



Developer Note

Macintosh PowerBook G3




Developer Note

11/10/97

Technical Publications

© Apple Computer, Inc. 1997

 Apple Computer, Inc.
© 1997 Apple Computer, Inc.
All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, mechanical, electronic, photocopying, recording, or otherwise, without prior written permission of Apple Computer, Inc., except to make a backup copy of any documentation provided on CD-ROM. Printed in the United States of America.

The Apple logo is a trademark of Apple Computer, Inc. Use of the “keyboard” Apple logo (Option-Shift-K) for commercial purposes without the prior written consent of Apple may constitute trademark infringement and unfair competition in violation of federal and state laws.

No licenses, express or implied, are granted with respect to any of the technology described in this book. Apple retains all intellectual property rights associated with the technology described in this book. This book is intended to assist application developers to develop applications only for Apple-labeled or Apple-licensed computers.

Every effort has been made to ensure that the information in this manual is accurate. Apple is not responsible for printing or clerical errors.

Apple Computer, Inc.
1 Infinite Loop
Cupertino, CA 95014
408-996-1010

Apple, the Apple logo, Mac, Macintosh, and PowerBook are trademarks of Apple Computer, Inc., registered in the United States and other countries.

Adobe, Acrobat, and PostScript are trademarks of Adobe Systems Incorporated or its subsidiaries and may be registered in certain jurisdictions.

Helvetica and Palatino are registered trademarks of Linotype-Hell AG and/or its subsidiaries.

ITC Zapf Dingbats is a registered trademark of International Typeface Corporation.

PowerPC is a trademark of International Business Machines Corporation, used under license therefrom.

Simultaneously published in the United States and Canada.

Even though Apple has reviewed this manual, APPLE MAKES NO WARRANTY OR REPRESENTATION, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THIS MANUAL, ITS QUALITY, ACCURACY, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. AS A RESULT, THIS MANUAL IS SOLD “AS IS,” AND YOU, THE PURCHASER, ARE ASSUMING THE ENTIRE RISK AS TO ITS QUALITY AND ACCURACY.

IN NO EVENT WILL APPLE BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT OR INACCURACY IN THIS MANUAL, even if advised of the possibility of such damages.

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, ORAL OR WRITTEN, EXPRESS OR IMPLIED. No Apple dealer, agent, or employee is authorized to make any modification, extension, or addition to this warranty.

Some states do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Contents

Preface	About This Developer Note	vii
	Contents of This Note	vii
	Supplemental Reference Documents	vii
	Conventions and Abbreviations	viii
	Typographical Conventions	viii
	Abbreviations	ix
Chapter 1	Delta Guide to the Macintosh PowerBook G3 Computer	1
	New Features	2
	Microprocessor and Cache	2
	Processor Clock Speeds	3
	Amount of RAM Installed	3
	Hard Disk Size	4
	20X-Speed CD-ROM Drive	5
	External Monitor Support	5
	Built-in Ethernet and Modem Card	6
	Hot Swapping of Expansion Devices	6
	System Software	7
	Changes in the ROM	7
	Changes in the Disk Software	7
	Configuration	7
	Compatibility Issues	8
	RAM Expansion Card	8
	Machine Identification	8
	System Software	8
	RAM Expansion Guidelines	9
	New PSX+ Memory Controller	9
	RAM Devices and Address Multiplexing	9
	RAM Expansion Buffers	12
	Compatible RAM Expansion Card	12
	RAM Expansion Card Electrical Limits	13

Figures and Tables

Chapter 1	Delta Guide to the Macintosh PowerBook G3 Computer	1
Figure 1-1	Block diagram of the PowerBook G3 computer	4
Table 1-1	Monitors and pixel depths supported	5
Table 1-2	Types of DRAM devices	10
Table 1-3	Address multiplexing	11

About This Developer Note

This developer note describes the Macintosh PowerBook G3 computer, a new Macintosh PowerBook computer based on the PowerBook 3400. This developer note describes only the changes that make the new computer different from its earlier counterpart. For a complete description of the PowerBook 3400 computer, see “Supplemental Reference Documents,” later in this preface.

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 supplementary reference documents described in this preface.

