UC04 INTELLIGENT
HOST ADAPTER
TECHNICAL MANUAL
(MSCP COMPATIBLE)

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UC0351002 Rev A
February, 1986

WARNING

This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the technical manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of Federal Communications Commission (FCC) Rules, which are designed to provide reasonable protection against such interference when operating in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Printed in U.S.A.

Section	Title	Page

ONE GENERAL DESCRIPTION

TWO SPECIFICATIONS

THREE PLANNING THE INSTALLATION

TABLE OF CONTENTS

TABLE OF CONTENTS

Section	Title	Page

TABLE OF CONTENTS

Section	Title	Page

NINE SCSI PROTOCOL

A ASSIGNING BUS AND VECTOR ADDRESSES

B SUBSYSTEM CONFIGURATION SELECTION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EMULEX PRODUCT WARRANTY

CONTROLLER WARRANTY: Emulex warrants for a period of twelve (12) months from the date of shipment that each Emulex controller product supplied shall be free from defects in material and workmanship.

CABLE WARRANTY: All Emulex provided cables are warranted for ninety (90) days from the time of shipment.

The above warranties shall not apply to expendable components such as fuses, bulbs, and the like, nor to connectors, adapters, and other items not a part of the basic product. Emulex shall have no obligation to make repairs or to cause replacement required through normal wear and tear or necessitated in whole or in part by catastrophe, fault or negligence of the user, improper or unauthorized use of the product, or use of the product in such a manner for which it was not designed, or by causes external to the product, such as but not limited to, power failure or air conditioning. Emulex's sole obligation hereunder shall be to repair or replace any defective product, and, unless otherwise stated, pay return transportation cost for such replacement.

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RETURNED MATERIAL: Warranty claims must be received by Emulex within the applicable warranty period. A replaced product, or part thereof, shall become the property of Emulex and shall be returned to Emulex at Purchaser's expense. All returned material must be accompanied by a RETURN MATERIALS AUTHORIZATION (RMA) number assigned by Emulex.

Section 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual is designed to help you install and use your UC04 Intelligent Host Adapter in the most efficient and straightforward manner possible. The contents of the nine sections and six appendices are described briefly below.

Section 1 — **General Description:** This section contains an overview of the UC04 Intelligent Host Adapter.

Section 2 — **Host Adapter Specification:** This section contains the specification for the UC04 Host Adapter.

Section 3 — **Planning the Installation:** This section contains operating system instructions and other pre-installation considerations.

Section 4 — **Installation:** This section contains the information needed to set the UC04 switches and to physically install and cable the subsystem.

Section 5 — **Troubleshooting:** This section describes fault isolation procedures that can be used to pinpoint trouble spots.

Section 6 — **Controller Registers:** This section contains a description of the subsystem's LSI-11 Bus registers and an overview of the Mass Storage Control Protocol (MSCP).

Section 7 — **Functional Description:** This section describes the controller architecture.

Section 8 — **Interfaces:** This section describes the subsystem LSI-11 Bus and SCSI interfaces.

Section 9 — **SCSI Protocol:** This section describes the protocol used on the SCSI bus.

Appendix A — **Assigning Bus and Vector Addresses:** This appendix contains a description of DEC autoconfigure algorithm for the assignment of CSR addresses and vector addresses.

Appendix B — **Subsystem Configuration Selection:** This appendix explains how to set the switches that define the drive configuration.

Appendix C — **PROM Removal and Replacement:** This appendix explains how to remove and replace the UC04 firmware PROM in the field. The PROM number and its location on the PCBA is also provided here.

Appendix D **Utilities and Diagnostics:** This appendix contains a list of the utilities and diagnostics that are applicable to the UC04.

Appendix E **Installing and Configuring Optical Disks:** This appendix describes some of the special steps that need to be taken if you are using optical disks in your subsystem.

Appendix F **Configuration Parameters for Disk Drives:** This appendix lists configuration parameters for the most common disk drives used with the UC04.

1.2 SUBSYSTEM OVERVIEW

The UC04 Intelligent Host Adapter connects high-capacity, mass-storage peripherals to the LSI-11, Micro/PDP-11, and MicroVAX computers manufactured by Digital Equipment Corporation (DEC). The UC04 implements DEC's Mass Storage Control Protocol (MSCP) to provide a software-transparent interface for the host DEC computer. To provide traditional Emulex flexibility in peripheral selection, the UC04 uses the versatile, ANSI standard, Small Computer System Interface (SCSI) as its peripheral interface.

1.2.1 MASS STORAGE CONTROL PROTOCOL (MSCP)

MSCP is a software interface designed to lower the host computer's mass-storage overhead by offloading much of the work associated with file management to an intelligent mass-storage subsystem. In concert with SCSI-compatible peripherals, the UC04 provides just such a subsystem. The MSCP functions that the UC04 Host Adapter assumes include error checking and correction, bad block replacement, seek optimization, command prioritizing and ordering, and data mapping.

This last feature is perhaps the most important. It allows the host computer's operating system software to store data in logical blocks that are identified by simple logical block numbers (LBNs). Because the host operating system does not need to have detailed knowledge of its mass-storage subsystem, the complexity of the operating system itself can be reduced. This reduction comes about because only one or two software modules are required to allow many different subsystems to be connected to a host.

1.2.2 SMALL COMPUTER SYSTEM INTERFACE (SCSI)

The Small Computer System Interface, which is used as the UC04 Host Adapter's peripheral interface, complements the MCSP protocol well. SCSI architecture is designed to allow up to eight host adapters and intelligent peripheral controllers to be connected together on an eight-bit data bus (the SCSI bus) (see Figure 1-1). Host adapters, such as the UC04, connect computers to the SCSI bus. Intelligent peripheral controllers support mass-storage peripherals such as mini-

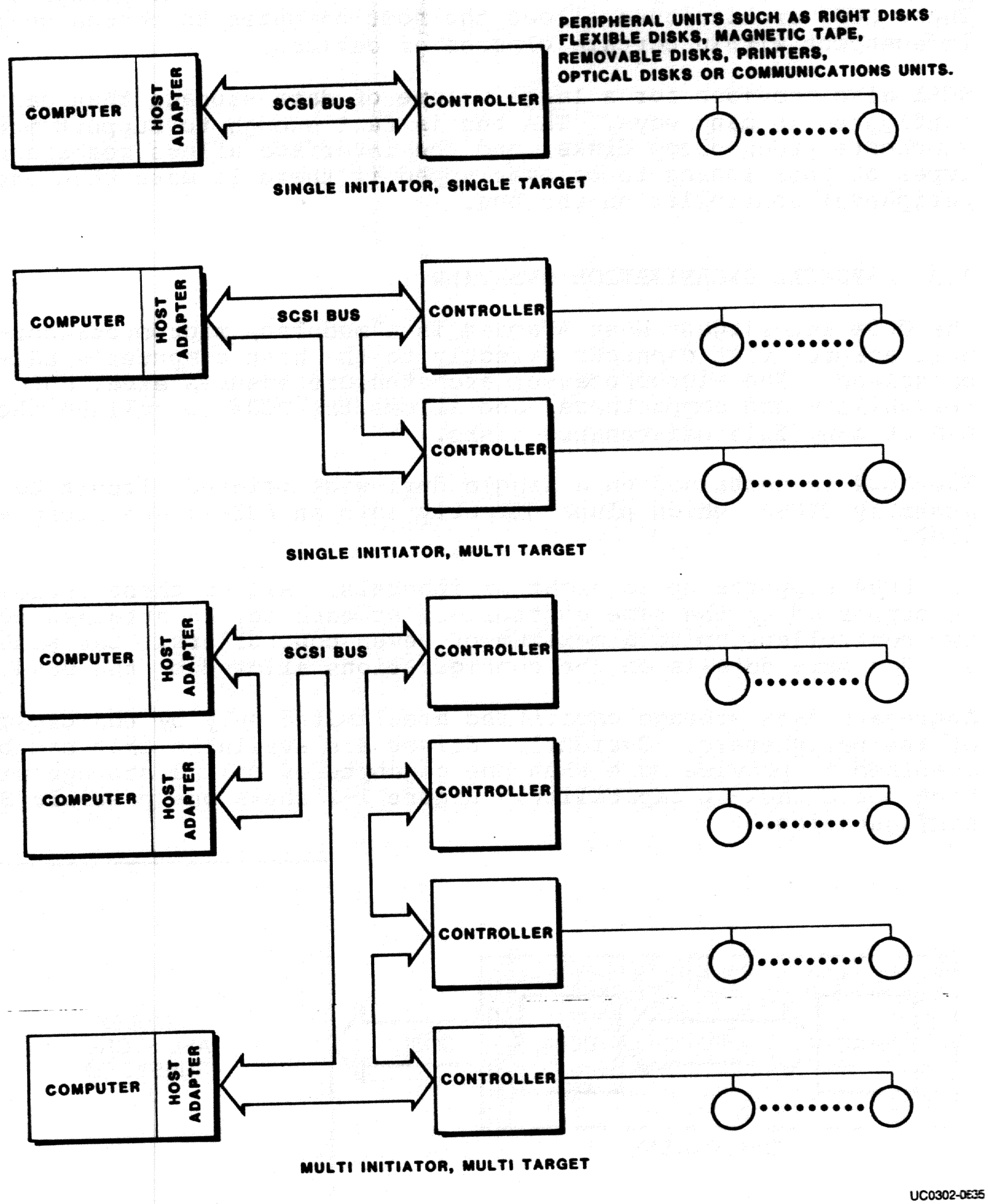


Figure 1-1. SCSI Bus Overview

Winchester disk drives and small streaming tape transports. The devices communicate over the SCSI bus using a device-independent protocol that largely masks the data structure of the peripheral. Thus, SCSI architecture allows the host computer to become device independent within certain classes of devices.

SCSI also provides for a large volume of data storage that can be configured in many ways. The bus is fast enough to support modern Winchester-technology disks, and the interface allows seeks and other types of positioning to be overlapped if there is more than one peripheral controller on the bus.

1.3 PHYSICAL ORGANIZATION OVERVIEW

The UC04 Intelligent Host Adapter is a modular, microprocessor-based host adapter that connects directly to the host computer's LSI-11 Bus backplane. The microprocessor architecture ensures excellent reliability and compactness, and allows the UC04 to relieve the host CPU of many file maintenance tasks.

The UC04 is contained on a single dual-wide printed circuit board assembly (PCBA) which plugs directly into an LSI-11 Bus backplane slot.

The UC04 supports up to eight peripherals. All of these devices may be supported by the same controller, or each may be attached to its own controller, up to a maximum of seven controllers. See section 3.2 for more details on the configurations allowed by the UC04.

