

# Record of Revision

---

Each time this manual is updated with a change packet, a change to part of a text page is indicated by a change bar in the margin directly opposite the change. A change bar in the footer of a text page indicates that most, if not all, of the text is new. A change bar in the footer of a page composed primarily of a table and/or figure may indicate that a change was made to that table/figure or, it could indicate that the entire table/figure is new. Change packets are assigned a numerical designator, which is indicated in the publication number on each page of the change packet.

Each time this manual is fully revised and reprinted, all change packets to the previous version are incorporated into the new version, and the new version is assigned an alphabetical revision level, which is indicated in the publication number on each page of the manual. A revised manual does not usually contain change bars.

---

REVISION	DESCRIPTION
	April 1992. Original printing.
A	March 1993. This revision includes extensive IOS changes, detailed peripheral error and troubleshooting information, and additional field repair procedures.
B	August 1993. This revision incorporates information about the CRAY EL98 system; in addition, the remote support information was completely revised. This revision replaces CMM-0431-0A0.
B1	March 1994. This change packet incorporates the memory HIPPI and new peripherals DD-5S and DS-3. It also includes revisions to the DD-4 control board and updates Remote Support cabling information.
B2	June 1994. This change packet includes revisions to field replacement procedures (FRPs) 13, 19, 21, and 23.
B3	December 1994. This change packet incorporates information about the new peripheral DD-5I.
B4	September 1995. This change packet corrects <code>mfdump</code> command information in the "UNICOS Dumps" subsection in Section 4.



# PREFACE

The *CRAY EL Series Troubleshooting and Maintenance Manual* includes detailed information about the architecture of the major components of the CRAY Y-MP EL and the CRAY EL98 systems, the peripheral devices, and operations within the system. Troubleshooting and remote support information, as well as field replacement procedures, are provided. The appendix contains the instruction set for the CRAY Y-MP EL and CRAY EL98 systems.

## Notational Conventions

---

The following conventions are used throughout this manual:

**Courier** type indicates directory pathnames, filenames, commands, and screen output.

**Courier bold** type indicates commands, options, and field inputs that you should enter.

The following conventions are used for command usage descriptions:

- The  $\leftarrow$  symbol indicates pressing the return key.
- The  $\longrightarrow$  symbol indicates holding the MENU mouse button down and moving the mouse pointer to the next menu item.
- Commands must be entered as shown in the command syntax. Spaces must be included or left out as shown; do not use tabs.
- Square brackets [ ] indicate an optional entry.
- Angle brackets < > indicate a required entry.
- A vertical bar | indicates a choice.

<u>Convention</u>	<u>Description</u>
Lowercase <i>italic</i>	Variable information.
x	An unused value.
n	A specified value.
(value)	The contents of the register or memory location designated by value.
Register bit designators	Register bits are numbered from right to left as powers of 2. Bit $2^0$ corresponds to the least significant bit of the register. One exception is the vector mask register. The vector mask register bits correspond to a word element in a vector register; bit $2^{63}$ corresponds to element 0 and bit $2^0$ corresponds to element 63. Another exception is when the state of the 32 1-bit semaphore registers is loaded into an S register. SM0 goes into S register bit position $2^{63}$ , SM1 goes into S register bit position $2^{62}$ , and so on.
Number base	All numbers used in this manual are decimal, unless otherwise indicated. Octal numbers are indicated with an 8 subscript. Exceptions are register numbers, the instruction parcel in instruction buffers, and instruction forms, which are given in octal without the subscript.

The following list provides examples of the preceding conventions.

<u>Example</u>	<u>Description</u>
Transmit ( <i>Ak</i> ) to <i>Si</i>	Transmit the contents of the A register specified by the <i>k</i> field to the S register specified by the <i>i</i> field.
167 <i>ixk</i>	Machine instruction 167. The x indicates that the <i>j</i> field is not used.
Read n words from memory	Read a specified number of words from memory.
Bit $2^{63}$	The value represents the most significant bit of an S register or element of a V register.
1000 <sub>8</sub>	The number base is octal.

# CONTENTS

## 1 SYSTEM OVERVIEW

---

Peripheral Device Options .....	1-3
Processor Overview .....	1-5
Memory Overview .....	1-7
Input/Output Subsystem Overview .....	1-10
The Maintenance SCSI .....	1-11
System Console .....	1-12
Maintenance Workstation .....	1-12

## 2 PROCESSING UNIT

---

ASIC Descriptions .....	2-2
Processor Module Description/Differences .....	2-3
Processor Control .....	2-13
The Exchange Mechanism .....	2-13
The Exchange Package .....	2-15
Processor Number Field .....	2-16
Program Address Register Field .....	2-16
Syndrome Field .....	2-16
Read Address Bank Field .....	2-16
Read Address Chip Select Field .....	2-16
Read Error Type Field .....	2-17
Port Field .....	2-17
Read Mode Field .....	2-17
Data Base Address Register Field .....	2-18
Data Limit Address Register Field .....	2-18
Instruction Base Address Register Field .....	2-19
Instruction Limit Address Register Field .....	2-19
Exchange Address Register Field .....	2-19
Vector Length Register Field .....	2-19
Cluster Number Register Field .....	2-19
Vector Not Used Field .....	2-20

## 2 PROCESSING UNIT (continued)

---

Waiting for Semaphore Field .....	2-20
Concurrent Block Writes Bit .....	2-20
Scalar Block Overlap Bit .....	2-20
Exchange .....	2-21
Fetch .....	2-23
Instruction Fetch Operation .....	2-25
Instruction Issue .....	2-26
Reservations and Hold Issue Conditions .....	2-30
Interprocessor Communications .....	2-31
Clusters .....	2-31
Shared Registers .....	2-32
Semaphore Registers .....	2-32
Deadlock .....	2-33
Interprocessor Interrupts .....	2-34
Real-time Clock .....	2-34

## 3 MEMORY

---

Memory Configurations .....	3-2
Memory Addressing .....	3-4
DRAM Specifications .....	3-4
Memory ASIC Description .....	3-5
Memory Organization .....	3-9
Memory Paths .....	3-9
Memory Ports .....	3-10
Memory Conflicts .....	3-12
Memory Access Time .....	3-15

## 4 INPUT/OUTPUT SUBSYSTEM

---

Basic Architecture .....	4-1
IOS Communications Paths .....	4-4
VME IOS Priority Scheme .....	4-7
Heurikon HK68/V30 .....	4-8
SCSI Controller .....	4-8

