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CMI *SERIES III*

Service Manual

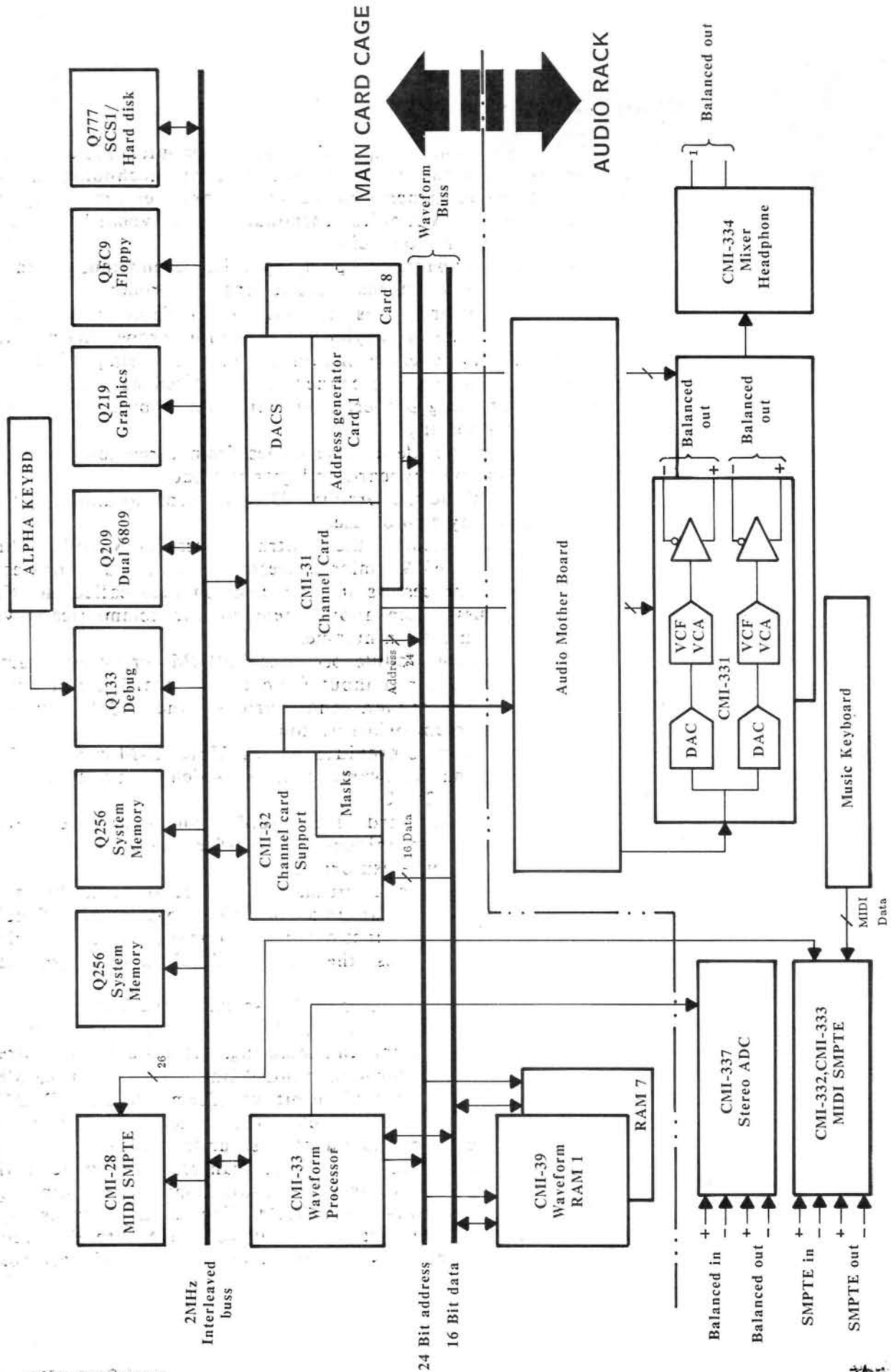
CMI System

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SYSTEM BLOCK DIAGRAM



General Principles

(Refer to Figure 1)

The C.M.I. is a complex special-purpose computer system which embraces many different hardware and software technologies. All processing and sound generation functions are performed by the Mainframe, while the Graphics Terminal and Keyboards serve as peripherals for operator interfacing.