Aggregate data storage capacities are limited only by the capacities of the peripherals. Currently, drives are available that can be combined to provide more than one gigabyte of online storage with high speed back-up capability. Figure 1-2 shows one possible SCSI configuration.

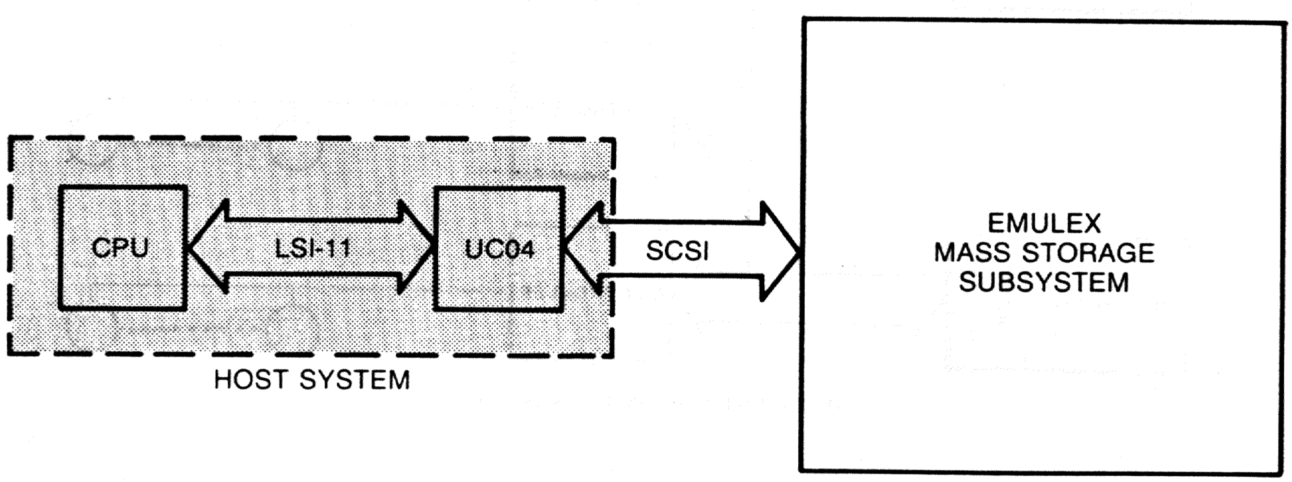


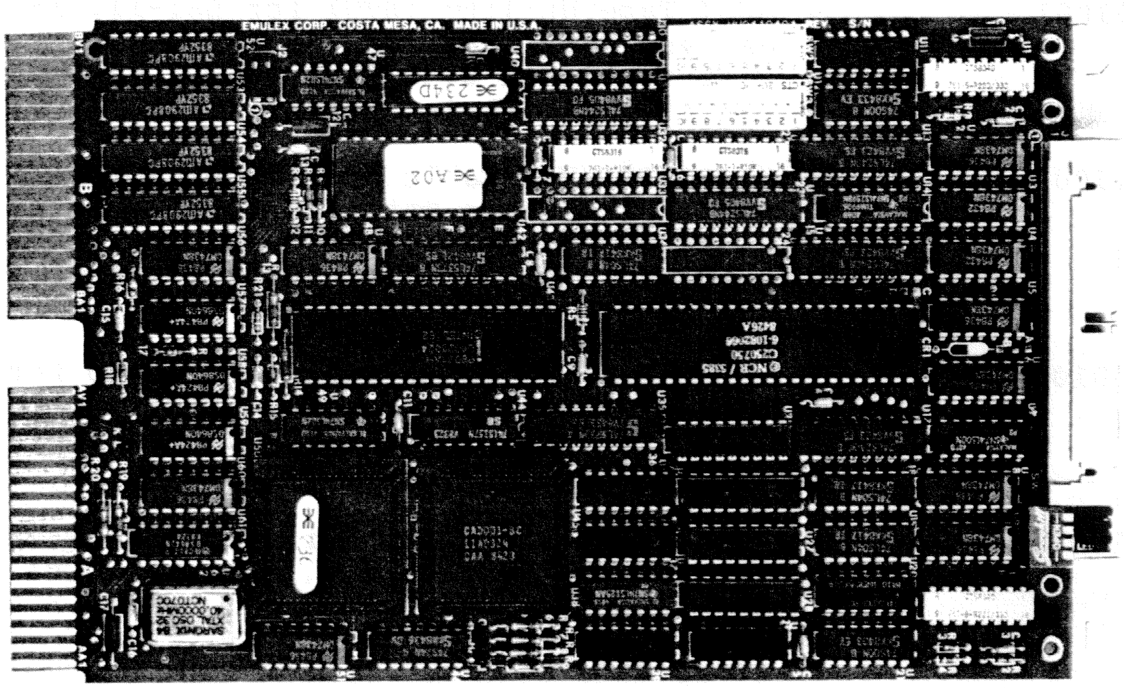
Figure 1-2. UC04 Subsystem Configuration

1.4 SUBSYSTEM MODELS and OPTIONS

The UC04 Intelligent Host Adapter, with appropriate peripherals, provides a DEC MSCP-compatible mass-storage subsystem. The UC04 is pictured in Figure 1-3. A single model of the UC04 is offered: the UC04.

Table 1-1. Basic Subsystem Contents

Itm	Qty	Description	Part Number	Comment
1	1	UC04 Host Adapter	UC0310202-DX	X is Firmware Revision
2	1	UC04 Technical Manual	UC0351002	



UC0302-0948

Figure 1-3. UC04 Intelligent Host Adapter

1.4.1 SUBSYSTEM OPTIONS

Table 1-2 lists the options that can be ordered to tailor your UC04 to your particular application.

Table 1-2. Subsystem Options

Option	Description
PX9951801-xx PX9951802-xx	Disk Formatter software for LSI-11. Media is per customer order. See Appendix D for part number and load media.
VX9951804	Formatter software for MicroVAX.
PD9951802-xx	Backup and Restore Program (BRP) for LSI-11. Allows image backup and restoration of disk. Compatible with TS11, SCSI tape, and the following DEC disk formats: RK06/07, RL01/02, RM02/03/05, RP04/05/06, and MSCP. Media is per customer order. See Appendix D for part number and load media.
PD9951801	SCSI Tape Utility (STU) for LSI-11. Includes BRP and MSCP/SCSI Disk Formatter Program. Distributed on 0.25 inch DC600A tape cartridge, Titleist format.
PU0213001	MICRO/PDP/VAX Cable Kit for MICRO/PDP-11 or MicroVAX chassis patch panels. Converts UC04 J1 to AMP connector. Includes SCSI cable, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.
PU0120105	MICRO/PDP/VAX Patch Panel. Required for installation of Emulex CP24 Distribution Panel and UC04/TC05 Controllers. Ordered in addition to PU0213001, above.
PU0113003	Rack mount cable kit for universal RETMA rack mount applications. Converts UC04 J1 to AMP connector. Includes SCSI cable, rack mount, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.
PU0113004	LSI-11/23 Chassis Mount Kit for LSI-11/23 BC type chassis. Mounts AMP connector in LSI-11/23 BC chassis. Includes SCSI cable, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.

Options are specified as separate line items on a sales order. An example of an actual sales order is shown in Figure 1-4.

Item	Model Number	Comment/Description
1.	UC04	Intelligent Host Adapter implementing DEC MSCP.
2.	PU0213001-02	MICRO/PDP/VAX Cable kit 10 ft SCSI cable.
3.	PU0120105	Emulex Patch Panel for use with item 2 and CP24 Distribution Panel
4.	PD9951802-01	Backup and Restore Program half-inch tape, PE, MS boot

Figure 1-4. Sales Order Example

1.5 FEATURES

Several features enhance the usefulness of the UC04 Intelligent Host Adapter.

1.5.1 MICROPROCESSOR DESIGN

The UC04 design incorporates an eight-bit, high-performance CMOS microprocessor to perform all controller functions. The microprocessor approach provides a reduced component count, high reliability, easy maintainability, and the microprogramming flexibility that allows MSCP to be implemented without expensive dedicated hardware.

1.5.2 IMPROVED THROUGHPUT

By using our custom designed buffer controller chip and host adapter controller chip, the UC04 can perform DMA transfers on the host LSI-11 bus in excess of 2 megabytes per second with a peak rate of 950 nanoseconds per word.

1.5.3 CONFIGURATION FLEXIBILITY

The UC04 Intelligent Host Adapter provides complete configuration flexibility. It is capable of supporting as many as seven SCSI compatible controllers with disk drives of varying capacities. The user can specify many different drive configurations by using the UC04's extended command set to load the Nonvolatile Random Access Memory (NOVRAM) that stores drive configuration data. The flexibility of the UC04 configuration NOVRAM eliminates the need for special configuration PROMs and field upgrade kits. See section 3.2 for a complete discussion of UC04 configuration options.

1.5.4 SELF-TEST

The controller incorporates an internal self-test routine which exercises all parts of the microprocessor, the on-board memory, the LSI-11 Bus interface, and the SCSI interface. Although this test does not completely test all circuitry, successful execution indicates a very high probability that the host adapter is operational. If the host adapter fails the self-test, it leaves three light-emitting diodes (LEDs) ON and sets an error bit in the Status and Address Register.

1.5.5 SEEK OPTIMIZATION

The UC04 is able to pool the various seeks that need to be performed and determine the most efficient order in which to do them. This is an especially important feature in heavily loaded systems. The host adapter's ability to arrange seeks in the optimum order can save a great deal of time and makes the entire system more efficient.

1.5.6 DISCONNECT/RECONNECT

The UC04 fully supports standard SCSI arbitration, including disconnect/reconnect. Using this feature, drives that are performing time-consuming tasks (e.g. seeks) release the SCSI bus temporarily and reconnect when when the seek is complete. Support of this feature permits the UC04 to initiate four commands simultaneously on four controllers; thus, several operations can be performed at once. The disconnect/reconnect option ensures efficient use of the SCSI bus and provides maximum overall subsystem throughput.

1.5.7 COMMAND BUFFER

The UC04 contains a buffer that is able to store 13 MSCP commands. This large buffer allows the subsystem to achieve a higher throughput and to operate at a very efficient level.