This note is published only in electronic form, as an Adobe™ Acrobat™ PDF (portable document file). The file is available from two sources:

- on the World Wide Web at

<http://devworld.apple.com/dev/dnotes3.shtml>

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

Contents of This Note

This note has only one chapter: a delta guide describing the differences between the Macintosh PowerBook G3 computer and the PowerBook 3400 computer. Because the note is so short, it has no index.

Supplemental Reference Documents

For a complete description of the PowerBook 3400 computer, developers should have the earlier developer note for that computer. Adobe Acrobat PDF (portable

document file) versions of all developer notes are available on the Developer CD and on the World Wide Web at

<http://dev.info.apple.com/reference.html>

For a description of the version of the Mac OS that comes with the new computer, developers should refer to Technote 1102, “Mac OS 8.” The technote is available on the Technote web site at

<http://devworld.apple.com/dev/technotes.shtml>

Printed copies of the Technote are available from Field Copy and Printing, telephone 1-415-323-3155. The Technotes are also available on the reference library issues of the Developer CD.

For more information about the PowerPC G3 microprocessor used in the Macintosh PowerBook G3 computer, developers may wish to refer to the standard reference, *PowerPC 740/750 Microprocessor Implementation Definition Book IV*. Information about the G3 microprocessors is also available on the World Wide Web at

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

Developers should also have copies of the relevant books of the *Inside Macintosh* series, available in technical bookstores.

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 book, 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:

GB	gigabytes	MHz	megahertz
K	1024	mV	millivolts
kbps	kilobits per second	μ A	microamperes
M	meg (1,048,576)	ns	nanoseconds
MB	megabytes	V	volts
Mbps	megabits per second		

Other abbreviations used in this note include:

ADB	Apple Desktop Bus
AWAC	audio waveform amplifier and converter
CD-ROM	compact disc read-only memory
DAC	digital-to-analog converter
DRAM	dynamic RAM
IC	integrated circuit
IDE	integrated device electronics
L2	level 2 or second level, a type of cache
LSB	least significant bit or byte
MSB	most significant bit or byte
PCI	Peripheral Component Interconnect, an industry-standard expansion bus
PDF	portable document file
PMU	power management unit
PSX	memory controller and PCI bus converter IC
RAM	random-access memory
ROM	read-only memory
SCSI	Small Computer System Interface

P R E F A C E

SRAM	static RAM
SVGA	super video graphics adapter
VGA	video graphics adapter

Delta Guide to the Macintosh PowerBook G3 Computer

The Macintosh PowerBook G3 is a high-performance laptop computer based on the PowerBook 3400 computer. This chapter is a delta guide—it compares the new computer with its earlier counterpart, describing only the changes and new features. For complete descriptions of the previous model, see the developer note for the PowerBook 3400 computer. For information about obtaining the developer note, see “Supplemental Reference Documents” (page vii).

New Features

The new features in the Macintosh PowerBook G3 computer include:

- third-generation PowerPC G3 microprocessor with an integrated L2 cache controller
- 512 KB of L2 cache on a backside bus
- processor clock speed of 250 MHz and cache bus speed of 100 MHz
- 32 MB of RAM installed
- larger capacity internal hard disk: 5 GB
- a faster built-in CD-ROM drive: 20X-speed
- improved support for an external monitor at up to 24 bits per pixel
- a built-in ethernet/modem card with improved performance
- support for hot swapping of devices in the expansion bay
- an upgraded system ROM to support the faster clock speeds
- the latest system software, Mac OS 8

The new features are described in the following sections.

Microprocessor and Cache

The new family of PowerPC microprocessor designs is called “G3,” for “generation three.” The G3 microprocessors have several new features that contribute to improved performance, including:

- a built-in L2 cache controller and cache tag RAM

- faster clock speed for the L2 cache on a backside bus
- microprocessor core optimized for Mac OS applications

The data storage for the backside L2 cache consists of 512 KB of fast static RAM on the main logic board. The backside cache controller and the cache tag storage are built into the microprocessor chip. The cache controller includes bus management and control hardware that allows the cache to run at sub-multiples of the processor's clock speed, rather than at the slower clock speed of the main system bus.

The arrangement of the backside cache is shown in Figure 1-1, the block diagram of the Macintosh PowerBook G3 computer.

The PowerPC G3 microprocessor comes in a slightly larger package than the PowerPC 603e microprocessor used in the PowerBook 3400 computer. The package depth is the same, but the PowerPC G3 IC runs hotter so the heat sink has been modified.

