Developer Note

Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 Computers

Developer Note

Developer Technical Publications

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
408-996-1010

Simultaneously published in the United States and Canada.

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About This Note

This developer note provides information about the Macintosh Centris™ 610, Centris 650, and Macintosh Quadra 800 computers, three new Macintosh models that provide the high performance of the MC68040 microprocessor at lower prices than those of the Macintosh Quadra 700 and 950 computers.

Note
While every attempt has been made to verify the accuracy of the information presented here, it is subject to change without notice. The primary reason for releasing this type of product information is to provide the development community with essential product specifications, theory, and application information for the purpose of stimulating work on compatible third-party products. ◆

Contents Of This Note

This note contains five chapters and an appendix and includes a set of 11 by 17-inch foldout pages.

Chapter 1, "Introduction," summarizes the features and describes the case designs and other external features of the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers.

Chapter 2, "Architecture," includes a block diagram and address maps and describes the integrated circuits that are specific to these three computers.

Chapter 3, "Expansion Slots," describes the NuBus and PDS expansion slots in these three computers and includes information about the 7-inch NuBus card for the Macintosh Centris 610.

Chapter 4, "Software," summarizes the features of the ROM software and tells how the system software operates on these three computers.

Chapter 5, "Internal Storage Devices," provides specifications and guidelines for storage devices to be installed inside these three computers.

Appendix A gives the specifications of the AppleCD 300i CD-ROM drive that is installed in some configurations of these three computers.

Foldout pages at the back contain specifications and drawings for certain parts described in Chapters 3 and 5.

Supplemental Reference Documents

To supplement the information in this developer note, developers should have copies of the appropriate reference books by Motorola for the MC68040 microprocessor. Software developers should have copies of Motorola's *MC68040 Programmer's Reference Manual*. Hardware developers should have copies of Motorola's *MC68040 User's Manual, MC68040 Designer's Handbook,* and *Preliminary Technical Summary: Third Generation 32-Bit Microprocessor.*

Developers should also have copies of the appropriate Apple reference books, including *Inside Macintosh*, including Volumes IV, V, and VI; *Guide to the Macintosh Family Hardware,* second edition; and *Developing Cards and Drivers for the Macintosh Family*, third edition. The Apple books are available in technical bookstores and through APDA.

Developers should also have copies of the document *Macintosh Classic II, Macintosh PowerBook Family, and Macintosh Quadra Family Developer Notes,* available through APDA.

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Conventions and Abbreviations

This developer note uses the following abbreviations and typographical conventions.

Typographical Conventions

New terms appear in **boldface** where they are first defined.

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

Hexadecimal numbers are preceded by a dollar sign ($). For example, the hexadecimal equivalent of decimal 16 is written as $10.

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

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

▲ **WARNING**
A note like this directs your attention to something that could cause damage or result in a loss of data. ▲

Standard Abbreviations

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

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

A	amperes	MHz	megahertz
K	1024	ms	milliseconds
KB	kilobytes	ns	nanoseconds
kΩ	kilohms	Ω	ohms
mA	milliamperes	V	volts
MB	megabytes	W	watts

Here are the abbreviations used in this developer note:

AC	alternating current
ADB	Apple Desktop Bus
AUI	Apple universal interface (accepts an Ethernet cable adapter)
CD-ROM	compact-disk read-only memory
CLUT	color look-up table
DAC	digital-to-analog converter
FPU	floating-point unit
IC	integrated circuit
I/O	input/output
MMU	memory management unit
$*n*	hexadecimal value *n*
NMI	nonmaskable interrupt
NTSC	National Television Standards Committee (a video standard)
PAL	phase-alternating lines (a video standard)
PDS	processor-direct slot
RAM	random-access memory
RGB	red-green-blue (a video standard)
RMS	root-mean-square
ROM	read-only memory
SANE	Standard Apple Numerics Environment
SCSI	Small Computer System Interface
SIMM	single in-line memory module (used for memory expansion)
SVGA	super VGA (a video standard for PC-type computers)
VGA	video graphics adapter (a video standard for PC-type computers)
VM	virtual memory
VRAM	video RAM

CHAPTER 1

Introduction

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers are new members of the Macintosh family. They provide powerful features such as the MC68040 microprocessor and multiple internal storage devices at lower prices than those of the existing Macintosh Quadra models.

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers are functionally similar to the Macintosh Quadra 700 and use similar versions of the MC68040 microprocessor. Here are the main differences between the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers and the Macintosh Quadra 700.

- New cases provide space for an internal CD-ROM drive.
- New custom ICs combine several functions for lower cost, higher reliability, and higher performance.
- Built-in video supports up to 16 bits per pixel, rather than 24.

The next section gives a summary of the features of the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers. Later sections describe each feature in more detail.

Summary of Features

The hardware features of the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers include

- a Motorola MC68040 microprocessor running at 20 MHz (Macintosh Centris 610), 25 MHz (Macintosh Centris 650), or 33 MHz (Macintosh Quadra 800)
- new product designs: low-profile desktop (Macintosh Centris 610), medium-sized desktop, like the Macintosh IIvx and Performa 600 (Macintosh Centris 650), and vertical minitower (Macintosh Quadra 800)
- built-in video hardware using separate video RAM
- an Apple SuperDrive high-density floppy disk drive with 1.44 MB capacity
- front-panel openings for internal mass-storage devices with removable media (usually floppy disk and CD-ROM): two in Macintosh Centris 610 and Macintosh Centris 650, three in Macintosh Quadra 800.
- on Macintosh Quadra 800 only, support for up to four internal SCSI devices
- standard Macintosh I/O ports: two ADB ports, two serial ports, and a SCSI port
- sound input and output connectors and an internal speaker
- integration of sound playback from the internal CD-ROM drive
- optional built-in support for Ethernet by way of an Apple AUI connector
- a processor-direct slot (PDS) for low-level hardware expansion
- three NuBus™ expansion slots with NuBus ’90 features (except on the Macintosh Centris 610, which can use an adapter card with its PDS for a 7-inch-long NuBus card)

Table 1-1 compares the features of the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers.

Table 1-1 Comparison of Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers

Feature	Macintosh Centris 610	Macintosh Centris 650	Macintosh Quadra 800
Processor type	MC68LC040*	MC68040 or MC68LC040*	MC68040
Processor speed	20 MHz	25 MHz	33 MHz
Minimum RAM	4 MB	4 or 8 MB	8 MB
Expansion RAM	2 SIMMs	4 SIMMs	4 SIMMs
Maximum RAM	68 MB	136 MB	136 MB
Minimum VRAM	512 KB	512 KB	512 KB
Maximum VRAM	1 MB	1 MB	1 MB
Sound capabilities	8-bit mono in, 8-bit stereo out	8-bit mono in, 8-bit stereo out	8-bit mono in, 8-bit stereo out
Floppy disk drive	1 internal	1 internal	1 internal
ADB ports	2	2	2
Case design	Low profile	Desktop	Minitower
Internal SCSI drives	2	2	3
External SCSI port	1	1	1
Ethernet	Built-in (optional)	Built-in (optional)	Built-in
Expansion slots	1 (adapter for 7-inch NuBus or PDS card)	3	3

* The MC68LC040 microprocessor does not have a built-in floating-point unit. It is possible to upgrade a machine with an MC68LC040 by removing the MC68LC040 from its socket and replacing it with an MC68040.

Product Designs

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers have three different product designs. The Macintosh Centris 610 has a low-profile design similar to that of the Macintosh LC II. The Macintosh Centris 650 uses the same desktop design as the Macintosh IIvx and Performa 600. The Macintosh Quadra 800 has a vertical minitower design like that of the Macintosh Quadra 950 but somewhat smaller.

Table 1-2 shows the dimensions of the three computers. The next three sections describe them individually.

Table 1-2 Dimensions of the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers

Model	Height	Width	Depth
Macintosh Centris 610	85 mm (3.4 inches)	415 mm (16.3 inches)	397 mm (15.6 inches)
Macintosh Centris 650	152 mm (6.0 inches)	330 mm (13.0 inches)	419 mm (16.5 inches)
Macintosh Quadra 800	360 mm (14.2 inches)	196 mm (7.8 inches)	396 mm (16.0 inches)

The Macintosh Centris 610 Design

The the Macintosh Centris 610 has a low-profile desktop design somewhat wider than the Macintosh LC II. In addition to the internal floppy disk drive, the Centris 610 has space for two internal SCSI devices: one 3.5-inch device and one 5.25-inch device with a slot for removable media, such as a CD-ROM drive. The Macintosh Centris 610 is designed to sit horizontally on a desktop; it is strong enough to serve as a stand for a 16-inch or smaller monitor.

The Macintosh Centris 610 can accommodate one expansion card by means of a PDS adapter or a NuBus adapter similar to that in the Macintosh IIsi. Either type of expansion card must be short—not more than 7 inches long. The section “The Expansion Slot in the Macintosh Centris 610 Computer” beginning on page 28 gives more information about 7-inch expansion cards.

Figure 1-1 shows the front of the Macintosh Centris 610. Notice the power button on the front of the case.

Figure 1-1 Front view of the Macintosh Centris 610 computer

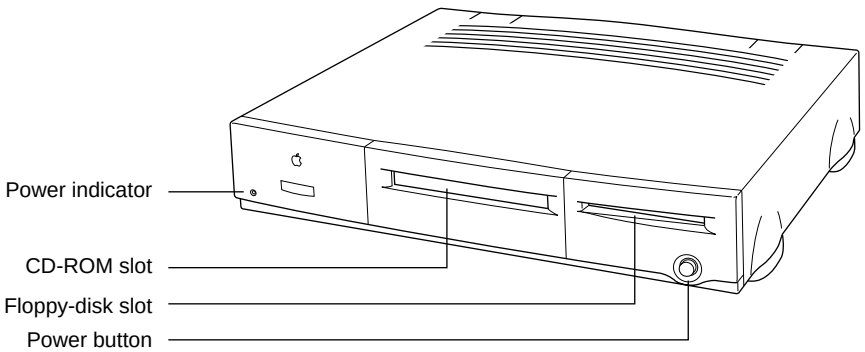
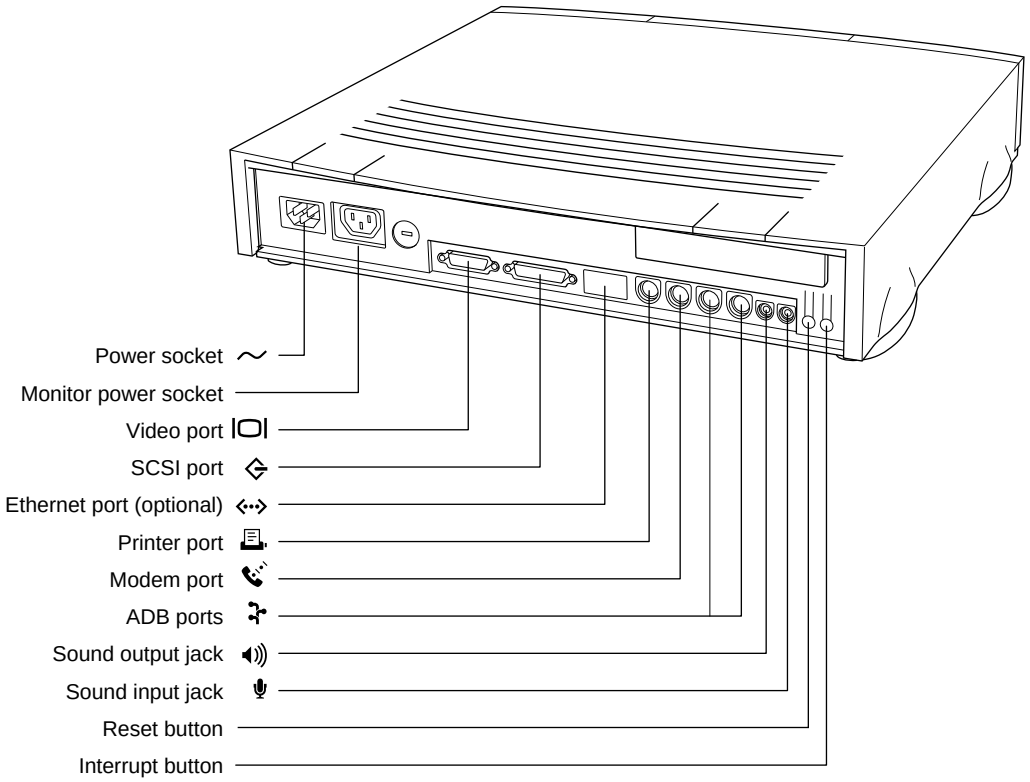


Figure 1-2 shows the back of the Macintosh Centris 610. Notice that the programmer’s NMI and reset buttons are on the back. The AC out receptacle on the back of the computer is not switched.

Figure 1-2 Back view of the Macintosh Centris 610 computer



The Macintosh Centris 650 Design

The Macintosh Centris 650 is similar to the Macintosh IIvx and Performa 600. Like those machines, the Macintosh Centris 650 is designed to sit horizontally on a desktop; it is strong enough to serve as a stand for a 16-inch or smaller monitor.

The case of the Macintosh Centris 650 provides front-panel access for two internal devices with removable media: the internal floppy disk drive and one other, typically a CD-ROM.

Figure 1-3 shows the front of the Macintosh Centris 650. Notice that the programmer's interrupt and reset switches are on the front.

Figure 1-3 Front view of the the Macintosh Centris 650 computer

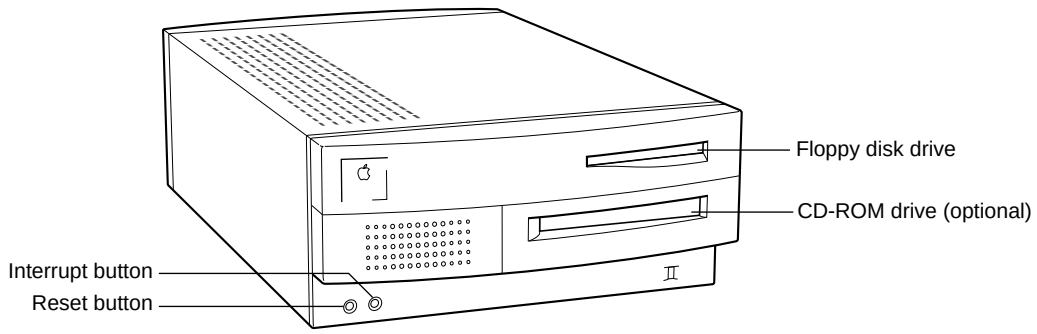
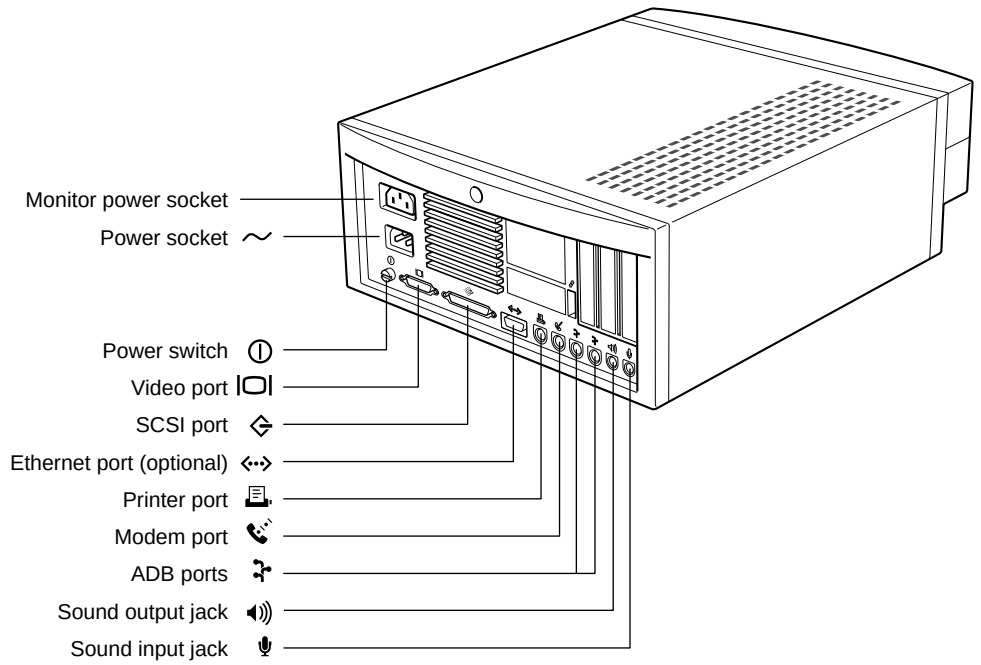


Figure 1-3 shows the back of the Macintosh Centris 650. The monitor power socket is a switched outlet.

Figure 1-4 Back view of the the Macintosh Centris 650 computer



The Macintosh Quadra 800 Design

The Macintosh Quadra 800 has a vertical minitower design like that of the Macintosh Quadra 950, but considerably smaller. The Macintosh Quadra 800 is designed to stand vertically; it cannot be used as a monitor stand.

The Macintosh Quadra 800 has space for three internal SCSI devices and a floppy disk drive. One of the internal SCSI devices can be a full-height drive or a drive array.

In addition to the access slot for the floppy disk drive, the Macintosh Quadra 800 has front-panel access for two SCSI devices with removable media; one of them can be a CD-ROM drive or some other 5.25-inch half-height device.

Like the Macintosh Centris 650, the Macintosh Quadra 800 can accommodate up to three expansion cards.

The Macintosh Quadra 800 has the programmer's reset and NMI buttons on the front of the case.

Figure 1-6 and Figure 1-6 show front and back views of the Macintosh Quadra 800.

Figure 1-5 Front view of the Macintosh Quadra 800 computer

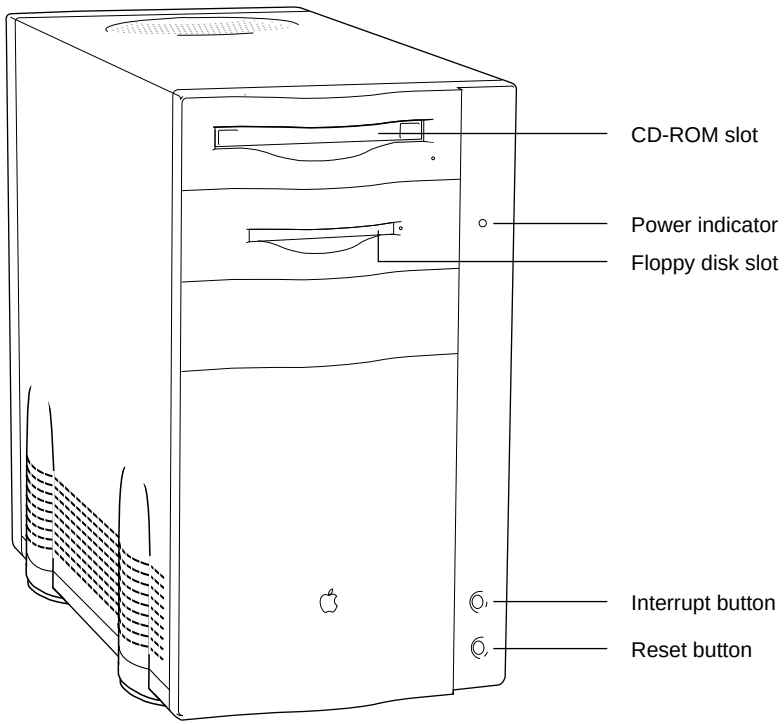
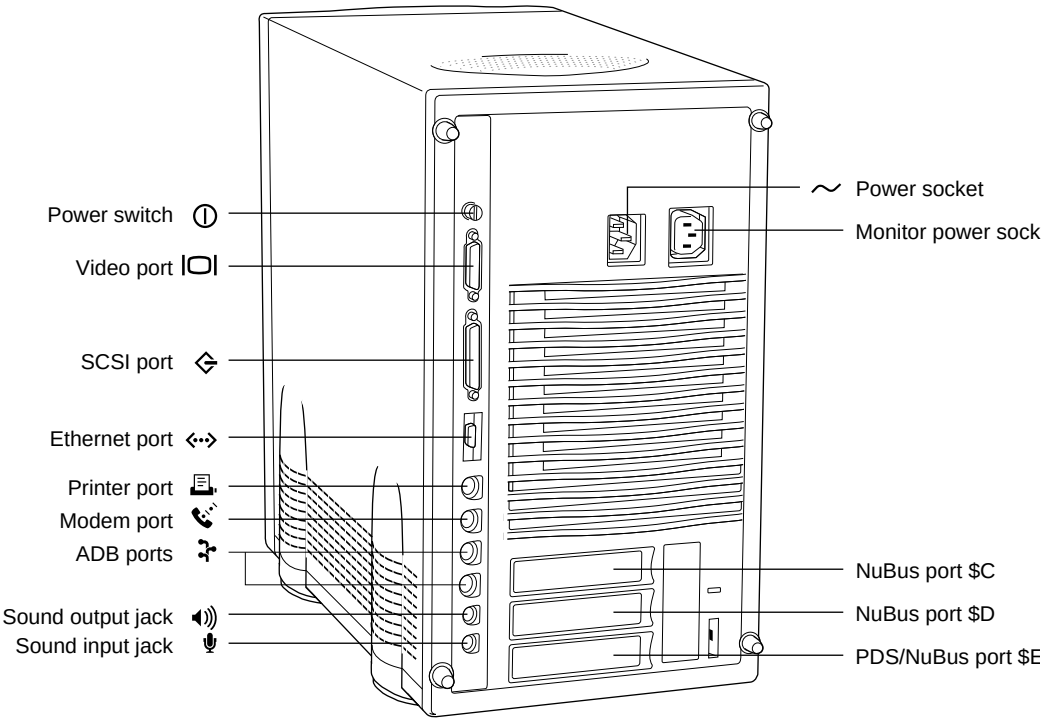


Figure 1-6 Back view of the Macintosh Quadra 800 computer



Expansion Slots

The Macintosh Centris 610 has a single expansion slot that accepts an adapter card for either a processor-direct slot (PDS) card or a NuBus card. The Macintosh Centris 650 and Macintosh Quadra 800 computers each have three NuBus expansion slots and a processor-direct slot. Chapter 3, “Expansion Slots,” gives the specifications of the expansion slot in the Macintosh Centris 610 computer and the NuBus and PDS slots in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers.

Power

On the Macintosh Centris 650 and Macintosh Quadra 800 computers, the user turns on the power by pressing the start button on the keyboard. The mechanical power switch on the back of the computer can be locked in the on position so that the computer will automatically restart after a power failure.

On the Macintosh Centris 610 computer, the user presses a separate power switchon the front of thecomputer, similar to the one on the Macintosh LC II. The Macintosh Centris 610 does not support the soft power switch on the keyboard.

The AC out receptacle on the back of the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers is switched on and off with the computer power; the AC out receptacle on the back of the Macintosh Centris 610 is not switched.

Power Supplies

The power supply in the Macintosh Centris 610 uses a new design and provides 86 W total. The power supply in the Macintosh Centris 650 is the same physical size as the one in the Macintosh Quadra 700 but delivers up to 112 W. The power supply in the Macintosh Quadra 800 can deliver up to 200 W; this large capacity allows it to support additional internal devices.

The expansion slots in the Macintosh Centris 650 and Macintosh Quadra 800 provide 15 W of power for each of three cards. The single expansion slot in the Macintosh Centris 610 provides 10 W of power.

Power for Internal Devices

The Macintosh Centris 610,Macintosh Centris 650, and Macintosh Quadra 800 computers provide power for internal devices such as disk drives and a CD-ROM drive. The power available after meeting the requirements for the main logic board and the expansion cards is shown in Table 1-3.

Table 1-3 Power available for internal devices

Model	+5 V	+12 V
Macintosh Centris 610	1.5 A	1.5 A
Macintosh Centris 650	1.5 A	2.0 A
Macintosh Quadra 800	16.0 A	4.3 A

Built-in Video Support

Each Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computer has a built-in video interface to support an external monitor. Like the video interface in the Macintosh Quadra computers, the video interface in the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers uses separate video

RAM (VRAM) for the screen buffer. The screen buffer is directly accessible by the processor, so it is capable of higher performance than a screen buffer on a NuBus card.

The video interface provides up to 16 bits per pixel, which translates to 32,768 colors. If sufficient VRAM is installed to support 16 bits per pixel on the connected monitor, the user can set the display to 16 bits per pixel by opening the Monitors control panel and choosing Thousands.

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers come with 512 KB of VRAM and sockets for expanding the VRAM to a total of 1 MB. Table 1-4 shows the maximum pixel depth (number of bits per pixel) the video can support with either size of VRAM on different-sized video monitors.

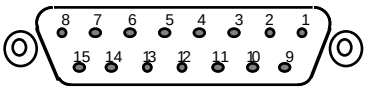
Table 1-4 Maximum pixel depths for the two VRAM sizes

Monitor type	Monitor screen size	Pixel depth with 512 KB VRAM	Pixel depth with 1 MB VRAM
12-inch color	512 × 384	16	16
12-inch monochrome	640 × 480	8	8
13-inch color	640 × 480	8	16
15-inch portrait	640 × 870	4	8
16-inch color	832 × 624	8	16
19-inch color	1024 × 768	4	8
21-inch monochrome	1152 × 870	4	8
21-inch color	1152 × 870	4	8
VGA	640 × 480	8	16
SVGA	800 × 600	8	16

The VRAM in the Macintosh Centris 610 computer uses 100-ns devices; the VRAM in the Macintosh Centris 650, and Macintosh Quadra 800 computers uses 80-ns devices. The video controller in the Macintosh Centris 650 and Macintosh Quadra 800 has been programmed to take advantage of the faster VRAM, speeding up video performance by as much as 20 percent compared to that of the Macintosh Quadra 700.

The video connector used in the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers is shown in Figure 1-7; it is the same 15-pin D-type connector used on other Macintosh computers and display cards and has the same pinouts. In addition to supporting all Apple monitors, the video interface can also drive a VGA or an SVGA monitor.