## 4 INPUT/OUTPUT SUBSYSTEM (continued)

---

Serial Ports .....	4-9
Input/Output Buffer Board .....	4-9
I/O IOTCB Format .....	4-10
IOBB Memory Address .....	4-11
CRAY EL Series Memory Address .....	4-11
Length .....	4-11
Next IOTCBptr .....	4-12
CONSOLE IOTCB Format .....	4-12
IOS Error Types and Explanations .....	4-13
IOS Panics .....	4-13
UNICOS Panics .....	4-14
IOS Exception Faults .....	4-14
System Dumps .....	4-15
IOS Dumps .....	4-15
UNICOS Dumps .....	4-16
Command Input Channel .....	4-16
Command Output Channel .....	4-17
Data Channel (Input and Output) .....	4-18
Communications .....	4-19
Y1 Bus Interface .....	4-20
Y1 Bus Signal Descriptions .....	4-21
Request Signal .....	4-22
Connect Signal .....	4-22
CC_DAT_STB .....	4-23
Burst Plus Signal .....	4-23
IOBB_DAT_STB Signal .....	4-23
Data Bus and Data Bus Parity Signals .....	4-23
Perr Signal .....	4-23
Attention and Vector Signals .....	4-24
IOTCB Pend Interrupt Signal .....	4-24
Reset Signal .....	4-24
Y1 Bus Pin Assignments .....	4-25
Y1 Bus Channel Operations .....	4-26
IOSNET .....	4-27
IOS-supported Peripheral Controllers .....	4-28

## 4 INPUT/OUTPUT SUBSYSTEM (continued)

---

Heurikon Corporation HK68/V30 VME IOP .....	4-29
DC-4 Disk Drive Controller .....	4-33
Controller Address Jumpers for Xylogics SV7800 IPI Controller .....	4-34
HYPERchannel Controller HI-1 .....	4-35
TC-2 Pertec Tape Controller .....	4-37
ESDI Disk Drive Controller DC-3 (CIPRICO Rimfire 3411) .....	4-40
CIPRICO Rimfire 3564 (SI-1) SCSI Host Bus Adapter .	4-43
Interphase Corporation V/FDDI 4211 Peregrine FI-1 ...	4-47
CMC-130 Series Ethernet Controller EI-1 .....	4-50
Maximum Strategy, Inc. Strategy 2 Disk Array Controller (DAC) .....	4-53
PROM and RAM Execution Level .....	4-62

## 5 PERIPHERAL DEVICES

---

Naming Conventions .....	5-3
IOS Error Log .....	5-4
Disk Maintenance Information .....	5-7
Flaw Handling for DD-3 and DD-4 Disks .....	5-7
Flaw Management Commands .....	5-8
Disk Array Subsystem and DD-3 Block Assignment ...	5-9
Disk Array Subsystem (DAS) Overview Information ...	5-10
DAS Flawmaps and Maintenance Commands ..	5-10
IOS Kernel Support Features for the DAS .....	5-11
Replacing a Failed Spindle within a DAS .....	5-13
Reconstructing Data to a Replacement Spindle Using IOS Kernel Commands .....	5-14
Reconstructing Data to a Replacement Spindle Using the DAC COM Port .....	5-15
TD-2 Tape Drive .....	5-18
TD-2 Operator Functions .....	5-18
TD-3 Tape Drive .....	5-23
Disk Array Controller .....	5-26
DataShuttle 2100 DR-1 Removable Disk Drive .....	5-31



## 5 PERIPHERAL DEVICES (continued)

---

Rear Panel Assembly .....	5-33
DD-3 (ESDI) Disk Drive .....	5-41
DD-4 (IPI) Disk Drive .....	5-48
DD-4 Installation and Addressing .....	5-49
DD-4 Power Supply .....	5-51
Setting the Circuit Board Switches .....	5-51
Identifying Switches on the I/O Board .....	5-54
Control Board Switch Identification .....	5-54
EXABYTE EXB-8500 8-mm Cartridge Tape Subsystem (EX-2) .....	5-55
Setting the SCSI ID with the DIP Switches .....	5-56
Anaconda 2800 Tape Drive .....	5-57
Unloading a Cartridge (Manual Operation) .....	5-58
Seagate Swift ST1239N Hard Disk Drive .....	5-60
MDB-500 DataCartridge DR-2 .....	5-60

## 6 POWER AND CONTROL SYSTEMS

---

Voltage Hazards .....	6-4
Power Circuit Troubleshooting Hints and Procedures .....	6-12
High Voltage DC Faults .....	6-12
Inhibit Faults .....	6-12
Input AC Circuit Breaker Tripping .....	6-13
Breaker Tripping Immediately .....	6-13
Breaker Tripping Intermittently .....	6-15
Processor Module and Memory Power Supplies .....	6-15
VME Power Supply .....	6-16
Bulk Converter .....	6-16
Control Panel/EPO Button .....	6-16
Control System .....	6-17
Monitoring Panel .....	6-20

## 7 FIELD REPLACEMENT PROCEDURES

---

Hazard Statements .....	7-1
-------------------------	-----

## 7 FIELD REPLACEMENT PROCEDURES (continued)

---

Safety Precautions .....	7-1
ESD Precautions .....	7-3
ESD Smock .....	7-3
Wrist Strap .....	7-3
ESD Shoes .....	7-3
Powering Up the CRAY EL Series System .....	7-4
Powering Down the CRAY EL Series System .....	7-8
Removing the Front Panel Assembly .....	7-9
Replacing the Front Panel Assembly .....	7-12
Opening or Removing the Side Panels .....	7-13
Closing or Replacing the Side Panels .....	7-14
Removing the Back Panel Assembly .....	7-15
Replacing the Back Panel Assembly .....	7-16
Removing the IOS VME Boards .....	7-17
Replacing the IOS VME Boards .....	7-19
Removing the IOS VME Card Cage .....	7-20
Replacing the IOS VME Card Cage .....	7-25
Removing the IOS VME Power Supply .....	7-27
Replacing the IOS VME Power Supply .....	7-30
Removing the CPU and Memory Boards .....	7-31
Removing the CRAY EL98 CPU and Memory Boards ..	7-33
Replacing the CPU and Memory Boards .....	7-35
Replacing the CRAY EL98 CPU and Memory Boards ..	7-35
Removing the Clock Module .....	7-37
Replacing the Clock Module .....	7-38
Removing the CPU Card Cage .....	7-39
Replacing the CPU Card Cage .....	7-43
Removing the CPU and Memory Power Supplies .....	7-44
Replacing the CPU and Memory Power Supplies .....	7-46
Removing the Bulk Converter .....	7-47
Replacing the Bulk Converter .....	7-51
Removing the Capacitor Bank .....	7-53
Replacing the Capacitor Bank .....	7-56
Removing the Incoming Power Module .....	7-58
Replacing the Incoming Power Module .....	7-62

