Chapter 5

Hardware

This chapter describes the architecture and functional elements of the Macintosh Portable portable computer. From the user's point of view the Macintosh Portable operates much like a Macintosh SE. However, the Macintosh Portable hardware is different in significant ways from that of the Macintosh SE, reflecting the differences in operating and transportation environments and the power source.

These notes primarily describe the changes from the Macintosh SE hardware. The Macintosh SE hardware is extensively documented in the *Guide to Macintosh Family Hardware, Second Edition* manual. ▪

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5.1 The Macintosh Portable Specifications

The Macintosh Portable contains the Motorola MC68HC000 microprocessor (CPU) operating at nearly 16 megahertz in a multiprocessing environment with two other processors:

1)a keyboard scanning and decoding microprocessor

2) a power management microprocessor

The Macintosh Portable is equipped with all the standard Macintosh SE architectural features, namely the VIA, SCC, SWIM, and SCSI chips. Sound is generated by the same sound circuitry as in the Macintosh II (Apple Sound Chip and dual Sony Sound Chips). Video is generated by a separate circuit and memory that drives the input to a flat-panel display.

The Macintosh Portable is also a loosely coupled multiprocessor. The power manager is implemented with an 8-bit CMOS microprocessor that not only handles power management duties, but is also responsible for the interface between the built-in trackball, a low-power mouse or other input device, and the Apple Desktop Bus. The interface between the power manager and the 68HC000 is implemented using one of the 8-bit bi-directional ports of the VIA and two asynchronous handshake lines.

Table 5-1 repeats the Macintosh Portable specifications given in Chapter 1. Table 5-2, in the next section, compares the hardware features of the Macintosh Portable with the Macintosh SE.

Table 5-1 The Macintosh Portable Specifications

Characteristic	Specification
CENTRAL PROCESSING UNIT (CPU):	16-bit, CMOS 68HC000, 16 MHz (twice SE speed and without video contention), 1 wait state
OPERATING SYSTEM (OS):	Enhanced Macintosh SE ROM
STANDARD MAIN MEMORY:	1MB RAM, 256 KB ROM
MEMORY EXPANSION:	Main memory (RAM) is expandable to 2 or 5 MB by using internal expansion cards (1 or 4 MB). ROM expansion space for Apple use in ROM revision and for international character sets is 1 MB, and for developer use is 4 MB (see Chapter 3, Figure 3-1.)
MASS STORAGE:	Built-in 1.4 MB floppy disk drive External floppy disk drive port Removable/optional second internal 1.4 MB floppy disk drive Optional internal low power SCSI hard disk, also external SCSI port
RAM DISK:	Ability to install system and application software in battery-backed-up RAM so that the machine is capable of functioning without resorting to the optional disk drive. This feature will provide a more rugged, lighter weight solution to portable applications, with longer battery operation and much faster access.
DISPLAY:	Flat-panel, 9.8" diagonal, active matrix reflective LCD, 640 x 400 pixels, 0.33 mm dot pitch, variable tilt
SOUND:	Apple stereo sound chip (same as Macintosh II)

Table 5-1 The Macintosh Portable Specifications (Continued)

Characteristic	Specification
I/O PORTS:	DB-19 external floppy disk DB-25 SCSI Mini DIN-4 Apple Desktop Bus port Two Mini DIN-8 serial ports DB-15 for external video 96-pin Euro-DIN expansion interface (not compatible with Macintosh SE) Stereo audio phone jack Battery recharger
INPUT DEVICES:	Built-in keyboard. Built-in trackball replaceable by optional keypad. (The keypad or trackball may be positioned on either side of the keyboard—right side is standard.) Low-power Apple Desktop Bus mouse (optional) plugs into ADB port at the rear of the machine.
OPTIONAL INTERNAL MODEM:	300/1200/2400 bps (AT command set compatible)
WEIGHT:	14 lbs. (minimum configuration) up to 17 lbs. (hard disk option, 5 MB RAM, internal modem option)
SIZE:	15.2" wide x 13.75" deep x 2" to 4" thick (wedge shaped)
SHOCK:	The unit can withstand a 50 G, 12 millisecond shock pulse in any axis while non-operating. This is true of all configurations, for example, with or without a hard disk.
BATTERY USE:	Internal, sealed lead-acid battery provides 8 hours normal use (single floppy configuration), varies dependent on drive usage. Rechargeable overnight using AC power adapter RAM contents are retained during main battery replacement

5.2 Comparison of the Macintosh Portable and the Macintosh SE

This section calls out the significant differences between the Macintosh Portable and the Macintosh SE.