Figure 1-7 Video cable connector



Note
The video interface can also generate RGB video at the appropriate scanning rates for NTSC and PAL broadcast monitors. An external encoder is required to convert the RGB signals to the composite format required by such monitors. ◆

Sound

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers use a microphone like the one that comes with some other Macintosh models. The microphone can be plugged into the Sound Input jack on the back of the computer.

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers have an internal connector for the stereo audio output of an internal CD-ROM drive. The audio signals from the CD-ROM are mixed with the computer's stereo sound output and also with the monophonic signal from the Sound Input jack. The combined stereo signals are fed to the Sound Output jack and are mixed to monophonic and fed to the internal speaker. The sound signals from the CD-ROM are also mixed to monophonic and fed to the sound input hardware, allowing the computer to digitize sounds from the CD-ROM.

Note
The CD-ROM audio connector is the same as the one in the Macintosh Quadra 900 and 950 computers. See Figure 5-8 on page 60. ◆

CHAPTER 2

Architecture

The Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers all have the same architecture. All three computers are based on the MC68040 microprocessor and use the same custom ICs.

Block Diagram

Figure 2-1 shows the block diagram for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers. As the dotted outlines on the diagram indicate, the Ethernet port is optional and the Macintosh Centris 610 has no NuBus slots.

The computer architecture has two internal buses, plus the NuBus on the Macintosh Centris 650 and Macintosh Quadra 800 models. The system bus is connected directly to the MC68040 and runs at the same clock rate. The I/O bus is partially buffered from the MC68040 and is synchronous with the system bus. The data portion of the I/O bus is 16 bits wide and includes features such as byte steering and dynamic bus sizing for compatibility with I/O devices and software that are also used with the MC68030.

The MC68040 Microprocessor

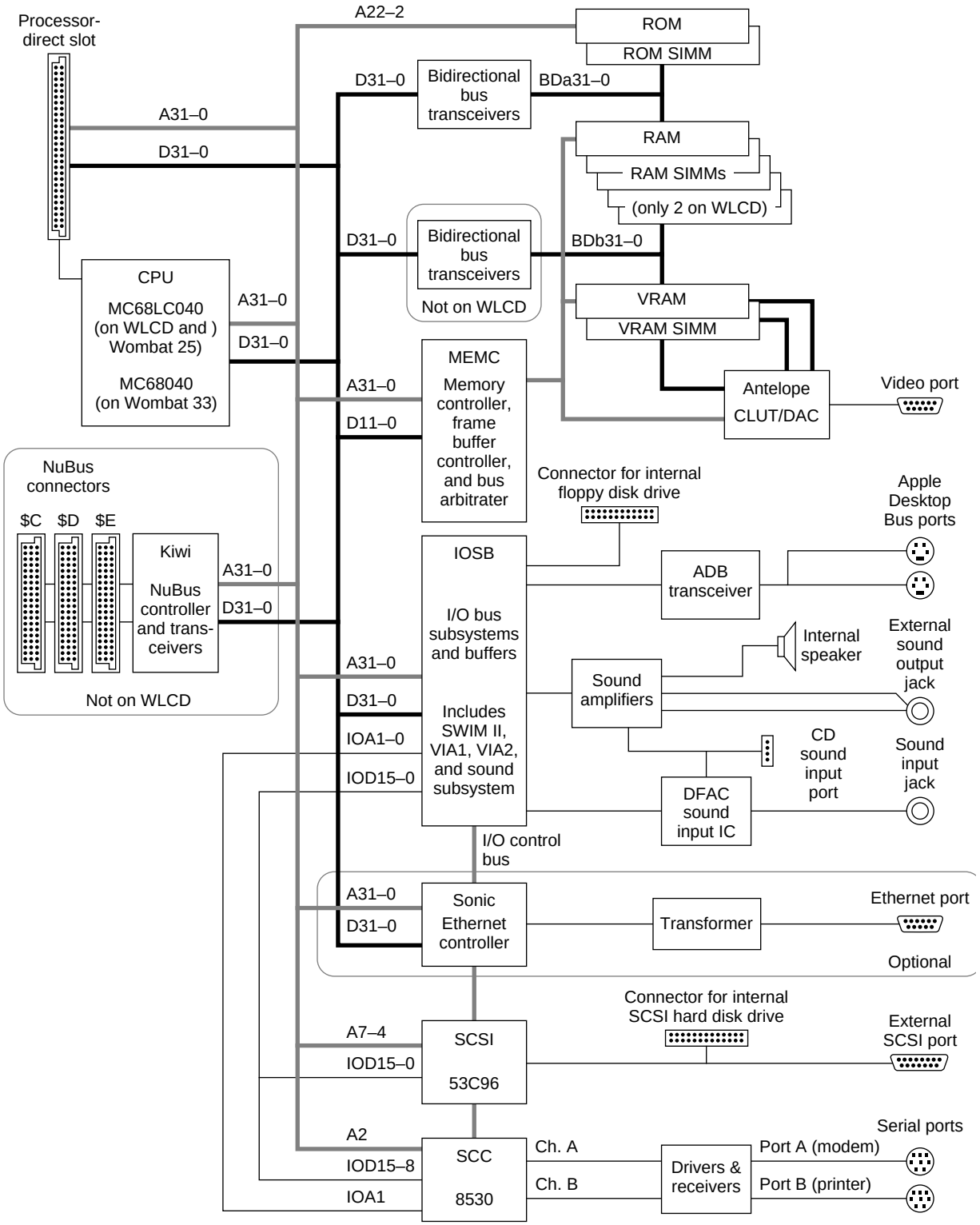
The MC68040 microprocessor is the most powerful member of the 68000 family, with performance approximately three times that of an MC68030 with the same clock speed. While the MC68040 is upwardly compatible with application software written for the MC68020 and MC68030, it also has many new features that contribute to its increased processing power.

The new features of the MC68040 include

- a redesigned and optimized integer unit
- a built-in floating-point unit (FPU)
- built-in memory management units (MMUs), one for instructions and one for data
- built-in instruction and data caches, 4 KB each

Note
The Macintosh Centris 610 and some versions of the Macintosh Centris 650 use the MC68LC040, a version of the MC68040 that does not have an FPU. Floating point operations on those computers use the operating system's floating-point software. Applications can find out whether an FPU is present by using the `Gestalt` function's `gestaltFPUType`. ◆

Figure 2-1 Block diagram



The MC68040 is different in many ways from the MC68020 and MC68030. For example, the MC68040's built-in FPU is not the same as the MC68881 FPU; similarly, the built-in MMU is not the same as the MC68851 MMU or the built-in MMU in the MC68030. Also, the instruction and data caches in the MC68040 use a new mode called CopyBack mode. For information about these differences and the way they are reflected in the new ROM software developed for the MC68040, see Chapter 4, "Software."

Note
The MC68040 has another new feature called cache snooping. That feature is not used in the Macintosh Centris and Macintosh Quadra computers and is not supported by the software. Devices that transfer data on the system bus, such as PDS bus masters, must drive the snoop control pins (SC0, SC1) to indicate no snooping. ◆

Processor Clock Speeds

The system bus clock in the Macintosh Centris 610 runs at 20.00 MHz. The Macintosh Centris 650 runs at 25.00 MHz and the Macintosh Quadra 800 runs at 33.33 MHz. The MC68040 processor receives both the bus clock and a 2X bus clock for internal timing.

PDS Clock Speeds

The PDS is connected to the pins of the MC68040 without any buffers. The PDS signals are the same for the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers, but the system clock speeds are different.

Except for timing, the processor-direct slots in the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers are identical to the ones in the Macintosh Quadra computers; the PDS card used with the adapter in the Macintosh Centris 610 is the same except for its size (maximum length of 7 inches).

Custom ICs

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers use three new very-large-scale integrated circuits:

- the MEMC memory controller IC
- the IOSB input/output subsystem and buffer IC
- the Kiwi NuBus controller IC

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers also use several other ICs that are used in other Macintosh computers, including the DFAC (digitally filtered audio chip), the Sonic Ethernet controller, the SCC serial I/O controller, and the 53C96 SCSI controller.

MEMC IC

The MEMC IC is a very large-scale IC that combines functions performed by several ICs in previous Macintosh designs. The MEMC provides the control and timing signals for the ROM, RAM, and VRAM. It also includes the logic that controls the system bus arbitrations and the frame buffer controller that provides the video timing and control signals.

IOSB IC

Like the MEMC IC, the IOSB IC combines functions performed by several ICs in previous Macintosh designs. The IOSB includes

- I/O data bus buffers
- a SWIM2 floppy disk controller
- VIA1 and VIA2
- address decoding for I/O devices
- sound circuits, including separate sound buffers for input and output

The IOSB IC provides the data bus services of the MC68030 that the MC68040 does not provide. Those services are **byte steering,** which allows 8-bit and 16-bit devices to be connected to a fixed byte lane, and **dynamic bus sizing,** which allows software to read and write longwords to 8-bit and 16-bit devices. Those services allow the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers to work with existing I/O software.

Kiwi IC

The Kiwi IC is a very large-scale IC that incorporates the functions of the YANCC IC used in the Macintosh Quadra 700 and 950 computers along with the bus transceivers and several driver ICs. The Kiwi IC provides an interface to the MC68040 on one side and a NuBus interface on the other side. The Kiwi IC is completely compatible with the YANCC IC, so no software changes are necessary to support it.

The Kiwi IC maps certain system bus cycles to NuBus cycles and certain NuBus cycles to system bus cycles. The features of the Kiwi IC include

- support for all types of single data transfers in either direction
- a buffer, one longword deep, for pended writes from the MC68040 to the NuBus
- support for block move transfers between NuBus masters and main memory
- support for pseudoblock transfers between the MC68040 and NuBus slaves
- support for some new functions defined in the NuBus ‘90 specification
- the ability to disable pended write operations

Like the YANCC NuBus controller used in the Macintosh Quadra computers, the Kiwi IC generates an interrupt when there is an error involving the write buffer. System software controls this interrupt by means of a control and status register in the Kiwi IC.

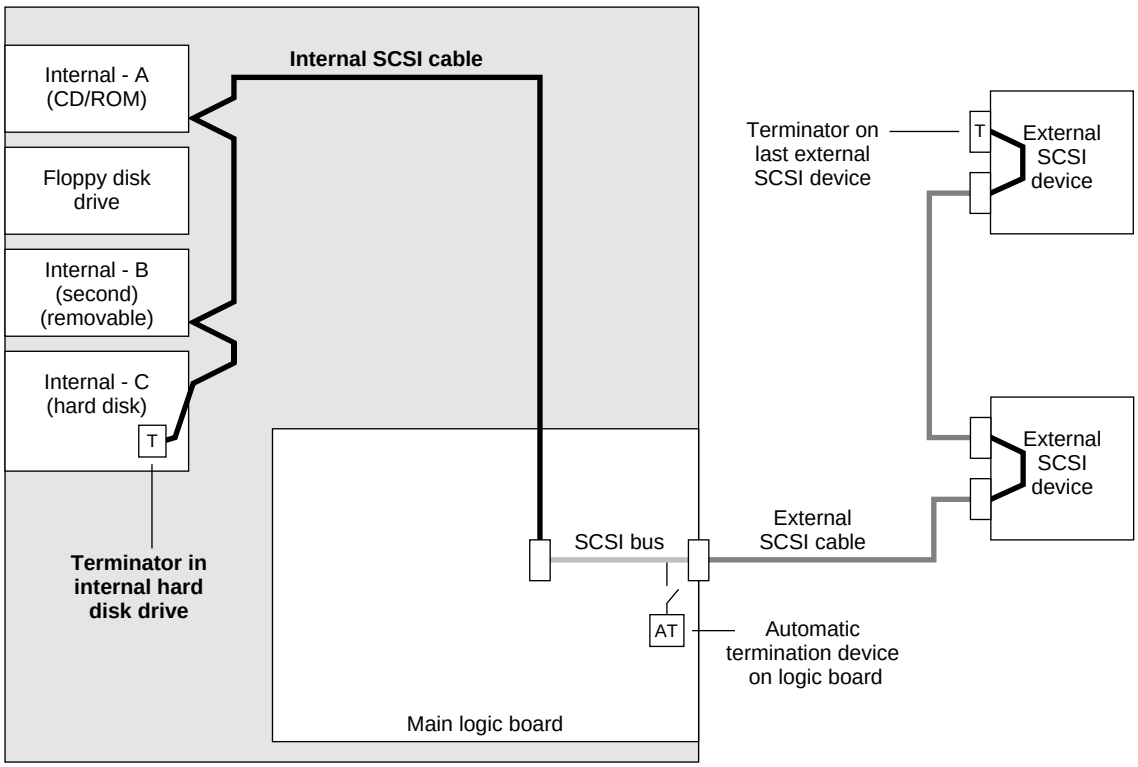
SCSI Bus and Termination

Because the internal portion of the SCSI bus must be long enough to connect multiple devices, the bus requires termination at both ends. As on other Macintosh models, the external end of the bus is normally terminated at the last external device. On the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers, the internal end of the bus—the end at the last internal hard disk drive—is terminated in the drive itself.

Figure 2-2 shows the arrangement of the SCSI cables in the Macintosh Quadra 800. The bus is continuous across the internal SCSI cable, the SCSI bus traces on the logic board, and the external SCSI cable (if any). The boxes with the letter *T* represent terminators. The Macintosh Centris 610 and Centris 650 have a similar arrangement but with only two internal SCSI devices.

Note
Signals on the SCSI bus are usually connected to open-collector devices that can pull the line low but depend on external power to pull it high. The bus includes a line (called TERMPOWER or TPWR) that provides the pull-up power. The standard Macintosh terminator block used at the last external SCSI device terminates each line with a 220-ohm pull-up resistor and a 330-ohm resistor to ground. ◆

Figure 2-2 Location of the SCSI bus terminators



Automatic SCSI Termination

The Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers include a new feature that automatically provides the proper termination when no external device is connected, that is, when the SCSI bus ends at the external connector. When no external device is connected, special circuitry terminates the bus on the logic board near the external connector. When one or more external SCSI devices are connected, the circuitry detects the external termination during system reset and disconnects the termination on the logic board. In Figure 2-2, the box marked *AT* on the logic board indicates the automatic termination device.

Installing Internal SCSI Devices

In the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers, the device at the end of the internal SCSI cable does include terminators; all other internal SCSI devices do not. When installing internal SCSI devices, the installer must make sure that the device at the end of the cable has terminators and must remove any existing terminators from other internal SCSI devices.

▲ **WARNING**

In the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers, SCSI termination must be present on only the last internal device—the one at the end of the internal SCSI cable. If internal SCSI devices are installed but none is terminated, the computer will malfunction; if terminators are present in more than one internal device, the computer will malfunction and the logic board may be damaged. If there are no internal SCSI devices, the internal cable should be disconnected; the automatic termination circuitry will connect the termination on the logic board. ▲

IMPORTANT

As in all SCSI installations, all devices on the SCSI bus must have different ID numbers. ▲

Chapter 5, "Internal Storage Devices," gives the mechanical specifications for internal SCSI devices and describes the bezel used with removable-media devices.

Comparison With Other Macintosh Computers

There are now three arrangements of SCSI cabling and termination used in Macintosh computers.

The first arrangement is used on Macintosh computers that support only one internal SCSI device (examples include the Macintosh SE, Macintosh IIci, and Macintosh Quadra 700). A separate terminator block at the last external device terminates the external end of the SCSI bus. Terminators built into the internal SCSI device terminate the internal end of the SCSI bus.

The second arrangement is used on the Macintosh Quadra 900 and 950 computers. These machines have two SCSI driver ICs, one for internal SCSI devices and one for external devices. (The software treats the two hardware buses as one virtual bus with a single set of SCSI ID numbers.) The internal and external segments of the bus are both terminated on the logic board. In addition, the internal cable is so long that it—like the external cable—requires termination at both ends, so it has built-in SCSI terminators for the last device. While this arrangement provides for higher transmission speeds because the two segments of the bus are terminated separately, it is expensive because it has two driver ICs and two sets of active terminators on the logic board.

The third arrangement is used in the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers as well as other recently introduced models with multiple internal devices (such as the Macintosh IIvx and the Macintosh Performa 600). As described earlier, this arrangement uses a single SCSI driver IC for both internal and external devices and automatic termination on the logic board. The SCSI bus reaches from the last device on the internal cable to the last device daisy-chained to the external SCSI connector. The internal SCSI cable does not have built-in terminators; instead, the internal SCSI device at the end of the cable must include the terminators.

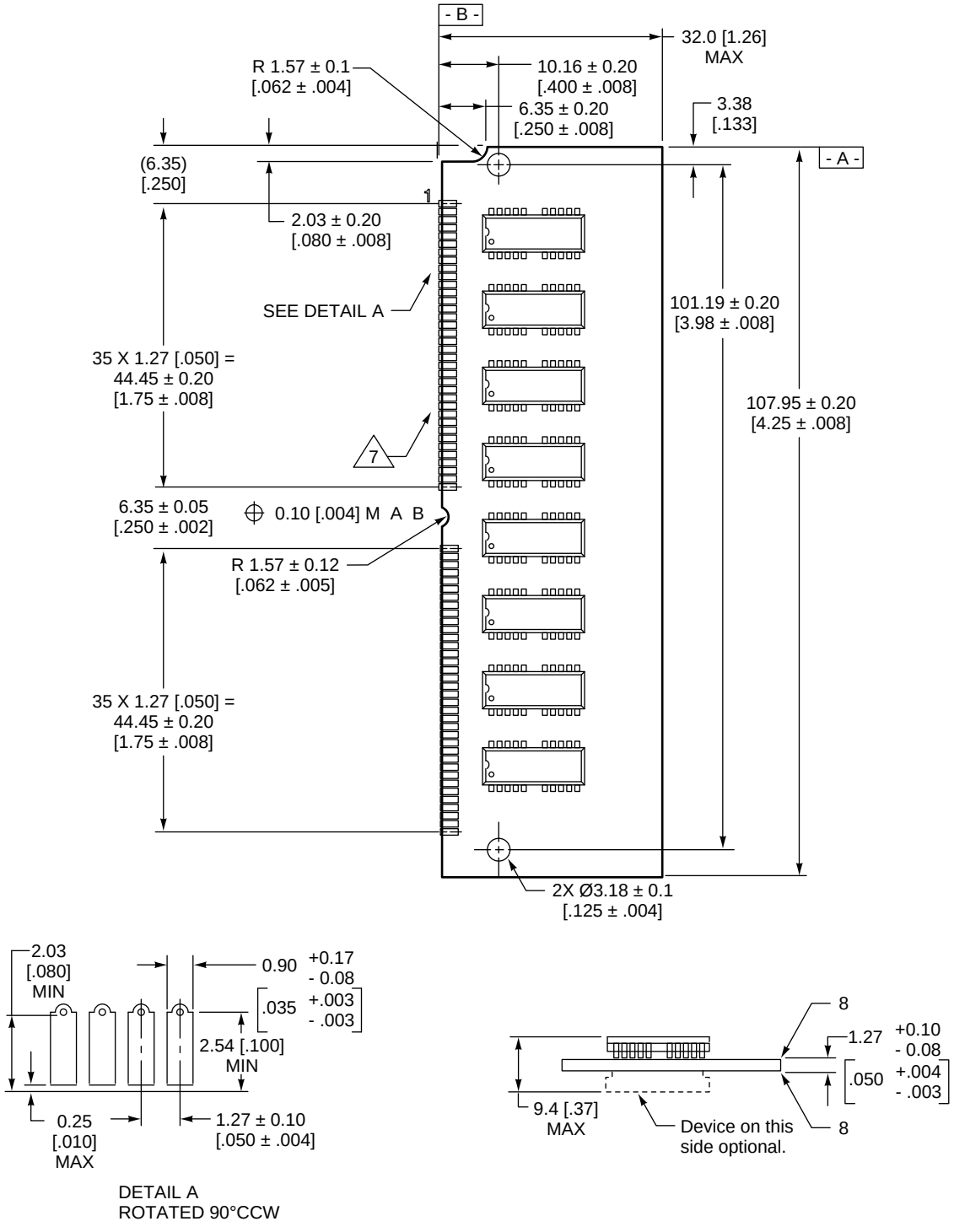
RAM

The minimum amount of RAM in the Macintosh Centris 610 is 4 MB, the minimum RAM in the Macintosh Centris 650 is either 4 MB or 8 MB, and the minimum RAM in the Macintosh Quadra 800 is 8 MB. The Macintosh Centris 610 has two SIMM slots for expansion RAM for a maximum of 68 MB using 32 MB devices in both SIMMs. The Macintosh Centris 650 and Macintosh Quadra 800 have four SIMM slots each, giving them a maximum RAM size of 132 MB (with 4 MB on the logic board) or 136 MB (with 8 MB on the logic board).

RAM SIMMs

For RAM expansion, the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers use 72-pin SIMMs, illustrated in Figure 2-3. These SIMMs are not the same as the 30-pin SIMMs used on older Macintosh computers or the 64-pin SIMMs used in LaserWriter printers and the Macintosh IIfx. The 72-pin SIMMs are an industry standard currently used in several other personal computers.

Figure 2-3 RAM expansion SIMM



Note: Dimensions are in millimeters with inches in brackets.

The Macintosh Centris 610 and Centris 650 computers require RAM with a memory access time of 80 ns or less. The Macintosh Quadra 800 computer requires RAM with a memory access time of 60 ns or less.

Note
In the Macintosh Centris 650 and Macintosh Quadra 800 computers, the memory controller provides interleaved access to RAM bank pairs, thus reducing access time for burst access cycles. Interleaved memory access requires that the bank pairs be the same size; if the bank pairs are different sizes, memory accesses are not interleaved. ◆

Address Maps

Like other Macintosh computers, the Macintosh Centris 610, Centris 650, and Macintosh Quadra 800 computers use memory-mapped I/O. Figure 2-4 shows how the address map is allocated to the various I/O interface devices. Figure 2-5 shows the address allocations for the expansion slots.

Note
The Macintosh Centris 610 computer has a connector for an expansion adapter. The connector is normally addressed as expansion slot $E. ◆

Figure 2-4 Addresses of I/O devices

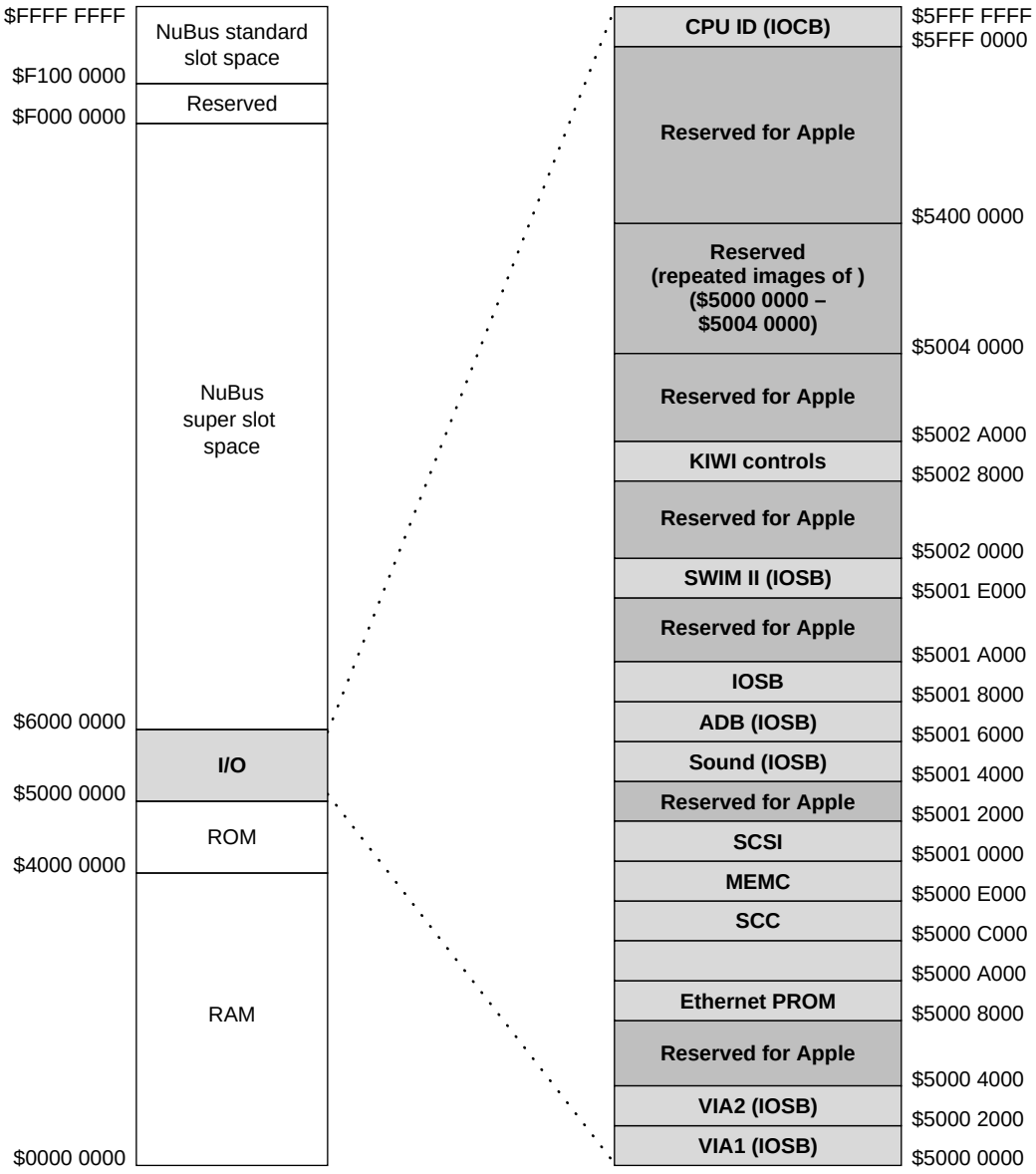
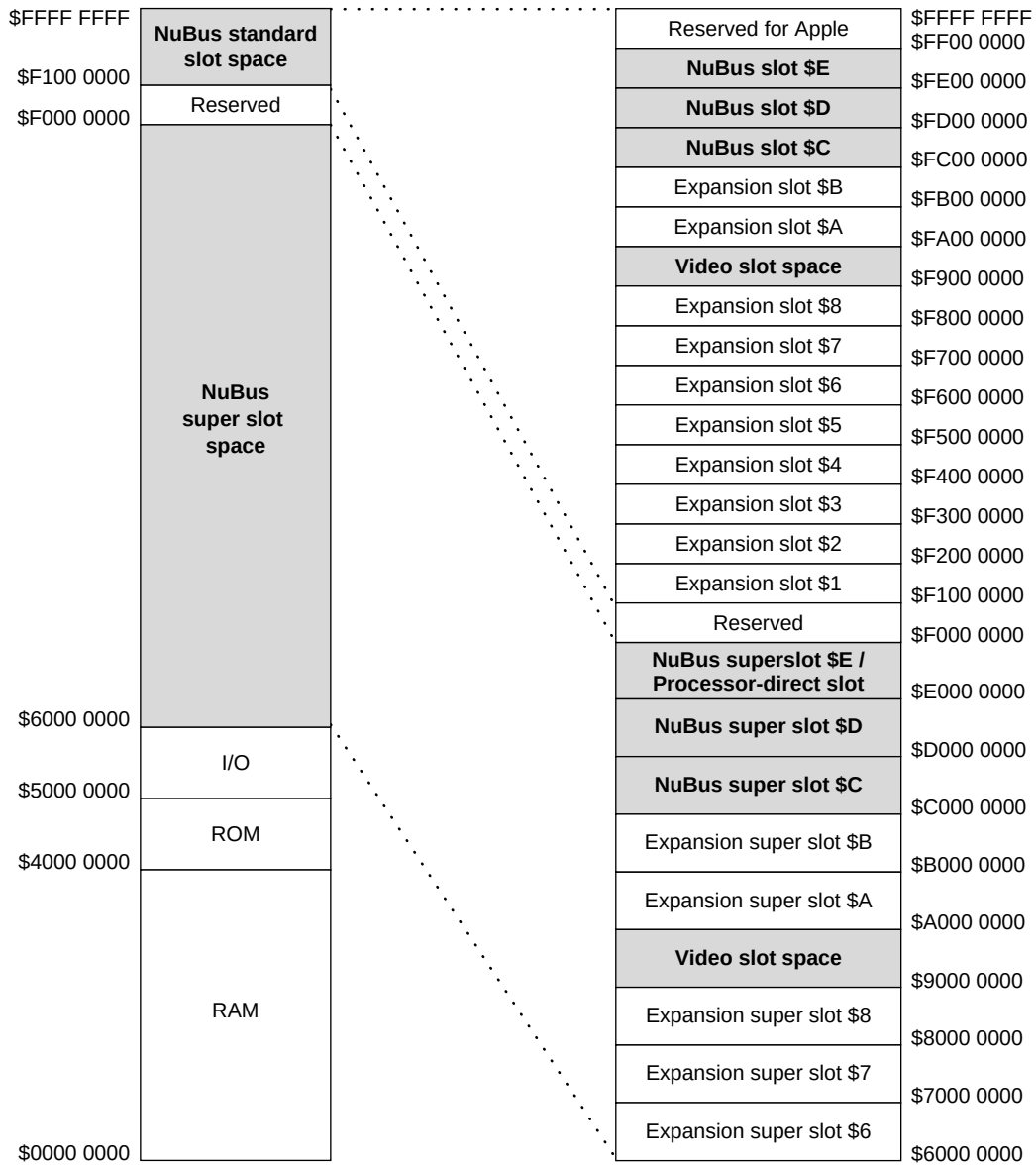


Figure 2-5 Addresses of expansion slots



Expansion Slots

The Macintosh Centris 610 computer has a single expansion slot that accepts an adapter card for either a processor-direct slot (PDS) card or a NuBus card. The Macintosh Centris 650 and Macintosh Quadra 800 computers each have three NuBus expansion slots and a processor-direct slot.