## 7 FIELD REPLACEMENT PROCEDURES (continued)

---

Removing the Control Panel .....	7-64
Replacing the Control Panel .....	7-66
Removing the Lower Fan Tray .....	7-67
Replacing the Lower Fan Tray .....	7-69
Removing the Upper Fan Tray .....	7-70
Replacing the Upper Fan Tray .....	7-72
Removing the Maintenance SCSI Peripheral Devices .....	7-73
Removing the Helical Scan Cartridge Drive .....	7-75
Removing the Hard Disk Drive .....	7-75
Removing the Streaming Tape Drive .....	7-76
Replacing the Maintenance SCSI Peripheral Devices .....	7-79
Replacing the Helical Scan Cartridge Drive (EX-2) ....	7-79
Replacing the Hard Disk Drive .....	7-79
Replacing the Streaming Tape Drive .....	7-80
Replacing the SCSI Assembly .....	7-80
Removing the Disk Array Controller (DAC) Boards .....	7-82
Replacing the Disk Array Controller (DAC) Boards .....	7-85
Removing the PE-3 Tray Power Supply .....	7-86
Replacing the PE-3 Tray Power Supply .....	7-90
Removing the DD-3 Disk Drive .....	7-91
Replacing the DD-3 Disk Drive .....	7-94
Keying the DR-1 Replacement Drive .....	7-95
Removing the DD-4 Disk Drive .....	7-98
Replacing the DD-4 Disk Drive .....	7-101
Removing the DD-4 Disk Drive Power Supply .....	7-102
Replacing the DD-4 Disk Drive Power Supply .....	7-103
Separating a Multicabinet System .....	7-104
Reconnecting a Multicabinet System .....	7-105
Performing a Safety Voltage Check .....	7-106
Removing a TD-2 Tape Drive .....	7-107
Replacing a TD-2 Tape Drive .....	7-111
Removing a TD-3 Tape Drive .....	7-113
Replacing a TD-3 Tape Drive .....	7-115
Removing the Power Cord Assembly .....	7-117
Replacing the Power Cord Assembly .....	7-122

## 7 FIELD REPLACEMENT PROCEDURES (continued)

---

Removing the Power Cord Assembly from Multicabinet Systems	7-124
Replacing the Incoming Power Cord Assembly in Multicabinet Systems .....	7-127
Removing the MAB .....	7-129
Replacing the MAB .....	7-131
Removing the Scan Adapter Board .....	7-132
Replacing the Scan Adapter Board .....	7-135
Removing the Y1 Channel Board .....	7-136
Replacing the Y1 Channel Board .....	7-138

## 8 REMOTE SUPPORT

---

The Remote Support System .....	8-1
On-site Hardware Configuration .....	8-2
Telebit NetBlazer Router .....	8-2
Microcom Modem .....	8-8
WYSE Terminal .....	8-9
Sun-4 Workstation and MWS-EL .....	8-11
Remote Support Configurations on an EL Site .....	8-13
Configuration 1 .....	8-13
Configuration 2 .....	8-14
Configuration 3 .....	8-15
Part Number Information for Remote Support Systems .	8-16
Software Configuration .....	8-21
Setting up the Microcom Modem .....	8-21
Establishing Remote Connections .....	8-22
Telnet Session .....	8-22
Starting MME from a Service Center through a Hub ...	8-23

## APPENDIX: CRAY EL SERIES INSTRUCTION SET

---

## FIGURES

---

Figure 1-1.	Left Side View (Maximum Configuration) . . . . .	1-2
Figure 1-2.	CRAY EL Series Computer System (Right Side View) . . . . .	1-2
Figure 1-3.	Chassis, Top View . . . . .	1-9
Figure 1-4.	IOS Configuration . . . . .	1-11
Figure 2-1.	CRAY EL Series Block Diagram . . . . .	2-5
Figure 2-2.	Primary CPU Bus Block Diagram . . . . .	2-7
Figure 2-3.	Secondary CPU Bus Block Diagram . . . . .	2-9
Figure 2-4.	Primary Processor Module . . . . .	2-11
Figure 2-5.	Secondary Processor Module . . . . .	2-12
Figure 2-6.	Exchange Package . . . . .	2-14
Figure 2-7.	Instruction Fetch Hardware . . . . .	2-23
Figure 2-8.	P Register . . . . .	2-24
Figure 2-9.	Instruction Issue . . . . .	2-26
Figure 2-10.	Instruction Flow, 1-Parcel Instruction . . . . .	2-27
Figure 2-11.	Instruction Flow, 2-Parcel Instruction . . . . .	2-27
Figure 2-12.	Instruction Flow, 3-Parcel Instruction . . . . .	2-28
Figure 2-13.	Instruction Flow, 2-Parcel Instruction (2 Instructions) . . . . .	2-28
Figure 2-14.	Instruction Flow, 2-Parcel Instruction (2 Instructions - Next Instruction Load) . . . . .	2-29
Figure 2-15.	Instruction Flow, 3-Parcel Instruction (2 Instructions) . . . . .	2-29
Figure 2-16.	Instruction Flow, 3-Parcel Instruction (2 Instructions - Next Instruction Load) . . . . .	2-30
Figure 2-17.	Relationship between Semaphore Registers and an S Register . . . . .	2-33
Figure 3-1.	Fully Populated Memory Module . . . . .	3-3
Figure 3-2.	Address Bit Assignments . . . . .	3-4
Figure 3-3.	Processor Slot Configuration, Front View . . . . .	3-5
Figure 3-4.	Memory Block Diagram . . . . .	3-7
Figure 3-5.	Central Memory Architecture . . . . .	3-9
Figure 3-6.	Flow for Memory Port Arbitration . . . . .	3-14
Figure 4-1.	Example of VMEbus Card Cage . . . . .	4-3

## FIGURES (continued)

---

Figure 4-2.	IOBB Block Diagram .....	4-10
Figure 4-3.	I/O IOTCB Format .....	4-11
Figure 4-4.	CONSOLE IOTCB Format .....	4-12
Figure 4-5.	IOBB Communication .....	4-20
Figure 4-6.	Y1 Bus Signal Descriptions .....	4-21
Figure 4-7.	IOP Daisy Chain Configuration .....	4-28
Figure 4-8.	HK68/V30 Block Diagram .....	4-31
Figure 4-9.	Heurikon HK68/V30 Rev. 2 Jumper Locations ...	4-32
Figure 4-10.	SV-7800 Jumper Locations .....	4-34
Figure 4-11.	PI492 Board Configuration .....	4-36
Figure 4-12.	Tapemaster 3000 Switch and Jumper Locations ..	4-38
Figure 4-13.	TM3000 Jumper Assignments .....	4-39
Figure 4-14.	Jumper Wire Locations and Designations for CIPRICO RF3411 .....	4-41
Figure 4-15.	ESDI System Disk Controller (CIPRICO RF3411)	4-42
Figure 4-16.	Block Diagram of Rimfire RF3564 .....	4-44
Figure 4-17.	Locations of Rimfire RF3564 Jumpers .....	4-45
Figure 4-18.	CIPRICO 3564 SCSI Controller .....	4-46
Figure 4-19.	V/FDDI 4211 Peregrine Board Layout .....	4-48
Figure 4-20.	V/FDDI 4211 Block Diagram .....	4-49
Figure 4-21.	CMC-130 Block Diagram .....	4-51
Figure 4-22.	Ethernet Interface Jumper Locations .....	4-52
Figure 4-23.	VME Array Controller Configuration (Bus Master)	4-54
Figure 4-24.	14-inch Rear Chassis Panel, DAC Chassis .....	4-55
Figure 4-25.	Drive Connector Block Cable Configuration (14-inch Chassis) .....	4-56
Figure 4-26.	Drive Interface Cabling (14-inch Chassis) .....	4-57
Figure 4-27.	User Interface Connector Blocks (14-inch Chassis)	4-58
Figure 4-28.	User Interface Cabling (14-inch Chassis) .....	4-59
Figure 4-29.	AB Power Supply and Fan Wiring .....	4-60
Figure 4-30.	Power Supply Wiring Diagram (14-inch Chassis) .....	4-61