1.5.8 ADAPTIVE DMA

While performing DMA transfers, the UC04 also monitors the LSI-11 bus for pending DMA requests and suspends its own DMA activity to allow other DMA transfers. The host processor programs the DMA burst length during the MSCP initialization sequence or the UC04 defaults to 16 words per burst. In addition, the UC04 firmware design includes a 4 or 8-microsecond burst delay (switch selectable) between DMA bursts to avoid data late conditions on other devices on the bus. Because of these adaptive DMA techniques, the UC04 ensures that CPU functions, including interrupt servicing, are not locked out for excessive time periods by high-speed disk transfers.

1.5.9 ERROR CONTROL

The host adapter presents an error-free media to the operating system by correcting soft errors transparently and by reporting only uncorrectable errors to the host.

1.5.10 BLOCK-MODE DMA

The UC04 supports block-mode commands for accessing memory. In this mode, the initial address of the data is transmitted, followed by a burst of up to 16 words of data. The memory address is automatically incremented to accommodate this burst. Block mode transfers considerably reduce the overhead associated with DMA transfers.

1.5.11 TWENTY-TWO-BIT ADDRESSING

The UC04 supports the full 22-bit addressing capability of the extended LSI-11 Bus.

1.5.12 AUTOMATIC BOOTSTRAP

The UC04 features an automatic bootstrap option which causes the system to bootstrap automatically on power-up or reset (this feature is not supported on the MicroVAX or LSI-11/73B). The user specifies which logical unit, from 0 to 7, to bootstrap from.

1.5.13 FIRMWARE FORMAT

The UC04 includes a firmware format routine which can be performed by entering commands under the DEC Octal Debugging Tool (ODT) or the MicroVAX console emulator. See section 6.7 for a detailed discussion of the firmware format procedure.

1.6 COMPATIBILITY

1.6.1 DIAGNOSTICS

Emulex offers a disk formatter for use with the UC04. The formatter also serves as a data reliability program.

1.6.2 OPERATING SYSTEMS

The UC04 implements MSCP. MSCP is supported by RT-11 (versions 5.0 and above), RSX-11M (versions 4.1 and above), RSX-11M-PLUS (versions 2.1 and above), RSTS/E (versions 8.0 and above), MicroVMS (versions 4.0 and above), Ultrix-32m (versions 1.1 and above), and Ultrix-11 (versions 3.0 and above).

1.6.3 HARDWARE COMPATIBILITY

The UC04 Intelligent Host Adapter complies with DEC LSI-11 Bus protocol, and it directly supports 22-bit addressing and block-mode DMA. The disk drives supported by the UC04 are not media-compatible with comparable DEC MSCP products. The fixed nature of DEC's disk media, however, makes this an unimportant consideration.

Section 2
SUBSYSTEM SPECIFICATION

2.1 OVERVIEW

This section contains the general, environmental, physical, electrical, and port specifications for the UC04 Intelligent Host Adapter. Specifications are contained in tables, and the tables are oriented around area of interest as listed below:

Subsection	Title
2.2	General Specification
2.3	Environmental Specification
2.4	Physical Specification
2.5	Electrical Specification

2.2 GENERAL SPECIFICATION

Table 2-1 contains a general specification for the UC04 Intelligent Host Adapter.

Table 2-1. UC04 Intelligent Host Adapter General Specification

Parameter	Description
FUNCTION	Provides mass data storage for all DEC computers that use the LSI-11 Bus
Logical CPU Interface	Minimal disk subset of DEC's Mass Storage Control Protocol
Diagnostic Software	Emulex Disk Formatter: U1MX8 Rev F and above for LSI-11; FVD03M Rev 2.1 and above for MicroVAX
Operating System Compatibility	RT-11 (V5.0 and above), RSX-11M (V4.1 and above), RSX-11M-Plus (V2.1 and above), RSTS/E (V8.0 and above), MicroVMS (V4.0 and above), Ultrix-32m (V1.1 and above), Ultrix-11 (V3.0 and above)

continued on next page

Table 2-1. UC04 Intelligent Host Adapter General Specifications (continued)

Parameter	Description
CPU I/O Technique	Direct Memory Access, including adaptive techniques, block mode, and scatter-write/gather-read
INTERFACE	
CPU Interface	Extended LSI-11 Bus interface
Device CSR Address	
Standard	772150
Alternate	772154 760334 760340 760344 760350 760354 760360
Vector Address	Programmable
Priority Level	BR4 and BR5
Bus Load	One DC load, 2.5 AC loads
Peripheral Interface	Small Computer System Interface (SCSI)
Driver Option	Single Ended
Maximum Length	20 ft (6 m)
SCSI Commands used with MSCP Implementation	00 Test Unit Ready 03 Request Sense 04 Format Unit (extended)* 07 Reassign Block 08 Read 0A Write 12 Inquiry** 15 Mode Select* 1A Mode Sense** 1D Send Diagnostic** 68 Read Long*** 6A Write Long***

* = Formatting only
** = Used by Emulex MSCP/SCSI Disk Formatter Program only
*** = Vendor unique commands on Emulex disk drive controllers

2.3 ENVIRONMENTAL SPECIFICATION

Table 2-2 contains the environmental specifications for the UC04 Intelligent Host Adapter.

Table 2-2. UC04 Intelligent Host Adapter Environmental Specifications

Parameter	Description
OPERATING TEMPERATURE	5°C (41°F) to 50°C (122°F) Where maximum temperature is reduced 1.8°C per 1000 meters (1°F per 1000 feet) altitude
RELATIVE HUMIDITY	10% to 90% with a maximum wet bulb of 28°C (82°F) and a minimum dew point of 2°C (36°F)
COOLING	6 cubic feet per minute
HEAT DISSIPATION	82 BTU per hour

2.4 PHYSICAL SPECIFICATION

Table 2-3 contains the physical specifications for the UC04 Intelligent Host Adapter.

Table 2-3. UC04 Intelligent Host Adapter Physical Specifications

Parameter	Description
PACKAGING	Single, dual-size, four-layer PCBA
Dimensions	8 x 5.9 in. (see Figure 2-1)
Shipping Weight	3 pounds

Physical Specification

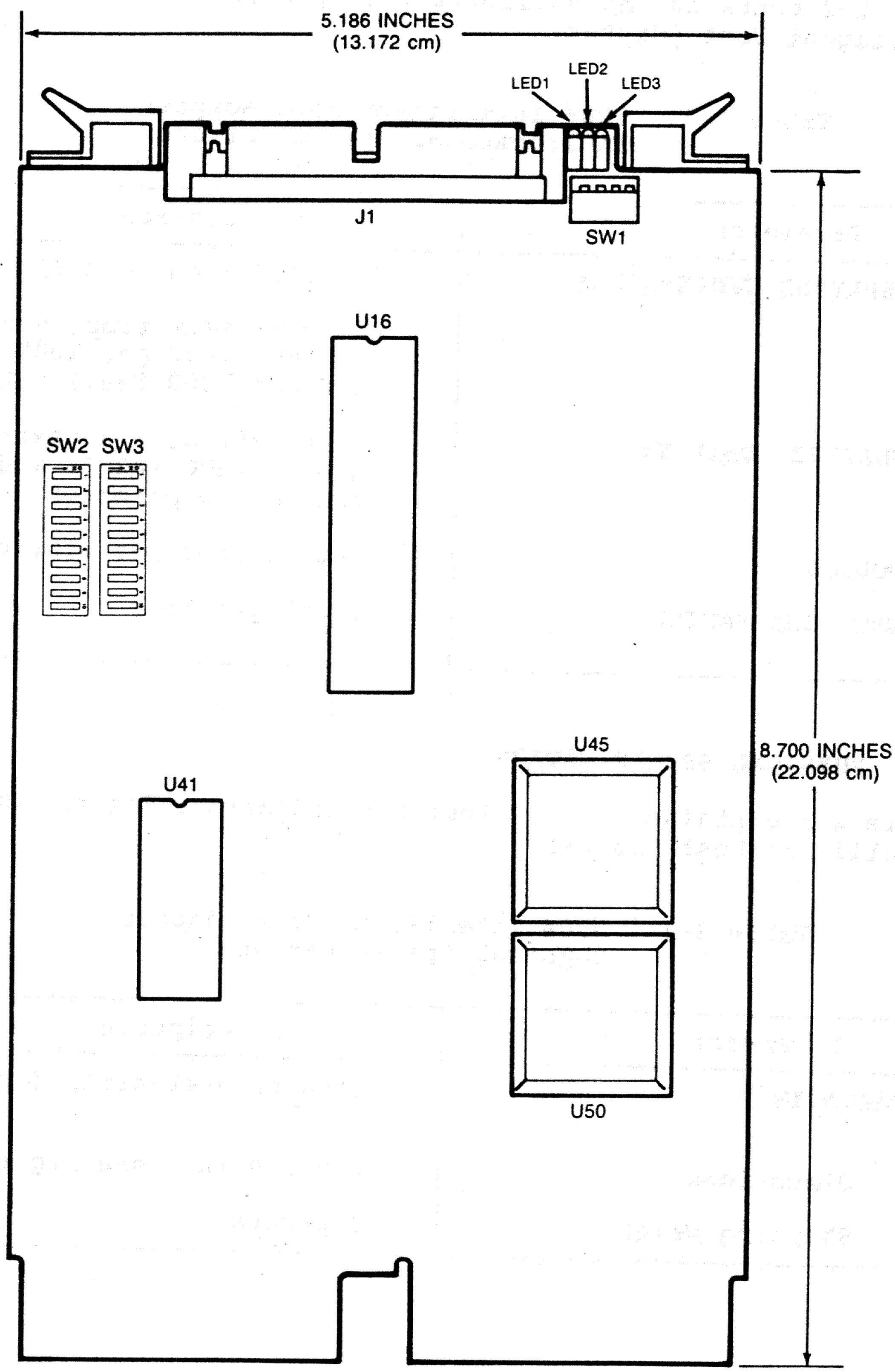


Figure 2-1. UC04 Host Adapter Dimensions

2.5 ELECTRICAL SPECIFICATION

Table 2-4 describes the electrical specification for the UC04 Intelligent Host Adapter.

Table 2-4. UC04 Intelligent Host Adapter Electrical Specifications

Parameter	Description
POWER	5 VDC ± 5%, 2.6 A

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Section 3
PLANNING THE INSTALLATION

3.1 OVERVIEW

This section contains information that you need to consider before you start the installation of the UC04. It includes the following sections:

Subsection	Title
3.2	Configuring the Subsystem
3.3	Generating the Operating System
3.4	Performance Consideration

3.2 CONFIGURING THE SUBSYSTEM

This section explains how to decide on a suitable configuration for your disk subsystem. Once you have decided, the configuration can be set in one of two ways:

- **Via switches.** More than 40 common configurations are preconfigured in the firmware. If one of these configurations meets your needs, you can select it by setting switches on the UC04 PCBA.
- **Via NOVRAM.** If you can't find a suitable configuration, you can set your own configuration and save it in the nonvolatile RAM (NOVRAM) on the UC04.