Note

The PowerPC G3 family of microprocessors includes the PowerPC 740™ and the PowerPC 750™; the Macintosh PowerBook G3 computer uses the PowerPC 750.

Processor Clock Speeds

The clock speed of the PowerPC G3 microprocessor in the Macintosh PowerBook G3 computer is 250 MHz. The backside L2 cache runs at 100 MHz, which is twice the 50 MHz clock speed of the main system bus.

Amount of RAM Installed

The Macintosh PowerBook G3 computer comes with 32 MB of RAM installed on the main logic board. The optional RAM expansion card is similar to the one used in the PowerBook 3400, giving the PowerBook G3 a maximum total RAM capacity of 160 MB.

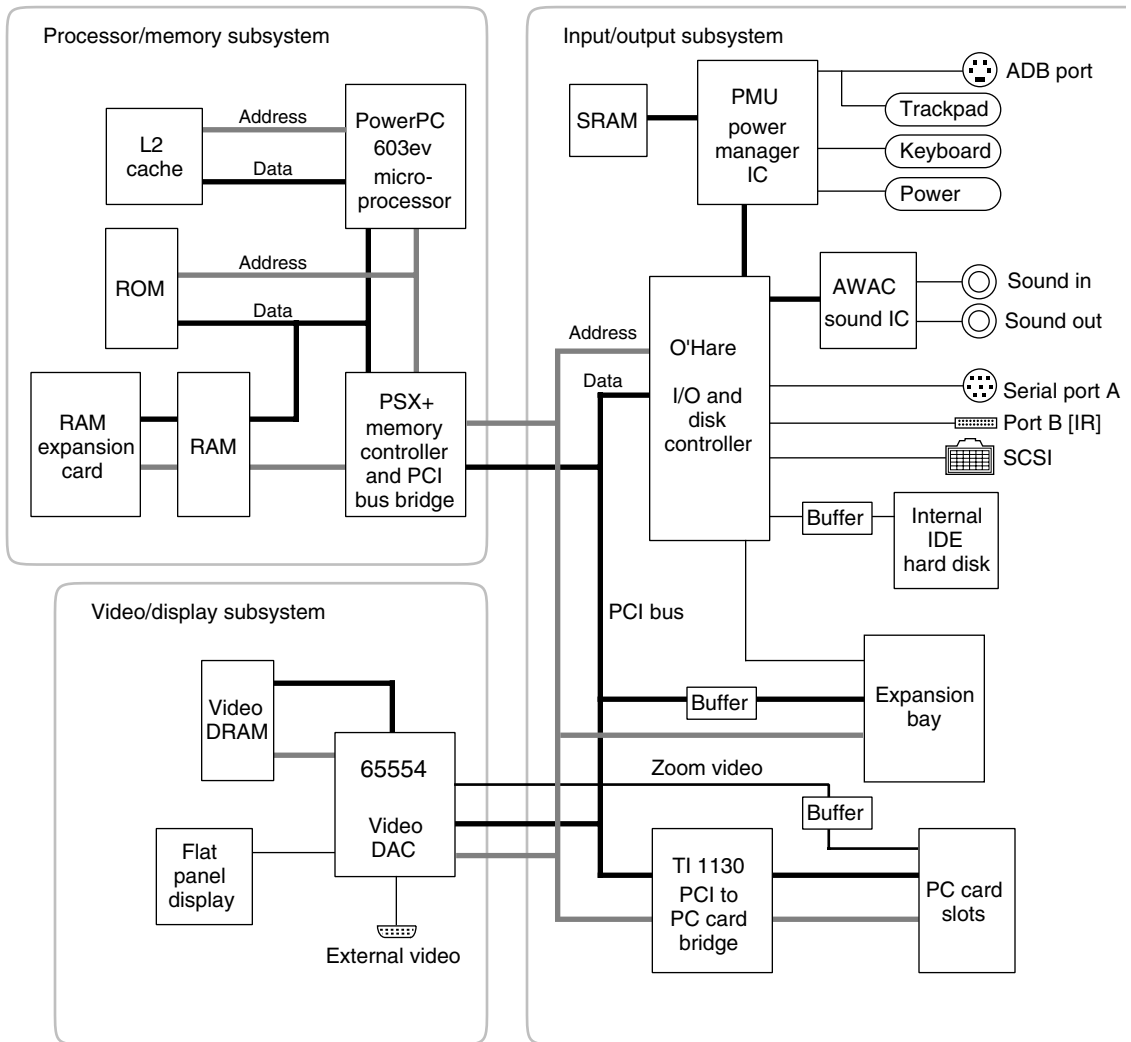
IMPORTANT

For information about the RAM expansion card, see "RAM Expansion Guidelines" beginning on page 9. ▲

Hard Disk Size

The storage capacity of the built-in hard disk in the new Macintosh PowerBook G3 models is 5 GB.

