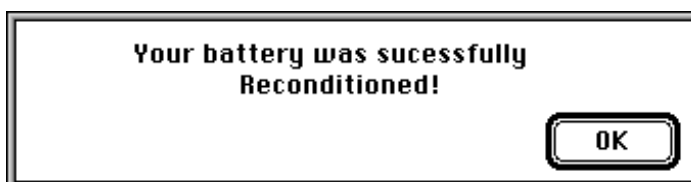
**Figure 3-7** Waiting image



Command-Period to quit.

If you decide to quit the application, the application restores the machine state and exits. The Finder restarts the system. If you continue reconditioning the battery, the process continues until the battery reaches the required voltage, at which point the dialog box shown in Figure 3-8 appears on the screen.

**Figure 3-8** Completion dialog box



This dialog box is displayed for one minute, during which time you may click the OK button. If you do not click the button, the application automatically times out, and the dialog box goes away automatically. When the reconditioning process has been completed, the Preferences file is updated to indicate that the battery has been reconditioned.

## PowerBook Duo 270c Control Panels

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The functions controlled by the PowerBook Duo control panel have been split between two panels: PowerBook Setup and PowerBook. Having two panels makes it easier to control functions currently available with the PowerBook Duo 270c computer and leaves room for growth. Dimming has been moved from PowerBook Display and is now part of PowerBook. Mirror remains in PowerBook Display.

The first control panel, PowerBook Setup, controls setup functions for the modem port configuration, SCSI disk mode, and automatic wakeup.

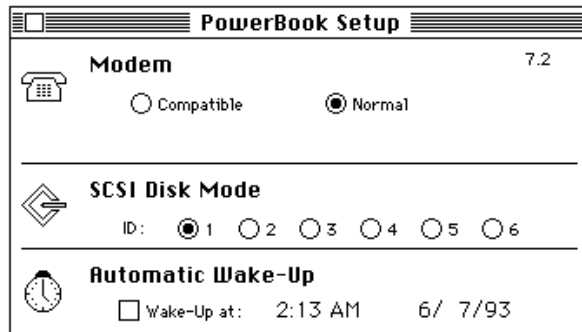
The second panel, PowerBook, is a power management control panel. It contains the battery conservation controls, including those items generally available through the Options button in PowerBook version 7.1: sleep, processor cycling, and Econo-Mode. It controls backlight dimming, and it can also automatically change the Power Manager configuration based on the machine's power source.

### PowerBook Setup Panel

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The PowerBook Duo 270c computer's PowerBook Setup control panel is a modified version of the PowerBook control panel that shipped with System 7.1. It is essentially the same control panel, but with all power conservation features removed.

The PowerBook Setup panel has been further modified to accommodate different modem configurations. The modem controls in the PowerBook Setup control panel distinguish between the Express Modem and other modems. Figure 3-9 shows the PowerBook Setup panel with modem controls.

**Figure 3-9** PowerBook Setup panel

The control panel determines what type of modem is installed and chooses the appropriate control titles. If an Express Modem is present, “Internal Modem” is changed to “Compatible” and “External Modem” to “Normal.” The functions associated with the radio buttons have not changed. However, the titles are different to remove the confusion generated by the incorrect use of internal/external modem when an Express Modem is installed.

If you have an Express Modem installed, you should use the Normal setting. In this mode, the modem is accessed through the Communications ToolBox (CTB). If you are using an application that is not CTB-aware, you should use the Compatible setting. This will patch the existing serial driver to route serial commands through the CTB to the Express Modem.

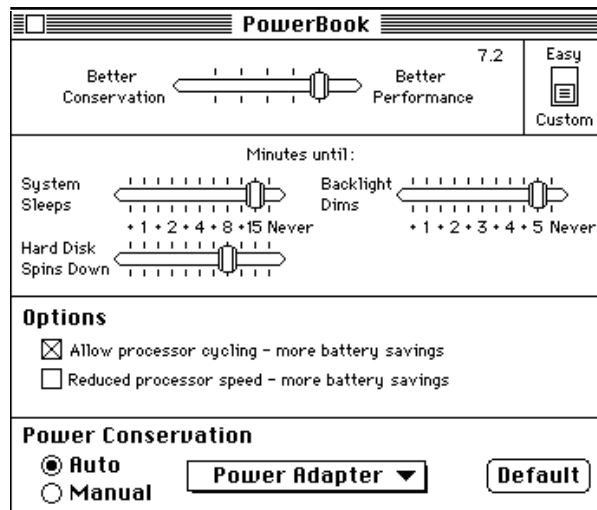
If you have a third-party internal modem installed, the control titles will be Internal Modem and External Modem, and they will behave as expected, with Internal Modem selecting the modem installed in the system. These titles are the same as those used in PowerBook 7.1.