## FIGURES (continued)

---

Figure 5-1.	Example of Cabinet Layouts for the CRAY EL Series System .....	5-2
Figure 5-2.	Disk Device Naming Conventions .....	5-3
Figure 5-3.	Tape Device Naming Conventions .....	5-4
Figure 5-4.	Operator Panel .....	5-19
Figure 5-5.	Basic TD-3 Menus with a SCSI Interface .....	5-25
Figure 5-6.	DAC (Exploded View) .....	5-27
Figure 5-7.	DAC Printed Circuit Board Locations .....	5-28
Figure 5-8.	ESDI DK516 DAS SZ963 PCB Layout .....	5-30
Figure 5-9.	DataShuttle Chassis (Top View) .....	5-32
Figure 5-10.	DataShuttle Front Panel Assembly .....	5-33
Figure 5-11.	DataShuttle Rear Panel Assembly .....	5-34
Figure 5-12.	Master Control Board Jumper and Switch Locations for the DataShuttle .....	5-35
Figure 5-13.	DR-1 Keying Process (Cabinet 1) .....	5-37
Figure 5-14.	DR-1 Keying Process (Cabinet 2) .....	5-38
Figure 5-15.	DR-1 Keying Process (Cabinet 3) .....	5-39
Figure 5-16.	DR-1 Keying Process (Cabinet 4) .....	5-40
Figure 5-17.	ESDI DK516 System SZ963 PCB Layout .....	5-42
Figure 5-18.	Terminator Module and Terminator Switch I .....	5-43
Figure 5-19.	Terminator Switch II .....	5-43
Figure 5-20.	Jumper Setting for Drive Address .....	5-44
Figure 5-21.	Jumper Setting for Write Protect .....	5-44
Figure 5-22.	Jumper Setting for Synchronized Spindle Mode Select .....	5-45
Figure 5-23.	Jumper Setting for Spindle Motor Control .....	5-45
Figure 5-24.	Jumper Setting for Sector Mode Select .....	5-46
Figure 5-25.	Jumper Setting for Sector Length .....	5-47
Figure 5-26.	I/O Cable Location .....	5-49
Figure 5-27.	DD-4 (IPI) Disk Device Naming Conventions ...	5-50
Figure 5-28.	DD-4 (IPI) Disk Drive .....	5-50
Figure 5-29.	DD-4 Power Supply .....	5-51
Figure 5-30.	Setting the DD-4 Circuit Board Switches .....	5-53

## FIGURES (continued)

---

Figure 5-31.	I/O Board Switches .....	5-54
Figure 5-32.	Control Board Switch Identification (Drive Addressing) .....	5-55
Figure 5-33.	Connectors and Controls on the Back Panel of the EXB-8500 .....	5-56
Figure 5-34.	Anaconda Logic Block Diagram .....	5-57
Figure 5-35.	Anaconda Firmware Modules .....	5-58
Figure 5-36.	Anaconda Tape Drive .....	5-59
Figure 5-37.	DR-2 Jumper Settings .....	5-62
Figure 5-38.	CRAY EL Series DR-2 Disk Drive .....	5-63
Figure 6-1.	Incoming AC Module .....	6-1
Figure 6-2.	AC Distribution .....	6-2
Figure 6-3.	12-Vdc Distribution .....	6-5
Figure 6-4.	High-voltage DC Distribution (380 Vdc) .....	6-6
Figure 6-5.	Plug Assignments .....	6-8
Figure 6-6.	Front Vertical Wireway (Control Panel Side) Distribution Plug Assignments .....	6-10
Figure 6-7.	Rear Vertical Wireway Distribution Plug Assignments .....	6-11
Figure 6-8.	Power Fault Flow .....	6-14
Figure 6-9.	Control Panel Door .....	6-17
Figure 6-10.	EPO Button .....	6-19
Figure 6-11.	Control Panel .....	6-20
Figure 6-12.	Control Panel Warning and Ready Indicators ....	6-21
Figure 7-1.	CRAY EL Series Control Panel LEDs .....	7-6
Figure 7-2.	EPO Button .....	7-7
Figure 7-3.	CRAY EL Series Circuit Breakers .....	7-7
Figure 7-4.	Two-piece Front Panel .....	7-10
Figure 7-5.	Front Panel Spring Catch (1 per Corner) .....	7-10
Figure 7-6.	Panel-mounting Screw .....	7-11
Figure 7-7.	Inner Front-panel EMI Shield .....	7-11
Figure 7-8.	Side Panel Latch .....	7-13
Figure 7-9.	Inner Back-panel EMI Shield .....	7-15



## FIGURES (continued)

---

Figure 7-10.	IOS VME Boards .....	7-18
Figure 7-11.	IOS VME Card Cage .....	7-22
Figure 7-12.	SCSI Subassembly .....	7-23
Figure 7-13.	Vertical Wireway .....	7-23
Figure 7-14.	Cable Carrier .....	7-24
Figure 7-15.	VME Power Supply Drawer .....	7-29
Figure 7-16.	Removing the CRAY Y-MP EL CPU Board .....	7-32
Figure 7-17.	MAB Caution Sticker .....	7-33
Figure 7-18.	CRAY EL98 Memory Arbitration Bus .....	7-34
Figure 7-19.	Clock Module Frequency Cable .....	7-37
Figure 7-20.	CPU Card Cage .....	7-41
Figure 7-21.	CPU Card Cage Power Plugs and Wireway Cable Carrier .....	7-42
Figure 7-22.	CPU and Memory Power Supplies - Top View ...	7-45
Figure 7-23.	Bulkhead Connectors .....	7-49
Figure 7-24.	Bulkhead-retaining Screws .....	7-50
Figure 7-25.	Back Capacitor-bank Access Plate .....	7-54
Figure 7-26.	Capacitor Bank Connectors .....	7-55
Figure 7-27.	Incoming Power Module Connectors and Data Cable .....	7-59
Figure 7-28.	Incoming Power Module Back Cover .....	7-60
Figure 7-29.	Incoming Power Module Terminal Block .....	7-61
Figure 7-30.	Cable Strain-relief Device .....	7-61
Figure 7-31.	Control Panel .....	7-65
Figure 7-32.	Control Panel Cables and Connectors .....	7-65
Figure 7-33.	Left Lower Fan Tray .....	7-68
Figure 7-34.	Lower Fan-tray Cable Carrier .....	7-68
Figure 7-35.	Top Fan-tray Perforated Cover .....	7-71
Figure 7-36.	IOS VME Card Cage .....	7-74
Figure 7-37.	SCSI Subassembly .....	7-75
Figure 7-38.	Removing EX-2 Bracket Upper Screws .....	7-76
Figure 7-39.	Removing EX-2 Bracket Lower Screws .....	7-77