This chapter gives basic specifications of the PDS cards and NuBus cards for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers. For complete specifications and guidelines for developers, see *Designing Cards and Drivers for the Macintosh Family,* third edition.

The Expansion Slot in the Macintosh Centris 610 Computer

The Macintosh Centris 610 computer has a single expansion slot that accepts one of two adapter cards: a NuBus slot adapter or a PDS adapter. The expansion slot is a 140-pin dual-position edge connector. Figure 3-1 is a simplified diagram showing the mechanical arrangement of the expansion slot, an adapter card, and an expansion card. Either type of expansion card can have an I/O connector that uses the opening in the back of the case.

Figure 3-1 An expansion card in the Macintosh Centris 610 computer

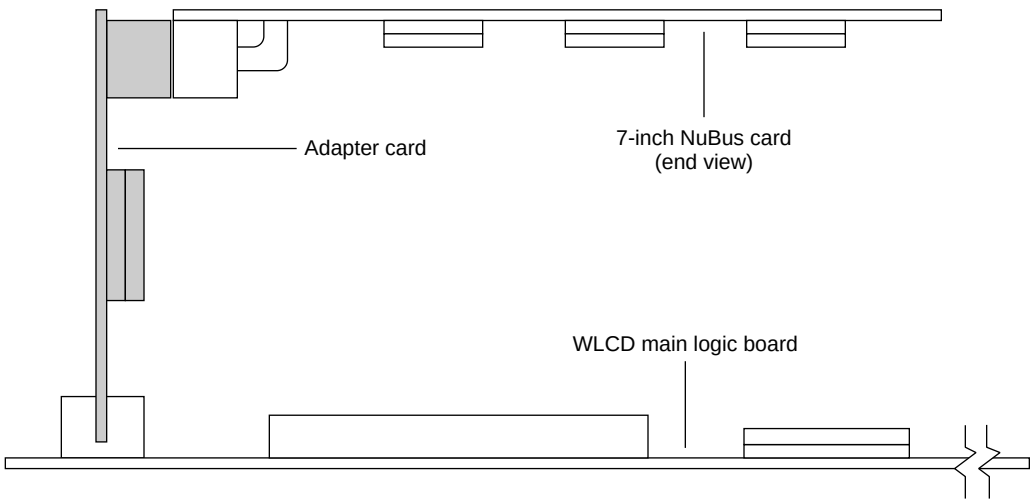
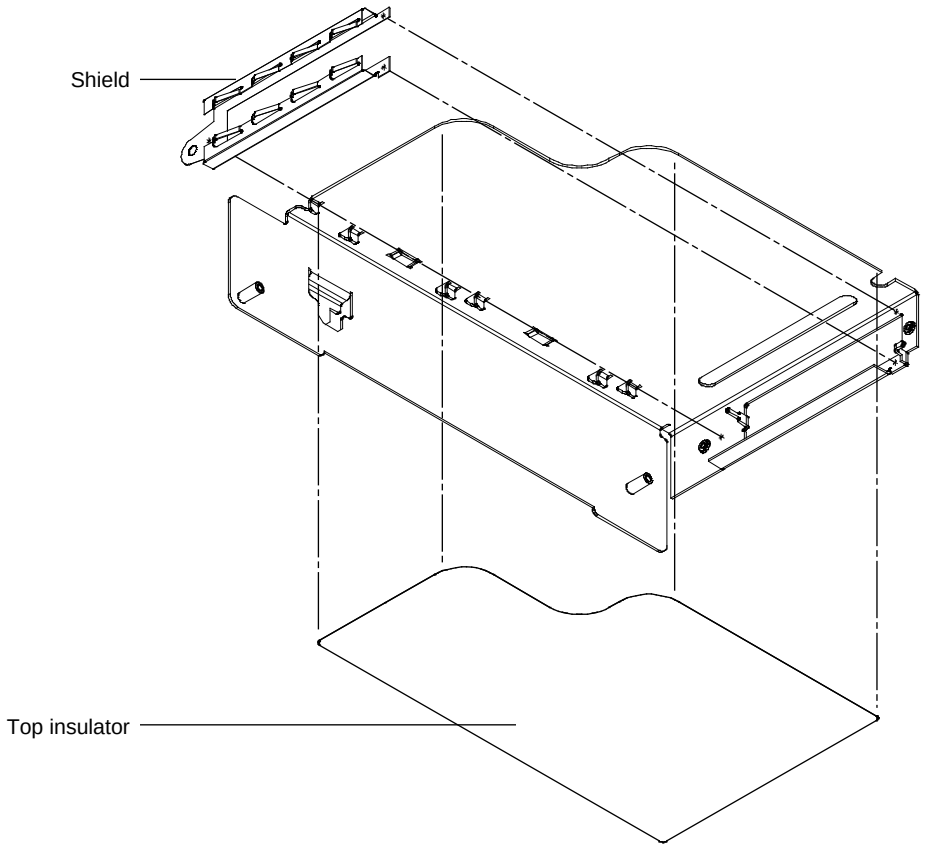


Figure 3-2 shows the shield bracket that protects the expansion card. The card is installed parallel with the top of the bracket. The shield provides electrical shielding for the I/O connector on the card.

Figure 3-2 The expansion-card shield bracketr



The folded 11 by 17-inch pages at the back of this note include design guides for the expansion bracket shown in Figure 3-2. Foldout 10 is a design guide for the shield bracket. Foldout 11 is a design guide for the insulator for the top of the adapter bracket. Foldout 12 is a design guide for the EMI shield for the adapter bracket.

Obtaining Parts

You can obtain the shield bracket and associated parts directly from Apple's suppliers. For those parts, Table 3-2 lists the part numbers and suppliers. The addresses of the suppliers are listed following the table.

Table 3-1 Part numbers and suppliers

Part number	Description	Supplier
805-0530	Expansion bracket	TBD
805-0531	Expansion card shield	TBD
725-0051	Insulator for expansion bracket	TBD

The Expansion Adapter Card

An adapter card in the Macintosh Centris 610 computer can provide a connector for a NuBus card or a connector for a PDS card. Either type of adapter card must have the same dimensions and use the same connector to plug into the connector on the computer's main logic board.

The differences between a NuBus adapter card and a PDS adapter card have to do with the type of expansion cards they support. The next two sections describe the mechanical characteristics of the two types of expansion cards for the Macintosh Centris 610 computer. See the sections "NuBus '90 Features" and "PDS Cards" later in this chapter for information about signal specifications for the expansion cards.

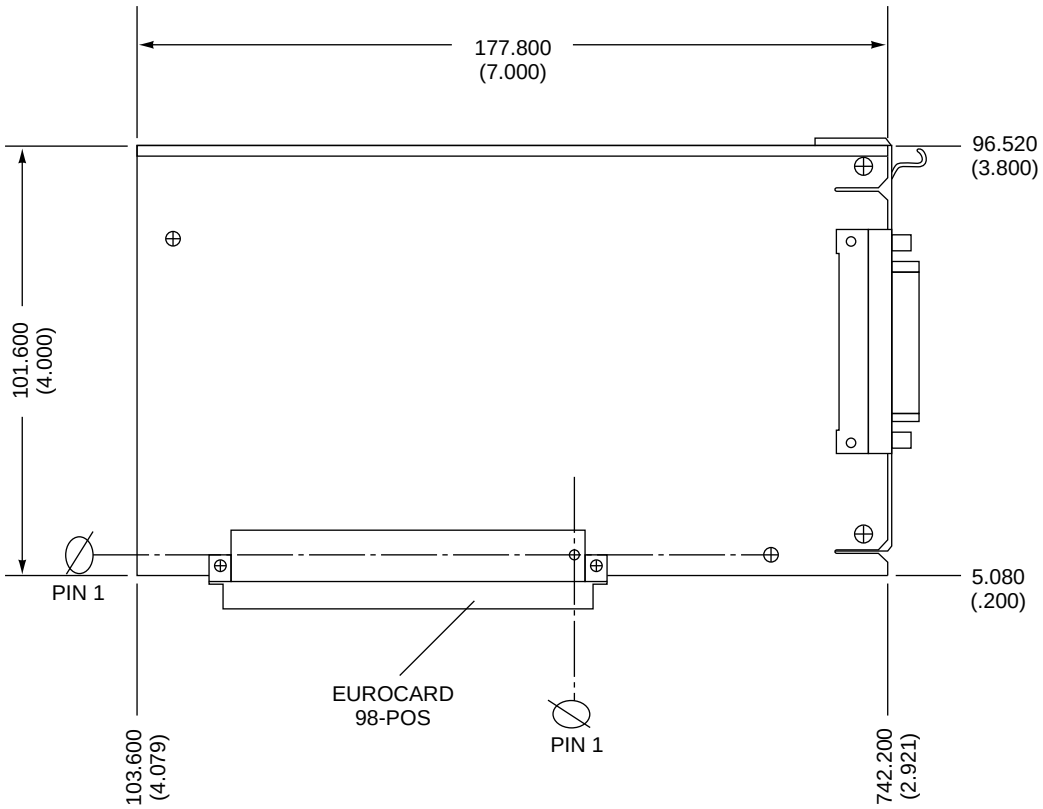
The folded 11 by 17-inch pages at the back of this note include a design guide for the expansion adapter card. Foldout 13 is a design drawing with dimensions for Apple's NuBus adapter card for the Macintosh Centris 610.

NuBus Card for the Macintosh Centris 610 Computer

The NuBus adapter for the Macintosh Centris 610 includes the NuBus interface circuitry and has a single standard NuBus connector.

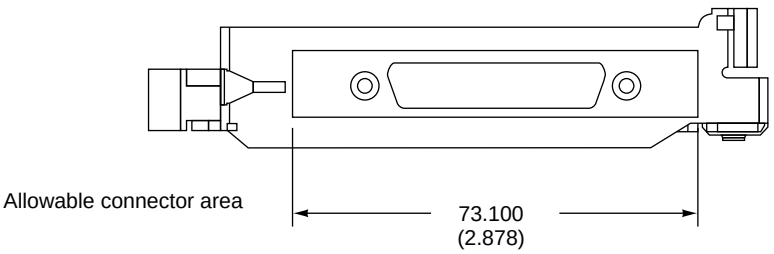
A NuBus card used in the Macintosh Centris 610 is only 7 inches long, as shown in Figure 3-3. Figure 3-4 is an end view of the card, showing the metal bracket that fits into the case opening.

Figure 3-3 Dimensions of the 7-inch NuBus expansion card



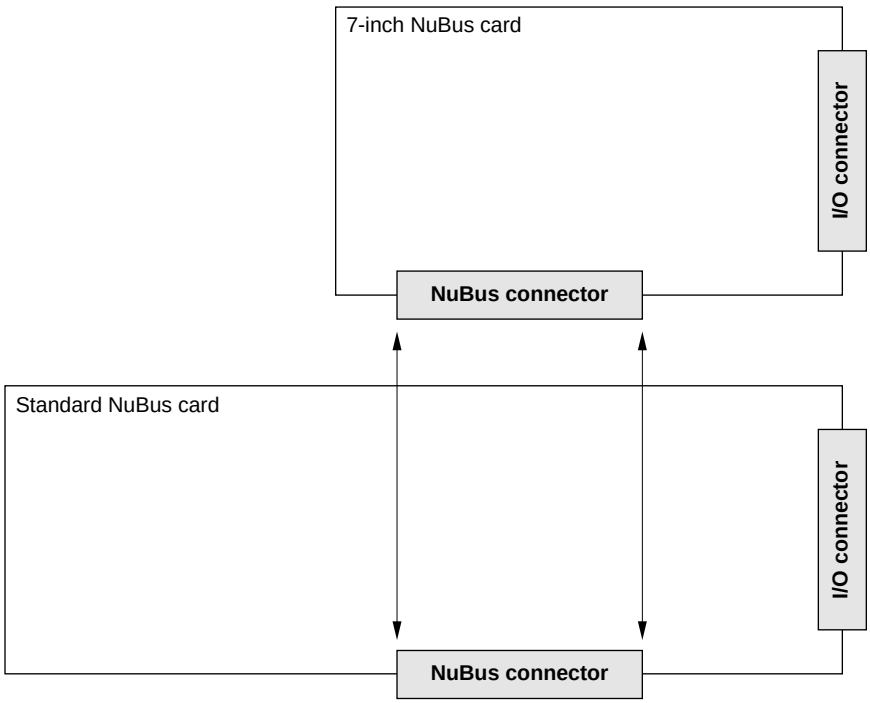
Note: Dimensions are in millimeters with inches in parentheses.

Figure 3-4 End view of the 7-inch NuBus expansion cardr



The 7-inch version of the NuBus card can be used in any Macintosh computer that has NuBus slots. Figure 3-5 shows how a 7-inch NuBus card aligns with a standard NuBus card.

Figure 3-5 Comparison of 7-inch and standard Nubus cardsr



A NuBus card for the Macintosh Centris 610 can use a maximum of 10 W of power. Table 3-2 shows how the power can be allocated to the different supply voltages. Power budget 1 shows the maximum power available from the +12 V and –12 V supplies. Power budget 2 shows how unused power from the +12 V and –12 V supplies can be allocated to the +5 V supply.

Table 3-2 Power budget for a NuBus card in the Macintosh Centris 610 computer

Supply voltage	Power budget 1	Power budget 2
+12 V	2.1 W	0.0 W
–12 V	1.8 W	0.0 W
+5 V	6.1 W	10.0 W

If you are designing a NuBus card, you might wish to consider whether your design can fit onto a 7-inch card and can operate within the 10-watt power limit of the expansion slot in a Macintosh Centris 610 . If your design will fit within those limits, it can be used in the Macintosh Centris 610 as well as Macintosh computers that accept standard NuBus cards.

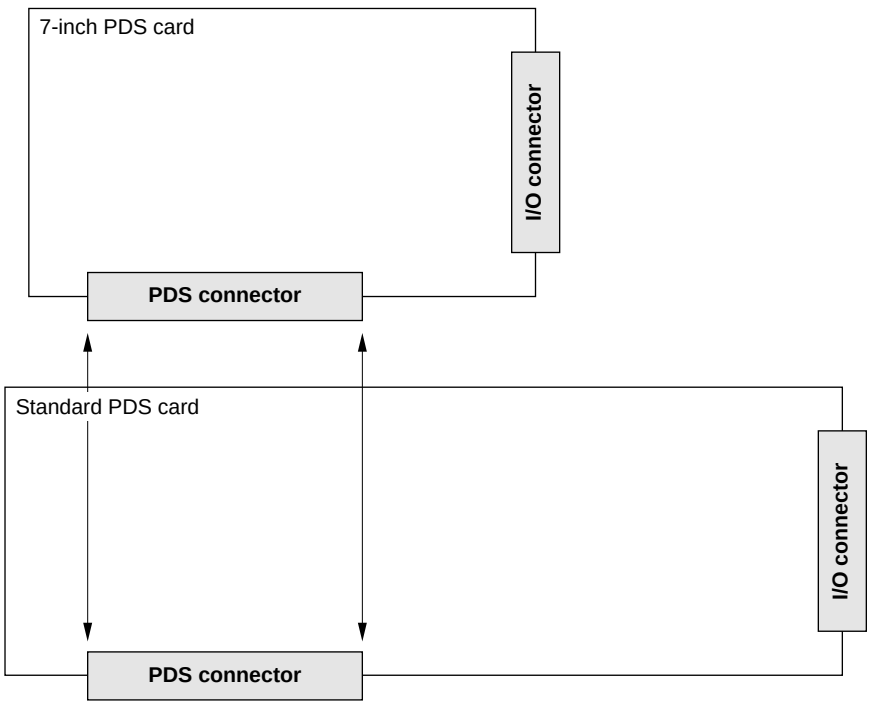
PDS Card for the Macintosh Centris 610 Computer

The PDS adapter for the Macintosh Centris 610 computer accepts a 7-inch version of the PDS card used in the Macintosh Centris and Macintosh Quadra computers. The dimensions of the PDS card for the Macintosh Centris 610 are the same as those of the 7-inch NuBus card shown in Figure 3-3. The connector on the PDS card is a 140-pin connector equivalent to the KEL connector part number 8807-140-170LH. The pinouts are the same as those shown in the section "68040 Direct Slot Expansion" in Chapter 16 of *Designing Cards and Drivers for the Macintosh Family,* third edition.

IMPORTANT

The 7-inch version of the PDS card can also be used in a Macintosh Centris 650 or Macintosh Quadra 800, but only if it has no I/O connector. In the larger computers, the I/O connector on the 7-inch PDS card does not reach the back of the case; see Figure 3-6. ▲

Figure 3-6 Comparison of 7-inch and standard PDS cards



Expansion Slots in the Macintosh Centris 650 and Macintosh Quadra 800 Computers

The expansion slots in the Macintosh Centris 650 and Quadra 800 computers accept standard-sized NuBus cards. The PDS cards for those computers are the same size as the NuBus cards.

NuBus Slots in the Macintosh Centris 650 and Macintosh Quadra 800 Computers

The Macintosh Centris 650 and Quadra 800 computers each have three NuBus slots that occupy expansion slot addresses $C, $D, and $E; the PDS lines up with slot $E.

The NuBus slots in the Macintosh Centris 650 and Quadra 800 computers support the NuBus ’90 features described later in this chapter. For complete specifications of the NuBus connectors and signals, refer to *Designing Cards and Drivers for the Macintosh Family,* third edition.

The Processor-Direct Slot in the Macintosh Centris 650 and Macintosh Quadra 800 Computers

For maximum performance, the processor-direct slot (PDS) is connected directly to the MC68040 microprocessor by way of the system bus.

The processor-direct slots in the Macintosh Centris 650 and Quadra 800 computers (and the PDS adapter in the Macintosh Centris 610) have the same design as the processor-direct slots in the Macintosh Quadra computers. If the cards are compatible with the system clock speeds, PDS cards that operate in Macintosh Quadra computers will also operate in the Macintosh Centris 650 and Macintosh Quadra 800 computers.

A PDS card for the Macintosh Centris 650 or Quadra 800 computer has the same dimensions as a NuBus card and can include a back-panel I/O connector. Because the PDS is located in line with NuBus slot $E, installing a PDS card reduces the available NuBus slots from three to two.

The section “PDS Connector Signals” later in this chapter describes the signals on the PDS card used in the Macintosh Centris 610, Centris 650, and Quadra 800 computers. For complete specifications and a discussion of the issues involved with developing PDS cards for the Macintosh Quadra computers, see *Designing Cards and Drivers for the Macintosh Family,* third edition.

NuBus ’90 Features

The NuBus, the industry-standard expansion bus used in all Macintosh II–family computers, runs at a clock rate of 10 MHz. The NuBus in the Macintosh Centris 650 and Macintosh Quadra 800 computers includes several features of NuBus ’90, including a clock signal at 20 MHz, twice the normal rate. The NuBus adapter for the Macintosh Centris 610 also supports most of the NuBus ’90 features described here.

NuBus ’90 is the 1990 proposal for revision of the IEEE standard for the NuBus (IEEE Std R1196-R-1990). The NuBus slots in the Macintosh Centris 650 and Macintosh Quadra 800 computers provide the following new features described in that proposal:

- Signals /TM2, /CLK2X, and /CLK2XEN support block transfers at double the standard rate. The Macintosh Centris 650 and Quadra 800 computers allow double-rate block transfers between NuBus cards but do not support double-rate transfers to or from the main logic board.
- Signals SB0 and SB1 support a serial bus on the formerly reserved pins A2 and C2. The serial-bus signals are bused and terminated, but the main circuit board does not drive them. (They are not connected on the Macintosh Centris 610 computer.)
- Signals /CM0, /CM1, /CM2, and /CBUSY support a cache-coherency protocol. Pins on the NuBus connector are assigned to these signals, but the Macintosh Centris 650 and Macintosh Quadra 800 computers don’t support them.

Table 3-3 lists the new signals described in the proposal for NuBus ’90.

Table 3-3 NuBus ’90 signals on the NuBus connector

Pin number	Signal name	Function
A2	SB0†	High-speed serial bus
C2	SB1†	High-speed serial bus
B8	/TM2†	New transfer mode: requests double-speed transfer
B9	/CM0†	For cache-coherency operations
B10	/CM1†	For cache-coherency operations
B11	/CM2†	For cache-coherency operations
B24	/CLK2X†	Synchronizes double-speed block transfers
B25	STDBYPWR	Bused only; no power provided
B26	/CLK2XEN	If not connected to other NuBus ’90 signals, enables /CLK2X driver
B27	/CBUSY	For cache-coherency operations

†This signal is not driven or monitored by circuits in the computer.

None of the computers described in this note provides power for the STBYPWR pin. On the Macintosh Centris 650 and Macintosh Quadra 800 computers, the STBYPWR pin is connected across all three slots. On the Macintosh Centris 610 computer, the STBYPWR pin is not connected.

IMPORTANT

The eight lines that were connected to the –5.2 V supply in the original NuBus specification are now used for new features. Many older NuBus cards connect those eight lines together; the presence of such a card in a Macintosh Centris or Macintosh Quadra computer will disable the new features that use those lines. All other features of both old and new cards will operate normally. ▲

PDS Cards

A PDS card can have memory locations in the upper part of the RAM memory space or in the space assigned to NuBus slot $E. If the card uses slot $E addresses, it must decode all addresses in both the slot space and the super slot space, responding to any access to an unused location by using the /TEA signal on the processor bus to indicate an illegal address.

A typical PDS card maps into the NuBus space and works with the system software's Slot Manager. On a Macintosh Centris or Macintosh Quadra, such a card must contain a NuBus declaration ROM and must notify the NuBus controller that it is using the NuBus space by asserting (pulling low) the signal /PDS.SLOT.E.EN on the PDS connector. This operation is not needed on the Macintosh Centris 610 computer because it doesn't have a NuBus controller.

▲ **WARNING**

A PDS expansion card for a Macintosh Centris or Macintosh Quadra computer must be designed to work with the MC68040 microprocessor; PDS cards designed for computers that use the MC68020 or the MC68030 will not work in a computer that uses the MC68040. ▲

PDS Connector Signals

The 68040 PDS connector is a 140-pin connector manufactured by KEL Connectors, Incorporated. The connector on the main circuit board is KEL part number 8817-140-170SH; the corresponding connector on the PDS card is part number 8807-140-170LH.