#### **IMPORTANT**

If you select Compatible, port A (Printer/Modem, Modem) is not available for serial connections. However, AppleTalk is still available. ▲

## PowerBook Control Panel

The PowerBook control panel, shown in Figure 3-10, is a completely new control panel. It controls only those functions associated with battery and power conservation, as described in the next two sections. The PowerBook control panel is designed for two different groups of users: those who require the power management procedure to be as simple and transparent as possible and power users who wish to have complete control over the power management function.

**Figure 3-10** PowerBook control panel

Information about power management is stored in the Preferences file in the System Folder. When the system is booted, the file is read and the contents are stored permanently in memory.

### Custom and Easy Controls for Battery Conservation

There are two methods of accessing controls. Initially, if you open the PowerBook control panel, you will see one simple slider switch (see Figure 3-10), Better Conservation/Better Performance. You may adjust this slider, as required, to improve battery conservation or system performance, or you may leave it in the default position.

If you toggle the Easy/Custom box in the control panel, you will be able to access three additional sliders that are subsets of Battery Conservation. They are System Sleeps, Hard Disk Spins Down, and Backlight Dims. If you move any of these sliders, the change will be reflected in the Better Conservation/Better Performance slider, alerting you as to whether the change improves performance or provides better conservation. The controls revert to the single slider if you toggle the Easy/Custom control again. The PowerBook control panel remembers the state in which the controls were left when last used.

### Power Conservation

There are two modes of battery conservation. One is used when the PowerBook Duo 270c computer is plugged into AC main power, and the other is used when the computer is running on its battery. A TimeMgr task installed by system extension in the PowerBook Duo file can automatically change the power management settings based on the machine environment.

When the PowerBook Duo 270c computer is shipped, the Power Conservation part of the PowerBook control panel is set with the default settings for Power Adapter and Auto

## Software Modifications

enabled, as shown in Figure 3-10. If you are using Easy mode, you will not be able to edit these settings. If you are in Custom mode, you can enable or disable automatic conservation (Auto), select either Battery or Power Adapter as the power source, or revert to the default settings. The changes you make in this panel are stored in the Preferences file.

At certain times, the PowerBook control panel compares the current Power Manager settings with both sets of parameters. It does this during open and activate events, when you switch from Manual to Auto power conservations, and when you switch to Custom mode. If a match is found, the name of the matching set is displayed in the pop-up menu, and both the menu and the default button are active. If no match is found, No Set Selected is shown in the pop-up menu, and both menu and default buttons are inactive. Once a valid set is selected, No Set Selected is removed from the pop-up menu.



# Color Lookup Table (CLUT)

This appendix contains more information about the PowerBook Duo 270c color lookup. Table A-1 shows the values for each index. Index numbers are shown in hexadecimal (\$0000, \$0001, etc.) and decimal (0, 1, etc.). Red (R) green (G), and blue (B) values are shown in hexadecimal (\$FFFF, \$CCCC, etc.). The first 215 entries are the RGB combinations, made up of 00, 33, 66, 99, CC, and FF. These colors are not dithered. You should generally select colors from these 215 entries of the CLUT.

The last 40 entries are assigned to red ramp, green ramp, blue ramp, and to gray scales. These last 40 entries are dithered, either spatially or temporally, to produce various shades of red, green, blue, and gray. The entries are made up of combinations of 00, 11, 22, 44, 55, 77, 88, AA, BB, DD, and EE.