## FIGURES (continued)

---

Figure 7-40.	SCSI Hard Drive and Streaming Tape Drive Screws .....	7-78
Figure 7-41.	DAC Controller Assembly .....	7-83
Figure 7-42.	DAC Controller Board Configuration .....	7-84
Figure 7-43.	PE-3 Tray .....	7-87
Figure 7-44.	Disk Tray Cover .....	7-88
Figure 7-45.	PE-3 Power Supply Front Plugs .....	7-88
Figure 7-46.	PE-3 Power Supply .....	7-89
Figure 7-47.	DD-3 Top Cover .....	7-92
Figure 7-48.	DD-3 Cables .....	7-92
Figure 7-49.	DD-3 Drive Handle .....	7-93
Figure 7-50.	DR-1 DataShuttle Screws .....	7-96
Figure 7-51.	DR-1 DataShuttle (Inside Back View) .....	7-97
Figure 7-52.	DR-1 Keying Example .....	7-97
Figure 7-53.	PE-4 Drawer .....	7-98
Figure 7-54.	PE-4 Drawer Trim .....	7-99
Figure 7-55.	IPI Drives and Ribbon Cables .....	7-100
Figure 7-56.	TD-2 Tape Drive Logic Board Cover .....	7-108
Figure 7-57.	TD-2 Tape Drive Ribbon Cables .....	7-109
Figure 7-58.	TD-2 Tape Drive Cable Carrier .....	7-110
Figure 7-59.	TD-3 Tape Drive Front View .....	7-113
Figure 7-60.	TD-3 Tape Drive Retaining Screws .....	7-114
Figure 7-61.	Incoming Power Module Connectors and Data Cable .....	7-118
Figure 7-62.	Incoming Power Module Back Cover .....	7-119
Figure 7-63.	Incoming Power Module Terminal Block .....	7-120
Figure 7-64.	Outgoing Power Cable .....	7-120
Figure 7-65.	Cable Strain-relief Device and Strain-relief Pliers .....	7-121
Figure 7-66.	AC Power Feed-through Box Terminal Posts ....	7-128
Figure 7-67.	Removing the MAB .....	7-130
Figure 7-68.	Filter Capacitors .....	7-133
Figure 7-69.	Bus Bar .....	7-134

## FIGURES (continued)

---

Figure 7-70.	Scan Adapter Board .....	7-134
Figure 7-71.	Y1 Channel Board .....	7-137
Figure 7-72.	Y1 Channel Board Phillips Screws .....	7-137
Figure 8-1.	Rear View of NetBlazer Model N2-1E .....	8-3
Figure 8-2.	Rear View of NetBlazer Model NS2-2E .....	8-3
Figure 8-3.	WD8013 Ethernet Board Configuration, Component View .....	8-4
Figure 8-4.	CNet 300E Ethernet Board Configuration, Component View .....	8-5
Figure 8-5.	CNet TB850 Ethernet Board Configuration, Component View .....	8-6
Figure 8-6.	CNet 380300 Ethernet Board Configuration, Component View .....	8-7
Figure 8-7.	Microcom QX/4232 Modem .....	8-8
Figure 8-8.	Microcom QX/4232 Modem Front and Back Panels	8-9
Figure 8-9.	WYSE Model WY-60 Display .....	8-10
Figure 8-10.	Rear View of WYSE Model WY-60 Display ....	8-10
Figure 8-11.	Sun-4 SPARCstation IPC .....	8-11
Figure 8-12.	Rear View of the Sun-4 SPARCstation .....	8-12
Figure 8-13.	Remote Support Configuration 1 .....	8-13
Figure 8-14.	Remote Support Configuration 2 .....	8-14
Figure 8-15.	Remote Support Configuration 3 .....	8-15
Figure 8-16.	System Connections and Signal Flow, Configuration 1 .....	8-18
Figure 8-17.	System Connections and Signal Flow, Configuration 2 .....	8-19
Figure 8-18.	System Connections and Signal Flow, CRAY EL98 Base Configuration .....	8-20
Figure 8-19.	Switch Settings, Step 7 .....	8-21
Figure 8-20.	Switch Settings, Step 9 .....	8-22

## TABLES

---

Table 2-1.	Exchange Package Field Descriptions .....	2-15
Table 2-2.	Port and Read Mode Field Translation .....	2-17
Table 3-1.	Priority Scheme .....	3-10
Table 3-2.	Port and Read Mode Field Translation .....	3-11
Table 4-1.	VME Backplane Wire List and Pin Assignment for J1/P1 Connectors .....	4-5
Table 4-2.	VMEbus Signal Descriptions .....	4-6
Table 4-3.	Data Bus Information .....	4-22
Table 4-4.	Attention and Vector Information .....	4-24
Table 4-5.	P1 Pin Assignments .....	4-25
Table 4-6.	P2 Pin Assignments .....	4-26
Table 4-7.	IOS-supported Peripheral Controllers .....	4-29
Table 4-8.	Bus Request Level .....	4-36
Table 4-9.	Interrupt Level .....	4-37
Table 5-1.	Peripheral Devices .....	5-1
Table 5-2.	POR Messages .....	5-20
Table 5-3.	TD-2 Operator Display Messages .....	5-22
Table 5-4.	Jumper and Switch Configurations for ESDI Interface .....	5-36
Table 6-1.	Power Connectors .....	6-9
Table 8-1.	Remote Support Hardware Part Numbers .....	8-16

# 1 SYSTEM OVERVIEW

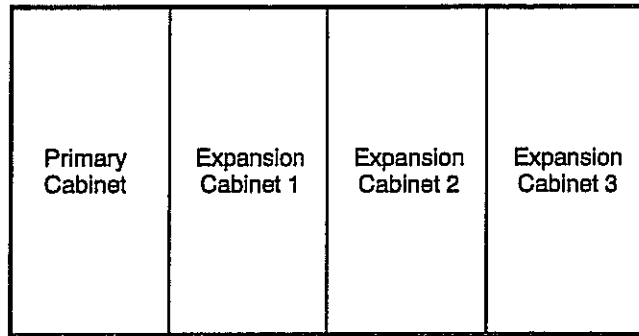
The CRAY EL series computer system is a completely self-contained system in which the central processing units, input/output subsystems (IOS), and all peripherals can be included in one cabinet. The cabinet can be installed easily in most office environments that are equipped with a 200- to 250-Vac, 50- to 60-Hz power source.

The design of the CRAY EL98 system allows the use of two possible processor module types. One type consists of a single, complete CPU and is called the primary processor module. The second type consists of a primary processor module and a daughter board, which is called the secondary processor module. In this configuration, the secondary processor module shares a portion of the primary processor module's logic and becomes a second, dependent CPU.

One to four processor modules can be installed in the CRAY EL series primary, or mainframe cabinet. The primary cabinet also holds four memory boards, an IOS using a Versabus Modular Eurocard (VMEbus)-based assembly, and optional peripherals requested by the customer. Another component in the primary cabinet is the small computer system interface (SCSI) subsystem known as the maintenance SCSI. The SCSI subsystem consists of a cartridge-type streaming tape drive, a 204-Mbyte hard disk drive, and an optional 8-mm helical scan tape drive. The SCSI tape drives are used to install any new releases of software as they become available. It is also used as the system backup and boot device.