Note that this section is concerned only with working out a configuration on paper. The details of setting switches or loading the NOVRAM are left for Section 4.

3.2.1 SCSI ADDRESS AND LUN

The UC04 can work with a wide variety of SCSI controllers and peripherals. These devices are identified on the SCSI bus by means of their SCSI Address and SCSI LUN (Logical Unit Number), as follows:

- **SCSI Address.** Every controller attached to the UC04 is assigned a SCSI Address. These controllers are connected to the UC04 and to each other via the SCSI bus. A single SCSI bus supports up to eight addresses and the UC04 itself uses one SCSI Address, so each UC04 can support up to seven SCSI controllers.
- **SCSI LUN.** Each peripheral device on a single controller is assigned a unique SCSI LUN. The UC04 supports a maximum of eight physical devices, or eight LUNs.

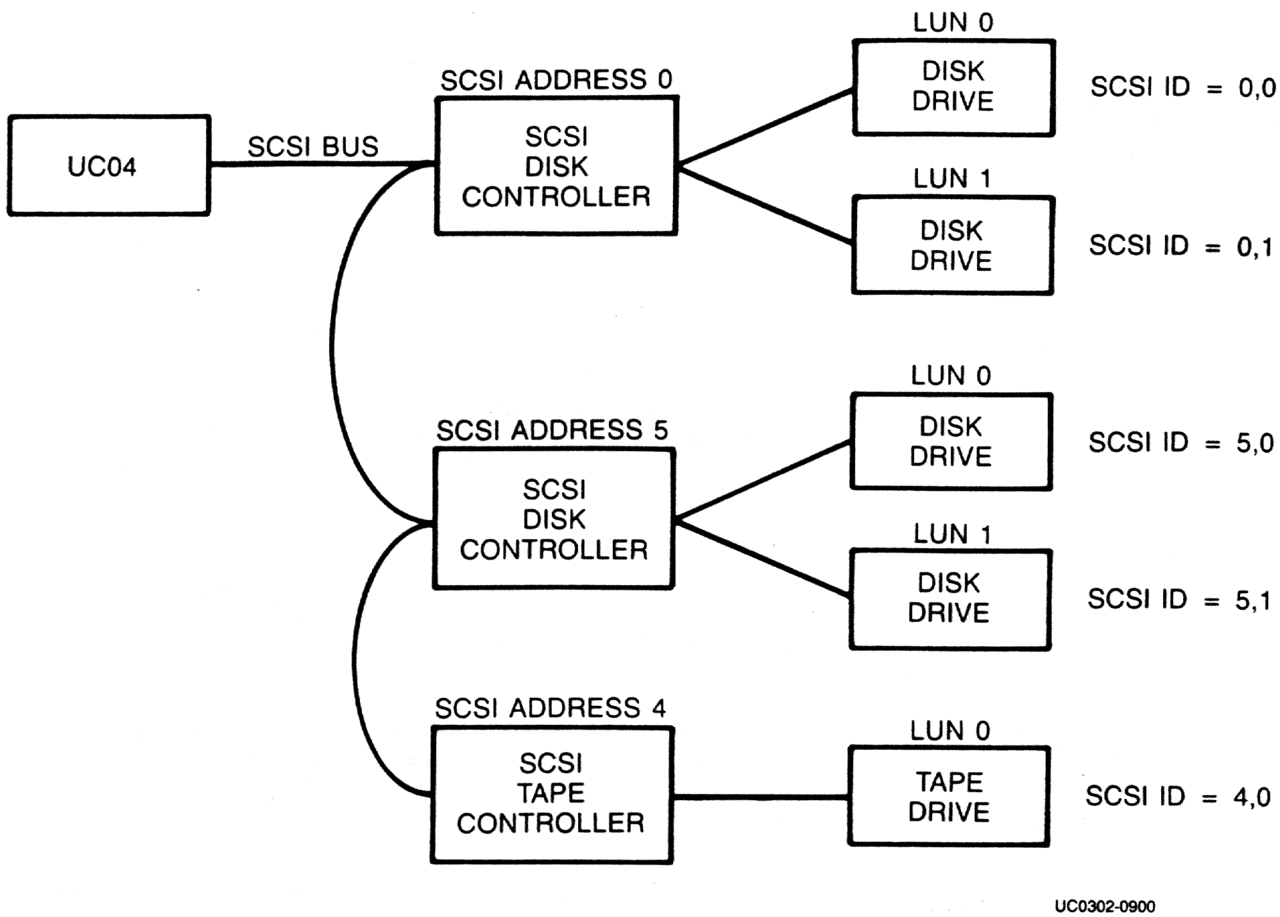


Figure 3-1. SCSI Bus Device Numbering Example

Figure 3-1 shows a typical configuration of a single UC04 with three controllers supporting a total of five LUNs. As you can see, although LUNs are repeated on different controllers, every device has a separate SCSI ID. Devices on the SCSI bus are referred to by both their SCSI Address and SCSI LUN, so the first drive on the first controller is 0,0, followed by 0,1. The first drive on the second controller (which has a SCSI Address of 5 in the example) is 5,0, and so forth.

All SCSI devices must have their address or LUN programmed into them, usually with switches or jumpers, and these addresses and LUNs must match the configuration you choose with the UC04. The next section discusses strategies for choosing a suitable SCSI configuration.

3.2.2 CHOOSING A CONFIGURATION

The UC04 must know the SCSI Addresses and LUNs of every device attached to it. This information is available to it in one of two ways: through the configuration switches or the NOVRAM. Which method you use to configure the system depends on your requirements.

- **Configuration switches.** The UC04 has a large number of configurations already stored in its firmware. These configurations are listed and explained in Appendix B.

  Each configuration supports a certain combination of controllers and peripherals with specified SCSI Addresses and LUNs. Therefore, if you choose one of the switch configurations, the SCSI Addresses and LUNs of your devices must match those shown in the configuration.

  By Emulex convention, the first controller on a UC04 is assigned SCSI Address 0, the second is SCSI Address 5, and a tape controller is SCSI Address 4. You are bound by these conventions if you use a switch configuration. The NOVRAM, however, allows you more freedom.

- **NOVRAM.** If you are unable to find a configuration that fits your requirements, you can make up your own configuration and store it permanently in the UC04's NOVRAM.

  If you choose to use this method, all you have to do is decide on SCSI Addresses and LUNs for each of your devices. You may choose any numbers that are convenient, as long as every device has a separate SCSI ID. To store the configuration permanently, you must run a utility that is part of the UC04 formatter. Follow the instructions included with the formatter to load the NOVRAM.

3.2.3 MSCP NUMBERS

The operating system identifies drives attached to MSCP controllers via sequential numbers that have nothing to do with SCSI ID numbers (the operating system is completely unaware of the SCSI bus). The following table shows the numbers assigned by various operating systems:

Operating System	Controller First, Second	Drives Supported By First Controller
RSTS/E	RU0, RU1	DU0, DU1
RT-11	Port1, Port2	DU0, DU1
RSX-11M	--- ---	DU0, DU1
RSX-11M-PLUS	DUA, DUB	DU0, DU1
MicroVMS	PUA, PUB	DUA0, DUA1

Configuring the Subsystem

In general, MSCP numbers are assigned sequentially across controller boundaries (although it is actually a host adapter, the UC04 is considered an MSCP controller by the operating system). For example, if there are three drives (DU0, DU1, and DU2) on the first MSCP controller in the system (at address 772150), then the first drive on the second controller (in floating address space) is numbered DU3. However, there are exceptions:

- **RSTS/E** requires that the first drive on the second controller be DU4, regardless of how many drives (up to a maximum of four) are on the first controller.

- **MicroVMS** allows you to repeat MSCP numbers on different controllers. The first drive on the first controller is DUA0, the first drive on the second controller is DUB0, and so forth.

The UC04 has a set of switches that allow you to designate an offset value if you are using the UC04 as an alternate MSCP controller. These switches must be set to the proper value for the operating system you are using. They should always be set to 4 for an alternate controller under RSTS/E. For the other operating systems, the switches should be set so that the first drive attached to the UC04 has a number one higher than the highest numbered drive on previous MSCP controllers. The setting of the switches does not matter under MicroVMS.

3.2.4 LOGICAL VS. PHYSICAL DRIVES

There is one more factor in the configuration process: logical splitting of physical drives. The UC04 allows the **first drive** in any single configuration to be split into two logical drives. If a switch configuration is used, the first drive is defined by the configuration table. If NOVRAM is used, the first drive is defined by the first NOVRAM block (this is discussed in more detail in the UC04 formatter technical manual).

If this is done, the two logical drives are treated as separate drives for nearly all purposes (although the physical drive has only a single SCSI LUN). For the purposes of MSCP numbering, these two logical drives are treated as two separate drives and are assigned separate MSCP numbers. This limits the number of devices you can attach to the UC04, since a single UC04 supports a maximum of eight logical devices (i.e., eight separate MSCP numbers).

Two different splits are available: 1:1 (each logical is half the size of the physical) and 7:1 (one drive is 7/8 the size of the physical and the other is 1/8 the size). Dividing a physical drive into two logical drives usually slows performance, especially when both logicals are active. Therefore, we do not recommend splitting a physical drive unless it is necessary to allow for convenient file backup when only one drive is present.

3.2.5 BUS ADDRESS

Like any other controller on a DEC computer, the UC04 must be assigned a bus address. Therefore, before the UC04 is installed, you must calculate a bus address for the UC04 and that address must be programmed into the UC04 via switches.

As an MSCP device, the UC04 emulates the DEC UDA50 and must be assigned a bus address accordingly. Normally, the first MSCP controller in a system is assigned an address of 772150 and subsequent controllers are assigned addresses in floating address space. If you are using autoconfigure to assign addresses, see Appendix A for details on how autoconfigure works. If you are not using autoconfigure, you may use any bus address that is convenient.

If your system contains both a DEC RQDX1 and one or more UC04s, we recommend assigning the standard address to the RQDX1 and floating addresses to the UC04s.

3.3 GENERATING THE OPERATING SYSTEM

Before the installation of the UC04 is completed, the operating system must be modified to add the appropriate number of UDA50 controllers. Although it is beyond the scope of this manual to include detailed instructions for adding devices under DEC operating systems, this section outlines the procedure for RSTS/E, RT-11, RSX-11M, RSX11M-Plus, and MicroVMS. Read only the section that applies to you.