Table 3-4 lists the signals on the pins of the PDS connector. Most of those signals are connected directly to pins on the MC68040 microprocessor. Table 3-5 defines the PDS signals that are not directly connected to the microprocessor. Table 3-6 shows two PDS signals that are connected to the microprocessor but that are not to be connected to a microprocessor on a PDS card.

Table 3-4 Pin assignments on the PDS connector

Pin number	Signal name	Pin number	Signal name
1	GND	36	D(4)
2	A(1)	37	+5V
3	A(3)	38	D(1)
4	A(4)	39	GND
5	A(6)	40	SIZ(1)
6	A(7)	41	RW
7	A(9)	42	/TIP.CPU
8	A(11)	43	n.c.
9	A(13)	44	/TEA
10	A(15)	45	/DLE
11	GND	46	SC(1)
12	A(18)	47	/TRST
13	A(19)	48	/CIOUT
14	A(21)	49	GND
15	A(23)	50	/BR.CPU
16	A(24)	51	/BR.40SLOT
17	A(26)	52	/BB
18	A(29)	53	/LOCK
19	A(31)	54	/MEMRESET
20	D(31)	55	/RSTO
21	D(29)	56	+5V
22	D(27)	57	n.c.
23	D(25)	58	/NMRQ(6)
24	D(24)	59	GND
25	D(22)	60	/IPL(0)
26	+5V	61	/IPL(1)
27	D(19)	62	/IPL(2)
28	D(17)	63	–12V
29	GND	64	GND
30	D(14)	65	n.c.
31	D(13)	66	n.c.
32	D(11)	67	n.c.
33	D(9)	68	n.c.
34	D(8)	69	n.c.
35	D(6)	70	+5V

Pin number	Signal name	Pin number	Signal name
71	AUX.CPUCLK	106	D(5)
72	A(0)	107	D(3)
73	A(2)	108	D(2)
74	+5V	109	D(0)
75	A(5)	110	SIZ(0)
76	GND	111	+5V
77	A(8)	112	/TBI
78	A(10)	113	/TA
79	A(12)	114	GND
80	A(14)	115	/TS
81	A(16)	116	SC(0)
82	A(17)	117	/MI
83	+5V	118	/MI.SLOT
84	A(20)	119	/BG.40SLOT
85	A(22)	120	/BG.CPU
86	GND	121	+5V
87	A(25)	122	TT(0)
88	A(27)	123	TT(1)
89	A(28)	124	GND
90	A(30)	125	TLN(0)
91	D(30)	126	TLN(1)
92	D(28)	127	/ANALOGRESET
93	D(26)	128	TM(0)
94	GND	129	TM(1)
95	D(23)	130	TM(2)
96	D(21)	131	+5V
97	D(20)	132	/PDS.SLOT.E.EN
98	D(18)	133	+12V
99	D(16)	134	n.c.
100	D(15)	135	TCK
101	+5V	136	TMS
102	D(12)	137	n.c.
103	D(10)	138	n.c.
104	GND	139	n.c.
105	D(7)	140	+5V

Note
On the Macintosh Centris 610, pin 132 (/PDS.SLOT.E.EN) is not connected. ▲

Table 3-5 Nonmicroprocessor signals on the PDS connector

Signal name	Direction*	Function
/ANALOGRESET	O/I	Enables PDS to drive system reset signal; used only for testing
AUX.CPUCLK	I	Buffered version of main processor's bus clock
/BG.CPU	O	Bus grant for main processor
/BG.40SLOT	I	Bus grant for PDS card
/BR.CPU	I	Bus request for main processor
/BR.40SLOT	O	Bus request for PDS card
/MEMRESET	I	Fast reset generated for memory controller IC
/MI.SLOT	O	Memory inhibit from PDS card to memory controller IC
/NMRQ(6)	O	NuBus slot $E interrupt; also connected to NuBus slot $E
/PDS.SLOT.E.EN	O	Notifies Kiwi NuBus controller IC that PDS card is installed and is using memory space assigned to NuBus slot $E

* I indicates input to the PDS card; O indicates output from the PDS card.

Note
The AUX.CPUCLK line is terminated with a series resistor. To reduce reflections on this line, all loads on the card should be lumped. ▲

IMPORTANT
The signals on the PDS connector are connected directly to the MC68040 with no buffers. Therefore, the address, data, and clock lines on a PDS card must present capacitive loads of not more than 40 pF. The control lines must present capacitive loads of not more than 20 pF. ▲

Table 3-6 Restricted microprocessor signals on the PDS connector

Signal name	Direction*	Function
/IPL(0–2)	I	Interrupt priority lines from the IOSB; not to be used as wire-OR lines; can be monitored by a PDS card
/TIP.CPU	I	From the MC68040 on the main circuit board; not connected to any other part of the computer

* I indicates input to the PDS card.

CHAPTER 4

Software

This chapter tells how the system software operates on the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers and summarizes the features of the ROM software.

System Software

In the past, Apple Computer, Inc., has released a new version of the Macintosh system software to accompany each new Macintosh computer. That is not the case with the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers. Instead of an additional version of the system software, those computers come with a new type of system extension called a *system enabler.*

Starting with the international release of System 7.1, each reference release of the Macintosh system software supports a new startup extension, the system enabler. The **system enabler** is a software resource that is able to perform the correct startup process for one or more Macintosh computers.

As soon as the system software on disk takes over the startup process, it searches for all system enablers that can start up the particular machine. Each system enabler contains a resource that specifies which computers it is able to start up and the time and date of its creation. If the system software finds more than one enabler for the particular computer, it passes control to the one with the most recent time and date.

In general, the system enabler included in each reference release of system software is able to start up all previous computers. The system enabler that accompanies a later computer will be able to start up that computer, possibly using resources from the previous reference release.

In System 7, the code that performed the startup process was stored in the `'boot' 2` resource. For compatibility, the new system still has a `'boot' 2` resource and always executes it. In fact, the `'boot' 2` resource contains the startup arbitration code that locates the appropriate system enabler. The actual startup code is stored in a resource of type `'boot' 3`; every system enabler must have a `'boot' 3` resource that contains the code to start up one or more computers. Table 4-1 shows the stages, in order, of the startup process leading to the execution of the enabler code.

Table 4-1 Stages in the startup process

Startup stage	Location of code	Executed by
Diagnostics	ROM	ROM
Boot blocks	Disk	ROM
Startup arbitration	'boot' 2 resource	System
Startup code	'boot' 3 resource	System, ROM, or enabler

ROM Software

The ROM software in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers is stored in a 1 MB ROM. The first half of the ROM is an overpatch of the 512 KB ROM used in the older Macintosh II–family computers. The second half of the ROM is new software to support the features of the MC68040-based computers. The section "ROM Memory Map" at the end of this chapter describes the format of the ROM.

The ROM in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers includes code that supports the MC68040 microprocessor and code for the new custom ICs.

ROM Support for the MC68040

The MC68040 microprocessor is different in many ways from the MC68030 and earlier members of the 68000 family. The MC68040 incorporates a built-in floating-point unit (FPU), a built-in memory management unit (MMU), caches for instructions and data, and many other new features that contribute to its improved performance. The ROM for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers incorporates the many changes required to take advantage of the features of the MC68040.

Support for the Built-in FPU

The ROM software for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers includes code to support the differences between the FPU in the MC68040 and the MC68881 and MC68882 FPUs used with the MC68020 and MC68030.

Note
The Macintosh Centris 610 computer and some configurations of the Macintosh Centris 650 use the MC68LC040, a version of the MC68040 that does not have an FPU. Floating point operations on those computers use the operating system's floating-point software. ◆

The method of detecting an FPU that was used in earlier ROM software does not work for the FPU in the MC68040, so the new ROM software uses a different method. (Applications still use the same method: a call to the Gestalt Manager or SysEnvirons.) Also, the floating-point software in the new ROM incorporates several enhancements to the SANE routines, including ΩSANE, which speeds up SANE calls made by way of A-traps.

The FPU in the MC68040 does not handle all the instructions and data types that the MC68881 and MC68882 handle, so the ROM software includes new code to deal with those instructions and data types. For example, the exception vector table has a new exception vector to software that handles data types not supported by the FPU.

Support for the Built-in MMU

The MMU in the MC68040 is different in many ways from the MC68851 used with the MC68020 and from the built-in MMU in the MC68030. The registers and table-entry layouts are different; also, the MC68040 does not support certain features of the MC68851 and the MMU in the MC68030. The ROM software in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers generates the correct tables and register values for either type of MMU.

Note
The MMU operation codes on the MC68040 are different from those on the MC68030. For example, both microprocessors have a PTEST operation, but the PTEST operation code for the MC68030 generates an unimplemented-instruction exception on the MC68040. ◆

In the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers, the MMU is set up to support only one ROM address space and one I/O address space. Actually, only one address space for each is necessary, and mapping one image of each address space reduces the size of the MMU tables.

Like the Macintosh Quadra computers, the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers combine an MMU with built-in video using frame buffers in separate banks of VRAM. The ROM software manages the address space for the video frame buffers separately from main memory.

Gestalt and SysEnvirons Values

Applications can find out which computer they are running on by calling the `Gestalt` or `SysEnvirons` function. Table 4-2 shows the values returned for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers.

Table 4-2 `Gestalt` and `SysEnvirons` values

Computer	`Gestalt 'mach'` value	`SysEnvirons` value
Macintosh Centris 610	52	50
Macintosh Centris 650	30	28
Macintosh Quadra 800	35	33

Support for the New Copyback Cache Mode

The MC68040 microprocessor has two internal caches, one for instructions and one for data. The caches perform the same function as those on earlier processors, storing the contents of recently addressed memory locations in anticipation that those contents will soon be used again.

The data cache in the MC68040 microprocessor has a new mode called CopyBack mode. That mode is different from the WriteThru mode used by the caches in the MC68020 and MC68030 microprocessors. CopyBack mode improves performance because the processor may write to a memory location several times before the data must be flushed from the cache. Operating in CopyBack mode can increase the processor's performance by up to 50 percent but also requires the operating system to manage some types of data more carefully.

The difference between WriteThru and CopyBack modes is the way they deal with data being written to memory. When the processor executes a write cycle, it first writes the data into the cache. After that, the two modes are different. In WriteThru mode, the cache writes the data to main memory immediately. In CopyBack mode, the cache does not update main memory each time data is written to the cache. Instead, the cache writes the data to main memory when that portion of the data cache is selected for replacement or when the data cache is flushed.

Cache Management by ROM Software

One consequence of the use of CopyBack mode is that main memory does not always contain the latest data. One way that old data can cause a problem is when an alternate bus master reads from memory that is being cached by the main processor and has not been updated. To prevent this problem, the ROM software uses only pages marked uncacheable when setting up communication areas with alternate bus masters.

Another way old data can cause a problem is when the microprocessor fills its instruction cache from an area with old data. To prevent this problem, the ROM software flushes the contents of the data cache to main memory after writing data that consists of instruction code. Specifically, the software flushes the data cache to main memory after each of the following operations:

- loading a resource into memory
- moving a heap block
- creating a jump table

Note
The ROM software in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers also invalidates the caches in the MC68040 in the same places that the older ROM software invalidated the caches in the MC68020 and MC68030. ◆

Cache Management by Applications

It has always been important to flush the caches on the MC68020 and MC68030 microprocessors before executing instructions that were recently written to memory. On the MC68040, flushing only the instruction cache in this situation is not sufficient. The instruction and data caches are independent of each other, and there is a strong possibility that the instruction cache will fill with old data from RAM while the new data has not yet been written to RAM from the data cache.

To prevent this problem in your applications, it is vital that you use one or more of the calls provided by the system software whenever you write data that will be executed as instructions. Macintosh Technical Note 261, "Cache as Cache Can," documents the `_FlushInstructionCache` and `_FlushDataCache` calls, which allow you to flush the caches. Because the purpose of the `_FlushInstructionCache` call is to maintain cache coherency, its operation on the MC68040 is to flush both the instruction and data caches. Flushing both caches with one call also avoids problems in situations in which interrupts might occur while the caches are being flushed individually.

IMPORTANT

Flushing the cache at certain times is critically important, but it is also important not to flush the cache too often. Unnecessary flushing of the cache impairs the performance of the MC68040 microprocessor. ▲

New Exception Handlers

Unlike the previous processors in the 68000 family, the MC68040 handles exceptions by the method called *instruction restart.* The processor recognizes exceptions at each instruction boundary in the execute stage of the integer pipeline and forces later instructions that have not yet reached the execute stage to be aborted. Also, the MC68040 creates some new exception stack frames, including those for its version of bus errors, which are called *access errors.*

Exception handlers, particularly bus error handlers, are affected by these differences. The ROM software includes appropriate changes to the universal startup code and modified bus error handlers for the Slot Manager and the Memory Manager.

ROM Support for the Video Hardware

Like the Macintosh Quadra computers, the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers have built-in video hardware with dedicated VRAM frame buffers controlled by the MEMC custom IC. The ROM software includes a new video driver to support the new hardware.

Because the MC68040 puts data on the data bus in a way that is different from the way the MC68020 and MC68030 do, the software on Apple's older video display cards must be modified to function correctly with the MC68040. The ROM software in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers patches the ROM software on the display cards so that they operate normally. The affected cards are the Macintosh II Video Card, the Macintosh Portrait Video Card, and the Macintosh Two-Page Video Card.

The problem with those video cards occurs because they rely on a feature of the MC68020 and MC68030 called *byte smearing* that is absent from the MC68040. The Slot Manager and the Device Manager have been patched to recognize those cards and substitute corrected code for their primary initialization software and video driver.

Note

Note: Third-party accelerator cards that use the MC68040 will encounter the byte-smearing problem when used with the older display cards listed above. For more information, refer to Macintosh Technical Note 282. ◆

ROM Software Enhancements

The ROM software includes the following features:

- support for memory on 64 MB boundaries
- support for a RAM disk
- support for virtual memory (VM)
- an enhanced `BlockMove` routine

Support for Memory on 64 MB Boundaries

Main RAM in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers consists of from one to ten banks that begin on 64 MB boundaries. At startup time, the ROM software determines the amount of RAM installed in each bank and stores the actual bank sizes in registers in the MEMC IC. Using those bank sizes, the MEMC IC decodes bus addresses so that the installed banks of RAM occupy contiguous addresses in physical memory space.

Support for a RAM Disk

The ROM software includes the capability to create a RAM disk that can then be used as the startup disk. The idea of a RAM disk was first proposed for the Macintosh Portable as a way of saving power by eliminating the need for continual disk activity. The RAM disk also increases performance of programs that execute and fetch data from the RAM disk, including the Macintosh Operating System.

In order for the RAM disk to work on a machine that uses an MMU, the RAM disk must be supported by ROM software. The software determines that the RAM disk is operating during warm starts and makes sure that its contents are not corrupted during the startup process.

The RAM disk driver works in concert with the MMU to protect the contents of the RAM disk from runaway applications. Using the MMU, the driver write-protects the memory pages that make up the RAM disk. The driver can unprotect individual pages when it is called upon to write data to disk, but the driver immediately protects the pages again before it exits. By protecting the contents of the RAM disk, the driver makes it possible for the user to restart the system from the RAM disk even after a system crash or reset.

Support for Virtual Memory

Starting with the Macintosh IIci computer, ROM software has provided some of the virtual memory (VM) routines to allow programmers to manipulate the tables in the

MMU. The ROM software for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers includes modifications to those routines to support the MC68040 along with some enhancements to provide write-protection capability for the main memory.

Specifically, the existing routines `LockMemory`, `LockMemoryContiguous`, and `UnlockMemory` can change the attributes of individual pages in the absence of VM. Also, two new calls, `ProtectMemory` and `UnprotectMemory`, have been added to allow programmers to protect pages of memory.

The ability to set the attributes of individual pages in memory becomes important with the advent of the large internal caches of the MC68040 and the common use of alternate bus masters. For example, when an area in memory is used as a communication buffer between the main processor and an alternate bus master, that area of memory must be marked uncacheable to maintain cache coherency after writes from the alternate bus master. On earlier machines that used the MC68020 and MC68030, it was acceptable to turn off the entire cache whenever any pages needed to be uncacheable because of the small sizes of the caches on those processors and the limited number of bus masters. On a machine with an MC68040 and on-board bus masters, such a practice would result in an unacceptable degradation of performance.

An Enhanced BlockMove Routine

The `BlockMove` routine in earlier ROM software checks the length of all requested transfers and chooses from `MOVE.B`, `MOVE.W`, `MOVE.L`, and `MOVEM.L` instructions to move data from place to place in memory. The addition of the `MOVE16` instruction in the MC68040 enables the new ROM software to provide further optimization.

▲ **WARNING**
If you plan to use the `MOVE16` instruction in code you are writing, you should be aware that there are limitations on its use. For more information, refer to the latest MC68040 errata sheet from Motorola. ▲

ROM Memory Map

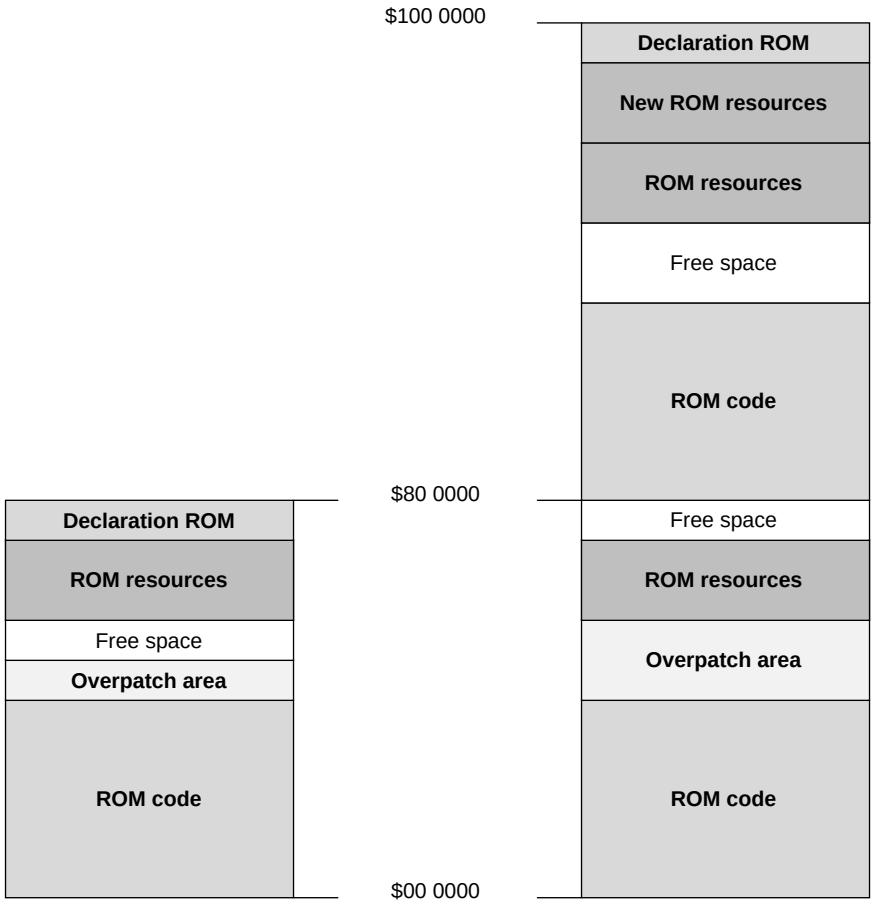
The ROM software for the Macintosh Centris 610 and Centris 650 and the Macintosh Quadra 800 computers is similar to the ROM used in the Macintosh Quadra 700 and Quadra 900 computers. It supports all Macintosh computers that use 32-bit processors—MC68020 and MC68030 as well as MC68040.

The ROM in the computers described here, like the ROM in the Macintosh Quadra 700 and Quadra 900 computers, is 1 MB in size. Figure 4-1 shows the memory map for the 1 MB ROM along with the map for the 512 KB ROM used in earlier Macintosh computers.

The 1 MB ROM is based on the ROM used in the Macintosh IIci computer and preserves as much of the original ROM image as possible. The ROM contains the new code and resources needed to support the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers. The changes include the startup diagnostics, located

at the end of the code section, and the declaration ROM, which is always located at the highest addresses in the ROM.

Figure 4-1 ROM memory maps



CHAPTER 5

Internal Storage Devices

This chapter describes the case spaces for internal devices in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers and tells how to design devices for installation into those spaces. For devices with removable media, this chapter describes the bezel that covers the front of the device and provides the slot for insertion and removal of the media.

The folded 11 by 17-inch pages at the back of this note include design guides for the drive carriers and front bezels described in this chapter.

Space for Internal 5.25-Inch Device

The Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers include space for an internal SCSI device with 5.25-inch removable media, such as a CD-ROM drive or an optical storage device. The device slides in from the front after the plastic bezel is removed. Figure 5-1 shows the locations of the storage devices in the Macintosh Centris 610 computer. Figure 5-2 shows the locations of the storage devices in the Macintosh Quadra 800 computer. Storage device locations in the Macintosh Centris 650 are the same as those in the Macintosh IIvx and the Macintosh Performa 600 computers.

Figure 5-1 Device locations in the Macintosh Centris 610 computer

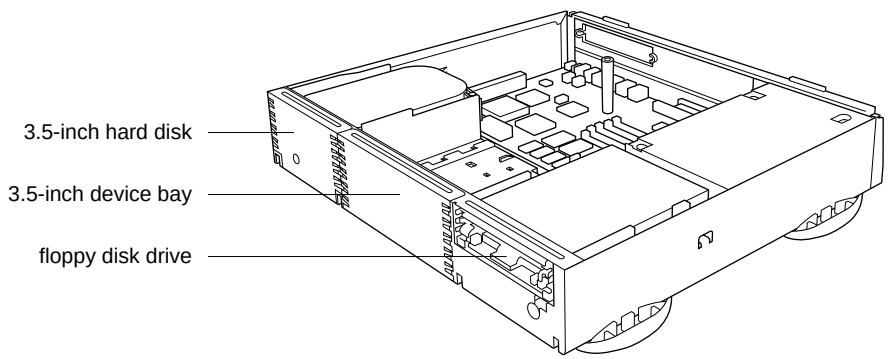
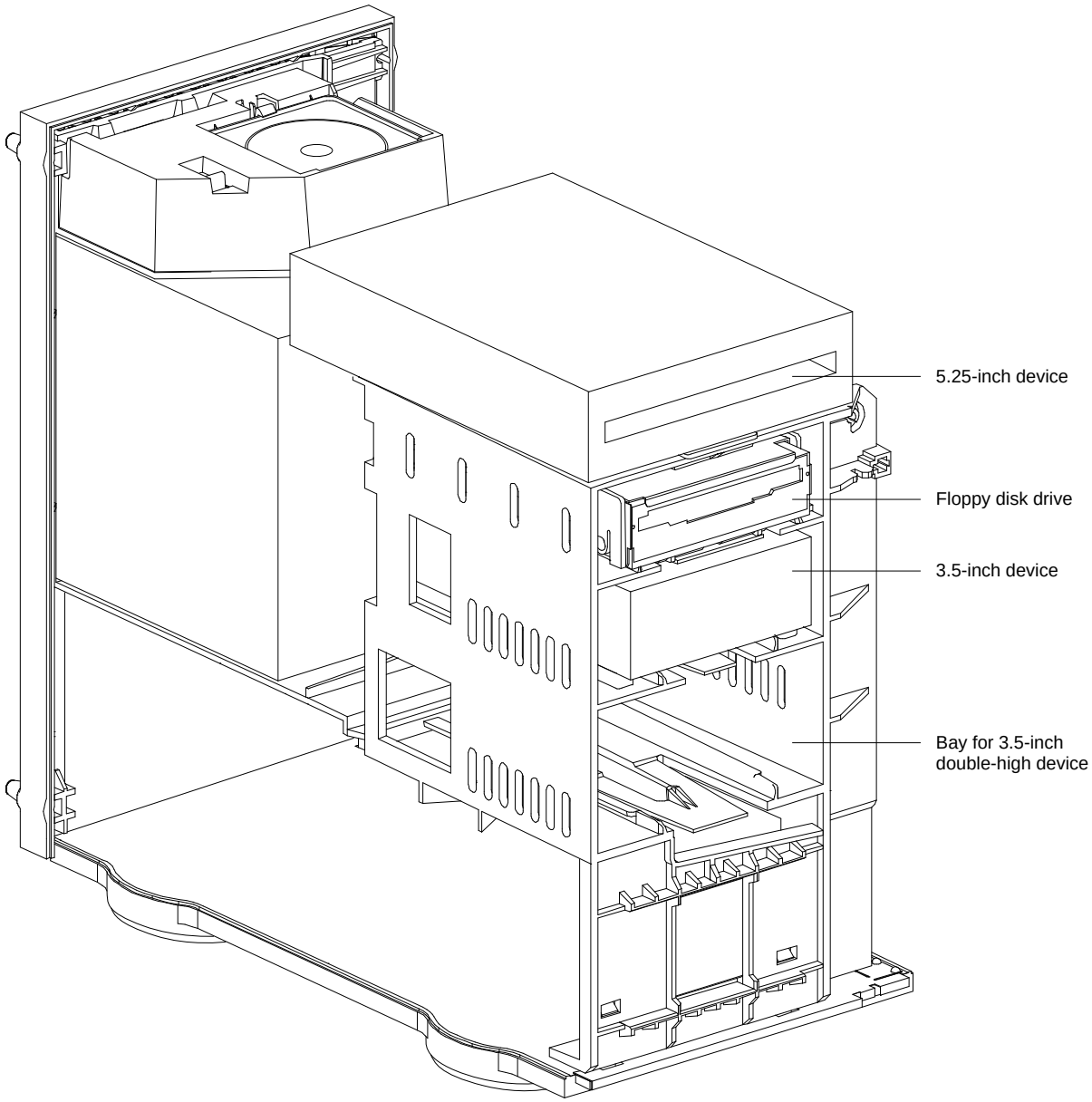


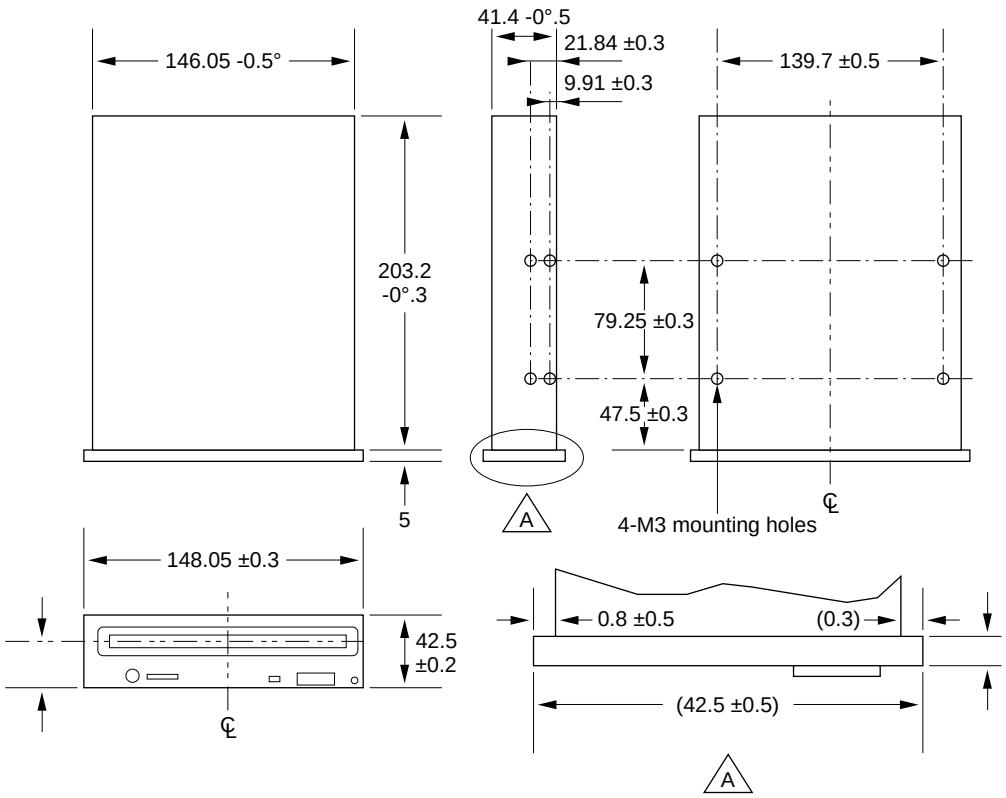
Figure 5-2 Device locations in the Macintosh Quadra 800 computer



Dimensions of 5.25-Inch Devices

Figure 5-3 shows the maximum dimensions of 5.25-inch devices in the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers. The figure depicts the actual dimensions of the AppleCD 300i CD-ROM drive, which is the largest device those computers are designed to accommodate.

