MIXER And AUDIO Outputs
The Audio and Mixer outputs are connected via 'XLR' type three pin panel mounted plugs.

Pin No.	Function
1	ground
2	Output -
3	Output +

SAMPLER Input
The Sampler connects via three pin 'XLR' type sockets.

Pin No.	Function
1	ground (floating)
2	Audio Input -
3	Audio Input +

CLOCK out
The CLOCK output socket is a 5 pin 180 degree DIN type connector.

Pin No.	Function
1	Run/Stop
2	ground
3	clock
4	Reset/start
5	no connection

SMPTE IN
This socket is an 'XLR type three pin socket.

Pin No.	Function
1	ground
2	SMPTE in -
3	SMPTE in +

SMPTE out
This connector is a panel mount 'XLR' type three pin plug.

Pin No.	Function
1	ground
2	SMPTE out -
3	SMPTE out +

METRONOME
This is a panel mount three pin 'XLR' type plug.

Pin No.	Function
1	ground
2	ground
3	metronome out

CLICK in
A three pin 'XLR' type socket is used for Click Track input.

Pin No.	Function
1	ground
2	no connection
3	Click Track in

CLICK out
An 'XLR' type three pin panel mount plug is used to connect Click Track out to external devices.

Pin No.	Function
1	ground
2	ground
3	Click Track out

Keyboard Connector
The CMI music and alpha-numeric keyboards connect up via an industry standard 'DB9S' type connector.

Pin No.	Function
1	+20 volts supply for alpha KBD only
2	MIDI from music keyboard +
3	-20 volts supply for alpha KBD only
4	MIDI from music keyboard -
5	Ground
6	RS-232C data to CMI
7	Ground
8	Protective ground
9	Keyboard data from CMI

MIDI Inputs
The MIDI inputs are a standard 5 pin 180 degree DIN type socket.

Pin No.	Function
1	no connection
2	no connection
3	no connection
4	MIDI in +
5	MIDI in -

MIDI Outputs
The MIDI outputs are a standard 5 pin 180 degree DIN type socket.

Pin No.	Function
1	no connection
2	ground
3	no connection
4	MIDI out +
5	MIDI out -

SYNC OUT
The SYNC OUT socket provides 4 sync outputs.

Pin No.	Function
1	sync out 1
2	ground
3	clock out
4	sync out 2
5	sync out 3

Introduction

Presented here is a list of cable connections and their allocated pins so that users may wire up their own cables. external cable connections only are shown, internal cables are presented elsewhere in this manual.

Cable schedule, Power Connections

The CMI is equipped with a standard IEC type three pin mains input power connector. Two pins are for active and neutral 100 to 240 volts AC only with the third being the earth or ground connection.

For feeding external devices a socket version of the IEC type connector is connected to the load side of the CMI mains switch. This provides up to 150VA of switched mains power.

SCSI Connector

The CMI comes equiped with an industry standard 50 way connector for devices on the SCSI bus.

VDU Socket

The VDU socket is a 5 pin 'Belling Lee' type L1904A socket. This feeds the VDU with power and video signals.

Pin no.	Function
1	16 volts AC power supply
2	16 volts AC power supply
3	no connection
4	video signal to monitor
5	video ground

Keyboard Power

The music kayboard receives its power supply from the CMI mainframe via this connector. A 'CANNON' type 7 pin socket is used with the pins allocated as follows:

Pin No.	Function
1	10 volts supply return
2	10 volts supply return
3	+10 volts DC supply
4	+10 volts DC supply
5	-20 volts DC supply
6	20 volts supply return
7	+20 volts supply

Printer 1 and Printer 2

These sockets are for external connection of printers to the CMI. They are industry standard 'DB25S' type connectors.

Pin no.	Function
1	Protective or chassis ground
2	Data out
5	Clear To Send
7	signal ground
20	Data Terminal Ready

1. Connector and signals

(1) I/F board connector: EIA Standard 25-pin cann
(2) Signal description and pin assignment: Shown b

Pin No.	Signal Name	Direction	
1	Protective Ground	—	Chassis ground
2	Transmitted Data (TXD)	Out	Transmitted serial d
3	Received Data (RXD)	In	Received serial data
5	Clear to Send (CTS)	In	This signal must be printer to send data
6	Data Set Ready (DSR)	In	This signal must be the printer to receiv
7	Signal Ground	In	Return path for dat
8	Data Carrier Detect (DCD)	In	This is the same sig and DSR can be ha signal polarity is
11	Reverse Channel (=2nd RTS)	Out	This signal is at the printer is ready to a negative EIA level v accept data entry. Operator can invert the DIP 4-4.
20	Data Terminal Ready (DTR)	Out	
17	TTY-TXD	Out	Low impedance ("M and 24 or X-ON sig and 24 indicates th accept data; High X-OFF signal being is busy. Operator c by the DIP 4-4.
24	TTY-TXD Retrurn	—	
25	TTY-RXD	In	Input data of serial
23	TTY-RXD Return	—	