Figure 1-1 Block diagram of the PowerBook G3 computer



20X-Speed CD-ROM Drive

The Macintosh PowerBook G3 computer includes a built-in 20X-speed CD-ROM drive. The 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.

External Monitor Support

Like the PowerBook 3400, the Macintosh PowerBook G3 computer has a built-in interface for an external video monitor. A new video controller (CT 65554) has a 64-bit data path for higher performance. A larger video RAM (2 MB) supports bit depths of up to 24 bits per pixel on larger monitors. Table 1-1 shows the resolutions and pixel depths for the various monitors.

Table 1-1 Monitors and pixel depths supported

Monitor type	Resolution	Bits per pixel
12-inch color	512 by 384	8, 16, 24
12-inch monochrome	640 by 480	8
13-inch and 14-inch color	640 by 480	8, 16, 24
VGA and SVGA	640 by 480*	8, 16, 24
SVGA	800 by 600	8, 16, 24
SVGA	1024 by 768	8, 16
Full-page monochrome	640 by 870	8
Full-page color	640 by 870	8, 16
16-inch color	832 by 624	8, 16, 24
Apple 15-inch multiple scan	640 by 480	8, 16, 24
Apple 15-inch multiple scan	800 by 600*	8, 16, 24
Apple 15-inch multiple scan	832 by 624	8, 16, 24
Apple 17-inch multiple scan	640 by 480	8, 16, 24

continued

Table 1-1 Monitors and pixel depths supported (continued)

Monitor type	Resolution	Bits per pixel
Apple 17-inch multiple scan	800 by 600*	8, 16, 24
Apple 17-inch multiple scan	832 by 624	8, 16, 24
Apple 17-inch multiple scan	1024 by 768	8, 16
Apple 20-inch multiple scan	640 by 480	8, 16, 24
Apple 20-inch multiple scan	800 by 600*	8, 16, 24
Apple 20-inch multiple scan	832 by 624	8, 16, 24
Apple 20-inch multiple scan	1024 by 768	8, 16
NTSC TV monitor	512 by 384*	8, 16, 24
NTSC TV monitor	640 by 480	8, 16, 24
PAL TV monitor	640 by 480*	8, 16, 24
PAL TV monitor	768 by 576	8, 16, 24

NOTE An asterisk indicates the startup resolution. Other resolutions can be selected using the Monitors and Sound control panel or the control strip.

Built-in Ethernet and Modem Card

The built-in ethernet and modem card occupies the internal PCI expansion slot. It is similar to the ethernet and modem card used in the PowerBook 3400, except it is built in and has better performance. Compared with the previous modem card, the new card's transfer rates are 20 to 30 percent higher.

Hot Swapping of Expansion Devices

The Macintosh PowerBook G3 supports hot swapping of expansion bay modules with floppy disk or IDE devices. Of course, if the user removes a disk drive with an open file on it, the system will display a dialog box asking the user to replace the drive. As in the PowerBook 3400, expansion bay modules with PCI devices can be installed or removed only when the power is off.

System Software

The system software shipped with the Macintosh PowerBook G3 computer is Mac OS 8. For a list of the features of Mac OS 8, see Technote 1102, "Mac OS 8." To find out how to obtain Apple Computer's Technotes, see "Supplemental Reference Documents" (page vii). You can also find information about Mac OS 8 on the Developer World web site, at

<http://www.devworld.apple.com/MacOS8/index.html>

Changes in the ROM

The ROM software has been modified to support the higher processor clock speeds and the larger L2 cache.

Changes in the Disk Software

The following changes have been made in the system software on the hard disk:

- The CD Setup application now supports the Macintosh 20X-speed CD-ROM drive.
- The Drive Setup application now supports the 5 GB hard disk drives.