**Table A-1** Color look up table

Index (hex)	Index (dec)	R value	G value	B value
\$0000	0	\$FFFF	\$FFFF	\$FFFF
\$0001	1	\$FFFF	\$FFFF	\$CCCC
\$0002	2	\$FFFF	\$FFFF	\$9999
\$0003	3	\$FFFF	\$FFFF	\$6666
\$0004	4	\$FFFF	\$FFFF	\$3333
\$0005	5	\$FFFF	\$FFFF	\$0000
\$0006	6	\$FFFF	\$CCCC	\$FFFF
\$0007	7	\$FFFF	\$CCCC	\$CCCC
\$0008	8	\$FFFF	\$CCCC	\$9999
\$0009	9	\$FFFF	\$CCCC	\$6666
\$000A	10	\$FFFF	\$CCCC	\$3333
\$000B	11	\$FFFF	\$CCCC	\$0000
\$000C	12	\$FFFF	\$9999	\$FFFF
\$000D	13	\$FFFF	\$9999	\$CCCC
\$000E	14	\$FFFF	\$9999	\$9999
\$000F	15	\$FFFF	\$9999	\$6666
\$0010	16	\$FFFF	\$9999	\$3333
\$0011	17	\$FFFF	\$9999	\$0000

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$0012	18	\$FFFF	\$6666	\$FFFF
\$0013	19	\$FFFF	\$6666	\$CCCC
\$0014	20	\$FFFF	\$6666	\$9999
\$0015	21	\$FFFF	\$6666	\$6666
\$0016	22	\$FFFF	\$6666	\$3333
\$0017	23	\$FFFF	\$6666	\$0000
\$0018	24	\$FFFF	\$3333	\$FFFF
\$0019	25	\$FFFF	\$3333	\$CCCC
\$001A	26	\$FFFF	\$3333	\$9999
\$001B	27	\$FFFF	\$3333	\$6666
\$001C	28	\$FFFF	\$3333	\$3333
\$001D	29	\$FFFF	\$3333	\$0000
\$001E	30	\$FFFF	\$0000	\$FFFF
\$001F	31	\$FFFF	\$0000	\$CCCC
\$0020	32	\$FFFF	\$0000	\$9999
\$0021	33	\$FFFF	\$0000	\$6666
\$0022	34	\$FFFF	\$0000	\$3333
\$0023	35	\$FFFF	\$0000	\$0000
\$0024	36	\$CCCC	\$FFFF	\$FFFF
\$0025	37	\$CCCC	\$FFFF	\$CCCC
\$0026	38	\$CCCC	\$FFFF	\$9999
\$0027	39	\$CCCC	\$FFFF	\$6666
\$0028	40	\$CCCC	\$FFFF	\$3333
\$0029	41	\$CCCC	\$FFFF	\$0000
\$002A	42	\$CCCC	\$CCCC	\$FFFF
\$002B	43	\$CCCC	\$CCCC	\$CCCC
\$002C	44	\$CCCC	\$CCCC	\$CCCC
\$002D	45	\$CCCC	\$CCCC	\$6666
\$002E	46	\$CCCC	\$CCCC	\$3333
\$002F	47	\$CCCC	\$CCCC	\$0000
\$0030	48	\$CCCC	\$9999	\$FFFF

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$0031	49	\$CCCC	\$9999	\$CCCC
\$0032	50	\$CCCC	\$9999	\$9999
\$0033	51	\$CCCC	\$9999	\$6666
\$0034	52	\$CCCC	\$9999	\$3333
\$0035	53	\$CCCC	\$9999	\$0000
\$0036	54	\$CCCC	\$6666	\$FFFF
\$0037	55	\$CCCC	\$6666	\$CCCC
\$0038	56	\$CCCC	\$6666	\$9999
\$0039	57	\$CCCC	\$6666	\$6666
\$003A	58	\$CCCC	\$6666	\$3333
\$003B	59	\$CCCC	\$6666	\$0000
\$003C	60	\$CCCC	\$3333	\$FFFF
\$003D	61	\$CCCC	\$3333	\$CCCC
\$003E	62	\$CCCC	\$3333	\$9999
\$003F	63	\$CCCC	\$3333	\$6666
\$0040	64	\$CCCC	\$3333	\$3333
\$0041	65	\$CCCC	\$3333	\$0000
\$0042	66	\$CCCC	\$0000	\$FFFF
\$0043	67	\$CCCC	\$0000	\$CCCC
\$0044	68	\$CCCC	\$0000	\$9999
\$0045	69	\$CCCC	\$0000	\$6666
\$0046	70	\$CCCC	\$0000	\$3333
\$0047	71	\$CCCC	\$0000	\$0000
\$0048	72	\$9999	\$FFFF	\$FFFF
\$0049	73	\$9999	\$FFFF	\$CCCC
\$004A	74	\$9999	\$FFFF	\$9999
\$004B	75	\$9999	\$FFFF	\$6666
\$004C	76	\$9999	\$FFFF	\$3333
\$004D	77	\$9999	\$FFFF	\$0000
\$004E	78	\$9999	\$9999	\$FFFF
\$004F	79	\$9999	\$CCCC	\$CCCC