The mainframe is capable of operating quite autonomously, that is, it is not reliant on any external connections for proper functioning. Under certain conditions it is possible for a fault condition in external peripherals such as keyboards to inhibit proper main frame operation, so the serviceperson should be wary of being misled. Of course, without the peripherals connected it is often hard to know if the system is functioning properly, but this point should be borne in mind when trouble-shooting.

Operator input to the Mainframe comes from three sources: music keyboard, alphanumeric keyboard and graphics pad.

Output devices include the Graphics Display terminal and the audio outputs. A printer may also be used.

The heart of the system is the Central Processing Module, which uses two Motorola 6809 microprocessors in a dual-processor configuration. Both processors share a common buss called the CMI Buss or the CPU Buss which allows them both to communicate with the other processors in the Mainframe.

The Processor Control Module provides EPROM for system startup and bootstrap, RS-232C serial input from the keyboard, serial output to the keyboard and printer, and various other CPU support functions such as interrupt prioritisation.

Main program memory is provided by the 256K RAM card(s). This holds all the operational software, much of which is overlaid from disk as the code exceeds 256K.

The Floppy-disk and Hard disk (SCSI) controllers use Direct Memory Access (DMA) techniques to transfer data between main memory and the two floppy-disk drives.

The Graphics Display is a bit-mapped image of 16K bytes of VRAM. This is displayed as an array of 256 by 512 points. Special hardware provides support functions for automatic vector drawing, which considerably enhances the speed of displaying graphical information.

The digital section contains a second buss called the Waveform Buss which is entirely independent of the CPU buss and is dedicated to sound generation, manipulation and sampling. It has a 23 bit address buss, a 16 bit data buss, synchronous control lines and runs at 3.3 Mhz. It supports up to 14 megabytes of 16 bit waveform RAM. All RAM is accessible by all channel cards in cycles of 16 time slices. This allows 16 channels to run at a maximum of just under 200khz each. The Waveform Processor is the only device that can read and write to the Waveform RAM so it is responsible for loading, saving, sampling and manipulating sounds in waveform RAM. The channel cards only generate read cycles to get data from waveform RAM to the Audio Output modules. The actual waveform data read out of waveform

SYSTEM OVERVIEW

RAM in response to addresses generated by the channel cards do not return to the channel card but are picked up from the waveform buss by the Channel Support card and sent directly to the the Audio Motherboard and thence the Audio Output Modules. (see System block diagram)

Access to the waveform buss is prioritized in the order Channel cards, Waveform RAM refresh, then Waveform Processor. Channel cards are allowed access to the buss in a cyclic "round robin" manner. The channel card may or may not use its allocated time slice. Unused channel card time slices are allocated to refresh, then Waveform processor access.

The Waveform Processor and Channel cards reside on both CPU and Waveform busses so that they may be controlled by the CPU as well as accessing sounds in Waveform RAM.

The channel cards

Each channel card contains a 2Mhz 6809 with 64 kbytes of program memory and the circuitry to generate 2 channels of wave form pitch, level, filter setting, resonance and address information. The channel cards themselves contain no waveform memory.

Access to the waveform RAM is via fixed cycling allocation. Each channel card is connected to one Audio Module by a 26-way flat cable which carries the control voltages, pitch and clock information used to clock the 16 bit DACs, and control the VCAs and VCFs.

Channel Support Card

This contains the timing generation and time slice allocation logic for the channel cards and the waveform buss. It also contains the channel card addressing logic, channel masks, some channel card program RAM refresh logic and master pitch oscillator. The time slice logic generates 8 equal time slices that are subdivided internally to the channel cards, each channel card generates 2 channels 8 time slices apart.

e.g. channel card 1 generates channels 0 and 8, channel card 2 generates 1 and 9 etc.

The Channel Support card also contains a timer which has one output bussed to all channel cards where it will cause FIRQs (Fast Interrupt Requests). This real time clock is used for channel card envelope timing.

Waveform Processor

This is a 10MHz 68000 with 8k words of ROM, 256k words of RAM, optically isolated serial interface to the ADC module, a waveform buss interface and a CPU buss interface. It also contains the Waveform Ram refresh arbitration logic. Access to waveform RAM is allowed during unused channel card time slices. 68000 code can run in waveform RAM if required.