Improvements

1. Portable: smaller size, lighter weight, greater shock and vibration resistance
2. Larger RAM expansion to allow larger application programs
3. Higher speed due to faster clock, removal of RAM contention for video
4. Floppy and hard disk drives are low profile, one-third height configuration
5. Low power hard disk with an internal connector to SCSI interface

Variations

1. The 96-pin expansion connector does not have the same pinout as in the Macintosh SE, but the same signals are accessable.
2. Macintosh SE expansion cards will not physically fit in the Macintosh Portable.
3. A *very limited* amount of internal battery power is available to supply any expansion card inserted into the 96-pin expansion connector.
4. The Macintosh Portable does not provide an external device access port for a custom connector.
5. The Macintosh Portable contains only one ADB port and it supports low-power input devices (preferred) or normal Macintosh input devices at some battery performance penalty.
6. A trackball replaces the numeric keypad in the basic configuration of the Macintosh Portable; the keypad is a user installable option.
7. The Macintosh Portable does not provide the termination power to the SCSI bus, and hence to any external SCSI devices.

Table 5-2 is a side-by-side comparison of the hardware features of the Macintosh Portable and the Macintosh SE.

Table 5-2 Macintosh Portable vs. Macintosh SE Hardware Comparison

Feature	Riviera	Macintosh SE	
Processor:	CMOS 68HC000 CPU	68000 CPU	
Clock Frequency:	15.6672 MHz	7.8336 MHz	
Auxiliary Processor:	Power Manager Processor	None	
Floppy Disk Drive:	1.4 MB Internal Floppy Drive, Optional Second Internal 1.4 MB Floppy Drive, Optional External 800 KB or 1.4 MB Floppy Drive	800 KB Internal Floppy Drive, Optional 2nd 800 KB Internal Drive, Optional External 800 KB	Floppy Drive
Hi Speed Periph.:	SCSI Port	SCSI Port	
Hard Disk:	Optional low-power SCSI HD40 Internal External SCSI connector.	Optional SCSI HD20 (Internal) External SCSI connector	
Serial Ports:	2 Mini-8 Built-In Ports,with extended input handshake capability	2 Mini-8 Built-In Ports, with extended input handshake capability	
Hardware Expansion:	Access to 68000 pins No power available, No removable door at rear	Access to 68000 pins, Customizable I/O Port in removable door at rear	
Sound:	Macintosh II Sound, Stereo	Macintosh Sound	
RAM :	1MB, Expandable on Internal SRAM card- 1 MB, or 4 MB expansion	1 MB Expandable to 4 MB DRAM (SIMMs)	
ROM :	256 KB ROM with Hierarchical File System, ROM supports SCSI, ADB, AppleTalk, Power Manager	256 KB ROM with Hierarchical File System, ROM supports SCSI, ADB, AppleTalk	
Operator Input:	Alphanumeric Keyboard, optional keypad or pointing device (left or right side) via ADB, Allows additional input devices, e.g. graphics tablet.	Alphanumeric Keyboard via Apple Desktop Bus, Allows additional input devices, e.g. graphics tablet	

Table 5-2 Macintosh Portable vs. Macintosh SE Hardware Comparison (Continued)

Feature	Riviera	Macintosh SE
Video Display	Built-In LCD, Flat Panel Display, 9.8", 640 x 400 B/W 75 dots per inch	Built-In Monitor, 9" 512 x 342 B/W, 72 dots per inch

5.3 Block diagrams of the Macintosh Portable and Macintosh SE

This section provides a functional overview of the Macintosh Portable architecture. It gives block diagrams of both the Macintosh Portable and the Macintosh SE, then goes on to briefly describe the function of each block in the Macintosh Portable diagram.

Figure 5-1 is a block diagram of the Macintosh Portable. Figure 5-2 is a block diagram of the Macintosh SE, for comparison. Most of the unshaded elements in Figure 5-1 are located on the main logic board of the Macintosh Portable. The 68000 central processor communicates over the system bus (address and data), indicated by the heavy black line. Also connected to the system bus are

- random access memory (RAM)
- read-only memory (ROM)
- an Apple custom VLSI chip that performs coarse address decoding and generalized logic unit (GLU) functions
- six additional interface and controller chips.

Each of the devices connected to the system bus is accessed (written to or read from) through a range of addresses in memory mapped address space. The address space is diagrammed in Chapter 3, “Firmware.”