NOTES:

1. "Direction" refers to the direction of signal flow as vie
2. All signals except TTY-TXD and TTY-RXD are based or

MIDI Outputs
MIDI standard open collector current loop drivers
MIDI standard 5-pin DIN sockets

Multi-Sync Outputs
Four sync outputs, pins 1,3,4 and 5 of the DIN socket
TTL open collector signals

Clock or Drum-machine Controller Output
TTL open collector signals
Compatible with drum machines such as Roland
Pin 1; Run/Halt Pin 2; Earth Pin 3; Clock
Pin 4; Reset/Start Pin 5; n/c

Sampling Inputs
Connector type: Cannon XLR 3 pin
Input signal: Balanced
Sensitivity: -18 dBm required for full scale conversion

DIGITAL
Processors: Dual 6809 CPU
68000 Waveform Processor
68000 General Interface Processor
8 6809 Channel processors

Memory: 512K bytes CPU system RAM
16K Video RAM
512K bytes Waveform Processor Private RAM
64K bytes program RAM on each channel card
16K bytes General Interface Private RAM
2-14M bytes Waveform RAM

Floppy Disk: Mitsubishi M2896-63
8 inch double sided, single/double density
Soft sectored, 128/256 bytes per sector

Hard Disk: 70M or 140M byte (unformatted) expandable as required
SCSI bus compatible

Graphics Display: Bit mapped VRAM 512 x 256 pixels
Composite video output
1 volt p-p nominal
75 ohms impedance

Input/Output: Serial RS232C, 9600 Baud plus MIDI

MECHANICAL
Dimensions: Width 750 mm
Depth 480 mm
Height 345 mm

Weight: 45 kilograms, depending on optioning

ELECTRICAL

Power Requirements
- Mains Voltage: 100-120 or 200-250 switch selectable
- Mains Current: 2 amps @ 240V, 4 amps @ 120v
- Mains Frequency: 50/60 Hz

AUDIO

Channel Outputs
- Connector type: Cannon XLR 3 pin (balanced)
- Number of channels: 16 (maximum per mainframe)
- Output level: +4dBm
- Output impedance: 600 ohms
- Output load: Greater than 600 ohms

Mixed Line Output
- Connector type: Cannon XLR 3 pin (balanced)
- Output level: +4dBm with one channel playing
  Switchable to -20dB attenuation.
- Output impedance: 600 ohms
- Output load: Greater than 600 ohms

Headphone Output
- Connector type: 1/4" Stereo Phones
- Amplifier: Stereo 500mW
- Signal: from mixer output.

Click Input
- Connector type: Cannon XLR 3 pin
- Level: 1 volt (min) to 20 volt (max) p-p
- Frequency range: 200 Hz to 8KHz
- Impedance: 10k ohms

Click Output
- Connector type: Cannon XLR 3 pin
- Output signal : 5 volt square clock

SMPTE Input
- Connector type: Cannon XLR 3 pin
- Level: -20 to +10dBm
- Speed: 24 fps to 30 fps
- Impedance: 10k ohms

SMPTE Output
- Connector type: Cannon XLR 3 pin
- Output signal : +15dBm
- Impedance: 33 ohms

MIDI Inputs
- MIDI standard opto-coupler receivers.
- MIDI standard 5-pin DIN sockets

maximum of 100KHz in mono mode and 50 kHz in stereo mode. The sample rate is governed by the frequency of a pulse stream coming from the Channel Card in channel one position. The sample rate is therefore established by software which sets up channel one to operate at the sampling frequency specified on the Sample Page.

As each digital conversion is made, the digital sample is passed serially to the waveform processor via a 10 way cable, and thence to waveform memory. When the **Sample** command is issued, the waveform processor starts conversions and loops until the data read is of a greater absolute value than the number specified as **Trigger Level**. It then begins transferring data to the waveform RAM, until the number of samples made is equal to the number specified as **Sample Number**.