Waveform RAM

Each Waveform RAM card contains 1M words of 16 bit waveform RAM. This RAM is refreshed by an on-board counter and logic on the Waveform Processor. Refresh cycles are only granted if no channel accesses are requested. An 8-bit mode is also supported for doubling sample time on low resolution samples.

General Interface Card

This board contains 4 MIDI in/out channels, SMPTE in/out, and synchronization clocks and clicks for the world beyond Fairlight. The music keyboard connects to this via one of the MIDI input channels. A 10MHz 68000 processor unscrambles control frames from key depresses and sends commands directly to the channel cards to play without intervention from the CPU. This processor also plays a major role in running music sequencers.

Audio Output Modules

These plug into the Audio Motherboard from the rear of the CMI Mainframe. Each contains 2 channels of 16 bit DAC, voltage controlled filter and voltage controlled amplifier and line driver. The waveform data come via a single flat cable from the Channel Support card to the Audio Motherboard then along the audio buss to each of the Audio Modules. Control clocks and voltages come directly from the channel cards via individual flat cables terminated in PC-mounting sockets on the Audio Motherboard. A switchable mix facility allows the two channels on each Audio module to be mixed.

Audio Mixer Module

The Mixer plugs into the Audio Motherboard from the rear of the CMI Mainframe and provides a single equally mixed output of all 16 channels to both a line socket and the headphone amplifier.

MIDI Support and SMPTE Support Modules

Both these modules plug into the Audio Motherboard from the rear of the machine. The SMPTE support module contains the analogue I/O circuitry required for SMPTE time code plus an electronic metronome which is controlled by data from the PIA output of the CPU Control Module and whose output is mixed onto the headphone amplifier.

The MIDI support module contains the optical isolation circuitry required for MIDI and provides mounting for the 5pin DIN connectors. Connections from both modules go to a socket on the Audio Motherboard which receives the flat cable connected at the other end to the General Interface Card.

Hardware/Software Relationships

This section gives a summary of the operational concepts involved in each of the CMI's major functions. This information should help relate a particular software function to the appropriate piece of hardware.

SYSTEM OVERVIEW

The software system is divided into two main sections, the resident software and overlays. The resident part is responsible for all the real-time functions such as sound generation, keyboard input processing and graphics pad operation. The overlays are used for the various control and sound manipulation functions provided by the display pages. Changing pages on the CMI loads a new overlay for that page from disk. Some pages use further overlays themselves, so that when certain functions are invoked from a particular page for the first time, a disk access will be made as the overlay is loaded.

Both 6809 processors access 65K bytes of program RAM, switched from the 256K memory board, so that some of the code may be executed by each processor individually, and both processors can share common data structures. Processor 2 carries out the non real-time functions such as disk I/O and graphics display.

The 68000 Waveform Processor is concerned with movement of data into and out of waveform memory and manipulation of data in waveform memory.

The 68000 MIDI Processor is concerned with starting and stopping audio channels.

A broad description of a range of specified functions follows.

System Startup/Boot

When power is first applied to the system, a power-on reset signal is generated for about a half second by a timer located on the Processor Control card, Q133. At the end of this time, both processors fetch restart vectors from EPROMS, also on the Q133 card and start executing the startup procedure in EPROM. Processor 1 initialises all the registers of the peripheral controller devices such as PIAs and ACIAs. Processor 2 initialises the Graphics Display, clears the screen, loads disk driver firmware into system RAM from ROMs on the QFC - 9 and/or Q - 777 controller modules, and displays the LOAD SYSTEM DISK IN DRIVE greeting. While this is happening the processor internal to the Music keyboard also starts up. The Music keyboard LED display first displays the message POWER ON, and then the message SERIES III. Processor 1 then loops, waiting to be triggered by Processor 2, which in turn loops waiting for a disk to be inserted in drive 0, as indicated by the appropriate status bit from the Floppy-disk Controller Card QFC9.

When the system disk has been correctly inserted, processor 2 executes the first stage of the bootstrap loader firmware (located on the Q133 card). This involves reading in the boot block, which is a special sector on the system disk. The code stored in the boot block is then executed which completes the boot load by loading the operating system and the Page 1 overlay. When Page 1 starts up, the message PAGE 1 READY is sent to the music keyboard display.