The rest of the sections in this chapter describe the functions of the blocks in the Macintosh Portable diagram.

Figure 5-1 The Macintosh Portable Architecture

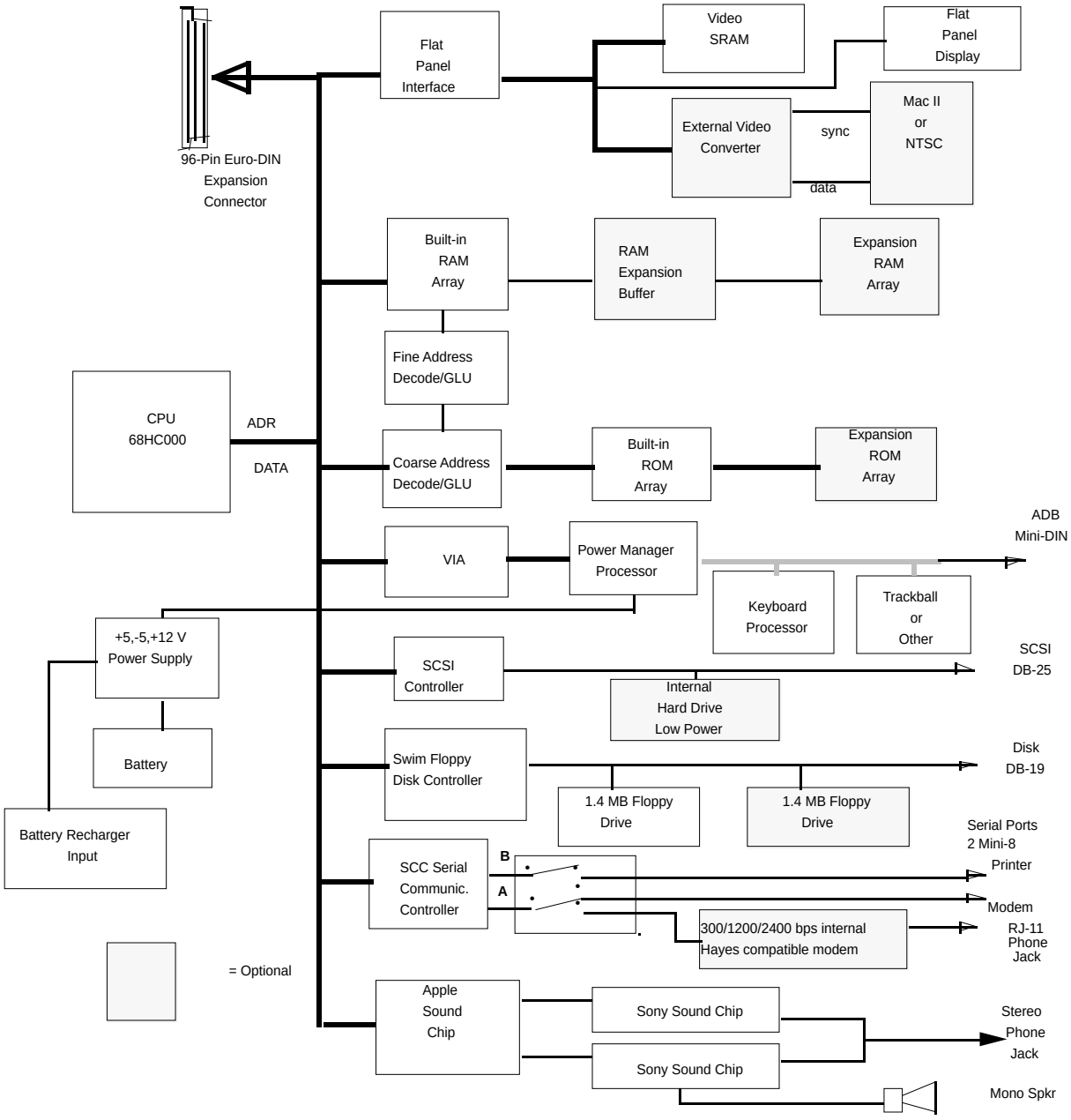
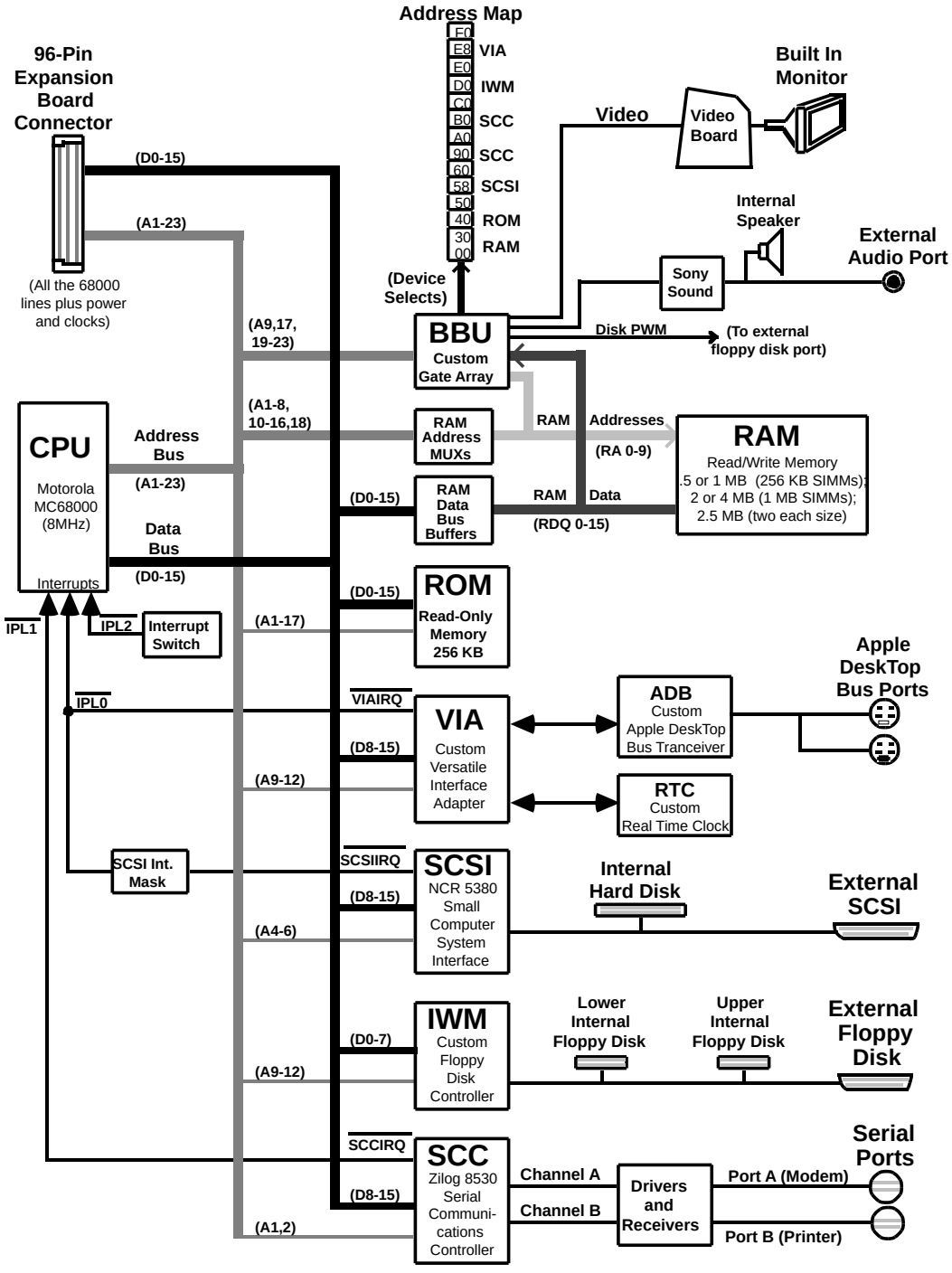