Figure 5-3 Maximum dimensions for 5.25-inch devices



NOTE Dimensions are in millimeters.

Mounting Methods for 5.25-Inch Devices

There are two different methods for mounting 5.25-inch devices in Macintosh computers. The Macintosh Centris 650, like the Macintosh IIvx and the Macintosh Performa 600CD, uses side rails. The Macintosh Centris 610 and the Macintosh Quadra 800 use a sled.

Side Rails for a 5.25-Inch Device

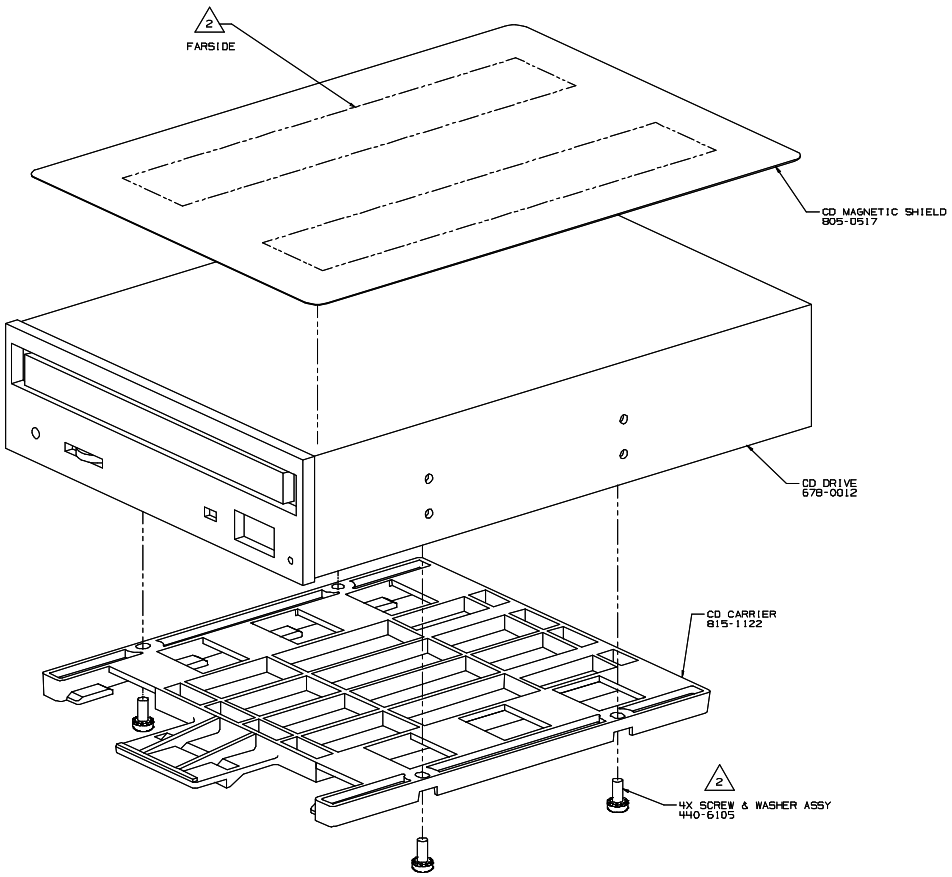
A 5.25-inch device in the Macintosh Centris 650 computer is held in place by side rails like the ones in the Macintosh IIvx and the Macintosh Performa 600. Those rails are included in the AppleCD 300i mounting kit, which will be available when the Macintosh Centris 650 computer is introduced.

Foldout 9 is a design guide for the CD mounting rails used in the Macintosh Centris 650.

Sled for a 5.25-Inch Device

In the Macintosh Centris 610 and the Macintosh Quadra 800, a 5.25-inch device is held in place by a slide-in sled attached to the bottom of the device. Figure 5-4 shows how the sled and a magnetic shield are attached to an AppleCD 300i for installation.

Figure 5-4 Mounting sled with the AppleCD 300i drive



Foldout 2 is a design guide for the sled used for a 5.25-inch device in the Macintosh Centris 610 and Macintosh Quadra 800 computers.

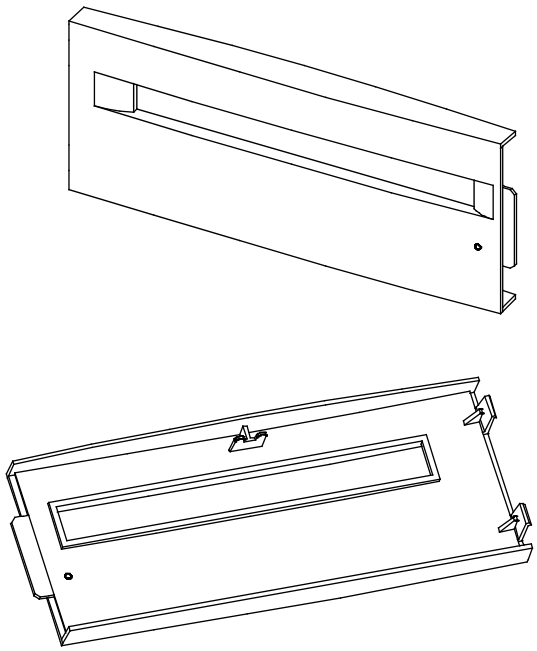
Front-Panel Bezels for 5.25-Inch Devices

For removable media devices such as CD-ROM, developers must provide a replacement bezel with a cutout for media access. This section describes the bezels Apple provides for installing the AppleCD 300i CD-ROM drive in each of the three computers described in this note.

5.25-Inch Bezel for the Macintosh Centris 610 Computer

Figure 5-5 shows the bezel used with the AppleCD 300i CD-ROM drive in the Macintosh Centris 610 computer.

Figure 5-5 Bezel for 5.25-inch device in the Macintosh Centris 610 computer

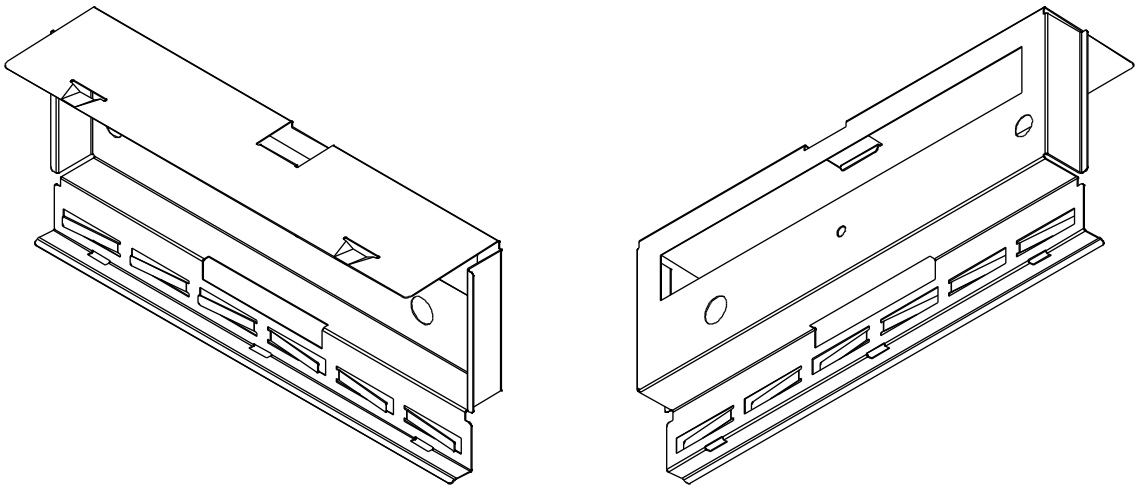


Foldout 1 is a design guide for the bezel used with the AppleCD 300i in the Macintosh Centris 610 computer.

Bezel Shield for the Macintosh Centris 610 Computer

The bezel for the Macintosh Centris 610 computer is accompanied by a metal plate to provide EMI shielding. Figure 5-6 shows the appearance of the bezel shield Apple provides for the AppleCD 300i CD-ROM drive.

Figure 5-6 Bezel shield for 5.25-inch device in the Macintosh Centris 610 computer



Foldout 3 is a design guide for the bezel shield used with the AppleCD 300i in the Macintosh Centris 610 computer.

5.25-Inch Bezel for the Macintosh Centris 650 Computer

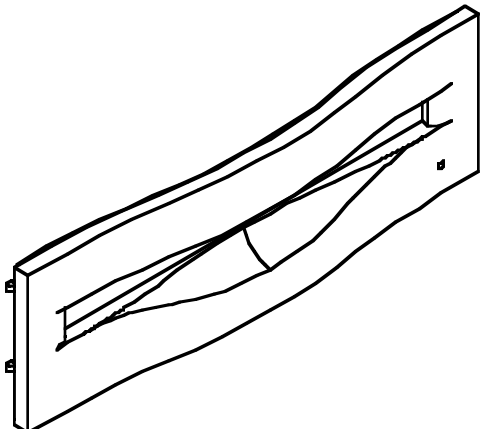
The bezel for the AppleCD 300i drive in the Macintosh Centris 650 is similar to the bezel in the Macintosh IIvx and the Macintosh Performa 600.

Foldout 7 is a design guide for the blank bezel installed in a Macintosh Centris 650 computer that has no 5.25-inch device installed. Foldout 8 is a design guide for the bezel used with the AppleCD 300i in the Macintosh Centris 650 computer.

5.25-Inch Bezel for the Macintosh Quadra 800 Computer

Figure 5-7 shows the appearance of the CD bezel used with the AppleCD 300i in the Macintosh Quadra 800 computer. Foldout 8 is a design guide for the CD bezel. Foldout 7 is a design guide for the blank bezel installed in a Macintosh Quadra 800 computer that has no 5.25-inch device installed.

Figure 5-7 Bezel used with a CD-ROM drive in the Macintosh Centris 650



Installing Other Internal Devices

Configurations of the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers that do not have a built-in CD-ROM drive have a blank bezel covering the 5.25-inch drive bay. If you wish to install a 5.25-inch SCSI device that does not use removable media in that space, you can retain the blank bezel and shield provided with the computer.

You can also design a 3.5-inch device to install in the 5.25-inch space. If the 3.5-inch device uses removable media, you have to position it at the front of the space and provide a bezel and shield with the appropriate opening for inserting and removing the media. If the device does not use removable media, you should position it toward the back of the space and retain the blank bezel and shield.

Obtaining Parts

You can obtain drive carriers and front-panel bezels directly from Apple's suppliers. For those parts, Table 5-1 lists the part numbers and suppliers. The addresses of the suppliers are listed following the table.

Table 5-1 Part numbers and suppliers

Part number	Description	Suppplier
815-1122	CD-ROM carrier for Macintosh Centris 610 and Macintosh Quadra 800	(TBD)
805-0517	Magnetic shield for CD-ROM drive in Macintosh Centris 610 and Macintosh Quadra 800	(TBD)
815-1411	CD-ROM bezel for Macintosh Centris 610	Trend Plastic (USA) Southborough (Ireland)
805-0503	Shield for CD-300 bezel for Macintosh Centris 610	(TBD)
815-1186	CD-ROM bezel for Macintosh Quadra 800	Trend Plastic (USA) Southborough (Ireland)
815-0645	CD-ROM carrier rails for Macintosh IIvx, Macintosh Performa 600, and Macintosh Centris 650	(TBD)
815-1414	CD-ROM bezel for Macintosh IIvx, Macintosh Performa 600, and Macintosh Centris 650	(TBD)

Here are the addresses of the suppliers of the parts listed in Table 5-1.

Trend Plastic
1480 Atteberry Lane
San Jose, CA 95131
Tel: 408-432-9600
Fax: 408-943-9575
AppleLink: TREND
Contact: Marla Wallance

Southborough
Oldcastle Road
Kells
Co. Meath
Ireland
Tel: 011-353-46-40538
Fax: 011-353-46-41051
Contact: Des Kenny

(Other suppliers TBD)

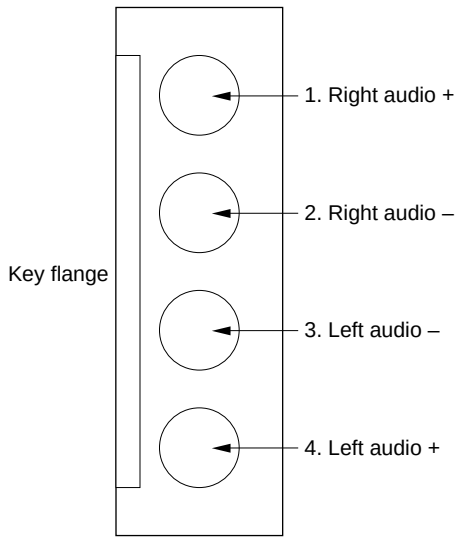
Internal CD-ROM Integration

Some configurations of the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers include the AppleCD 300i CD-ROM drive as standard equipment. See the Appendix "AppleCD 300i Specifications" for information about the drive.

Apple's internal CD-ROM drive uses SCSI ID number 3. Developers offering internal 5.25-inch removable-media drives for the Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers should also use SCSI ID number 3.

A CD-ROM audio input connector is provided on the computer's main logic board. The connector is a Molex 22-27-2041-T102 or equivalent. Figure 5-8 shows the connector pinout. The signal level for the input is 0.5 V ± 0.1 V RMS at 47 kΩ.

Figure 5-8 Internal CD-ROM audio connector



AppleCD 300i Specifications

This appendix describes the performance and capabilities of the AppleCD 300i drive, the internal CD-ROM drive included in some configurations of Macintosh Centris 610, Macintosh Centris 650, and Macintosh Quadra 800 computers.

General

The AppleCD 300i supports the world-wide standards and specifications for CD-ROM and CD-Digital Audio discs described in the Sony/Phillips 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.

For improved performance, the AppleCD 300i features a new double-speed mechanism that supports sustained data transfer rates of 300 KB per second—double the transfer rate of previous drives. A 256 KB buffer on the drive controller further enhances performance.

Specifications

Table A-1 lists the specifications and performance characteristics of the AppleCD 300i drive. Table A-2 lists the SCSI commands and messages supported by the drive.

Table A-1 AppleCD 300i specifications

Physical	
Depth (excluding bezel)	203.2 mm (8.00 in.)
Width	146.0 mm (5.75 in.)
Height	41.4 mm (1.63 in.)
Weight	1.25 kg (2.75 lbs.)
General	
Spin up time (maximum)	3 sec (double speed), 2 sec (normal speed)
Spin down time (maximum)	1.5 sec (double speed), 1 sec (normal speed)
Eject time (maximum)	7 sec (double speed), 6.5 sec (normal speed)

continued

Table A-1 AppleCD 300i specifications (continued)

CD-ROM	
Modes supported	CD-ROM (Mode 1 and Mode 2), CD-ROM XA (Mode 2, Form 1 and Form 2), and CD-I (Mode 2, Form 1 and Form 2)
Block lengths supported	
CD-ROM Mode 1	2048, 1024, and 512 bytes
CD-ROM Mode 2	2340, 2336, 1024, and 512 bytes
CD-ROM XA	2647, 2353, and 2336 bytes
Blocks per disc	336,150 (typical)
Data capacity	656 MB, Mode 1 748 MB, Mode 2
Address description	Minutes, seconds, frames
Transfer rate (sustained)	300 KB/sec, Mode 1 (double speed) 150 KB/sec, Mode 1 (normal speed) 342.2 KB/sec, Mode 2 (double speed) 171.1 KB/sec, Mode 2 (normal speed)
Blocks per second	150 (double speed), 75 (normal speed)
Access time (typical)	
Full stroke (first to last block)	520 ms (double speed), 550 ms (normal speed)
Random (block to block)	295 ms (double speed), 350 ms (normal speed)
Track to adjacent track	2 ms
SCSI transfer rate (burst)	1.5 MB/sec, Mode 1 and Mode 2, asynchronous 4 MB/sec, Mode 1 and Mode 2, synchronous
SCSI buffer memory	256 KB
Uncorrected error rate (maximum)	
ECC enabled (Mode 1)	< 1 bit error per 10^{-12} blocks read (double speed) < 1 bit error per 10^{-15} blocks read (normal speed)
ECC disabled (Mode 1 or Mode 2)	< 1 bit error per 10^{-9} blocks read (double speed) < 1 bit error per 10^{-12} blocks read (normal speed)
CD-Audio	
Block lengths supported	2448, 2368, and 2352 bytes
Playing time	74 minutes, 42 seconds
Line output	0.7 volts RMS at 47 KΩ
Headphone output (front panel)	0.65 volts RMS at 32 Ω
Distortion	< 0.04 percent at 1 KHz
Signal to noise ratio	> 80 dB
Frequency response	5 Hz to 20 KHz

Table A-2 AppleCD 300i SCSI implementation summary

Bus phases	Bus free
	Arbitration
	Selection
	Reselection
	Command
	Data
	Status
	Message
Commands	$00, test unit ready
	$01, rezero unit
	$03, request phase
	$08, read
	$0B, seek
	$12, inquiry
	$15, mode select
	$16, reserve
	$17, release
	$1A, mode sense
	$1B, start/stop unit
	$1C, receive diagnostic
	$1D, send diagnostic
	$1E, prevent/allow media removal
	$25, read capacity
	$28, read extended
	$2B, seek extended
	$3B, write buffer
	$3C, read buffer
	$42, read sub-channel
	$43, read TOC
	$44, read header
	$45, play audio
	$47, play audio MSF

continued

Table A-2 AppleCD 300i SCSI implementation summary (continued)

Commands (continued)	$48, play audio track/index
	$4B, pause/resume
	$D8, read CD-Digital Audio
	$D9, read CD-Digital Audio MSF
	$DA, set CD-ROM speed
Status	Status byte = 1 if error condition
	Status byte = 0 if no error
Messages	Command complete
	Disconnect

Index

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Y

Foldouts

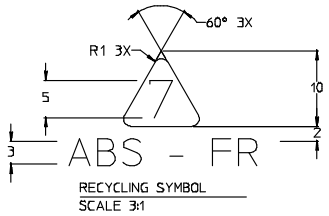
NOTES :

(UNLESS OTHERWISE SPECIFIED)

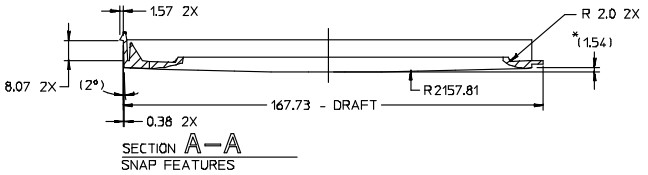
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982
2. MATERIAL : ABS CYCOLAC KJE 3487-1. COLOR : APPLE PLATINUM PER COLOR APPLE COLOR CONTROL PANEL 912-0037. TOLERANCE PER COLOR TOLERANCE SET 912-1037.
3. ALL UNSPECIFIED DRAFT ANGLES TO BE 0° 30'.
4. ALL NON-APPEARANCE SURFACE EDGES TO HAVE A 0.25 +0.03 RADIUS, EXCEPT AT PARTING LINE.
5. FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.20 PER 25.00, NOT TO EXCEED 1.00 OVER THE ENTIRE SURFACE
6. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.05 PER 25.00, NOT TO EXCEED 0.20 OVER ENTIRE LENGTH
7. EXTERIOR (APPEARANCE) SURFACES TO BE TEXTURED PER APPLE SPECIFICATION 062-0222 (G-2).
8. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE 3.
9. FLASH NOT TO EXCEED 0.13
10. GATE TRIM TO BE 0.5 MAX.
11. PARTING LINE MISMATCH NOT TO EXCEED 0.10
12. NO SINK DEPRESSIONS TO BE VISIBLE ON APPEARANCE SURFACES
13. APPEARANCE SURFACES TO BE FREE OF COSMETIC DEFECTS INCLUDING, BUT NOT LIMITED TO, SPLAY INCLUDED PARTICLES, BURNED PLASTIC MARKS AND SIMILAR IMPERFECTIONS. SEE APPLE SPEC. 062-2006.
14. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SURFACES.
15. MOLD DESIGN TO MINIMIZE GATE BLUSH, FLOW LINES, AND MOLD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARDS AND PRACTICES OF PLASTIC CUSTOM MOLDERS" BY THE SOCIETY OF THE PLASTIC INDUSTRY, INC.
16. EJECTOR PIN, PARTING LINE, AND GATE LOCATION MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
17. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE MARKED WITH APPLE'S NAME, APPROPRIATE PART NUMBER AND DATE.
18. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 HIGH CHARACTERS APPX. 0.3 TALL, NOT TO EXCEED 0.5, IN LOCATION SHOWN.
19. TOLERANCE :

DIM.	TOL.
0 - <50	+/- 0.13
50 - <150	+/- 0.20
150 - <300	+/- 0.33
>300	+/- 0.50

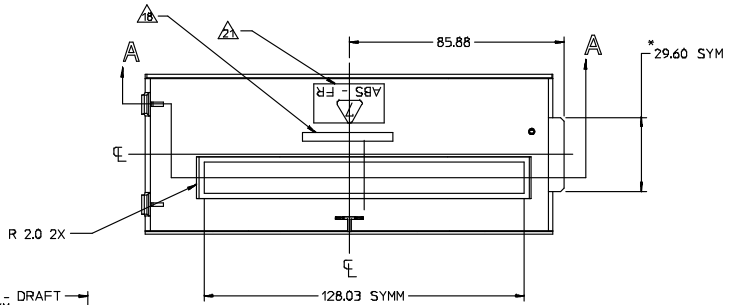
20. NOMINAL WALL THICKNESS 3
21. MARK MATERIAL WITH RECYCLING TRIANGLE AND MATERIAL IDENTIFIER APPX WHERE SHOWN. IDENTIFIER "ABS-FR" TO BE MARKED ON INTERIOR NON-FUNCTIONAL (NON-APPEARANCE) SURFACE USING 3.0 HIGH CHARACTERS, 2.0 BELOW ISOCELES TRIANGLE (10.0) TALL TO POINT OF INTERSECTION WITH 1.0 RADII AT CORNERS. MATERIAL CALLOUT "7" IN 5.0 HIGH CHARACTERS TO BE APPOX CENTERED IN TRIANGLE. ALL CHARACTERS TO BE RAISED 0.3, BUT NOT EXCEED 0.5 FROM SURFACE. SEE DWG BELOW.
22. THIS IS A SUPPLIMENTAL CRITICAL FUNCTION DRAWING AND IS TO BE USED IN CONJUNCTION WITH FILE 815-1411-03.wfga. 815-1411-03.igs TO MANUFACTURE AND TO INSPECT THE PART.
23. STARRED (*) DIMENSIONS ARE FOR INCOMING QUALITY CONTROL INSPECTION.