In the discussions that follow, the following assumptions are made:

- This is the first pass that is being made through SYSGEN. Therefore, no saved answer file exists. Answer NO to questions such as "Use as input saved answer file?"
- Your host system configuration conforms to the standard LSI-11 device configuration algorithm (otherwise autoconfigure results are not reliable). Read Appendix A if you are not familiar with the DEC autoconfigure algorithm.
- You are generating a mapped version of the operating system on the appropriate hardware (unless you are using RT-11).

3.3.1 RSTS/E OPERATING SYSTEMS (V8.0 AND ABOVE)

RSTS/E uses an autoconfigure technique to determine the hardware configuration each time the system is bootstrapped. The scanning program is contained in INIT.SYS and it relies on the same hardware configuration conventions as do the other DEC operating systems.

RSTS/E versions 9.0 and below support two MSCP controllers; versions 9.1 and above support up to four MSCP controllers. The first MSCP controller must be located at the standard CSR address, 772150. The second unit should be located in floating address space.

The INIT.SYS program also uses a user-specified table, located in the currently installed monitor, to make exceptions to the autoconfigure algorithm. This table is modified by the HARDWARE option of the INIT.SYS program. Use of this table allows an MSCP controller to be placed at virtually any address on the I/O page. Note that this table must be reset any time a new monitor is installed. An MSCP controller must be located at the standard address (772150) to be a boot device.

Interrupt vector addresses are assigned to the MSCP controllers by INIT.SYS and programmed into the devices during initialization.

3.3.1.1 Adding MSCP Support

Support for an MSCP controller must be included in a monitor at SYSGEN time. To include support for an MSCP controller in a RSTS/E monitor, respond to the SYSGEN question "number of MSCP servers" with the number of MSCP controllers on the system.

Units connected to MSCP controllers will be accessible to an on-line RSTS/E system only after the monitor is successfully SYSGENed and installed with the INSTALL sub-option of the INIT.SYS program, and the units have been successfully initialized with the DSKINT sub-option of INIT.SYS.

3.3.2 RT-11 OPERATING SYSTEMS (V5.0 AND ABOVE)

The RT-11 Operating System supports up to four MSCP controllers with up to 256 devices (total) on the four controllers. The following paragraphs discuss the CSR and vector addresses for MSCP controllers under RT-11 in host systems that have only one MSCP controller and in those that have more than one controller. Disk partitioning, a unique feature of RT-11 that is applicable regardless of the number of controllers, is also discussed.

3.3.2.1 Installing a Single MSCP Controller

If your host system includes only one MSCP controller, install it with a CSR address of 772150. The RT-11 version of autoconfigure will find and install the handler (driver) for that controller. In single MSCP controller configurations, it is not necessary to run SYSGEN. You may use one of the pregenerated monitors that are provided with the RT-11 Distribution. To get the most out of your MSCP subsystem you must modify the system start-up command file, STARTx.COM, to properly partition the disk drives. See subsection 3.5.2.3.

3.3.2.2 Installing Multiple MSCP Controllers

If your host system includes more than one MSCP controller, you can modify the MSCP handler as described in the **RT-11 Software Support Manual**, or perform a SYSGEN. The following procedure outlines the SYSGEN technique:

1. Initiate SYSGEN:

   IND SYSGEN<cr>

   Answer all question appropriately until you are asked if you want to use the start-up command when booting.

2. Indicate that you want the system to use the start-up command file when booting:

   Do you want the start-up indirect
   file (Y)? **Y<cr>**

   The start-up command file is required to allow additional CSR addresses to be specified and to partition the disks consistently when the system is bootstrapped. Answer the next few questions appropriately.

3. Indicate that you want MSCP support when the Disk Options question appears:

   Enter the device name you want support for
   [dd]: **DU<cr>**

4. Indicate the number of MSCP controllers on your system in response to this question:

   How many ports are to be
   supported (1)? **2<cr>**

   RT-11 refers to individual MSCP controllers as ports. Each port has its own CSR and vector addresses.

5. Specify support for all other devices in your host system configuration as well. Indicate that there are no more devices by entering a period.

   Enter the device name you want support for
   [dd]: **.<cr>**

   SYSGEN does not prompt for the number of DU devices here. Answer the next several questions appropriately.

6. You must specify the addresses of all MSCP controllers (ports) using the SET CSR keyboard command. To ensure that this is done consistently and automatically on power-up, you must add the commands to the system start-up command file, STARTx.COM. The "x" stands for the monitor that is being used, where "x" is S, F, or X for single-job, foreground/background, or extended memory respectively. Edit the command file to include the following statements:

```
SET DU CSR=772150   (Default)
SET DU CSR2=xxxxxx
SET DU VECTOR=154   (Default)
SET DU VEC2=xxx
```

   The CSR and vector address for the second device can be any unused address in the I/O page or vector page which is accessible by the UC04 switches. Default statements are not required.

3.3.2.3 Disk Partitioning

RT-11 is unable to handle drives with a capacity of more than 65,535 blocks (33.5M bytes). To allow drives with larger capacities to be used, RT-11 allows individual physical drives to be partitioned into multiple logical drives. This is done by assigning as many logical drive names (DU0, DU1, etc.) to a physical drive as that drive can support. The statements that make that assignment should be placed in the system start-up command file. This placement ensures that the drives are automatically partitioned every time the system is bootstrapped, and that the partitions are always the same. Use the following procedure to determine the total number of logical drives to assign to each physical drive.

1. Figure out the capacity for each MSCP unit you are planning to use. If you will be defining the subsystem with switches, consult Appendix B to find out which configuration you will be using. The MSCP Disk Capacity column of Table B-4 contains the capacities you need. If you will be using the NOVRAM to define the subsystem, you will have to figure out the capacity based on such things as the number of spare cylinders you specify, the number of spare sectors, etc. Appendix F contains capacities for some of the common drives used with the UC04.

   You must calculate a capacity for each MSCP unit. Remember that if the UC04 is at an alternate CSR address (not 772150), then you must specify an MSCP Unit number offset by using switches SW2-1 through SW2-3 (see subsection 4.5.5.2). Add the selected offset to determine the proper Unit number to use in the SET statements.

2. Divide the capacity for each MSCP Unit by 65,535. If the result is a number greater than one, then that MSCP Unit should be partitioned into multiple logical units. (The last partition on a disk may be smaller that 65,535 blocks.) Round the result up to the nearest whole number. That whole number equals the number of logical disks into which that MSCP unit should be partitioned.

3. You must then include a series of statements in the system start-up command file, STARTx.COM, to assign logical names to each partition. The statements have the following format:

```
SET DUn UNIT=y PART=x PORT=z
```

where "n" is the logical device name, "y" is the physical MSCP unit number, "x" is the partition number, and "z" is the controller or port number the drive is attached to. You must **do this for each partition on each drive, including drives that can hold only one partition.**

Example: You have selected configuration number 02 from Table B-4. MSCP Unit 0 has a capacity of 218,432 blocks; Unit 1 has a capacity of 20,301 blocks (using a Medalist disk controller).

Unit 0 $\frac{218,432}{65,535}$ = 3.33 (4 logical units)

Unit 1 $\frac{20,301}{65,535}$ = 0.31 (1 logical unit)

Dividing the Unit Capacities by 65,535 and rounding the result up to the nearest whole number gives the number of logical units into which each unit should be partitioned.

You begin assigning logical names to the partitions beginning with DU0. Assign logical names to the partitions on MSCP Unit 0 first. The following commands would be entered into the STARTx.COM file:

```
SET DU0 UNIT=0 PART=0 PORT=0
SET DU1 UNIT=0 PART=1 PORT=0
SET DU2 UNIT=0 PART=2 PORT=0
SET DU3 UNIT=0 PART=3 PORT=0

SET DU4 UNIT=1 PART=0 PORT=1
```

4. Finish up the SYSGEN as outlined in the **RT-11 Software Support Manual.**

3.3.3 RSX-11M OPERATING SYSTEMS (V4.0 AND ABOVE)

RSX-11M SYSGEN is an interrogative program that allows a complete, running RSX-11M system to be configured for a particular hardware environment. SYSGEN is well documented in the **RSX-11M System Generation and Installation Guide**, and you should rely primarily on that manual. This explanation is provided only to remove some ambiguities inherent in the installation of the UC04.

SYSGEN supports autoconfigure and MSCP controllers are detected by autoconfigure. However, autoconfigure detects only the MSCP controller that is located at the standard CSR address. Additional MSCP controllers at alternate addresses must be attached to the operating system manually.

NOTE

> If the UC04 controls the system disk, you must set switch SW2-6 (22-bit addressing) in the ON position (even if your system has only 256K bytes of memory).

3.3.3.1 Installing a Single MSCP Controller

If you have only one UC04, install it at the standard address (772150) and use autoconfigure to connect your peripherals. The procedure given in the **RSX-11M System Generation and Configuration Guide** is adequate.

3.3.3.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say a DEC RQDX1 and a UC04, we recommend that you use autoconfigure to connect the RQDX1 at the standard address (772150). Locating the UC04 at an alternate CSR address does not prevent its being used as the system device. If your initial system configuration includes two MSCP controllers, connect the alternate MSCP controller to the operating system during the initial SYSGEN. If you are adding the alternate MSCP controller to a current system configuration, it should be connected to the operating system after the inital SYSGEN is complete and the system is running. The following procedure describes the process.

1. Invoke SYSGEN.

```
> SET /UIC=[200,200]<cr>
> @SYSGEN<cr>
```

2. To indicate that you want to use autoconfigure, answer YES to the following question:

   ```
   Autoconfigure the host system hardware?
   [Y/N]: Y<cr>
   ```

3. To indicate that you do not want to override autoconfigure results, answer NO to this question:

   ```
   Do you want to override Autoconfigure
   results? [Y/N]: N<cr>
   ```

   Answer the rest of the questions in the SETUP section appropriately, and continue to the next section, TARGET CONFIGURATION. In TARGET CONFIGURATION, answer the first few questions appropriately (since autoconfigure was requested, the defaults presented for these questions should be accurate for your system).

4. In response to the Devices question, indicate that you have two MSCP-type controllers:

   ```
   Devices: DU=2<cr>
   Devices: .<cr>
   ```

   This response will supersede the value of 1 that autoconfigure has determined. Typing a period (.) terminates device input.

   Continue through the next four sections, HOST CONFIGURATION, EXECUTIVE OPTIONS, TERMINAL DRIVER OPTIONS, and SYSTEM OPTIONS, answering questions appropriately.