Figure 5-2 Macintosh SE Architecture



5.3 The central processing unit (CPU)

The Macintosh Portable replaces the standard Macintosh 8 MHz HMOS MC68000 with a CMOS MC68HC000 for reduced power consumption and higher speed.

The 68HC000 has a 16-bit data bus and a 24-bit address bus.

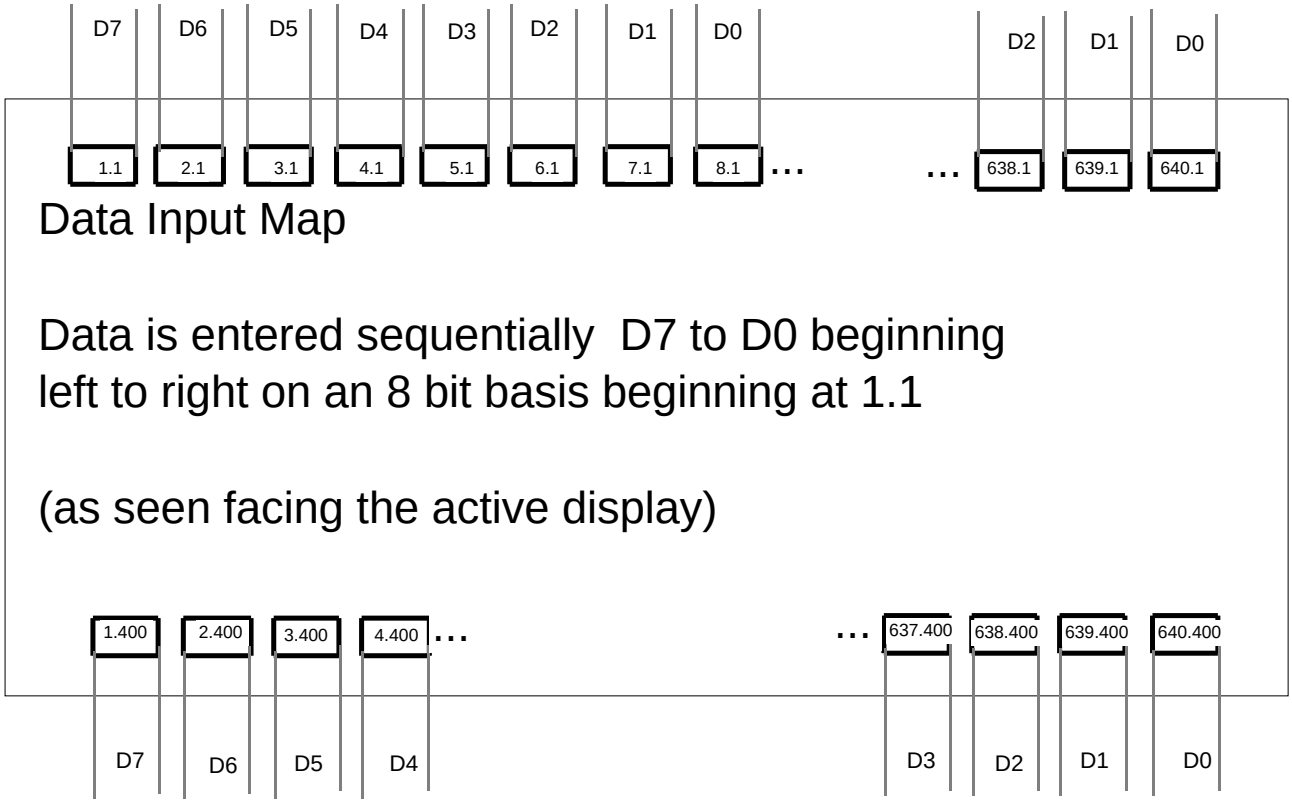
The frequency at which the Macintosh Portable system performs useful work is 15.667 MHz. However, to reduce power consumption during idle periods the Macintosh Portable is designed with a two state variable wait state system that effectively makes the clock frequency either approximately 1 MHz or 15.667 MHz. (See Chapter 6, “The Power Manager.”)

5.4 Video Display Interface chip

The Video Display Interface chip is a custom IC designed to keep the Macintosh Portable 68HC000 CPU from having to refresh the screen (LCD display), thereby allowing the CPU to do more useful work. It also generates all the signals necessary for the flat-panel display, including the vertical and horizontal synchronization pulses. The difference between the Macintosh Portable and the Macintosh SE due to the function of this chip will have no effect on compatibility of your software.

From the point of view of the 68HC000, the video interface is seen as a continuous RAM array of 32,000 bytes (768 bytes reserved for later use). The video controller interface is nominally 16 bits wide from the 68HC000 to the Video Display Interface chip, but behaves like main memory in that it is also byte addressable. The first pixel displayed on the screen is the most significant bit of the first byte of video RAM (at Screen_base), while the last pixel displayed on the screen is the least significant bit of the last byte (at Screen_base+32,000–1). Figure 5-3 shows the entry order of data in terms of the pixels on the LCD. The pixels that are displayed between the first and last are addressed in a similar fashion; the display can be thought of as a linear array of bits.