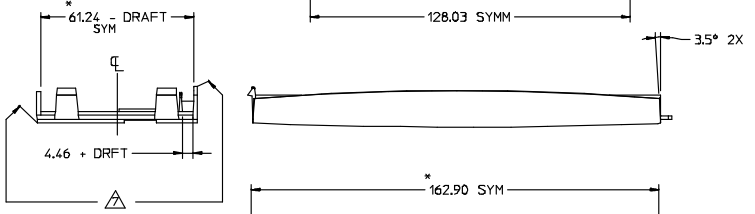


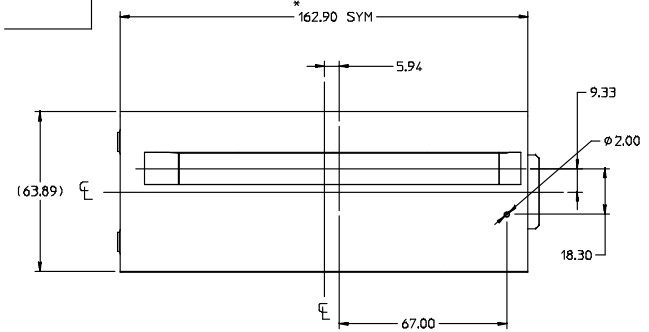
RECYCLING SYMBOL
SCALE 3:1

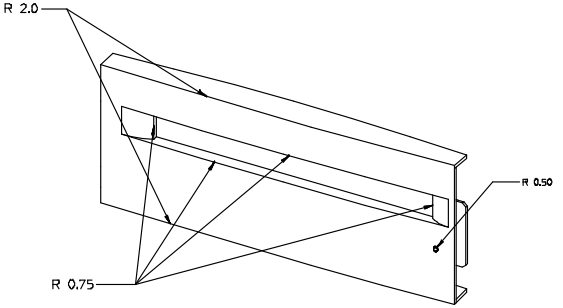


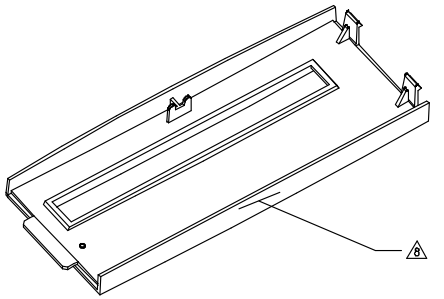
SECTION A-A
SNAP FEATURES











FOLDOUT 1	
CD bezel for Macintosh Centris 610	
815-1411-A	**1 of 1**

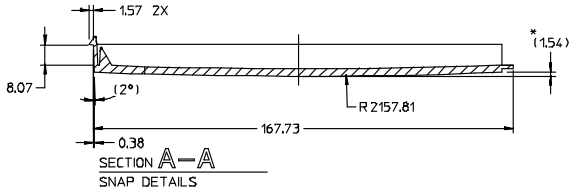
NOTES :

(UNLESS OTHERWISE SPECIFIED)

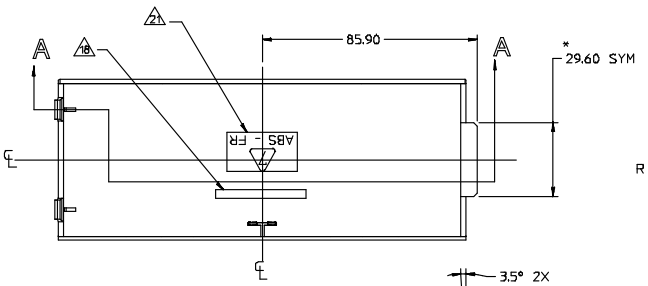
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982
2. MATERIAL : ABS CYCOLAC KJC 3418?-1. COLOR : APPLE PLATINUM PER COLOR APPLE COLOR CONTROL PANEL 912-0037. TOLERANCE PER COLOR TOLERANCE SET 912-1037.
3. ALL UNSPECIFIED DRAFT ANGLES TO BE 0° 30'.
4. ALL NON-APPEARANCE SURFACE EDGES TO HAVE A 0.25 ±0.03 RADIUS. EXCEPT AT PARTING LINE.
5. FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.20 PER 25.00, NOT TO EXCEED 1.00 OVER THE ENTIRE SURFACE
6. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.05 PER 25.00, NOT TO EXCEED 0.20 OVER ENTIRE LENGTH
7. EXTERIOR (APPEARANCE) SURFACES TO BE TEXTURED PER APPLE SPECIFICATION 062-0222 (G-2).
8. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE 3.
9. FLASH NOT TO EXCEED 0.13
10. GATE TRIM TO BE 0.3 MAX.
11. PARTING LINE MISMATCH NOT TO EXCEED 0.10
12. NO SINK DEPRESSIONS TO BE VISIBLE ON APPEARANCE SURFACES
13. APPEARANCE SURFACES TO BE FREE OF COSMETIC DEFECTS INCLUDING, BUT NOT LIMITED TO, SPLAY INCLUDED PARTICLES, BURNED PLASTIC MARKS AND SIMILAR IMPERFECTIONS. SEE APPLE SPEC. 062-2006.
14. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SURFACES.
15. MOLD DESIGN TO MINIMIZE GATE BLUSH, FLOW LINES, AND MOLD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARDS AND PRACTICES OF PLASTIC CUSTOM MOLDERS" BY THE SOCIETY OF THE PLASTIC INDUSTRY, INC.
16. EJECTOR PIN, PARTING LINE, AND GATE LOCATION MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
17. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE MARKED WITH APPLE'S NAME, APPROPRIATE PART NUMBER AND DATE.
18. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 HIGH CHARACTERS APPX. 0.3 TALL, NOT TO EXCEED 0.5, IN LOCATION SHOWN.
19. TOLERANCE :

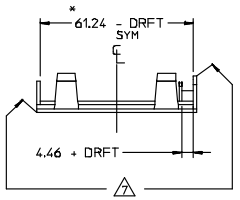
DIM.	TOL.
0 - <50	+/- 0.13
50 - <150	+/- 0.20
150 - <300	+/- 0.33
>300	+/- 0.50

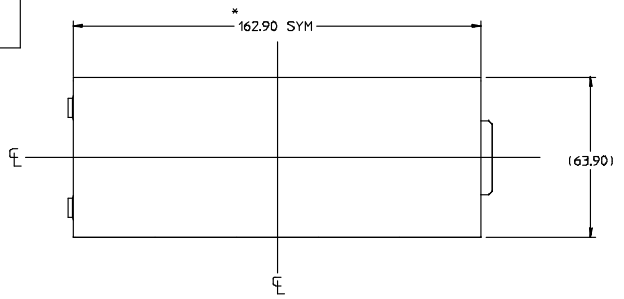
20. NOMINAL WALL THICKNESS 3
21. MARK MATERIAL WITH RECYCLING TRIANGLE AND MATERIAL IDENTIFIER APPX WHERE SHOWN. IDENTIFIER "ABS-FR" TO BE MARKED ON INTERIOR NON-FUNCTIONAL (NON-APPEARANCE) SURFACE USING 3.0 HIGH CHARACTERS. 2.0 BELOW ISOCELES TRIANGLE (10.0) TALL TO POINT OF INTERSECTION) WITH 1.0 RADII AT CORNERS. MATERIAL CALLOUT "7" IN 5.0 HIGH CHARACTERS TO BE APPOX CENTERED IN TRIANGLE. ALL CHARACTERS TO BE RAISED 0.3, BUT NOT EXCEED 0.5 FROM SURFACE. SEE DWG BELOW.
22. THIS IS A SUPPLIMENTAL CRITICAL FUNCTION DRAWING AND IS TO BE USED IN CONJUNCTION WITH FILE 815-1376-04.wjgs. 815-1376-04a.jgs TO MANUFACTURE AND TO INSPECT THE PART.
23. STARRED (*) DIMENSIONS ARE FOR INCOMING QUALITY CONTROL INSPECTION.

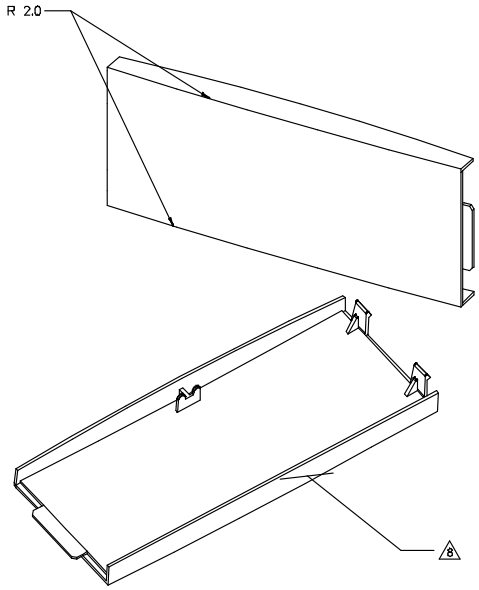


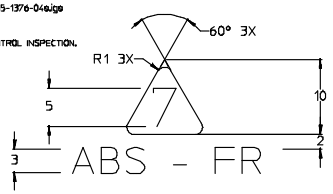
SECTION A–A
SNAP DETAILS









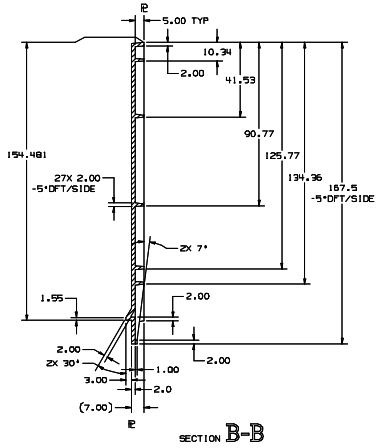


RECYCLING SYMBOL
SCALE 3:1

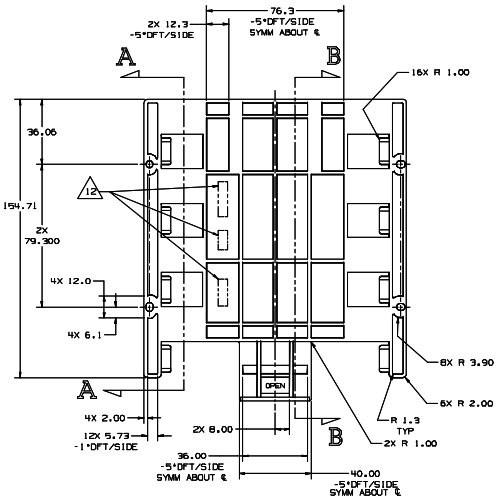
FOLDOUT 1a	
Blank bezel for Macintosh Centris 610	
815-1376-A	1 of 1

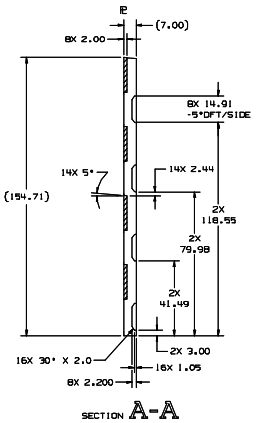
NOTES: (UNLESS OTHERISE SPECIFIED)

1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. STARRED (*) DIMENSIONS INDICATE PROCESS CONTROL DIMENSIONS.
3. MATERIAL: G.E. CYCLOAC K,C #3H187-Y.
   COLOR: APPLE PLATINUM PER COLOR CONTROL PANEL 912-0037.
   TOLERANCE PER COLOR TOLERANCE SET 912-1037.
4. NOMINAL WALL THICKNESS TO BE 2.00.
5. UNSPECIFIED DRAFT ANGLES TO BE 1°.
6. ALL EDGES TO BE 0.25 ±0.12 RADIUS, EXCEPT AT PARTING LINE.
7. GATE TRIM TO BE 0.3 MAX. FLUSH WITH SURFACE.
8. FLASH NOT TO EXCEED 0.13.
9. PARTING LINE MISMATCH NOT TO EXCEED 0.25.
10. STRAIGHTEDGES TO HAVE STRAIGHTNESS TOLERANCE OF 0.07 PER 25.0 NOT TO EXCEED 0.5 OVER THE ENTIRE SURFACE.
11. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.10 PER 25.0, NOT TO EXCEED 1.0 OVER THE ENTIRE SURFACE.
12. MARK APPLE PART NUMBER AND REVISION LETTER WITH 2.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN. REVISION LETTER TO BE LOCATED ON AN EJECTOR PIN.
13. MOLD FINISH ON ALL SURFACES TO BE SPI-SPE #3.
14. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICE OF CUSTOM MOLDERS" BY THE SOCIETY OF THE PLASTICS INDUSTRY, INC..
15. EJECTOR PIN, PARTING LINE, AND GATE LOCATION MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
16. MOLD TO BE PROPERTY OF APPLE COMPUTER INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE PART NUMBER.

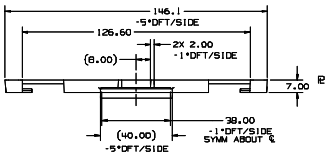


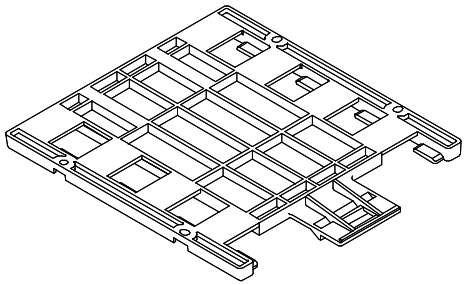
SECTION B-B

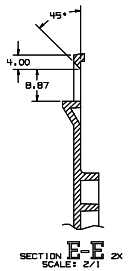




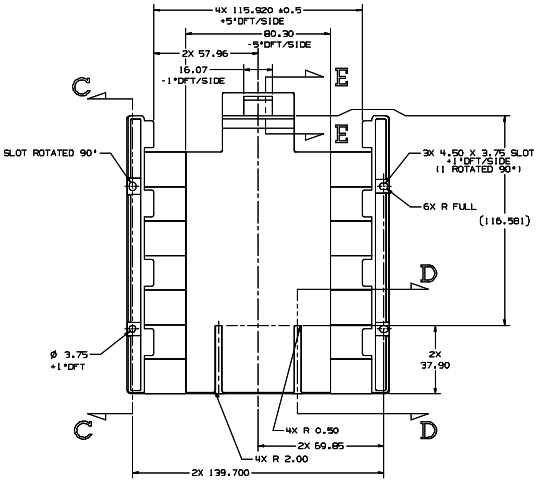
SECTION A-A

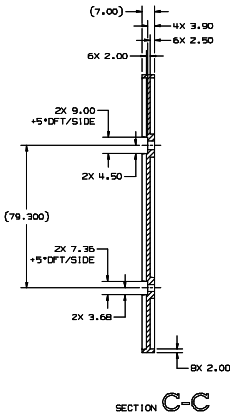




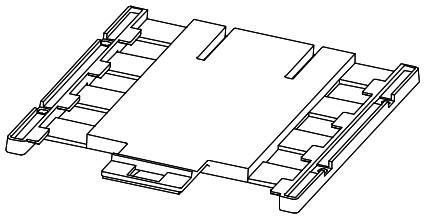


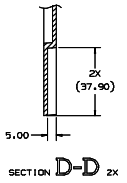
SECTION E-E 2X
SCALE: 2/1



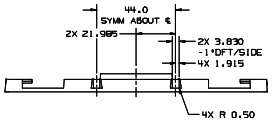


SECTION C-C





SECTION D-D 2X



FOLDOUT 2	
Mounting sled for 5.25-inch drive	
815-1122-03	**1 of 1**

NOTES (UNLESS SPECIFIED OTHERWISE):

1 MATERIAL: 0.25 (.010") THK DR9 (TIN PRE-PLATED CRS).

2 INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.

3 ALL DIMENSIONS ARE INCHES AND MILLIMETERS: USE METRIC TOLERANCE BLOCK.

4 ALL UNSPECIFIED INSIDE BEND RADII TO BE 0.3mm.

5 ALL UNSPECIFIED RIGHT ANGLE BENDS TO BE 90°±0.5°.

6 ALL SHARP CORNERS TO BE BROKEN 0.8 X 45°.

7 STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.15mm PER 25.00mm, NOT TO EXCEED 0.5mm OVER THE ENTIRE LENGTH.

8 FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.10mm PER 25.00mm, NOT TO EXCEED 0.50mm OVER THE ENTIRE SURFACE.

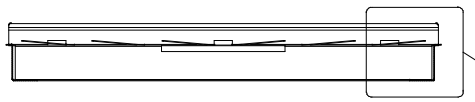
9 SURFACES TO BE FREE OF CONTAMINATES, METAL FLAKES, AND OIL.

10 MARK APPLE PART NUMBER AND REVISIONS LETTER WITH 3.0mm MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE INDICATED.

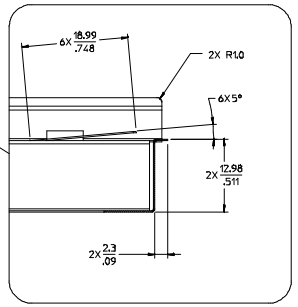
11 STEEL RULE DIES, SPECIAL PUNCHES, OR OTHER UNIQUE TOOLING REQUIRED TO FABRICATE THIS PART TO BE PROPERTY OF APPLE COMPUTER INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE APPLE PART NUMBER.

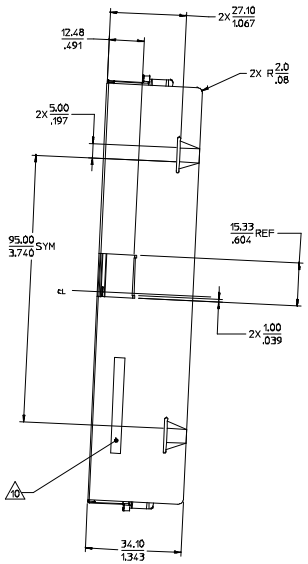
12 MAXIMUM BURR ALLOWANCE IS 15% OF MATERIAL THICKNESS.

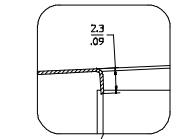
13 THIS IS A SUPPLEMENTAL DETAIL DRAWING AND IS TO BE USED IN CONJUNCTION WITH PART MODEL FILE shld300.igs TO MANUFACTURE AND TO INSPECT THE PART.



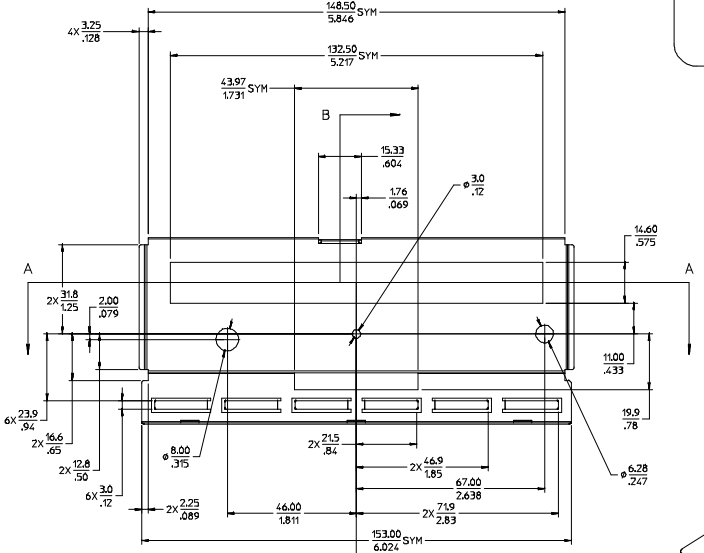
SEC A-A

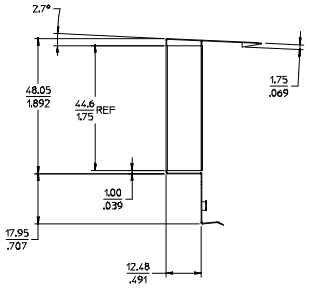


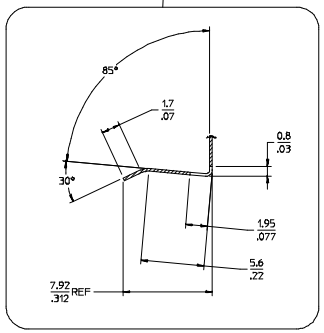


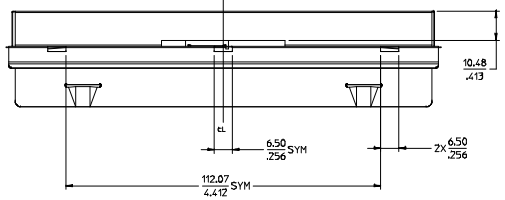


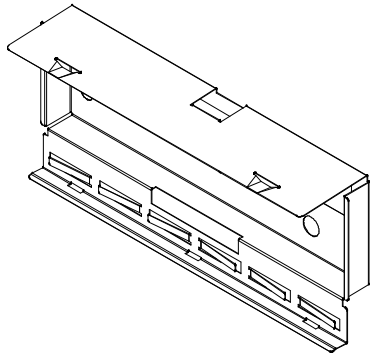
SEC B-B

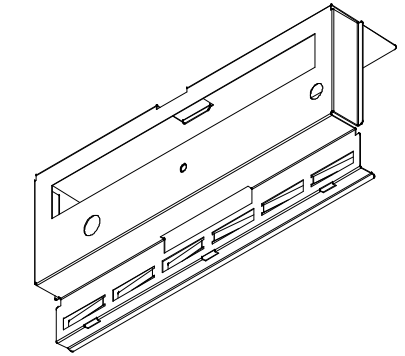












FOLDOUT 3

Shield for CD bezel for Macintosh Centris 610

805-XXXX-01	1 of 1

NOTES: UNLESS OTHERWISE SPECIFIED

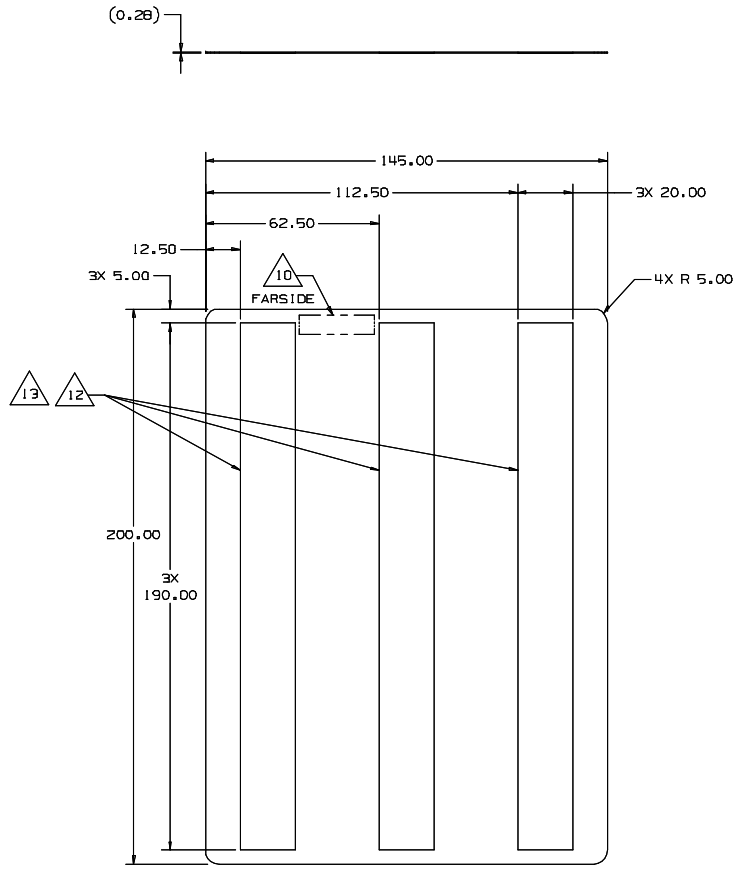
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. MATERIAL: 0.28 (.011"| SUPER-ORTHOSIL-4 COATED WITH CARLITE OVER GLASS OR ENGINEERING APPROVED EQUIVALENT.
3. STARRED (*) DIMENSIONS ARE CONTROL DIMENSIONS.
4. ALL UNSPECIFIED INSIDE BEND RADII TO BE 0.3 .
5. ALL UNSPECIFIED RIGHT ANGLE BENDS TO BE 90° ±0.5 .
6. ALL SHARP CORNERS TO BE BROKEN 0.8 X 45°.
7. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.15 PER 25.00, NOT TO EXCEED 0.50 OVER THE ENTIRE LENGTH.
8. FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.10 PER 25.00, NOT TO EXCEED 0.50 OVER THE ENTIRE SURFACE.
9. SURFACES TO BE FREE OF CONTAMINATES, METAL FLAKES, AND OIL.

△10 MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE INDICATED.

11. STEEL RULE DIES, SPECIAL PUNCHES OR OTHER UNIQUE TOOLING REQUIRES TO MAKE THIS PART TO BE PROPERTY OF APPLE COMPUTER, INC., AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE APPLE PART NUMBER.

△12 ADHESIVE: SCOTCH 3M P/N 9500 OR ENGINEERING APPROVED EQUIVALENT.

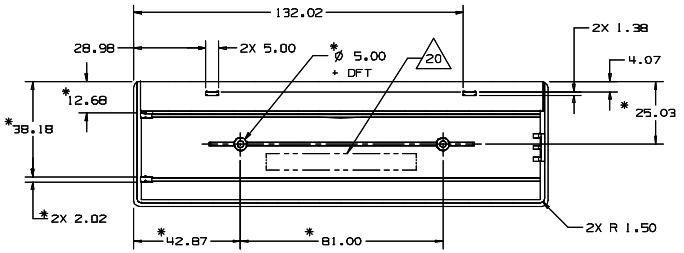
△13 ADHESIVE TO BE APPLIED TO SURFACE AS INDICATED AND MUST BE COVERED WITH A REMOVABLE PAPER ELEMENT.