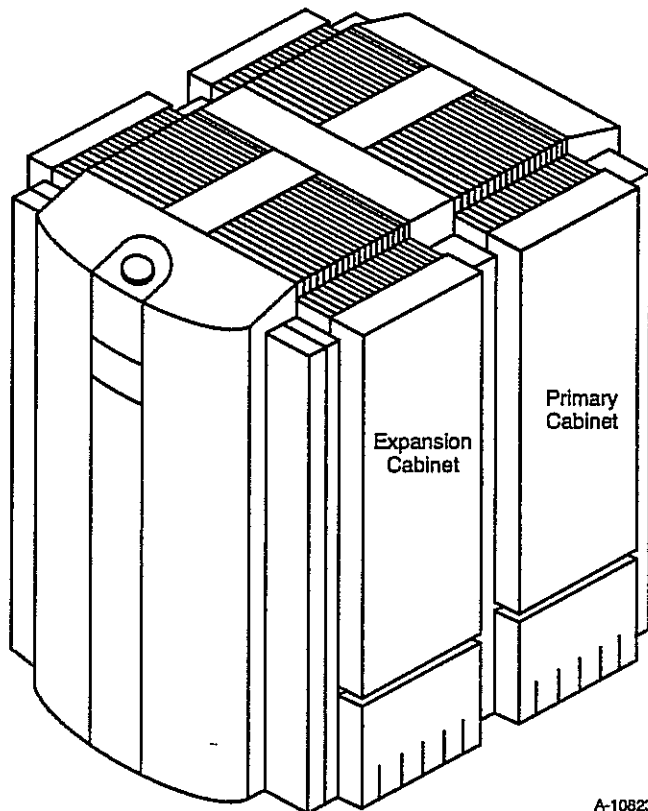
The primary cabinet is designed so that another standard cabinet can be bolted to the primary cabinet to expand the system. As many as three expansion cabinets can be connected to the system for additional IOS and peripheral capabilities.

Figure 1-1 shows how three expansion cabinets are configured with the CRAY EL series system. Figure 1-2 shows a two-cabinet CRAY EL series system.



A-10822

Figure 1-1. Left Side View (Maximum Configuration)



A-10823

Figure 1-2. CRAY EL Series Computer System (Right Side View)

All CRAY EL series system cabinets are air cooled by integrated fans at both the top and bottom of the chassis. This form of cooling is referred to as vertical cooling.

## Peripheral Device Options

---

The following list describes the peripheral devices available with the CRAY EL series system and their characteristics. Customers select peripheral devices according to their requirements.

### Disk units

- DD-3 medium-performance disk unit
  - Provides 1.3 Gbytes of storage; uses 5.25-in. enhanced serial drive interface (ESDI) drive
  - Has a 2-Mbyte/s peak, 1.9-Mbyte/s sustained transfer rate
  - Packaged maximum eight drives per PE-3 drawer with a shared power supply
  - Manufactured by Hitachi, Ltd. as Hitachi model DK-516-15
- DC-3 controller
  - Provides error-correction code (ECC) and media defect management
  - Controls up to four ESDI DD-3 disk drives
  - Manufactured by Ciprico Inc. as CIPRICO model RF-3411
- DD-4 high-performance disk unit
  - Includes a 2.7-Gbyte unformatted 8-inch two-head intelligent peripheral interface (IPI) dual-port disk drive
  - Has a 7.5-Mbytes/s peak, 6- to 7-Mbyte/s sustained transfer rate
  - Packaged two disk drives per PE-4 drawer with one power supply per drive
  - Manufactured by Seagate Technology, Inc. as Sabre VII drive
- DC-4 controller
  - Uses intelligent peripheral interface (IPI)-2 protocol
  - Contains two IPI channels; each channel can support two DD-4 disk drives

- Manufactured by Xylogics, Inc. as Xylogics model SV7800
- DAS-2 disk array subsystem
  - Is an intelligent disk array controller system
  - Includes a bank of eight 1.3-Gbyte 5.25 in. ESDIs for storage, plus one for parity and one spare (all contained in one drawer)
  - Has a peak transfer rate of 13 Mbytes/s for data blocks that contain 1-Mbyte or more
  - Uses hardware bit striping to distribute data evenly across all drives
  - Has 12-Gbyte unformatted capacity
  - Manufactured by Maximum Strategy, Inc.
  - Is not available with the CRAY EL98 system

#### Tape units

- TD-2 9-track tape drive subsystem
  - Includes one TC-2 tape controller unit that is manufactured by Ciprico, Inc. as CIPRICO model TM-3000
  - Includes one TD-2 800 bpi (NRZI), 1600 bpi (PE), 3200 bpi (DPE), 6250 bpi (GCR) 9-track low-profile tape drive, 125 ips. Manufactured by Storage Technology Corporation as model 9914
- TD-3 0.5-inch cartridge tape drive
  - Includes one SCSI peripheral controller (SI-1) that is manufactured by Ciprico, Inc. as CIPRICO model 3564
  - Includes one 18-track tape drive in low-profile configuration that is manufactured by Storage Technology Corporation as model 4220
- Cartridge tape drive (EXABYTE models)
  - Is an EX-2 5.0-Gbyte, 8-mm tape drive that is manufactured by EXABYTE Corporation as EXABYTE model EX3-8500
- Cartridge tape drive



- Uses a 0.25-in. cartridge (QIC) with 1.6-Gbytes of storage
- Manufactured by Archive Technology, Inc. as the Anaconda model 2750

#### Special devices

- DR-1 removable disk system that uses dual 5.25-in. ESDI disks in easily removable cartridges designed to protect data from damage during transport
- DR-1 requires a DC-3
- DR-2 removable IOS disk drive

## **Processor Overview**

---

The processor in the CRAY Y-MP EL computer system is located on a single 16 x 22 inch printed circuit (PC) board; however, the processor module of a CRAY EL98 computer system consists of two PC boards, the primary module and the secondary module. These PC boards contain all of the logic associated with the CRAY EL series system processor. Very large scale integration (VLSI) solid-state technology enables a relatively small PC board to contain an entire processor.

The VLSI chips used in the processor are application-specific integrated circuits (ASICs). They are constructed using complementary metal oxide semiconductors (CMOS). The ASICs are available in a variety of package sizes. The internal construction of the ASIC consists of between 60,000 and 200,000 undefined gates. This massive number of gates is contained in a 2 x 2 inch package, which consumes an average of 5 watts at + 5 volts.

The processor module for the CRAY Y-MP EL system contains 23 separate ASICs, and the processor module for the CRAY EL98 system contains 39 ASICs, with each consisting of nine application types as described in Section 2.