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$0050	80	\$9999	\$CCCC	\$9999
\$0051	81	\$9999	\$CCCC	\$6666
\$0052	82	\$9999	\$CCCC	\$3333
\$0053	83	\$9999	\$CCCC	\$0000
\$0054	84	\$9999	\$9999	\$FFFF
\$0055	85	\$9999	\$9999	\$CCCC
\$0056	86	\$9999	\$9999	\$9999
\$0057	87	\$9999	\$9999	\$6666
\$0058	88	\$9999	\$9999	\$3333
\$0059	89	\$9999	\$9999	\$0000
\$005A	90	\$9999	\$6666	\$FFFF
\$005B	91	\$9999	\$6666	\$CCCC
\$005C	92	\$9999	\$6666	\$9999
\$005D	93	\$9999	\$6666	\$6666
\$005E	94	\$9999	\$6666	\$3333
\$005F	95	\$9999	\$6666	\$0000
\$0060	96	\$9999	\$3333	\$FFFF
\$0061	97	\$9999	\$3333	\$CCCC
\$0062	98	\$9999	\$3333	\$9999
\$0063	99	\$9999	\$3333	\$6666
\$0064	100	\$9999	\$3333	\$3333
\$0065	101	\$9999	\$3333	\$0000
\$0066	102	\$9999	\$0000	\$FFFF
\$0067	103	\$9999	\$0000	\$CCCC
\$0068	104	\$9999	\$0000	\$9999
\$0069	105	\$9999	\$0000	\$6666
\$006A	106	\$9999	\$0000	\$3333
\$006B	107	\$9999	\$0000	\$0000
\$006C	108	\$6666	\$FFFF	\$FFFF
\$006D	109	\$6666	\$FFFF	\$CCCC
\$006E	110	\$6666	\$FFFF	\$9999

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$006F	111	\$6666	\$FFFF	\$6666
\$0070	112	\$6666	\$FFFF	\$3333
\$0071	113	\$6666	\$FFFF	\$0000
\$0072	114	\$6666	\$CCCC	\$FFFF
\$0073	115	\$6666	\$CCCC	\$CCCC
\$0074	116	\$6666	\$CCCC	\$9999
\$0075	117	\$6666	\$CCCC	\$6666
\$0076	118	\$6666	\$CCCC	\$3333
\$0077	119	\$6666	\$CCCC	\$0000
\$0078	120	\$6666	\$9999	\$FFFF
\$0079	121	\$6666	\$9999	\$CCCC
\$007A	122	\$6666	\$9999	\$9999
\$007B	123	\$6666	\$9999	\$6666
\$007C	124	\$6666	\$9999	\$3333
\$007D	125	\$6666	\$9999	\$0000
\$007E	126	\$6666	\$6666	\$FFFF
\$007F	127	\$6666	\$6666	\$CCCC
\$0080	128	\$6666	\$6666	\$9999
\$0081	129	\$6666	\$6666	\$6666
\$0082	130	\$6666	\$6666	\$3333
\$0083	131	\$6666	\$6666	\$0000
\$0084	132	\$6666	\$3333	\$FFFF
\$0085	133	\$6666	\$3333	\$CCCC
\$0086	134	\$6666	\$3333	\$9999
\$0087	135	\$6666	\$3333	\$6666
\$0088	136	\$6666	\$3333	\$3333
\$0089	137	\$6666	\$3333	\$0000
\$008A	138	\$6666	\$0000	\$FFFF
\$008B	139	\$6666	\$0000	\$CCCC
\$008C	140	\$6666	\$0000	\$9999
\$008D	141	\$6666	\$0000	\$6666