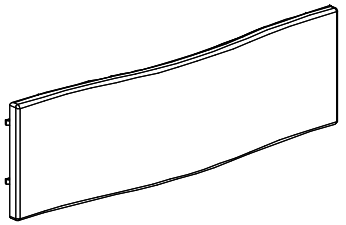


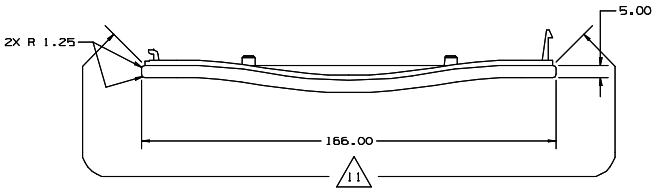
FOLDOUT 4	
Magnetic shield for CD-ROM drive	
805-0517-02	**1 of 1**

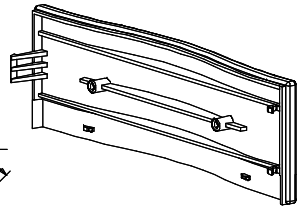
NOTE: UNLESS OTHERWISE SPECIFIED

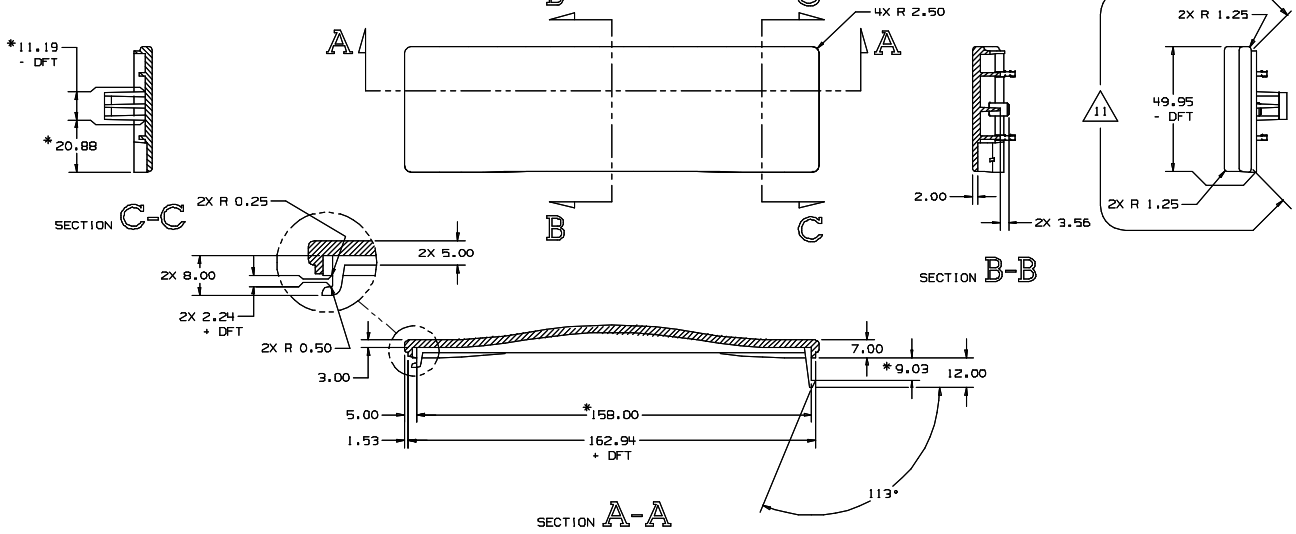
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. ALL DIMENSIONS ARE IN MILLIMETERS: REFER TO METRIC TOLERANCE BLOCK.
3. MATERIAL: ABS CYCOLAC KJC 34187-1, COLOR: APPLE PLATINUM PER COLOR CONTROL PANEL 912-0037, TOL PER COLOR TOL SET 912-1037.
4. WALL THICKNESS: 3.00.
5. DRAFT ANGLES: EXTERIOR SURFACES TO BE 0° PER SIDE. INTERIOR SURFACES TO BE 1° PER SIDE.
6. ALL EXTERIOR (APPEARANCE SURFACE) EDGES TO BE 0.15 RADIUS, EXCEPT AT PARTING LINE.
7. ALL INTERIOR (NON-APPEARANCE SURFACE) INSIDE RADII (90° CORNERS) TO BE 0.15 OUTSIDE RADII, (270° CORNERS) TO BE 0.50, EXCEPT AT PARTING LINE.
8. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.15 PER 25mm, NOT TO EXCEED 0.5 OVER THE ENTIRE LENGTH.
9. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.15 PER 25mm, NOT TO EXCEED 0.5 OVER THE ENTIRE SURFACE.
10. APPEARANCE SURFACES ARE THOSE SURFACES TEXTURED PER APPLE SPEC 062-0222, PER NOTES 11, 12 & 14.
11. ALL EXTERIOR (APPEARANCE) SURFACES TO BE RE6642 G2 TEXTURE PER APPLE SPECIFICATION 062-0222 WHERE INDICATED.
12. TEXTURE TO BE SPI-SPE#3 (APPLE SPEC 062-0222) WHERE INDICATED.
13. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE#3.
14. TEXTURE TO BE RE6643 G-3 PER APPLE SPECIFICATION, WHERE INDICATED.
15. GATE TO BE MACHINE TRIMMED 0.15 BELOW SURFACE.
16. REFER TO APPLE SPEC 062-2006 FOR COSMETIC ACCEPTANCE CRITERIA.
17. FLASH NOT TO EXCEED 0.05.
18. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SIDE OF PART.
19. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICES OF CUSTOM MOLDERS" BY THE SOCIETY OF PLASTIC INDUSTRY, INC.
20. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN.
21. EJECTOR PIN, PARTING LINE, AND GATE LOCATIONS MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
22. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE TOOL NUMBER.
23. STARRED (*) DIMENSIONS AND NOTES ARE CRITICAL CONTROL DIMENSIONS AND NOTES FOR QC INSPECTION.
24. THIS DRAWING CONTAINS CRITICAL TO FUNCTION DIMENSIONS ONLY, REFER TO UNIGRAPHICS CAD FILE (815-1189-04) FOR COMPLETE PART INFO.







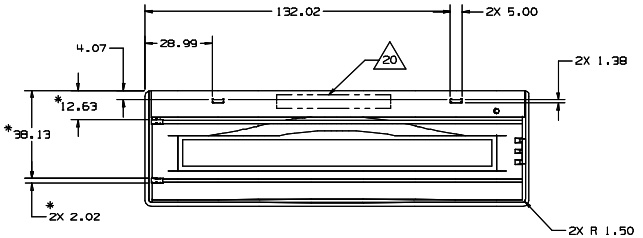


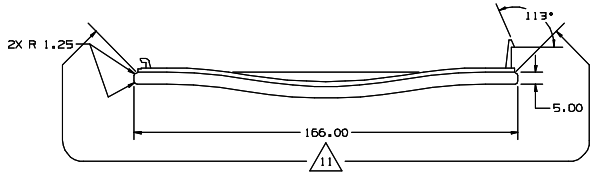


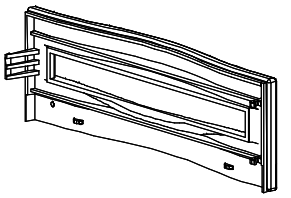
FOLDOUT 5	
Blank bezel for Macintosh Quadra 800	
815-1189-05	**1 of 1**

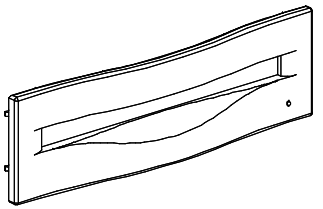
NOTE: UNLESS OTHERWISE SPECIFIED

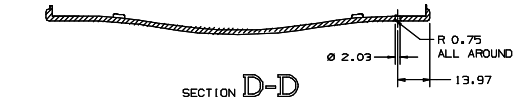
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. ALL DIMENSIONS ARE IN MILLIMETERS; REFER TO METRIC TOLERANCE BLOCK.
3. MATERIAL: ABS CYCOLAC KJC 3H187-1, COLOR: APPLE PLATINUM PER COLOR CONTROL PANEL 912-0037, TOL PER COLOR TOL SET 912-1037.
4. WALL THICKNESS: 3.00.
5. DRAFT ANGLES: EXTERIOR SURFACES TO BE 0° PER SIDE. INTERIOR SURFACES TO BE 1° PER SIDE.
6. ALL EXTERIOR (APPEARANCE SURFACE) EDGES TO BE 0.15 RADIUS, EXCEPT AT PARTING LINE.
7. ALL INTERIOR (NON-APPEARANCE SURFACE) INSIDE RADII (90° CORNERS) TO BE 0.15 OUTSIDE RADII, (270° CORNERS) TO BE 0.50 EXCEPT AT PARTING LINE.
8. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.15 PER 25mm, NOT TO EXCEED 0.5 OVER THE ENTIRE LENGTH.
9. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.15 PER 25mm, NOT TO EXCEED 0.5 OVER THE ENTIRE SURFACE.
10. APPEARANCE SURFACES ARE THOSE SURFACES TEXTURED PER APPLE SPEC 062-0222, PER NOTES 11, 12 & 14.
11. ALL EXTERIOR (APPEARANCE) SURFACES TO BE RE6642 G2 TEXTURE PER APPLE SPECIFICATION 062-0222 WHERE INDICATED.
12. TEXTURE TO BE SPI-SPE#3 (APPLE SPEC 062-0222) WHERE INDICATED.
13. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE#3.
14. TEXTURE TO BE RE6643 G-3 PER APPLE SPECIFICATION, WHERE INDICATED.
15. GATE TO BE MACHINE TRIMMED 0.15 BELOW SURFACE.
16. REFER TO APPLE SPEC 062-2006 FOR COSMETIC ACCEPTANCE CRITERIA.
17. FLASH NOT TO EXCEED 0.05.
18. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SIDE OF PART.
19. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICES OF CUSTOM MOLDERS" BY THE SOCIETY OF PLASTIC INDUSTRY, INC.
20. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN.
21. EJECTOR PIN, PARTING LINE, AND GATE LOCATIONS MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
22. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE TOOL NUMBER.
23. STARRED (*) DIMENSIONS AND NOTES ARE CRITICAL CONTROL DIMENSIONS AND NOTES FOR QC INSPECTION.
24. THIS DRAWING CONTAINS CRITICAL TO FUNCTION DIMENSIONS ONLY, REFER TO UNIGRAPHICS CAD FILE (815-1186-03) FOR COMPLETE PART INFO.



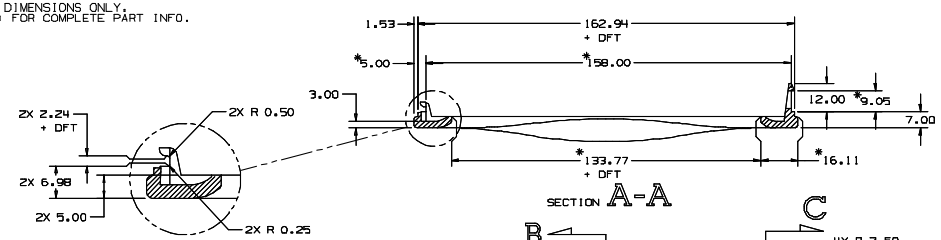




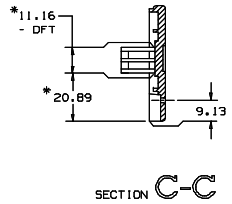




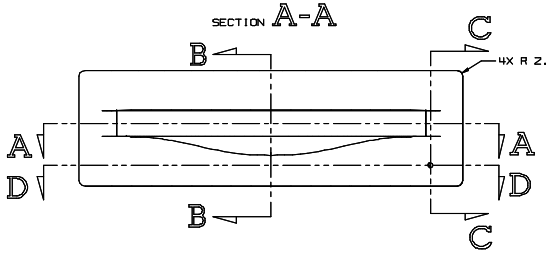
SECTION D-D

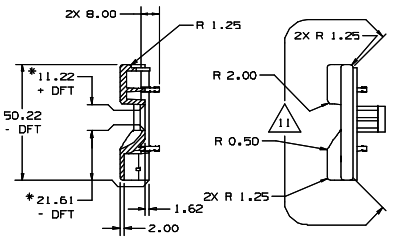


SECTION A-A



SECTION C-C



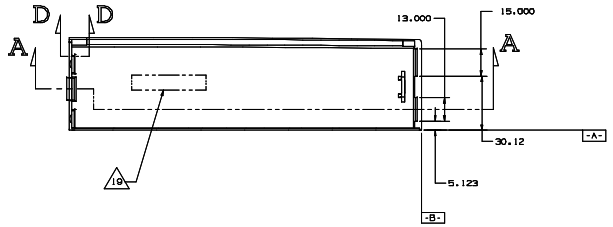


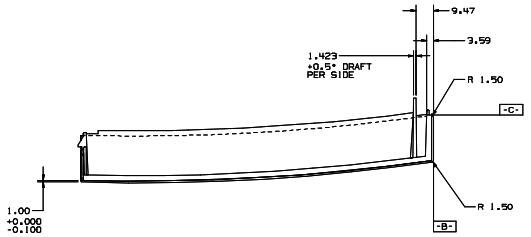
SECTION B-B

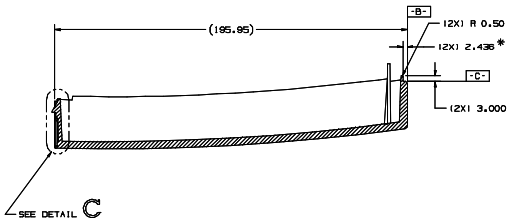
FOLDOUT 6	
CD bezel for Macintosh Quadra 800	
815-1186-04	1 of 1

NOTE: UNLESS OTHERWISE SPECIFIED

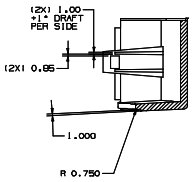
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. ALL DIMENSIONS ARE IN MILLIMETERS; REFER TO METRIC TOLERANCE BLOCK.
3. MATERIAL: ABS CYCOLAC KJC 34187-1, COLOR: APPLE PLATINUM PER COLOR CONTROL PANEL 912-0037, TOL PER COLOR TOL SET 912-1037.
4. WALL THICKNESS: 4.00
5. DRAFT ANGLES: EXTERIOR SURFACES TO BE 2° PER SIDE. INTERIOR SURFACES TO BE 2° PER SIDE.
6. ALL EXTERIOR (APPEARANCE SURFACE) EDGES TO BE .25 RADIUS, EXCEPT AT PARTING LINE.
7. ALL INTERIOR (NON-APPEARANCE SURFACE) INSIDE RADII (90° CORNERS) TO BE R.40, OUTSIDE RADII (270° CORNERS) TO BE R.50, EXCEPT AT PARTING LINE.
8. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.07 PER 25mm, NOT TO EXCEED 0.50 OVER THE ENTIRE LENGTH.
9. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.10 PER 25mm, NOT TO EXCEED 0.50 OVER THE ENTIRE SURFACE.
10. APPEARANCE SURFACES ARE THOSE SURFACES TEXTURED PER APPLE SPEC 062-0222, PER NOTES 11, 12 & 14.
11. ALL EXTERIOR (APPEARANCE) SURFACES TO BE RB6842 G2 TEXTURE PER APPLE SPECIFICATION 062-0222 EXCEPT WHERE INDICATED.
12. TEXTURE TO BE SPI-SPE#5 (APPLE SPEC 062-0222) WHERE INDICATED.
13. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE#3.
14. GATE TO BE MACHINE TRIMMED 0.5 ±0.2 BELOW SURFACE X Ø6.35
15. REFER TO APPLE SPEC 062-2006 FOR COSMETIC ACCEPTANCE CRITERIA.
16. FLASH NOT TO EXCEED 0.13.
17. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SIDE OF PART.
18. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICES OF CUSTOM MOLDERS" BY THE SOCIETY OF PLASTIC INDUSTRY, INC.
19. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN.
20. EJECTOR PIN, PARTING LINE, AND GATE LOCATIONS MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
21. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE TOOL NUMBER.
22. STARRED (*) DIMENSIONS AND NOTES ARE CRITICAL CONTROL DIMENSIONS AND NOTES FOR QC INSPECTION.



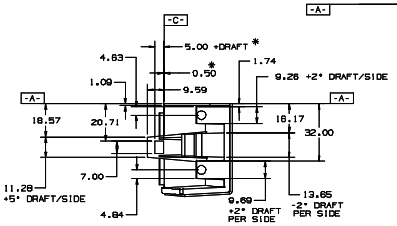


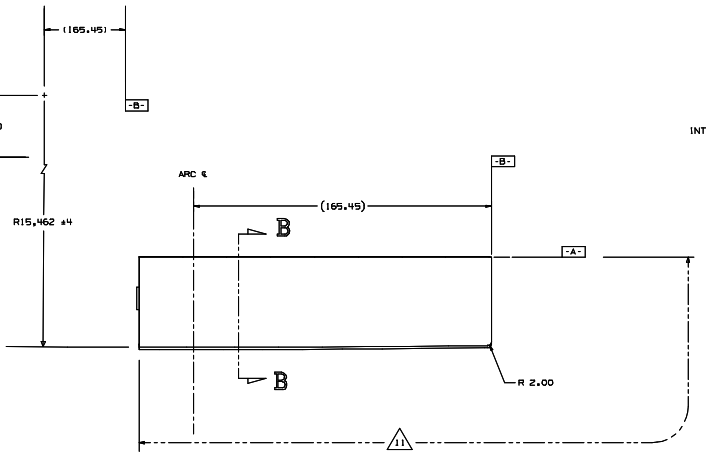


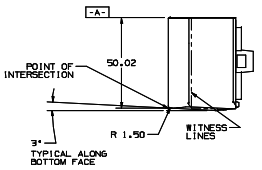
SECTION A-A

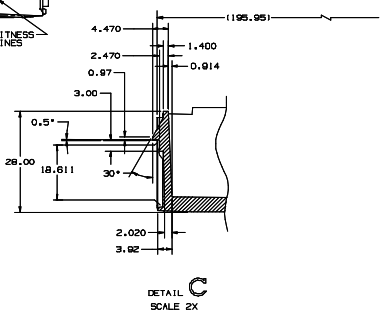


SECTION B-B

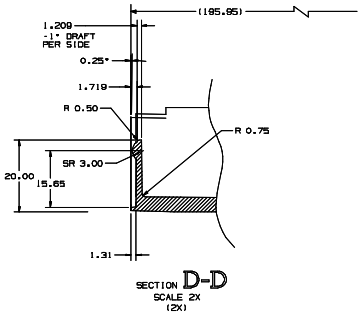




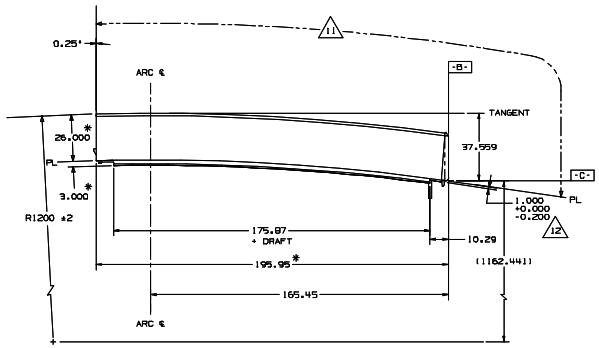




DETAIL C
SCALE 2X



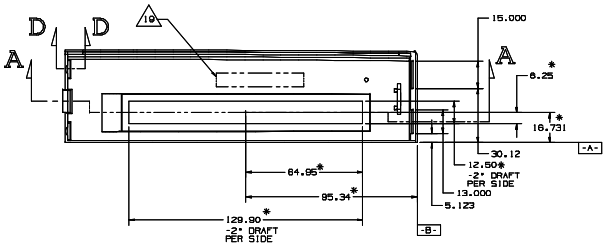
SECTION D-D
SCALE 2X
(2X)

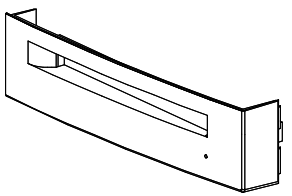


FOLDOUT 7	
Blank bezel for Macintosh Centris 650	
815-0715-03	**1 of 1**

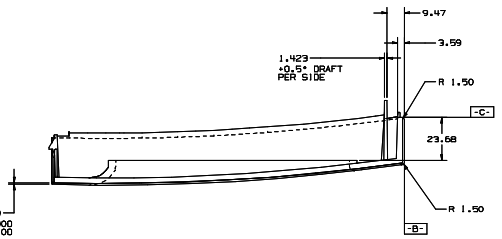
NOTE: UNLESS OTHERWISE SPECIFIED

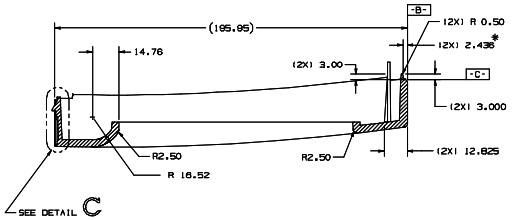
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. ALL DIMENSIONS ARE IN MILLIMETERS: REFER TO METRIC TOLERANCE BLOCK.
3. MATERIAL: ABS CYCOLAC KJC 34187-1; COLOR: APPLE PLATINUM PER COLOR CONTROL PANEL 912-0037, TOL PER COLOR TOL SET 912-1037.
4. WALL THICKNESS: 4.00
5. DRAFT ANGLES: EXTERIOR SURFACES TO BE 2° PER SIDE. INTERIOR SURFACES TO BE 2° PER SIDE.
6. ALL EXTERIOR (APPEARANCE SURFACE) EDGES TO BE .25 RADIUS, EXCEPT AT PARTING LINE.
7. ALL INTERIOR (NON-APPEARANCE SURFACE) INSIDE RADII (90° CORNERS) TO BE R.40, OUTSIDE RADII (270° CORNERS) TO BE R.50, EXCEPT AT PARTING LINE.
8. STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.07 PER 25mm, NOT TO EXCEED 0.50 OVER THE ENTIRE LENGTH.
9. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.10 PER 25mm, NOT TO EXCEED 0.50 OVER THE ENTIRE SURFACE.
10. APPEARANCE SURFACES ARE THOSE SURFACES TEXTURED PER APPLE SPEC 082-0222, PER NOTES 11, 12 & 14.
11. ALL EXTERIOR (APPEARANCE) SURFACES TO BE RE6842 G2 TEXTURE PER APPLE SPECIFICATION 082-0222 EXCEPT WHERE INDICATED.
12. TEXTURE TO BE SPI-SPE#5 (APPLE SPEC 082-0222) WHERE INDICATED.
13. MOLD FINISH ON INTERIOR (NON-APPEARANCE) SURFACES TO BE SPI-SPE#3.
14. GATE TO BE MACHINE TRIMMED 0.5 ±0.2 BELOW SURFACE X Ø6.35
15. REFER TO APPLE SPEC 082-2006 FOR COSMETIC ACCEPTANCE CRITERIA.
16. FLASH NOT TO EXCEED 0.13.
17. PART TO BE FREE OF MOLD RELEASE ON APPEARANCE SIDE OF PART.
18. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICES OF CUSTOM MOLDERS" BY THE SOCIETY OF PLASTIC INDUSTRY, INC.
19. MARK APPLE PART NUMBER AND REVISION LETTER WITH 10.00 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN.
20. EJECTOR PIN, PARTING LINE, AND GATE LOCATIONS MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN ENGINEERING PRIOR TO MOLD FABRICATION.
21. MOLD TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE TOOL NUMBER.
23. STARRED (*) DIMENSIONS AND NOTES ARE CRITICAL CONTROL DIMENSIONS AND NOTES FOR QC INSPECTION.