Figure 5-3 Display Pixel Map



Flat panel display description

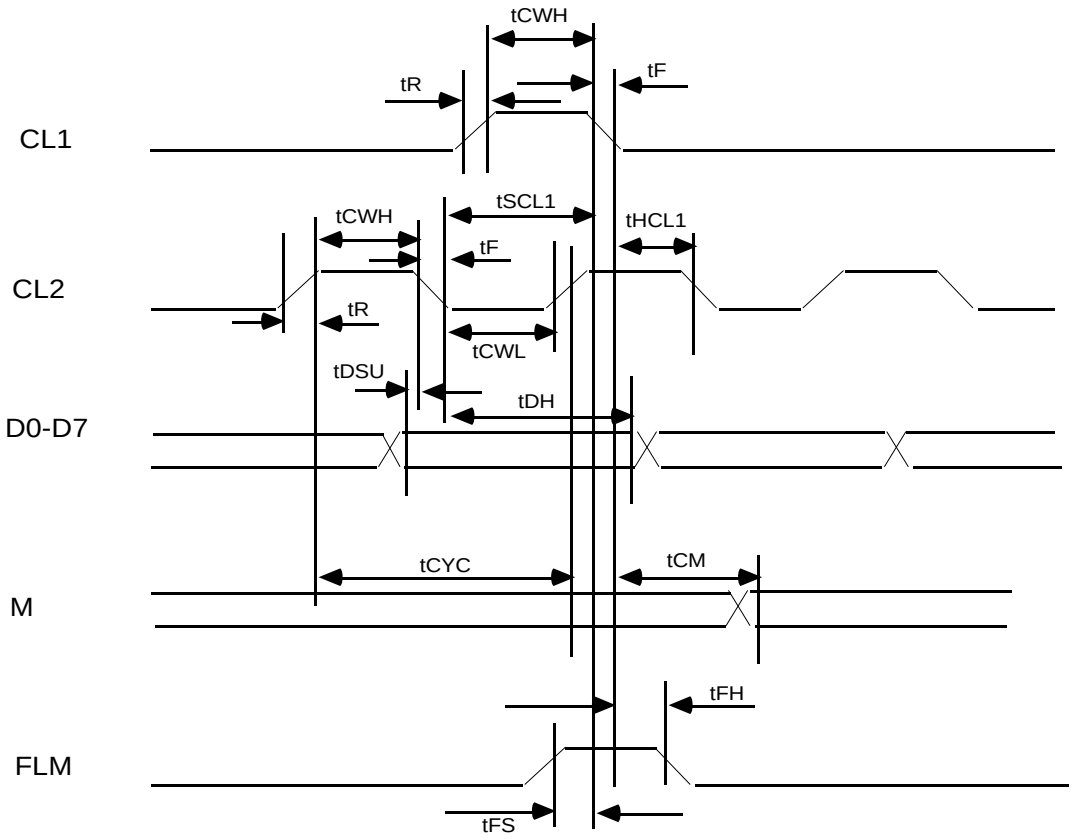
The display gives a high quality presentation of alphanumeric and graphic information on a 211 mm x 132 mm (8.31 in x 5.20 in) active display area. Display intensity, contrast ratio, and pixel turn on and turn off time are similar to CRT parameters (P4 phosphor).

Display Capacity	640 x 400 dots
Display Mode	Reflective
Driving Method	8-bit Parallel
Interface	CMOS Logic

Video signal timing

The Video Display Interfacechip generates the synchronization signals (FLM, CL1, CL2) and data signals as shown in Figure 5-4. The signal M is generated by the chip and is derived by dividing the FLM frequency by two. CL1 is the horizontal synchronization signal; it marks the end of a 640 pixel line. FLM is the vertical synchronization signal; it marks the beginning of a new frame of video every 16.32 milliseconds. This means that the display is being refreshed at a 61.8 Hz rate.

Figure 5-4 Video Interface Timing Diagram



SYMBOL	ITEM	MIN	MAX
tCYC	CL2 cycle time	190 ns	
tCWH	CL2 pulse width (high)	95 ns	
tCWL	CL2 pulse width (low)	95ns	
tSCL1	CL1 setup time	90 ns	
tHCL1	CL1 hold time	90 ns	
tR, tF	clock rise/fall time		30 ns
tDSU	Data setup time	60 ns	
tDH	Data hold time	60 ns	
tCM	M delay time	-500ns	+500ns
tFS	FLM setup time	100 ns	
tFH	FLM hold time	100 ns	

Contrast control

The contrast control for the flat panel display is derived from the PWM (pulse width modulated) output of the power manager processor. The modulation has 256 steps, which the user can set in the Low to High range of the Screen Contrast control in the Control Panel (see Figure 4-1).

The PWM signal is filtered to a DC signal by an RC network before being applied to the display to control its contrast.

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