Playing Music from the Keyboard

Three byte MIDI frames are transmitted serially from the CMI music keyboard to the Port D ACIA on the CMI - 332 MIDI Support Module. At present Fairlight keyboard MIDI is confined to MIDI Channel 1. When other MIDI keyboards are used they can be configured to transmit through channels 1 to 16 of Ports A, B and C on the CMI - 332. MIDI frames then pass to the CMI - 28 General Interface card. The CMI - 28 is concerned with starting and stopping output channels. When MIDI data comes directly from the music keyboard, Processors 1 & 2 are not involved.

Music Keyboard Functions

As well as sending music key depression/release data to the mainframe, the music keyboard has a number of ancillary functions.

A multiplexed analog-to-digital converter samples the level of the three faders and two control wheels on the left-hand end of the keyboard as well as the three pedal inputs on the rear. Whenever one of these changes its level by more than a certain amount, a packet of MIDI control data is transmitted to the Mainframe giving the device number and the new level.

The two switches on the left of the keyboard and the three switches which plug into the rear of the keyboard are also scanned, and when any of these are opened or closed, suitable MIDI data is sent to the Mainframe.

Pressing a key on the numeric keypad on the right-hand end of the keyboard sends a character to the Mainframe in exactly the same way as an alphanumeric key depression.

The alphanumeric LED display on the music keyboard is driven by the serial link coming from the Mainframe. The processor in the keyboard controls the displaying of individual characters as well as <rubout> and <clear>. When messages longer than the 12 digits of the display are required, a horizontal scrolling routine in the CMI system software is used.

Playing Programmed Music Sequences

When programmed sequences are played, P1 and P2 are involved. Data is read from disk and converted into MIDI frames and timing information. The MIDI data is fed into the MIDI input queue of the CMI - 28, and output under the control of the timing information.

Floppy disk

Floppy disk format is soft sectored, 128 bytes per sector (single density), or 256 bytes per sector (double density). FM recording is used for extra reliability. The floppy drive itself is controlled by a Western Digital WD1791 L.S.I. controller located on the Floppy Disk Controller Card QFC9.

The Floppy disk driver EPROM is located on the QFC9 card. Routines in this EPROM provides utilities including read sector, write sector, and verify C.R.C. which are called by the RAM-resident disk-operating system.

In the event of a disk error being detected during a read or write operation, the software will perform a number of re-tries, including head relocation, to try to recover from the error. If the error persists, an error message is displayed.

Hard disk

The hard disk is controlled by the Q777 SCSI TSmall Computer Systems Interface) card. The hard disk driver firmware is located on the Q777 card. Hard disks are 85 Meabyte or 140 Megabyte, expandable as required.

Graphics Display, Graphics Pad

The graphics display is generated by writing a bit-mapped image to the dedicated 16K byte VRAM. This block of RAM is mapped in and out of the processor memory space under software control. The graphics pad sends special format ASCII characters through the same path as normal ASCII characters from the alphanumeric keyboard. These are then converted into graphics coordinates, and VRAM addresses, in software, which also generates the graphics pad cursor.

Command entry

Data arriving from the alpanumeric keyboard is fed to the ACIA on the Q133 Processor control card. Alphanumeric characters are passed to Processor P2. They are then processed by the OS9 Operating System.

Loading/Saving Sounds

Sounds are stored on hard disk. Each voice file occupies up to 14 megabytes of disk space. The Voice files and other user files are stored in the directory /CMIF/CMIFILES. When a file is loaded, the directory is searched and the address of the file found. The Voice is then DMA'd into the system memory under the control of Processor 2, and DMA'd from the system memory through to the waveform buss via the waveform processor. *Saving sounds to disk operates by the reverse process.*

Sound Sampling

Audio input for sampling is fed to either or both of the Right and Left Line Inputs at the rear of the CMI III. The CMI - 337 Sample card performs the analogue to digital conversion. There is a single analogue to digital conversion circuit, which switches between left and right channels during stereo conversions. The sampling rate is a

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 diplays 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.

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.

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 used 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, 256 k 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.

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.