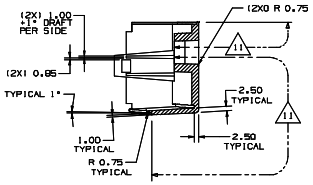


ISOMETRIC VIEW

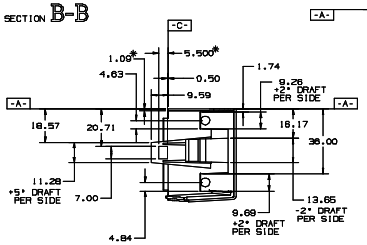


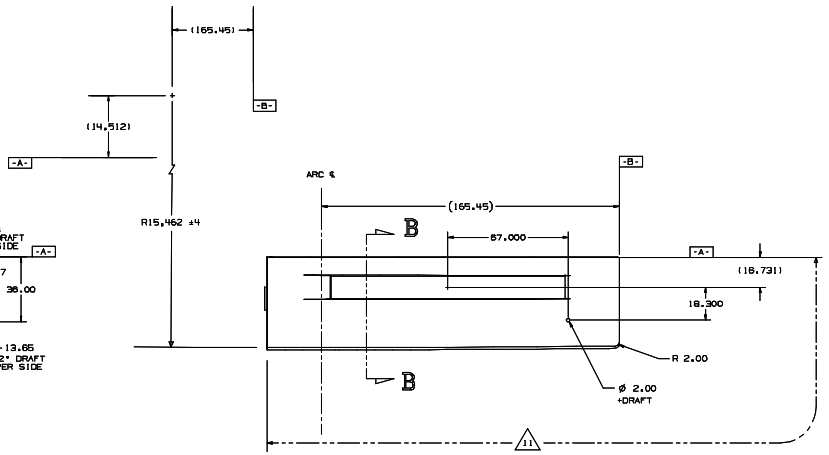


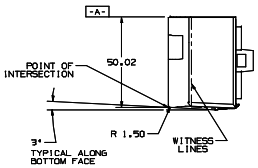
SECTION A-A

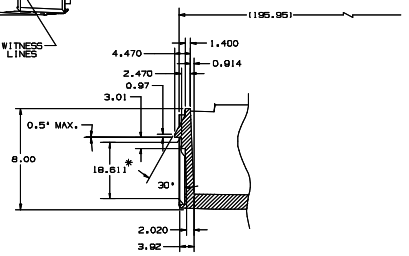


SECTION B-B

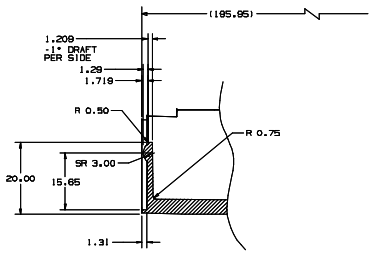




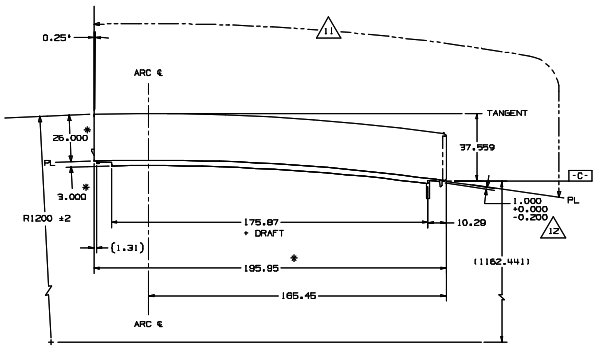




DETAIL C
SCALE 2X



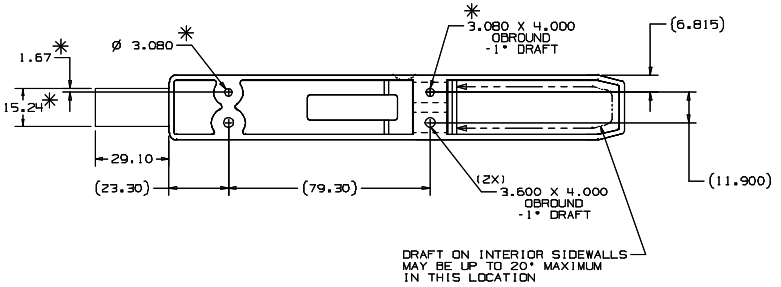
SECTION D-D
SCALE 2X
(2X)

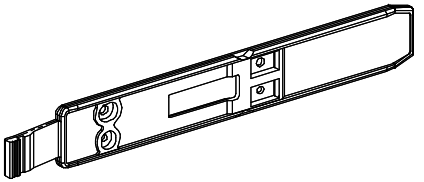


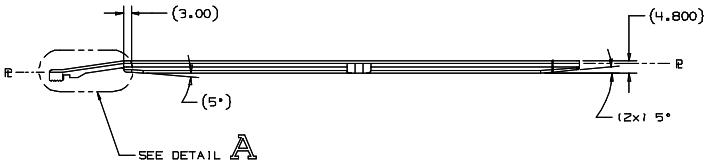
FOLDOUT 8	
CD bezel for Macintosh Centris 650	
815-1414-01	1 of 1

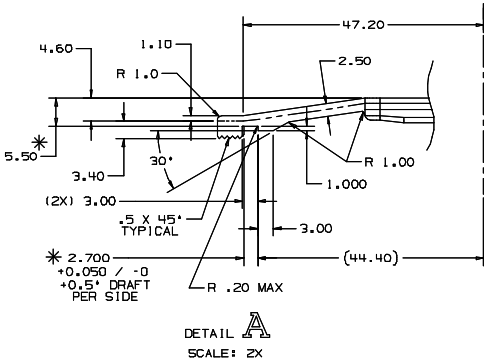
NOTE: UNLESS OTHERWISE SPECIFIED

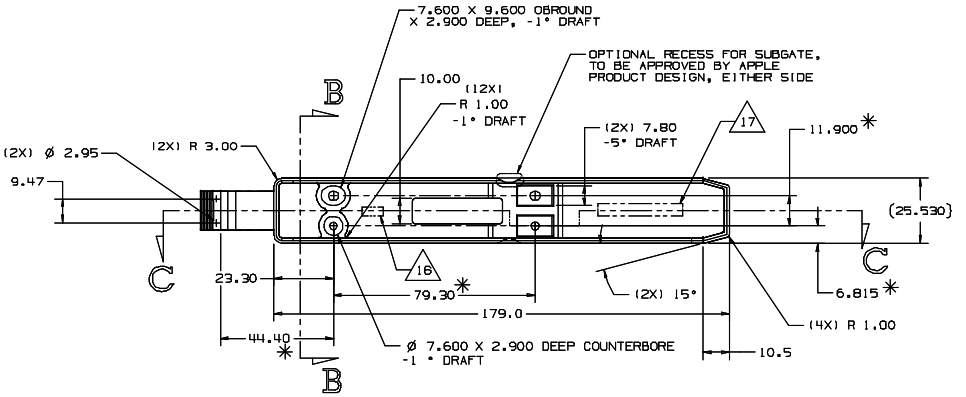
1. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
2. MATERIAL: POLYCARBONATE, GENERAL ELECTRIC 241-701
3. COLOR: BLACK
4. ALL UNSPECIFIED DRAFT ANGLES TO BE 1.5°.
5. ALL UNSPECIFIED EXTERIOR (APPEARANCE SURFACE) SHARP EDGES TO BE 0.10. RADIUS, EXCEPT AT PARTING LINE.
6. ALL INSIDE RADII TO BE 0.25 RADIUS MINIMUM, EXCEPT AT PARTING LINE.
7. STRAIGHT EDGES TO HAVE STRAIGHTNESS TOLERANCE OF 0.05 PER 25.0, NOT TO EXCEED 0.20 OVER THE ENTIRE LENGTH.
8. FLAT SURFACES TO HAVE FLATNESS TOLERANCE OF 0.05 PER 25.0, NOT TO EXCEED 0.20 OVER THE ENTIRE SURFACE.
9. MOLD FINISH TO BE SPI-SPE #3 PER APPLE SPECIFICATION 062-0222, SECTION 3.6.
10. "*" DENOTES CONTROL DIMENSION FOR MOLDING PURPOSES.
11. FLASH NOT TO EXCEED 0.08 TOTAL.
12. PARTING LINE MISMATCH NOT EXCEED 0.10.
13. EJECTOR PIN, PARTING LINE, AND GATE LOCATIONS MUST BE APPROVED BY APPLE COMPUTER PRODUCT DESIGN TOOL ENGINEERING PRIOR TO MOLD FABRICATION.
14. MOLD TO BE PROPERTY OF APPLE COMPUTER INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE TOOL NUMBERS.
15. MOLD DESIGN TO MINIMIZE EJECTION PIN MARKS, GATE BLUSH, LINES AND WELD MARKS. MOLD CONSTRUCTION TO CONFORM TO GOOD MOLDING INDUSTRY PRACTICE AS STATED IN THE CURRENT EDITION OF "STANDARD PRACTICES OF CUSTOM MOLDERS" BY THE SOCIETY OF THE PLASTICS INDUSTRY, INC.
16. MARK MATERIAL RECYCLING IDENTIFIER "PC" WITH 3.0 MINIMUM HIGH CHARACTERS
17. MARK APPLE PART NUMBER AND REVISION LETTER WITH 3.0 MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE SHOWN.

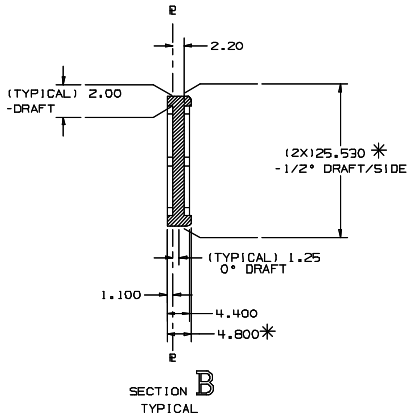


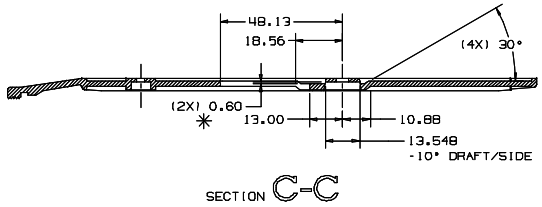












FOLDOUT 9	
CD mounting rails for Macintosh Centris 650	
815-0645-04	1 of 1

NOTES (UNLESS SPECIFIED OTHERWISE).

1 MATERIAL: CRS 1.00mm THICK
FINISH: ELECTROGALVANIZED ZINC PRE-PLATE
(FINGERPRINT-LESS)

2 TYPICAL INSIDE BEND RADIUS: 1.0mm.

3 UNSPECIFIED RADII TO BE 1.0mm.

4 BREAK AND DEBURR ALL SHARP CORNERS AND EDGES. MAXIMUM BURR ALLOWANCE IS 15% OF MATERIAL THICKNESS.

5 INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-1982.

6 SURFACES TO BE FREE OF CONTAMINANTS, METAL FLAKES AND LUBRICANTS.

7 STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.20 PER 25.0, NOT TO EXCEED 0.40 OVER THE ENTIRE LENGTH.

8 FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.20 PER 25.0, NOT TO EXCEED 0.40 OVER THE ENTIRE SURFACE.

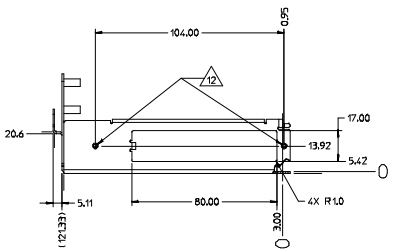
9 STEEL RULE DIES, SPECIAL PUNCHES AND OTHER UNIQUE TOOLING REQUIRED TO FABRICATE THIS PART TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE APPLE PART NUMBER.

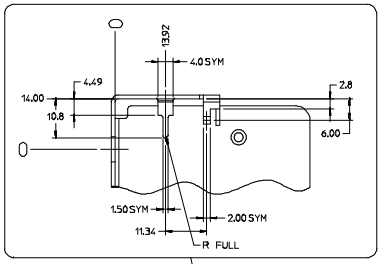
10 STAMP ASSEMBLY NUMBER 600-0627 AND REVISION LEVEL WITH 3.0mm MINIMUM HIGH CHARACTERS APPROXIMATELY WHERE INDICATED.

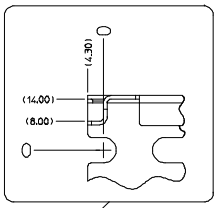
11 INSTALL M3 THREADED STANDOFF (PEM PART NO. SO-M3-10 OR EQUIV.) WHERE INDICATED (2 PLACES).

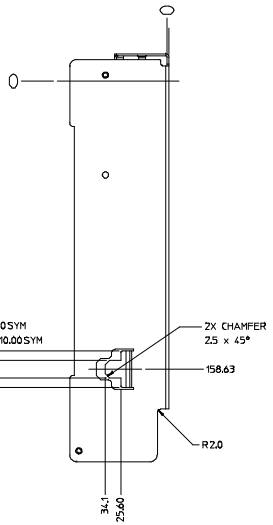
12 EXTRUDE HOLE AND TAP M3 THREADS WHERE INDICATED (2 PLACES). HOLES TO HAVE A MINIMUM OF THREE (3) THREADS.

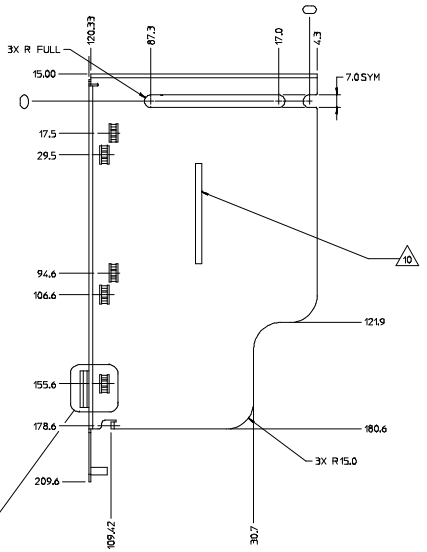
13 THIS IS A SUPPLEMENTAL DETAIL DRAWING AND IS TO BE USED IN CONJUNCTION WITH PART MODEL FILE 805-0530-06w.igs TO MANUFACTURE AND INSPECT THE PART.

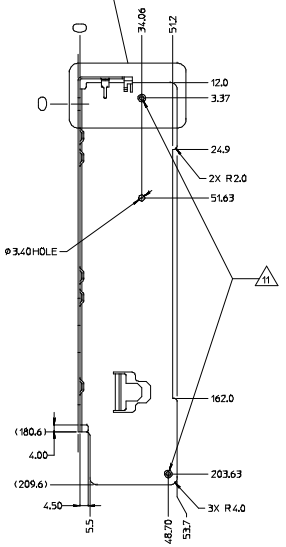


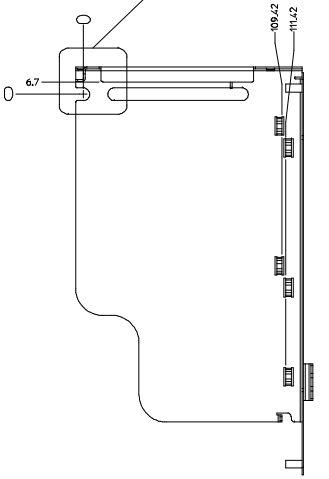


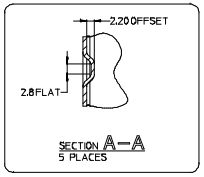


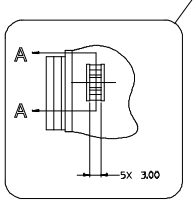


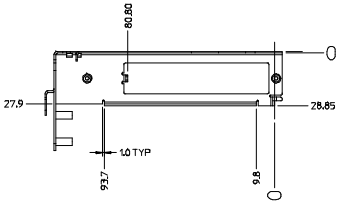


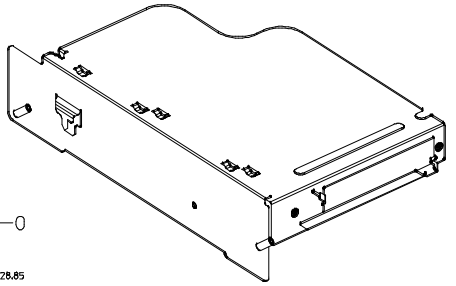


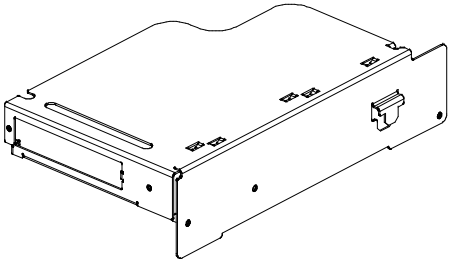








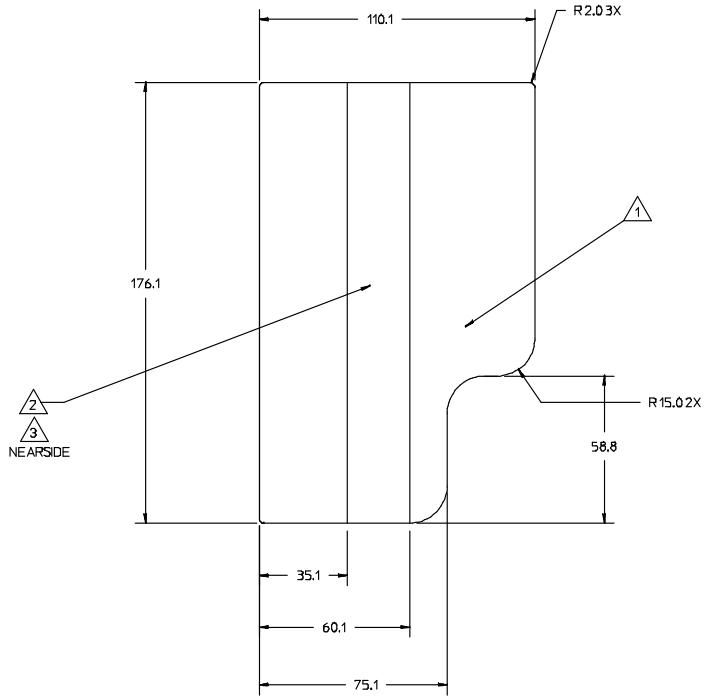


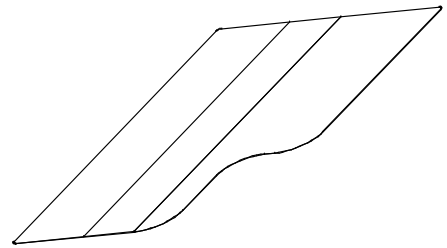


FOLDOUT 10	
Expansion-card bracket for Macintosh Centris 610	
805-0530-06	**1 of 1**

NOTES: UNLESS OTHERWISE SPECIFIED:

1. MATERIAL POLYCARBONATE SHEET, 0.20 (.008) THICK FLAMMABLILTY RATING TO BE LL94-V2 MINIMUM.
2. ADHESIVE MATERIAL 3M 467 ADHESIVE OR EQUIVALENT.
3. ADHESIVE TO BE APPLIED TO SURFACE AS INDICATED, AND MUST BE COVERED WITH A REMOVABLE PAPER ELEMENT.
4. ALL REQUIRED TOOLING TO BE PROPERTY OF APPLE COMPUTER, INC AND SHALL BE MARKED WITH APPLE'S NAME, APPROPRIATE PART NUMBER, AND DATE.





FOLDOUT 11	
Insulator for expansion-card bracket	
725-0051-02	**1 of 1**

NOTES (UNLESS SPECIFIED OTHERWISE):

1 MATERIAL: 0.20 (.008") THK STAINLESS STEEL 301 SERIES, HALF-HARD.

2 TYPICAL INSIDE BEND RADIUS: 0.15mm.

3 ALL SHARP CORNERS TO BE RADIUSED 0.5R.

4 BREAK AND DEBURR ALL SHARP CORNERS AND EDGES. MAXIMUM BURR ALLOWANCE IS 15% OF MATERIAL THICKNESS.

5 INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5-1982.

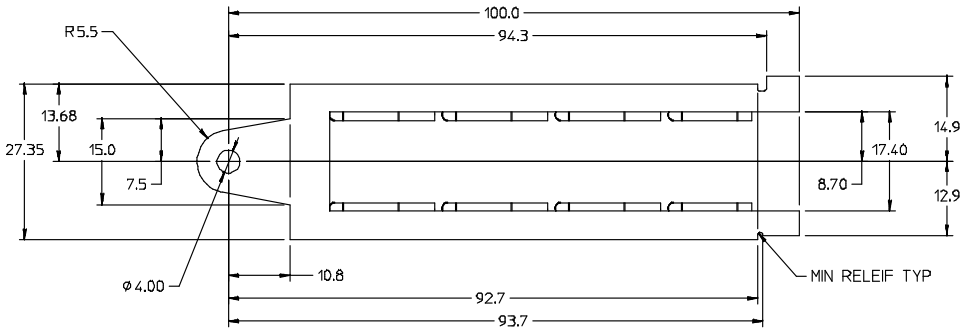
6 SURFACES TO BE FREE OF CONTAMINANTS, METAL FLAKES AND LUBRICANTS.

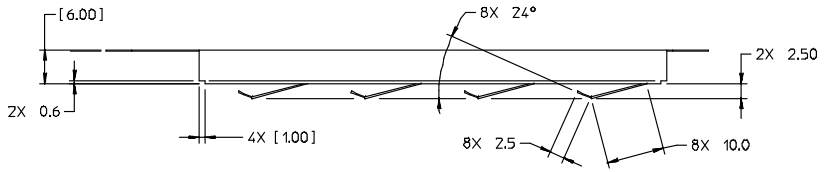
7 STRAIGHT EDGES TO HAVE A STRAIGHTNESS TOLERANCE OF 0.20 PER 25.0, NOT TO EXCEED 0.40 OVER THE ENTIRE LENGTH.

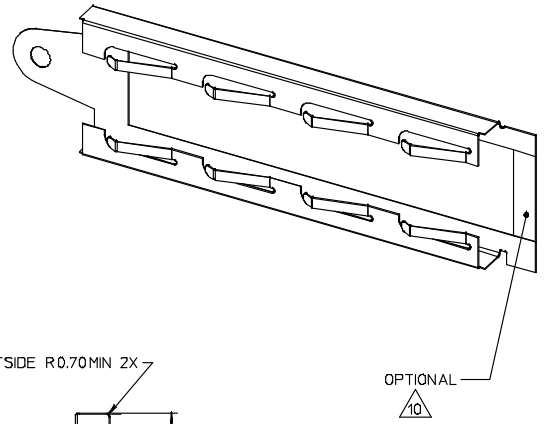
8 FLAT SURFACES TO HAVE A FLATNESS TOLERANCE OF 0.20 PER 25.0, NOT TO EXCEED 0.40 OVER THE ENTIRE SURFACE.

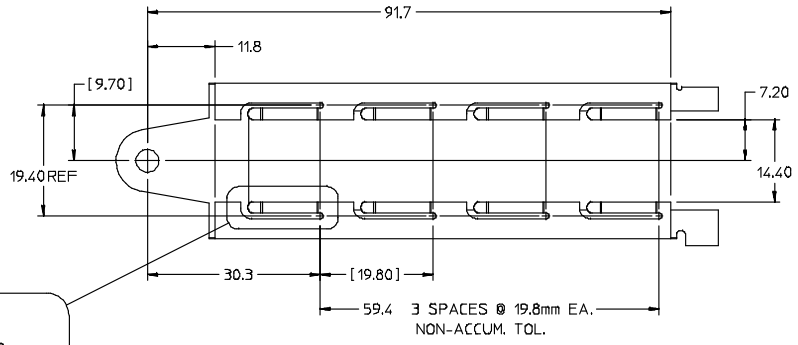
9 STEEL RULE DIES, SPECIAL PUNCHES AND OTHER UNIQUE TOOLING REQUIRED TO FABRICATE THIS PART TO BE PROPERTY OF APPLE COMPUTER, INC. AND SHALL BE PERMANENTLY MARKED WITH APPLE'S NAME AND APPROPRIATE APPLE PART NUMBER.

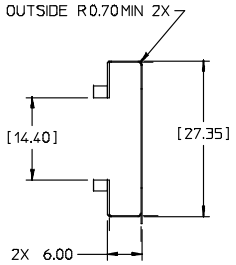
10 OPTIONAL STRIP MAY BE ADDED FOR SUPPORT DURING FORMING BUT MUST BE TRIMMED AWAY WHEN PART IS COMPLETED.

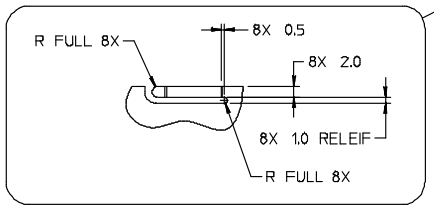








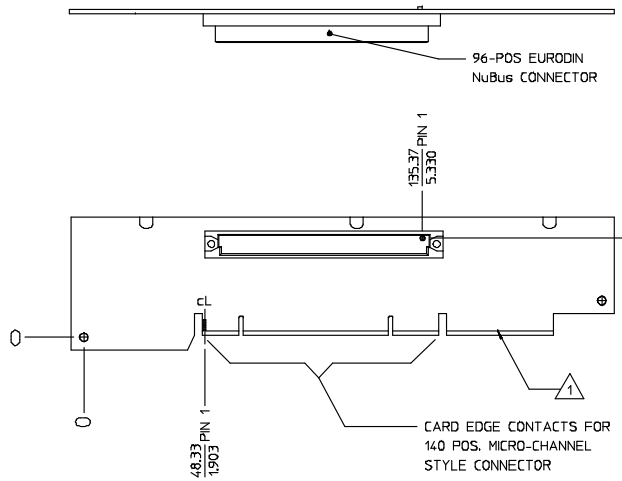


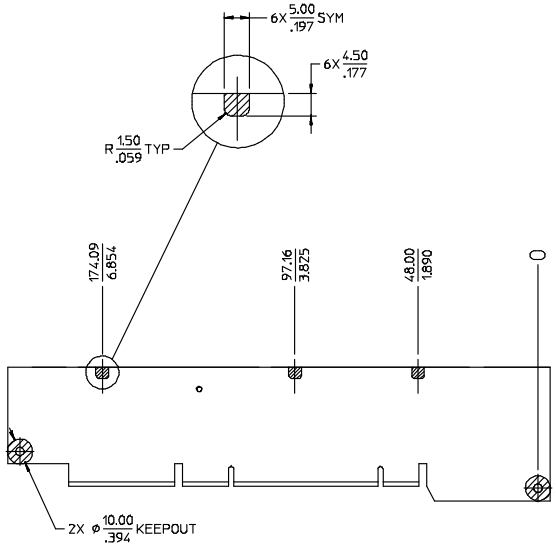


FOLDOUT 12	
EMI shield for expansion-card bracket	
630-0450-10	**1 of 1**

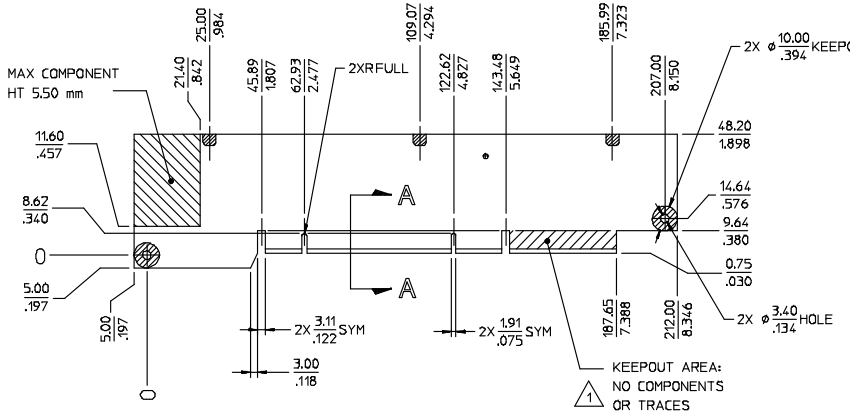
NOTES (UNLESS OTHERWISE SPECIFIED):

1. BOARD GEOMETRY ALLOWS THIS EDGE TO BE PLUGGED INTO 212 POSITION MICRO-CHANNEL STYLE CONNECTOR.

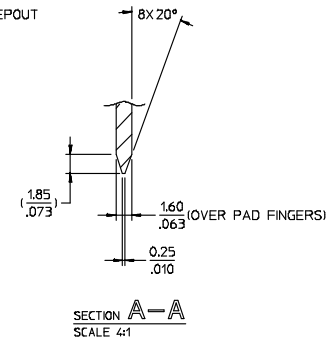




BACKSIDE



TOP SIDE
(COMPONENT)



FOLDOUT 13	
NuBus adaptor card for Macintosh Centris 610	
630-0450-12	**1 of 1**

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 IINTX printer. Final pages were created on the Varityper VT600 imagesetter. Line art was created using Adobe™ Illustrator. PostScript™, the page-description language for the LaserWriter, was developed by Adobe Systems Incorporated.

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

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Special thanks to Dale Adams, ChengHwee Chee, David Daetz, Tim Dierks, Lorenzo Dunn, Bill Galcher, Brad Helm, Garet Igarashi, David Limp, Tom Llewellyn, Brian Mellea, Wayne Miller, and Teriann Wakeman.