The secondary processor module of the CRAY EL98 system contains 16 ASICs and shares the functions of 7 ASICs on the primary module. Each secondary processor connects to the primary processor via stand-off connectors using 558 signal pins. The ASICs that reside on the secondary processor are:

- 1 AS ASIC
- 8 DS ASICs
- 4 EU ASICs
- 1 MC ASIC
- 1 PC ASIC
- 1 RC ASIC

The ASICs shared with the primary processor are:

- 1 AR ASIC
- 2 CC ASICs
- 4 MD ASICs

The CRAY Y-MP EL system is designed to contain up to four independent processors; the processors can work in conjunction by using shared registers or using the common memory section. The CRAY EL98 system can contain four processor modules that can provide up to eight independent processors; the processors can work in conjunction by using shared registers or using the common memory section. An additional PC board in the CRAY EL98 system is mounted on the top of the mainframe card cage, called the memory arbitration bus (MAB), to provide arbitration between the processor modules. Each processor connects to the system backplane using 1,230 signal pins.

All processors run on a 30-nanosecond (ns) clock. This clock is provided by a separate clock module mounted on the rear of the mainframe card cage. Also mounted on the rear of the card cage is a scan chain multiplex module that controls the scan process during a system master clear (MC) operation and at any time a scan of the memory board is requested by the operating system or the operator.

## Memory Overview

---

Central memory in the CRAY EL series system is distributed across four PC boards. Each PC board is 16 x 22 inches (the same size as the processor board) and is composed of two ASIC types used for data control and fanout. Each board contains nine ASICs and a specific number of dynamic random-access memory integrated circuits (DRAMs). The number of DRAMs depends upon the customer's choice of available memory options.

The CRAY EL series system can be ordered with a 32-Mword, a 64-Mword, a 128-Mword, a 256-Mword, or a 512-Mword central memory. In the case of the 32-Mword, 64-Mword, and 256-Mword options, the memory PC boards are half-populated modules. The 32-Mword, 64-Mword, and 128-Mword modules are populated with 1M x 4 DRAMs, and the 256-Mword and 512-Mword modules are populated with 4M x 4 DRAMs.

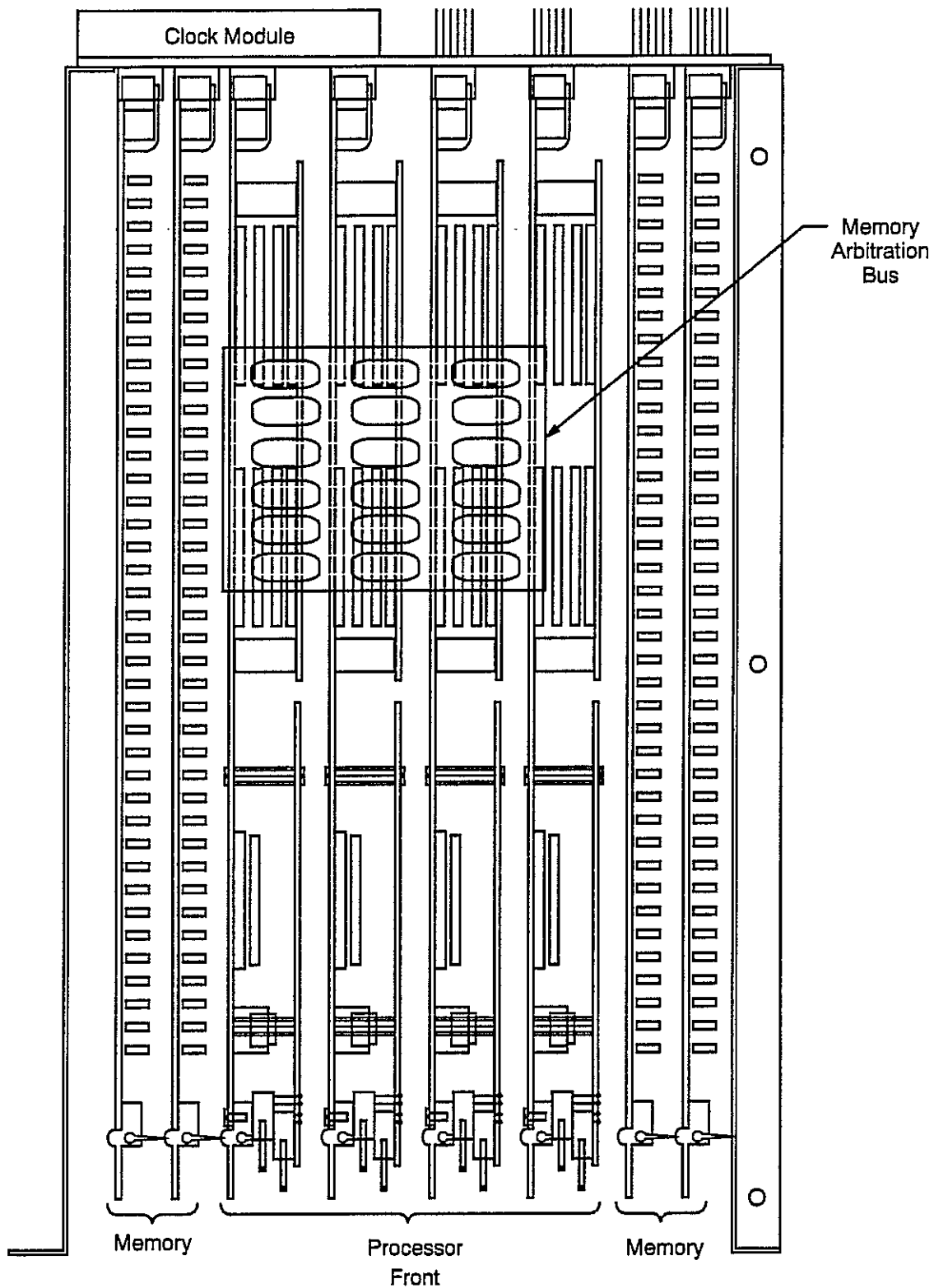
The CRAY EL series system central memory contains a total of 64 banks spread across the four modules. Each module contains 16 banks and is considered a memory section. These 16 banks are separated into lower and upper banks on each board. Thus, a half-populated memory board uses only the lower bank, but still retains the full 16 banks of memory. This means that a fully populated memory module uses both upper and lower banks.

Figure 1-3 shows the chassis locations of the ten modules in the CRAY EL series computer system. Note that this figure represents a top view, with the front of the chassis at the bottom of the diagram. Also represented in Figure 1-3 is the MAB, shown in the center of the diagram.

The entire mainframe is controlled by a clock circuit contained on a separate circuit board that is mounted on the back of the mainframe card cage. The circuit board consists of three different clock circuits: one for normal clock speed (30 ns), one for fast clock speed (27 ns), and one for slow clock speed (33 ns). The fast and slow circuits are used only to isolate an intermittent problem in the system. There is no preventive maintenance that requires the running of clock margins. The clock circuit board also contains an external clock path through which an external clock can be connected to the system while the normal clock circuits are disabled.

A scan-logic board is attached to the back of the mainframe card cage. This circuit board provides paths to each of the processor modules that allow the operation of a scan chain. This scan chain is currently used to condition several operational registers before a deadstart exchange

sequence occurs. The scan circuits can also be used as a diagnostic tool in the case of catastrophic failures that require more than the usual suite of diagnostic tools provided to the product specialist.