Configuration

The Macintosh PowerBook G3 computer comes in one configuration and has the following specifications:

- processor clock speed of 250 MHz
- backside L2 cache of 512 KB
- L2 cache clock speed of 100 MHz
- 32 MB of main RAM installed
- system bus clock speed of 50 MHz
- 5 GB internal hard disk
- built-in 20X CD-ROM drive
- floppy disk drive module installed in the media bay

- 12.1-inch active-matrix color display with backlight
- support for an external video monitor at up to 24 bits per pixel

Compatibility Issues

Except for the changes described in this developer note, the features of the new Macintosh PowerBook G3 models are the same as those of the PowerBook 3400 computer. There should be no compatibility problems with applications and peripherals that operate correctly with the PowerBook 3400 computer, with the exceptions described in this section.

RAM Expansion Card

The RAM expansion card for the Macintosh PowerBook G3 computer is similar to the one for the PowerBook 3400 computer, but with a few important differences. For a complete description of those differences, see the section “RAM Expansion Guidelines” (page 9).

Machine Identification

The new Macintosh PowerBook G3 computer has a new machine ID value. The Gestalt Manager returns a `gestaltMachineType` value of 313 (hexadecimal 139). *Inside Macintosh: Overview* describes the Gestalt Manager and tells how to use the `gestaltMachineType` value to obtain the machine name string.

System Software

For a description of the version of the Mac OS that comes with the Macintosh PowerBook G3 computer, developers should refer to Technote 1102, “Mac OS 8.” Information is also available on the Apple Developer World web site, at <http://www.devworld.apple.com/MacOS8/index.html>

RAM Expansion Guidelines

Like the PowerBook 3400, the Macintosh PowerBook G3 computer accepts one internal RAM expansion card. The RAM expansion card has the same mechanical and electrical characteristics as the card for the PowerBook 3400, with the exceptions described in this section.

New PSX+ Memory Controller

The Macintosh PowerBook G3 uses a new memory controller IC called the PSX+ in place of the PSX IC used in the PowerBook 3400. The PSX+ IC supports higher clock speeds for the main system bus. The PSX+ also has certain other differences from the PSX:

- The PSX+ does not support 16-megabit DRAM devices configured as 2M x 8 bits with 12 x 9 address multiplexing.
- The PSX+ does not support RAM expansion modules designed for the PowerBook 3400 using 64-megabit DRAM devices configured as 4M x 16 bits. Those modules have address bits 9 and 10 swapped; modules for the Macintosh PowerBook G3 must have those address bits connected directly and not swapped.

RAM Devices and Address Multiplexing

The PSX+ used in the Macintosh PowerBook G3 computer supports most but not all of the RAM devices supported by the PSX. Table 1-2 lists several types of DRAM devices and specifies whether each type is supported by the PSX and PSX+ ICs.

IMPORTANT

The Macintosh PowerBook G3 computer supports only the types of DRAM devices specified for use with the PSX+ in Table 1-2. Other types of DRAM devices should not be used with this computer. ▲

Table 1-2 Types of DRAM devices

Device size	Address bit configuration		Use with PSX	Use with PSX+
	Row bits	Column bits		
512K by 8	10	9	Yes	Yes
1M by 4 or 1M by 16	11	9	No	No
1M by 4 or 1M by 16	10	10	Yes	Yes
2M by 8	12	9	Yes	No
2M by 8	11	10	Yes	Yes
4M by 4	11	11	Yes	Yes
4M by 16	12	10	Yes, with bits 9 and 10 swapped	Yes, with no swapping of address bits
4M by 16	11	11	No	Yes
8M by 8	—	—	No	No
16M by 4	—	—	No	No

For each type of DRAM device supported by the PSX+ IC in the Macintosh PowerBook G3 computer, Table 1-3 shows how the signals are multiplexed during the row and column address phases. The numbers in square brackets at the top of the table identify the signals on the RAM address bus that are connected to the device's address pins. The rows in the table show the address bits that drive each address pin during row addressing and column addressing.