5. When you reach the PERIPHERAL OPTIONS section, SYSGEN will ask you questions that pertain only to the MSCP devices on your system. (If you indicated that you wished to override other autoconfigure results when you responded to the Devices question, SYSGEN asks questions on those devices.)

   The first question requests information about the controller's interrupt vector address, CSR address, the number of DU-type disk drives (there is no default value for this parameter), the number of command rings, and the number of response rings. The question is asked twice, once for controller 0 and once for controller 1, since we have specified two DU-type controllers:

   ```
   * DU contr 0 [D:154,172150,,4,4]
   154,772150,3,4,4<cr>
   ```

The standard vector address for MSCP controllers is 154. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300 and 774 can be allocated. See Appendix A for a description of DEC's algorithm for assigning floating vectors.

The standard CSR address for MSCP controllers is 772150. The second unit should be located in floating CSR address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

The number of DU-type disk drives depends on the configuration that you have selected for the UC04, or on the number of drives that are attached to a DEC MSCP controller.

For the UC04, the number of DU-type drives is equal to the number of physical drives it is supporting, or, if the first drive is logically split, to that number plus one. If a Titleist .25-inch cartridge tape drive is included in the configuration, do not count it as a MSCP disk drive when you answer this question. Tape drives are not supported by MSCP.

For a DEC controller, the number of drives depends on the type of controller. The following types of disk drives can be attached to DEC MSCP controllers:

RX50
RD52
RD53
RC25
RA60
RA80
RA81

The RX50 contains two 5.25-inch floppy diskette drives; therefore count each RX50 as two drives. The RC25 has both fixed and removable hard media; count each RC25 as two drives.

Four command rings and four response rings are reasonable and adequate for most applications. However, RSX-11M supports up to eight command rings and eight response rings. The number of rings you specify depends on your application.

6. SYSGEN then asks you to specify the type of disk drive(s) on each controller:

   * DU contr 0 unit 0. is an RA60/80/81/RC25/RD51/RX50 [D:RA81] **RA81<cr>**

   For the RQDX1, indicate that you have an RD51 and two RX50s (in that order).

For the UC04, indicate that you have one RD51 for each logical disk (the tape drive is excluded).

RSX-11M does not tolerate gaps in sequence; the unit numbers must be contiguous. In addition, the unit numbers specified for each controller must be the same as those reported by the controller during initialization.

7. Finish up the SYSGEN as outlined in the **RSX-11M System Generation and Installation Guide.**

3.3.4 RSX-11M-PLUS OPERATING SYSTEMS (V2.1 AND ABOVE)

RSX-11M-PLUS SYSGEN is an interrogative program that allows a complete, running RSX-11M-PLUS system to be configured for a particular hardware environment. SYSGEN is well documented in the **RSX-11M-PLUS System Generation and Installation Guide**, and you should rely primarily on that manual. This explanation is provided only to remove some ambiguities inherent to the installation of the UC04.

SYSGEN supports autoconfigure, and MSCP controllers are detected by autoconfigure. However, autoconfigure detects only the MSCP controller that is located at the standard CSR address. Additional MSCP controllers at alternate addresses must be attached to the operating system manually.

3.3.4.1 Installing a Single MSCP Controller

If you have only one UC04, install it at the standard address (772150) and use autoconfigure to connect your peripherals. The procedure given in the **RSX-11M-PLUS System Generation and Configuration Guide** is adequate.

3.3.4.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say an RQDX1 and a UC04, we recommend that you use autoconfigure to connect the RQDX1 at the standard address (772150). Locating the UC04 at the alternate CSR address does not prevent its being used as the system device. If the intial system configuration includes two MSCP controllers, connect the alternate MSCP controller to the operating system during the initial SYSGEN. If you are adding the alternate MSCP controller to a curring system configuration, it should be connected to the operating system after the initial SYSGEN is complete and the system is running. To connect the second controller, use the Add a Device option of SYSGEN. The following procedure describes the process.

Generating the Operating System

1. Invoke SYSGEN.

    > **SET /UIC=[200,200]<cr>**
    > **@SYSGEN<cr>**

2. To indicate that you want to do a subset of the SYSGEN procedure, answer NO to the following questions:

    Do you want to do a complete SYSGEN?
    [Y/N D:Y]: **N<cr>**

    Do you want to continue a previous SYSGEN
    from some point? [Y/N D:Y]: **N<cr>**

3. To indicate that you want to execute a specific module of the SYSGEN procedure, answer YES to this question:

    Do you want to do any individual sections
    of SYSGEN? [Y/N D:Y]: **Y<cr>**

4. Select the Add a Device section of SYSGEN:

    Which sections would you like to do?
    [S R:0.-15.]: **H<cr>**

    Type the letter **H** to select the Add a Device section. SYSGEN will now ask you all of the questions in the Choosing Peripheral Configuration section.

    The questions that SYSGEN asks pertain the type and number of controllers that are installed on your system. There is one question for each type of controller that RSX-11M-PLUS can support. Answer zero (0) for all types of controllers until you are prompted for the number of UDA-type devices.

5. When you are asked to specify the number of MSCP-type devices, answer appropriately:

    How many MSCP disk controllers do you
    have? [D R:0.-63. D:0.] **2<cr>**

6. Give the total number of MSCP disk drives (on all controllers) installed on the system.

    How many MSCP disk drives do you have?
    [D R:0.-n. D:1.] **5<cr>**

    The number of DU-type disk drives depends on the configuration that you have selected for the UC04, or on the number of drives that are attached to a DEC MSCP controller.

For the UC04, the number of DU-type drives is equal to the number of physical drives it is supporting, or, if the first drive is logically split, to that number plus one. If a Titleist .25-inch cartridge tape drive is included in the configuration, do not count it as a MSCP disk drive when you answer this question. Tape drives are not supported by MSCP.

For a DEC controller, the number of drives depends on the type of controller. The following types of disk drives can be attached to DEC MSCP controllers:

RX50
RD52
RD53
RC25
RA60
RA80
RA81

The RX50 contains two 5.25-inch floppy diskette drives; therefore count each RX50 as two drives. The RC25 has both fixed and removable hard media; count each RC25 as two drives.

7. SYSGEN then asks you to specify controllers for each disk drive.

```
To which DU controller is DU0: connected?
[S R:1-1]: A<cr>
```

This question is asked as many times as you have indicated that there are MSCP drives on the system. RSX-11M-PLUS does not tolerate gaps in sequence; the unit numbers must be contiguous. In addition, the unit numbers specified for each controller must be the same as those reported by the controller during initialization.

8. Enter the vector address for each MSCP controller:

```
Enter the vector address of DUA
[O R:60-774 D:154]
```

The standard vector address for MSCP controllers is 154. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300 and 774 can be allocated. See Appendix A for a description of DEC's algorithm for assigning floating vectors.

9. Enter the CSR address for each MSCP controller:

```
What is its CSR address?
[O R:760000-777700 D:772150]
```

   The standard CSR address for MSCP controllers is 772150. The second unit should be located in floating CSR address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

10. Specify the number of command rings for each MSCP controller:

```
Enter the number of command rings for DUA
[D R:1.-8. D:4.] 4<cr>
```

   Four command rings are reasonable and adequate for most applications, although RSX-11M-Plus supports up to eight.

11. Specify the number of response rings for each MSCP controller:

```
Enter the number of response rings for DUA
[D R:1.-8. D:4.] 4<cr>
```

   Four response rings are reasonable and adequate for most applications, although RSX-11M-Plus supports up to eight.

12. Finish up the SYSGEN as outlined in the **RSX-11M-PLUS System Generation and Installation Guide.**

3.3.5 MicroVMS OPERATING SYSTEMS

MicroVMS supports MSCP controllers at the standard address, 772150_8, and in floating address space. MicroVMS has a software utility that can be used to determine the LSI-11 bus address and interrupt vector address for any I/O devices to be installed on the computer's LSI-11 bus. A running MicroVAX/MicroVMS computer system is required in order to use this utility.

If you do not have access to a running system, you must determine the LSI-11 bus addresses and vector addresses manually (although autoconfigure can still be used to connect the devices to the computer automatically on power-up). See Appendix A for a description of the algorithm used by SYSGEN to determine LSI-11 bus and vector addresses.

The following procedure tells how to use MicroVMS SYSGEN to determine LSI-11 bus addresses and interrupt vectors.

```
Name: PUA  Units: 1  Nexus: 0  CSR: 772150   Vector1: 154  Vector2: 000
Name: TTA  Units: 1  Nexus: 0  CSR: 770100*  Vector1: 300* Vector2: 304*
Name: TXA  Units: 1  Nexus: 0  CSR: 760500*  Vector1: 310* Vector2: 000

*Floating address or vector
Note: All addresses and vectors are expressed in octal notation.
```

Figure 3-2. Sample SHOW CONFIGURATION

1. Login to the system manager's account. Run the SYSGEN utility:

   $ **RUN SYS$SYSTEM:SYSGEN<return>**
   SYSGEN>

   The SYSGEN> prompt indicates that the utility is ready to accept commands.

2. Obtain a list of devices already installed by typing:

   SYSGEN> **SHOW/CONFIGURATION<return>**

   SYSGEN lists by logical name the devices already installed on the LSI-11 Bus (see Figure 3-2). Make a note of the other devices with floating addresses (greater than 760000_8) or floating vectors (greater than 300_8) that you plan to re-install with your UC04.

3. To determine the LSI-11 bus addresses and vectors that autoconfigure expects for a particular device type, execute the CONFIGURE command:

   SYSGEN> **CONFIGURE<return>**
   DEVICE>

   Specify the LSI-11 bus devices to be installed by typing their LSI-11 bus names at the DEVICE prompt (the device name for MSCP controllers under MicroVMS is UDA).

   DEVICE> **UDA,2<return>**
   DEVICE> **DHV11<return>**
   DEVICE> **DZ11<return>**

   A comma separates the device name from the number of devices of that type to be installed. The number of devices is specified in decimal.

   In addition to the UC04, you need only specify devices that have floating addresses or vectors. Devices with fixed addresses or vectors do not affect the address or vector assignments of devices with floating addresses and vectors.

```
SYSGEN>  CONFIGURE
DEVICE> UDA,2
DEVICE> DHV11
DEVICE> DZ11
DEVICE> ^Z
Device: UDA     Name: PUA    CSR: 772150     Vector: 154     Support: yes
Device: DZ11    Name: TTA    CSR: 760100*    Vector: 300*    Support: yes
Device: UDA     Name: PUB    CSR: 760354*    Vector: 310*    Support: yes
Device: DHV11   Name: TXA    CSR: 760500*    Vector: 320*    Support: yes

*Floating address or vector
Note: All addresses and vectors are expressed in octal notation.
```

Figure 3-3. CONFIGURE Command Listing

4. Indicate that all devices have been entered by pressing the <ctrl> and Z keys simultaneously:

   DEVICE> ^Z

   SYSGEN lists the addresses and vectors of the devices entered in the format shown in Figure 3-3.