Disk Operations

The CMI uses one eight-inch double-sided floppy disk drive and one or two 5.25" hard disc drives.

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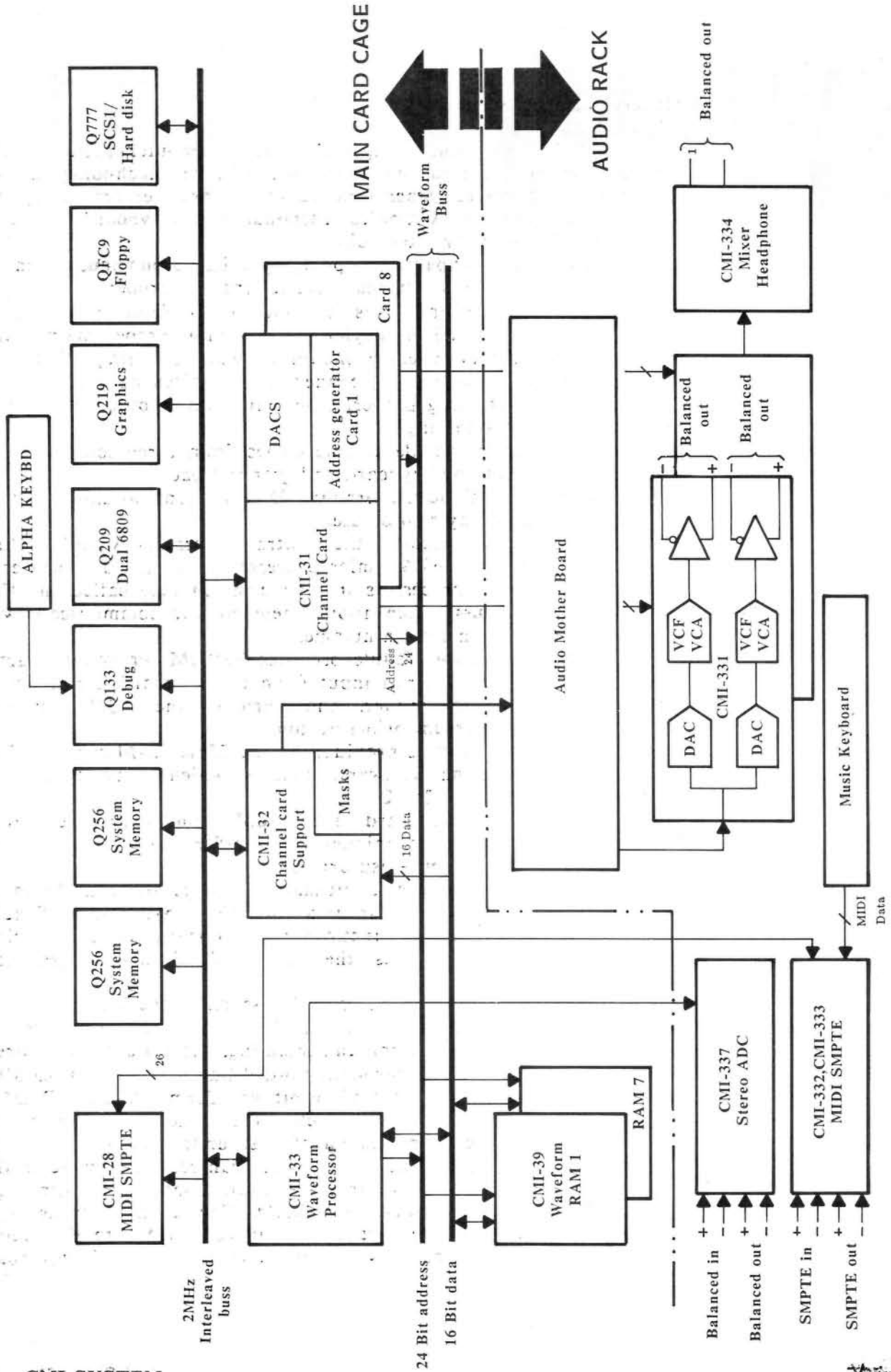
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