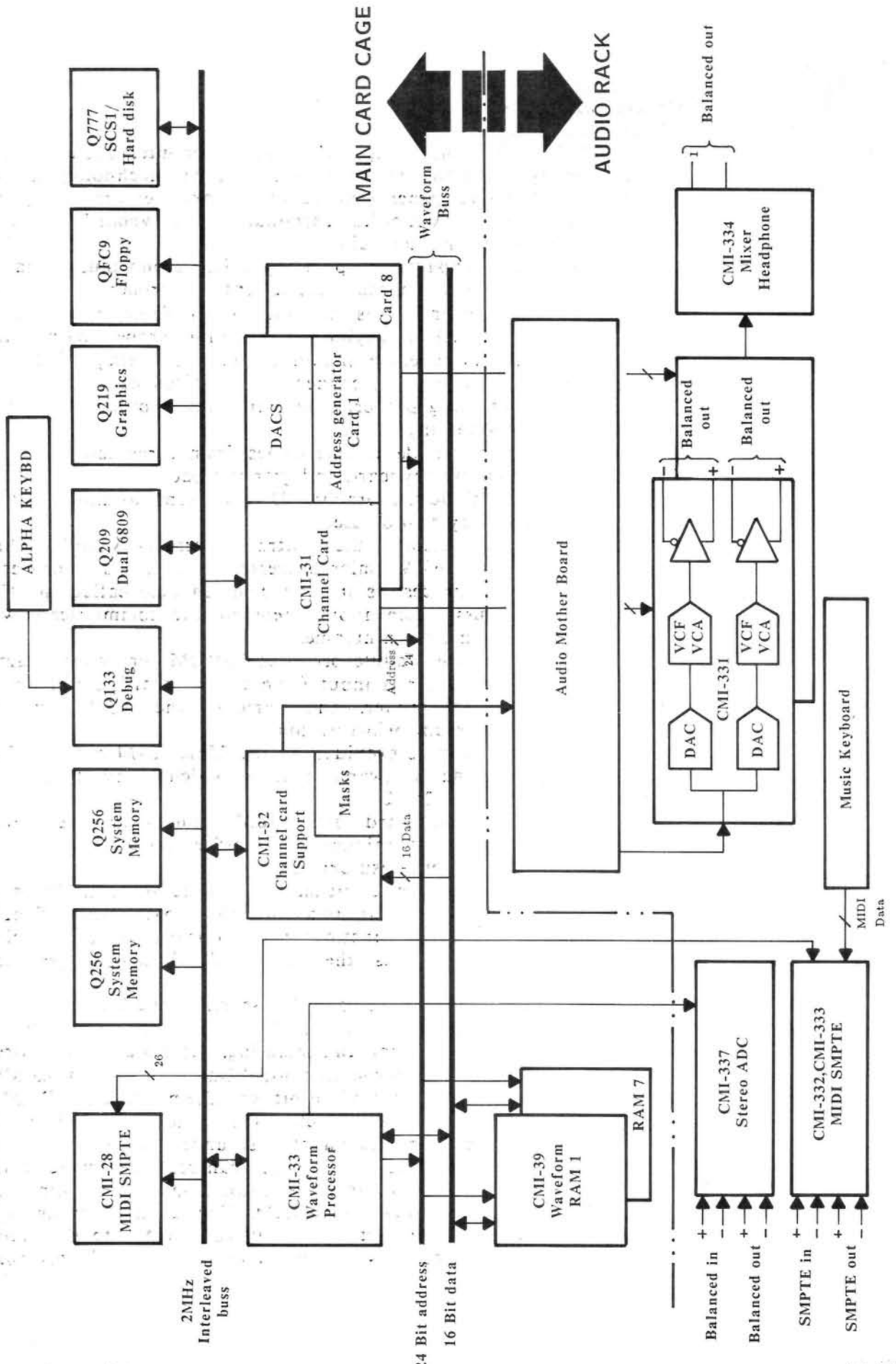
The Processor Control Module provides EPROM for system startup and bootstrap, RS-232C serial input from the keyboard, serial output to the keyboard and printer, and various other CPU support functions such as interrupt prioritisation.

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


MAIN CARD CAGE
AUDIO RACK
Waveform Buss
Q777 SCS1/ Hard disk
QFC9 Floppy
Q219 Graphics
Q209 Dual 6809
ALPHA KEYBD
Q133 Debug
Q256 System Memory
Q256 System Memory
CMI-28 MIDI SMPTE
CMI-33 Waveform Processor
CMI-32 Channel card Support
Masks
CMI-31 Channel Card
DACS
Address generator Card 1
Card 8
Address 24
16 Data
26
CMI-39 Waveform RAM 1
RAM 7
Audio Mother Board
CMI-334 Mixer Headphone
Balanced out
Balanced out
Balanced out
VCF VCA
VCF VCA
CMI-331
DAC
DAC
Music Keyboard
MIDI Data
CMI-337 Stereo ADC
CMI-332,CMI-333 MIDI SMPTE
2MHz Interleaved buss
24 Bit address
16 Bit data
Balanced in
Balanced out
SMPTE in
SMPTE out

CMI System 1

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