5. Note the CSR addresses listed for the LSI-11 bus devices in floating address space. Program the listed addresses into non-Emulex devices as instructed by the manufacturer's documentation. For the UC04, program the address given for the UC04 (lowest numerical address) into the board as described in subsection 4.5.1.

6. Complete SYSGEN according to the DEC documentation.

If you want to select a non-standard address for the UC04, that is one that differs from the address selected by the CONFIGURE command, you must enter CONNECT statements in the SYCONIF.COM file that is in the system manager's account, SYS$MANAGER. Use the syntax of the CONNECT statements as described in the DEC documentation on MicroVMS SYSGEN.

NOTE

> Do not alter the STARTUP.COM or UVSTARTUP.COM command files in the main system account, SYS$SYSTEM.

3.4 PERFORMANCE CONSIDERATIONS

The only performance consideration on the UC04 involves the sector interleave ratio of disk-type devices that are connected to the UC04. Table 3-1 lists the sector interleave ratios recommended by Emulex to achieve the best performance from the subsystem.

Table 3-1. Recommended Sector Interleave Ratios

Drive Model	Interleave Ratio
Atasi 3064	1:1
IOMEGA Alpha-10.5	2:1
Maxtor XT1140	1:1
Rodime	1:1
Fujitsu	1:1

Use the MSCP/SCSI Disk Formatter Program that was provided with your UC04 to format the disk drives. Remember, the formatter is an offline utility, so format several IOMEGA cartridges at the same time.

BLANK

4.1 OVERVIEW

This section describes the procedure for installing the UC04 Emulating Host Adapter. The subsection titles are listed below to serve as an outline of the procedure.

Subsection	Title
4.2	Inspection
4.3	SCSI Controller Preparation
4.4	System Preparation
4.5	UC04 Host Adapter Setup
4.6	Physical Installation
4.7	Subsystem Cabling
4.8	Testing

If you are unfamiliar with the subsystem installation procedure, Emulex recommends reading this Installation Section before beginning.

4.1.1 SUBSYSTEM CONFIGURATIONS

This section is limited to switch setting data and physical installation instructions. No attempt is made to describe the many subsystem configurations that are possible. **IF YOU ARE NOT FAMILIAR WITH THE POSSIBLE CONFIGURATIONS, WE STRONGLY RECOMMEND THAT YOU READ SECTION 3, PLANNING THE INSTALLATION, BEFORE ATTEMPTING TO INSTALL THIS SUBSYSTEM.**

When installing the subsystem, you should keep a record of the subsystem configuration and environment. Figure 4-1 is a Configuration Record Sheet, which lists the information required and shows where the data can be found. This information will be of help to an Emulex service representative should your subsystem require service.

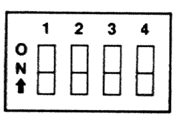
UC04 CONFIGURATION REFERENCE SHEET

GENERAL INFORMATION

1. Host computer type ______________________________
2. Host computer operating system ______________________________
   Version ____________
3. Subsystem Model ______________________________
   Controller(s) ______________________________
   ____
   ____
   Disk drive(s) ______________________________
   ____
   ____
   Tape drive(s) ______________________________

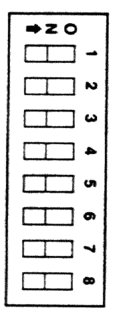
UC04 INTELLIGENT HOST ADAPTER

1. Firmware revision number ______________________________
2. Warranty expiration date ______________________________
3. Top assembly number ______________________________
   Serial number ______________________________
4. LSI-11 Bus address ______________________________
5. Interrupt vector address ______________________________
6. Switch settings (□ = OFF ■ = ON)

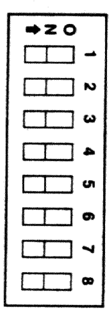


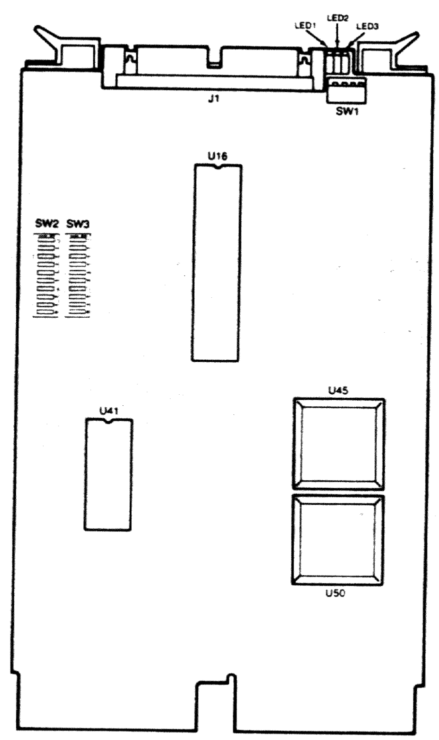
SW1

SW2



SW3





U16 label identifies top assembly and serial numbers.
U41 label identifies firmware revision
Use Pencil

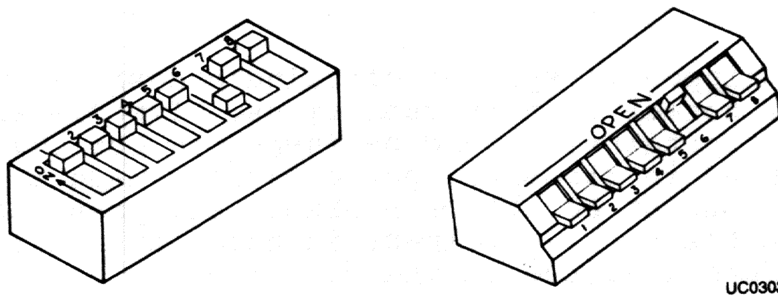
UC0302-0641

Figure 4-1. UC04 Configuration Reference Sheet

4.1.2 DIP SWITCH TYPES

Switch-setting tables in this manual use the numeral one (1) to indicate the ON (closed) position and the numeral zero (0) to indicate the OFF (open) position.

Three DIP switch types may be used in this product, as shown in Figure 4-2. All are set according to the code shown in the switch setting example.



------------ SW1 ------------							
1	2	3	4	5	6	7	8
1	1	1	1	1	0	1	1

Figure 4-2. Switch Setting Example

4.1.3 MAINTAINING FCC CLASS A COMPLIANCE

Emulex has tested the UC04 Intelligent Host Adapter with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the UC04 does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the UC04 and its associated SCSI peripheral subsystem can be installed:

- o With the UC04 Host Adapter and the SCSI subsystem both mounted in the same cabinet, or
- o With the UC04 mounted in the CPU cabinet and the SCSI subsystem mounted in a separate cabinet.

To limit radiated interference, DEC completely encloses the components of its computers that generate or could conduct radio-frequency interference (RFI) with a grounded metal shield (earth ground). During installation of the UC04, nothing must be done that would reduce this shield's effectiveness. That is, when the UC04 installation is complete, no gap in the shield that would allow RFI to escape can be allowed.

Conducted interference is generally prevented by installing a filter in the AC line between the computer and the AC outlet. Most power distribution panels that are of current manufacture contain suitable filters.

The steps that must be taken to maintain the integrity of the shield and to limit conducted interference are explained fully in subsection 4.7.

4.2 INSPECTION

Emulex products are shipped in special containers designed to provide full protection under normal transit conditions. Immediately upon receipt, the shipping container should be inspected for evidence of possible damage incurred in transit. Any obvious damage to the container, or indications of actual or probable equipment damage, should be reported to the carrier company in accordance with instructions on the form included in the container.

Unpack the UC04 subsystem and, using the shipping invoice, verify that all equipment is present. Verify also that model or part numbers (P/N), revision levels, and serial numbers agree with those on the shipping invoice. Subsection 1.5 explains model numbers and details kit contents. These verifications are important to confirm warranty. If evidence of physical damage or identity mismatch is found, notify an Emulex representative immediately. If the equipment must be returned to Emulex, it should be shipped in the original container.

4.2.1 UC04 HOST ADAPTER INSPECTION

Visually inspect the UC04 Host Adapter after unpacking. Check for such items as bent or broken connector pins, damaged components, or any other evidence of physical damage.

Examine all socketed components carefully to ensure that they are properly seated.

4.3 SCSI CONTROLLER PREPARATION

All SCSI mass-storage subsystems, which usually include a SCSI controller, its associated drives or transports, and a power supply in a single chassis, must be configured to operate with the UC04. Configuration items that must be taken into consideration include drive and controller placement, controller SCSI address, SCSI bus termination, and drive or transport unit number.

4.3.1 SCSI MASS-STORAGE SUBSYSTEM PLACEMENT

Unpack and install the SCSI subsystem according to the manufacturer's instructions. Position the subsystem in its final location before beginning the installation of the UC04. This placement allows the SCSI cable routing and length to be judged accurately. Remember, the maximum recommended length of the SCSI cable is 20 feet (6 meters).

4.3.2 CONTROLLER ADDRESSING

An address must be selected for each SCSI controller (some subsystems may contain more than one controller). If you are configuring the UC04 with the NOVRAM, you must calculate the SCSI address for each controller. If you are configuring the UC04 with switches, the SCSI address is determined by which configuration you choose. After selecting a configuration, assign the SCSI address specified for that configuration to the controller(s). The address is specified in the SCSI Addr column of Table B-4. Take care that no two controllers are assigned the same address.

4.3.3 PERIPHERAL (DRIVE) UNIT NUMBERS

Some peripherals must have unit numbers assigned to them during installation. If you are configuring the UC04 with the NOVRAM, you must calculate the unit number yourself. If you are configuring the UC04 with switches, check the Drive LUN (logical unit number) column of Table B-4. Use the row that corresponds to the configuration that you are using. Check the manual supplied with the drive for instructions on how to program the unit number into the drive.

4.3.4 SCSI TERMINATION

The last controller on the SCSI bus must electrically terminate the bus. The last controller should have termination enabled; all others should have it disabled. See your controller or subsystem manual for instructions on enabling and disabling the termination option.

4.4 SYSTEM PREPARATION

To prepare your CPU to accept the UC04, use the following procedures:

MICRO/PDP-11 and MicroVAX Tower Preparation:

1. Power down the system by switching OFF the main DC breaker.

2. Remove the rear cover from the chassis so that the patch panel is exposed. The rear cover is held on by snap pads. Grasp the cover at the top and bottom, and pull straight back.