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$008E	142	\$6666	\$0000	\$3333
\$008F	143	\$6666	\$0000	\$0000
\$0090	144	\$3333	\$FFFF	\$FFFF
\$0091	145	\$3333	\$FFFF	\$CCCC
\$0092	146	\$3333	\$FFFF	\$9999
\$0093	147	\$3333	\$FFFF	\$6666
\$0094	148	\$3333	\$FFFF	\$3333
\$0095	149	\$3333	\$FFFF	\$0000
\$0096	150	\$3333	\$CCCC	\$FFFF
\$0097	151	\$3333	\$CCCC	\$CCCC
\$0098	152	\$3333	\$CCCC	\$9999
\$0099	153	\$3333	\$CCCC	\$6666
\$009A	154	\$3333	\$CCCC	\$3333
\$009B	155	\$3333	\$CCCC	\$0000
\$009C	156	\$3333	\$9999	\$FFFF
\$009D	157	\$3333	\$9999	\$CCCC
\$009E	158	\$3333	\$9999	\$9999
\$009F	159	\$3333	\$9999	\$6666
\$00A0	160	\$3333	\$9999	\$3333
\$00A1	161	\$3333	\$9999	\$0000
\$00A2	162	\$3333	\$6666	\$FFFF
\$00A3	163	\$3333	\$6666	\$CCCC
\$00A4	164	\$3333	\$6666	\$9999
\$00A5	165	\$3333	\$6666	\$6666
\$00A6	166	\$3333	\$6666	\$3333
\$00A7	167	\$3333	\$6666	\$0000
\$00A8	168	\$3333	\$3333	\$FFFF
\$00A9	169	\$3333	\$3333	\$CCCC
\$00AA	170	\$3333	\$3333	\$9999
\$00AB	171	\$3333	\$3333	\$6666
\$00AC	172	\$3333	\$3333	\$3333

Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$00AD	173	\$3333	\$3333	\$0000
\$00AE	174	\$3333	\$0000	\$FFFF
\$00AF	175	\$3333	\$0000	\$CCCC
\$00B0	176	\$3333	\$0000	\$9999
\$00B1	177	\$3333	\$0000	\$6666
\$00B2	178	\$3333	\$0000	\$3333
\$00B3	179	\$3333	\$0000	\$0000
\$00B4	180	\$0000	\$FFFF	\$FFFF
\$00B5	181	\$0000	\$FFFF	\$CCCC
\$00B6	182	\$0000	\$FFFF	\$9999
\$00B7	183	\$0000	\$FFFF	\$6666
\$00B8	184	\$0000	\$FFFF	\$3333
\$00B9	185	\$0000	\$FFFF	\$0000
\$00BA	186	\$0000	\$CCCC	\$FFFF
\$00BB	187	\$0000	\$CCCC	\$CCCC
\$00BC	188	\$0000	\$CCCC	\$9999
\$00BD	189	\$0000	\$CCCC	\$6666
\$00BE	190	\$0000	\$CCCC	\$3333
\$00BF	191	\$0000	\$CCCC	\$0000
\$00C0	192	\$0000	\$9999	\$FFFF
\$00C1	193	\$0000	\$9999	\$CCCC
\$00C2	194	\$0000	\$9999	\$9999
\$00C3	195	\$0000	\$9999	\$6666
\$00C4	196	\$0000	\$9999	\$3333
\$00C5	197	\$0000	\$9999	\$0000
\$00C6	198	\$0000	\$6666	\$FFFF
\$00C7	199	\$0000	\$6666	\$CCCC
\$00C8	200	\$0000	\$6666	\$9999
\$00C9	201	\$0000	\$6666	\$6666
\$00CA	202	\$0000	\$6666	\$3333
\$00CB	203	\$0000	\$3333	\$0000

## Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$00CC	204	\$0000	\$3333	\$FFFF
\$00CD	205	\$0000	\$3333	\$CCCC
\$00CE	206	\$0000	\$3333	\$9999
\$00CF	207	\$0000	\$3333	\$6666
\$00D0	208	\$0000	\$3333	\$3333
\$00D1	209	\$0000	\$0000	\$0000
\$00D2	210	\$0000	\$0000	\$FFFF
\$00D3	211	\$0000	\$0000	\$CCCC
\$00D4	212	\$0000	\$0000	\$9999
\$00D5	213	\$0000	\$0000	\$6666
\$00D6	214	\$0000	\$0000	\$3333
\$00D7	215	\$EEEE	\$0000	\$0000
\$00D8	216	\$DDDD	\$0000	\$0000
\$00D9	217	\$BBBB	\$0000	\$0000
\$00DA	218	\$AAAA	\$0000	\$0000
\$00DB	219	\$8888	\$0000	\$0000
\$00DC	220	\$7777	\$0000	\$0000
\$00DD	221	\$5555	\$0000	\$0000
\$00DE	222	\$4444	\$0000	\$0000
\$00DF	223	\$2222	\$0000	\$0000
\$00E0	224	\$1111	\$0000	\$0000
\$00E1	225	\$0000	\$EEEE	\$0000
\$00E2	226	\$0000	\$0000	\$0000
\$00E3	227	\$0000	\$BBBB	\$0000
\$00E4	228	\$0000	\$AAAA	\$0000
\$00E5	229	\$0000	\$8888	\$0000
\$00E6	230	\$0000	\$7777	\$0000
\$00E7	231	\$0000	\$5555	\$0000
\$00E8	232	\$0000	\$4444	\$0000
\$00E9	233	\$0000	\$2222	\$0000
\$00EA	234	\$0000	\$1111	\$0000



Color Lookup Table (CLUT)

**Table A-1** Color look up table (continued)

<b>Index (hex)</b>	<b>Index (dec)</b>	<b>R value</b>	<b>G value</b>	<b>B value</b>
\$00EB	235	\$0000	\$0000	\$EEEE
\$00EC	236	\$0000	\$0000	\$DDDD
\$00ED	237	\$0000	\$0000	\$BBBB
\$00EE	238	\$0000	\$0000	\$AAAA
\$00EF	239	\$0000	\$0000	\$8888
\$00F0	240	\$0000	\$0000	\$7777
\$00F1	241	\$0000	\$0000	\$5555
\$00F2	242	\$0000	\$0000	\$4444
\$00F3	243	\$0000	\$0000	\$2222
\$00F4	244	\$0000	\$0000	\$1111
\$00F5	245	\$EEEE	\$EEEE	\$EEEE
\$00F6	246	\$DDDD	\$DDDD	\$DDDD
\$00F7	247	\$BBBB	\$BBBB	\$BBBB
\$00F8	248	\$AAAA	\$AAAA	\$AAAA
\$00F9	249	\$8888	\$8888	\$8888
\$00FA	250	\$7777	\$7777	\$7777
\$00FB	251	\$5555	\$5555	\$5555
\$00FC	252	\$4444	\$4444	\$4444
\$00FD	253	\$2222	\$2222	\$2222
\$00FE	254	\$1111	\$1111	\$1111
\$00FF	255	\$0000	\$0000	\$0000

A P P E N D I X A

Color Lookup Table (CLUT)

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This Apple manual was written, edited, and composed on a desktop publishing system using Apple Macintosh computers and FrameMaker software. Proof pages were created on an Apple LaserWriter II<sub>NTX</sub> printer. Final page negatives were output directly from text files on an AGFA ProSet 9800 imagesetter. Line art was created using Adobe<sup>™</sup> Illustrator. PostScript<sup>™</sup>, the page-description language for the LaserWriter, was developed by Adobe Systems Incorporated.

Text type is Palatino<sup>®</sup> and display type is Helvetica<sup>®</sup>. Bullets are ITC Zapf Dingbats<sup>®</sup>. Some elements, such as program listings, are set in Apple Courier.

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Special thanks to Mike Puckett, Clark Donahue, Markus Wallgren, Bill Schonfeld, Ray Kubick, and Rolly Reed