A-11551

Figure 1-3. Chassis, Top View

## Input/Output Subsystem Overview

---

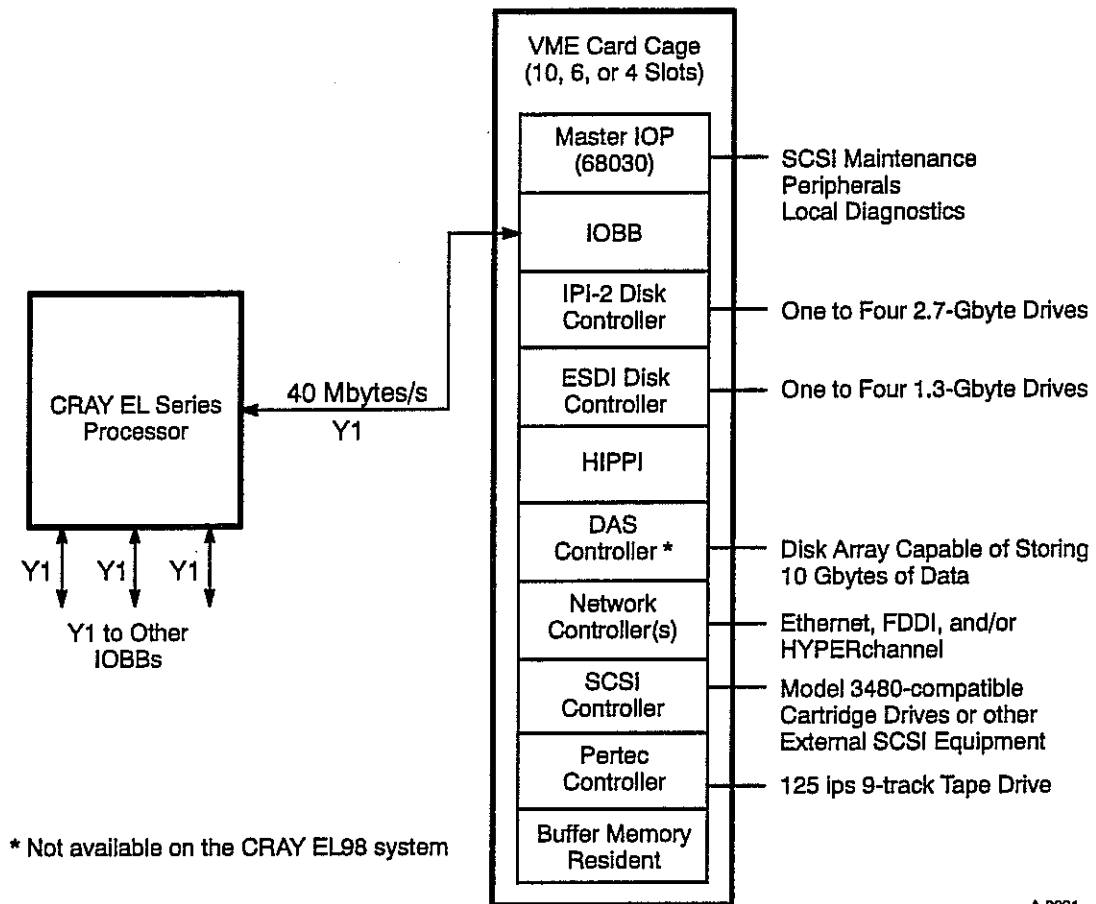
The IOS for the CRAY EL series system provides customers with the maximum choice of peripheral equipment. The IOS is a VME-based system that communicates with the mainframe via the Y1 bus (a 40-Mbyte/s channel) connected to the input/output buffer board (IOBB). The IOBB is the only Cray Research, Inc. proprietary board within the IOS. All other functions within the IOS are performed using vendor-supplied VME boards.

The standard VME mechanical chassis is a 19-inch rack-mounted chassis that is air cooled, supports standard 6U x 160 mm VME boards, and requires a 750-watt power supply. The backplane is a modular design based on a 10-slot system. The backplane configurations include:

- 10-slot + 10-slot option
- 10-slot + 6-slot + 4-slot option
- 6-slot + 4-slot + 6-slot + 4-slot option

Each cabinet within the CRAY EL series system contains a VMEbus chassis. In its maximum configuration, this VMEbus can be configured as the 6-slot, 4-slot, 6-slot, 4-slot option, resulting in a maximum of 16 IOS configurations (4 cabinets x 4 IOSs per cabinet = 16 IOSs per system). The customer decides how many IOSs to include in a system, depending on desired performance.

The IOS configuration requires use of a 68030-type microprocessor and as many as eight peripheral controllers to handle data transfers. A possible IOS configuration is represented in Figure 1-4. The types of controllers used are defined by the customer's choice of system peripherals.



A-9991

Figure 1-4. IOS Configuration

## The Maintenance SCSI

The maintenance SCSI consists of two required peripherals, one of which is a Winchester-technology hard disk drive capable of storing 204 Mbytes of data. This disk drive maintains the IOS kernel, the IOS diagnostic binary files, and the UNICOS operating system. The second SCSI peripheral is a QIC 1.3-Gbyte streaming cartridge (0.25-in. tape) tape drive. An optional product that can also be connected is the 8-mm helical scan tape drive, capable of storing 5 Gbytes of data.

The primary purpose of a SCSI device is to provide a boot storage address to bring the system from a cold or dead machine state to an operating state. The maintenance SCSI also uses the tape drives to make system backup tapes or to load new operating system releases.

The operating system kernel (UNICOS) resides on the maintenance hard drive. Similarly, the offline IOS diagnostics, which are a part of the IOS kernel, are resident on the hard disk. No other maintenance diagnostics are on the hard disk.

## **System Console**

---

The CRAY EL series system uses a WYSE 60 terminal manufactured by Wyse Technology, Inc. as the system console. Using this system console, it is possible to boot the operating system and to perform other system functions as allowed under the operating system. This system console is an integral part of the CRAY EL series system.

## **Maintenance Workstation**

---

An optional proprietary maintenance workstation model EL (MWS-EL) is connected to a separate input bus. This workstation is a Sun-4 permanently connected to the system or a portable windowing workstation that is brought to the site by the product specialist and is not considered part of the CRAY EL series system. Instead, the MWS-EL is owned by the maintenance organization and is available for maintenance representative use only. This workstation provides a remote access connection from the communications gateway hub and, in the case of an on-site visit from a maintenance representative, provides a platform for maintenance functions.

The MWS-EL contains a hard disk drive with a complete copy of the mainframe maintenance environment (MME), which is used to isolate problems in the processor or memory using the offline diagnostics available to the CRAY EL series system.

The MWS-EL is connected to the CRAY EL series system via an RS-422 connection that connects to the IOP controller board in each of the incorporated IOSs. The master IOP, which resides in IOS0 slot 0, acts as the MWS-EL arbitrator and must be installed in that location for correct MWS-EL operation. However, the MWS-EL has individual access to all IOSs.