Note

The address bits in Table 1-3 are numbered in PowerPC notation: MSB to LSB from left to right, starting with bit 0. Some other documentation uses the MC680x0 notation where MSB is bit 31. To convert from one convention to the other, simply subtract each bit number from 31. ♦

Table 1-3 Address multiplexing

DRAM address signals connected to device address pins												
Device size and address bits, row x column	[11]	[10]	[9]	[8]	[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]
512K by 8, 10 x 9												
Row address bits	–	–	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	–	20	21	22	23	24	25	26	27	28
1M by 4 or 1M by 16, 10 x 10												
Row address bits	–	–	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28
2M by 8, 11 x 10												
Row address bits	–	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28
4M by 4 or 4M by 16, 11 x 11												
Row address bits	–	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	7	9	20	21	22	23	24	25	26	27	28
4M by 4 or 4M by 16, 12 x 10												
Row address bits	7	8	10	11	12	13	14	15	16	17	18	19
Column address bits	–	–	9	20	21	22	23	24	25	26	27	28

RAM Expansion Buffers

Like the PowerBook 3400 computer, the Macintosh PowerBook G3 computer requires buffers on the RADDR(0–11), /RAMWE, RAMOE, /RAS(n), and /CAS(n) signals. In addition, the buffer devices must have input hysteresis to ensure that the outputs of the buffers do not oscillate during the time when RESET is low and the PSX IC's outputs are in the high-impedance state. A suitable buffer device is IDT's 74FCT163244CPA, which has 150mV of input hysteresis.

Compatible RAM Expansion Card

RAM expansion cards using the appropriate types of DRAM devices as shown in Table 1-2 (page 10) will work in both PowerBook 3400 and Macintosh PowerBook G3 computers. There are two exceptions: 2M by 8 devices with 12 x 9 address bits, which will not work at all in the PowerBook G3 computer, and 4M by 16 parts with 12 x 10 address bits, which would work on both computers if address pins 9 and 10 could be configured to match the computer.

It is possible to design a RAM expansion module using 4M by 16 parts with 12 x 10 address bits so that the module can be used on both PowerBook 3400 and PowerBook G3 computers. The module can detect which type of computer it is installed in by testing pin 1 of the memory connector. In the PowerBook G3 computer, pin 1 is a no connect; in the PowerBook 3400, pin 1 is connected to ground. Developers can design an address configuration circuit that is controlled by using pin 1 as an ID pin.

A self-configuring card must still meet the timing and electrical requirements described in the developer note for the PowerBook 3400, in particular

- When the computer is in sleep mode, the current required to operate the configuration circuit must be less than 100 μ A.
- Any signal delay through the configuration circuit must be included in the 5 ns maximum allowable address and signal line propagation delay.

IMPORTANT

The possibility of a self-configuring RAM expansion card arises only in the case of cards using 4M by 16 DRAM devices with 12 x 10 address bits. Cards using 2M by 8 devices with 12 x 9 address bits will not work in the PowerBook G3 computer at all. Cards using other types of devices shown as supported in Table 1-2 (page 10) will work in both machines. ▲

RAM Expansion Card Electrical Limits

The RAM expansion card must not exceed the following maximum current limits on the +3 V supply:

Active	500 mA
Standby	24 mA
Sleep	12 mA per bank

The maximum current specified for active operation generally rules out the use of 4-bit DRAM devices in a RAM expansion card. Such a card would have 16 such devices, and the 500 mA maximum current would allow only about 30 mA per device. To keep within the current limits, RAM expansion cards should use only 8-bit or 16-bit DRAM devices.

During sleep mode in a PowerBook computer, the RAM devices are being refreshed at the rate of 12.6 μ sec per row, with the devices in standby mode the rest of the time. The restriction on sleep current is required not only to maximize the battery life but to meet the limitations of the backup battery during hot swapping of the main battery.

IMPORTANT

The developer note for the Macintosh PowerBook 3400 Computer gives a maximum current limit of 12 mA during sleep mode. That is an error; the correct specification is 12 mA per bank for up to 4 banks.

This Apple manual was written, edited, and composed on a desktop publishing system using Apple Macintosh computers and FrameMaker software. Line art was created using Adobe[™] Illustrator and Adobe Photoshop.

Text type is Palatino[®] and display type is Helvetica[®]. Bullets are ITC Zapf Dingbats[®]. Some elements, such as program listings, are set in Adobe Letter Gothic.

WRITER
Allen Watson III

ILLUSTRATOR
Karin Stroud

DEVELOPMENTAL EDITOR
Donna S. Lee

PRODUCTION EDITOR
Gerri Gray

Special thanks to Peter Baum, John DiFonzo, Steve Sfarzo, and Fernando Urbina.