3. Remove the patch panel.

4. Find the flat-ribbon cable that connects the CPU module to the patch panel. For ease of installation, you may disconnect the CPU flat-ribbon cable from the patch panel.

LSI-11 Series Preparation:

1. Power down the system by switching OFF the main AC breaker.

2. Remove the cover from the chassis so that the backplane is exposed.

Do not replace the covers or patch panels until the installation is verified (subsection 4.8)

4.5 HOST ADAPTER SETUP

Several configuration setups must be made on the UC04 Host Adapter before inserting it into the chassis. These are made by option switches SW1, SW2, and SW3.

Figure 4-3 shows the locations of the configuration switches referenced in the paragraphs below.

NOTE

> If a switch position is changed on the UC04, either reset the unit by toggling switch SW1-1 and then issuing a host bus init, or remove and restore the unit's power. This reset is required because the switches are read by the host operating system's initialization routine.

Table 4-1 defines the functions and factory configuration of all switches on the UC04 controller. The factory configuration switch settings are representative of most UC04 Host Adapter applications.

There are also several jumpers on the UC04 PCBA. Although none of these control configuration options, you may want to check and make sure they are in their factory configuration. Figure 4-3 shows the location of the jumpers on the PCBA; Table 4-2 lists the function and factory configuration of each jumper.

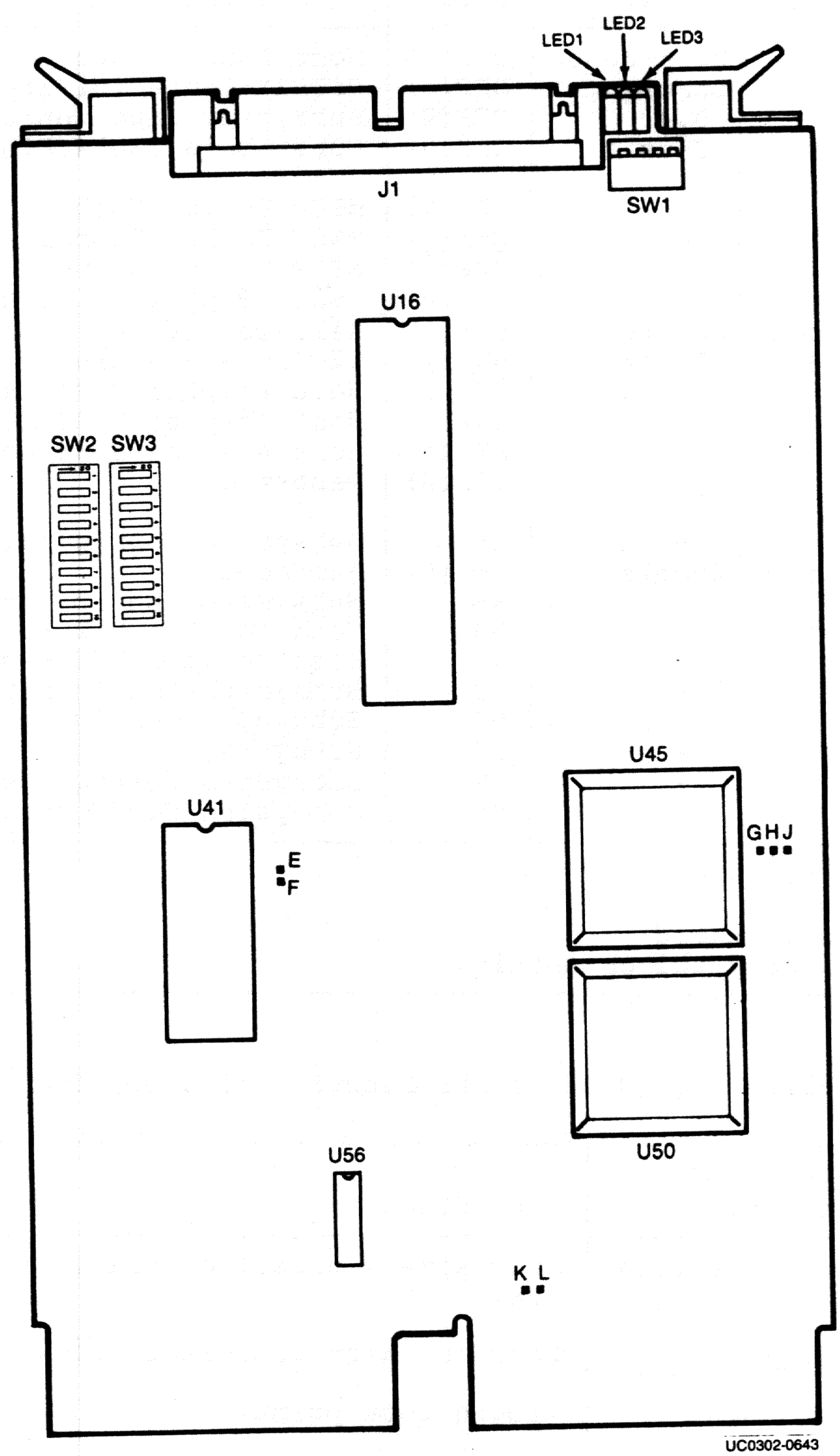


Figure 4-3. UC04 Host Adapter Assembly

Table 4-1. UC04 Switch Definitions/Factory Configuration

SW	OFF(0)	ON(1)	Fact	Function	Section
SW1-1	Run	Halt-Reset	OFF(0)	Host Adapter Run vs Halt	
SW1-2	Disable	Enable	OFF(0)	ULTRIX Compatibility	4.5.5.7
SW1-3	4,0	0,4	OFF(0)	Subsystem Tape Configuration	4.5.5.5
SW1-4	4 us	8 us	OFF(0)	Burst Delay Selection	4.5.5.6
SW2-1	-	-	OFF(0)	MSCP Device Number	4.5.5.2
SW2-2	-	-	OFF(0)	MSCP Device Number	4.5.5.2
SW2-3	-	-	OFF(0)	MSCP Device Number	4.5.5.2
SW2-4	-	-	OFF(0)	Host Adapter LSI Bus Address	4.5.1
SW2-5	Disable	Enable	OFF(0)	Self-Test Error Reporting	
SW2-6	18 bit	22 bit	ON(1)	22-Bit Addressing	4.5.5.4
SW2-7	-	-	ON(1)	Host Adapter SCSI Address	4.5.3
SW2-8	-	-	ON(1)	Host Adapter SCSI Address	4.5.3
SW2-9	-	-	ON(1)	Host Adapter SCSI Address	4.5.3
SW2-10	-	-	OFF(0)	Reserved	
SW3-1	-	-	NS	Subsystem Configuration	4.5.4
SW3-2	Disable	Enable	OFF(0)	Autoboot	4.5.5.1
SW3-3	-	-	NS	Subsystem Controller Type	4.5.5.3
SW3-4	-	-	NS	Host Adapter LSI Bus Address	4.5.1
SW3-5	-	-	NS	Host Adapter LSI Bus Address	4.5.1
SW3-6	-	-	NS	Subsystem Configuration	4.5.4
SW3-7	-	-	NS	Subsystem Configuration	4.5.4
SW3-8	-	-	NS	Subsystem Configuration	4.5.4
SW3-9	-	-	NS	Subsystem Configuration	4.5.4
SW3-10	-	-	NS	Subsystem Configuration	4.5.4

ON(1) = Closed
OFF(0) = Open
NS = No Standard
FACT = Factory switch setting

Table 4-2. UC04 Jumper Functions/Factory Configuration

Jumper	Factory Setting	Function
E-F	Not Installed	PROM size (installed = 32K, not installed = 16K)
G-H	Installed	Connects microprocessor clock
J	Not used	Ground test point
K-L	Not installed	Used for burn-in testing

4.5.1 HOST ADAPTER BUS ADDRESS

All LSI-11 Bus I/O devices have a block of several command and status registers through which the system can command and monitor the device. The registers are addressed sequentially from a starting address assigned to that device type, in this case an MSCP-class host adapter.

The address for the first of the UC04's two LSI-11 Bus registers is selected by DIP switches SW3-4, SW3-5, and SW2-4. See Table 4-3 for register address switch settings.

Table 4-3. Controller Address Switch Settings

CSR Address (Octal)	-SW3- 5	4	SW2 4
772150	0	0	0
772154	0	0	1
760334	0	1	0
760340	0	1	1
760344	1	0	0
760350	1	0	1
760354	1	1	0
760360	1	1	1

4.5.2 INTERRUPT VECTOR ADDRESS

The interrupt vector address for the UC04 is programmed into the device by the operating system during power-up. See subsection 3.2 for a discussion of device configuration.

4.5.3 HOST ADAPTER SCSI ADDRESS

The UC04 must be assigned a SCSI address. This address is programmed into the UC04 using switches SW2-7 through SW2-9. See Table 4-4 for switch setting information.

Table 4-4. UC04 SCSI Address Selection

SCSI Address	- SW2 - 7	8	9	Fact	SCSI Address	- SW2 - 7	8	9	Factory
0	0	0	0		4	1	0	0	
1	0	0	1		5	1	0	1	
2	0	1	0		6	1	1	0	
3	0	1	1		7	1	1	1	✓

= Factory

4.5.4 SUBSYSTEM CONFIGURATION SELECTION

The characteristics of the disk or tape subsystem(s) attached to the UC04 must be specified in one of two ways: with the configuration switches on the UC04 PCBA or by using the NOVRAM to specify the parameters of the disk drives.

If you use the configuration switches, you are limited to only the configurations supported by the UC04 firmware. The NOVRAM is more flexible, since it allows you to specify the parameters for any type of disk drive. This may be important if you are planning to expand your system at a later date. If you use the configuration switches to define the subsystem and later add a drive that is not supported by the switches, you will have to reconfigure the UC04 using the NOVRAM, and this requires that you reformat all disk drives attached to the UC04.

Switches SW3-1 and SW3-6 through SW3-10 are used for configuring the subsystem. If you will be using the NOVRAM, these switches should all be OFF and the configuration itself will not be done until the UC04 is installed and you are running the formatter program (see subsection 4.8).

If you wish to use the switches to configure the subsystem, they must be set before the UC04 is installed. Instructions for setting these switches, along with a list of all supported drive configurations, is contained in Appendix B. Read this appendix now if you plan to select the drive configuration with switches.

4.5.5 OPTIONS

There are other UC04 options that can be implemented by the user. These features are selected by physically installing the option on the PCBA or by enabling the option using a switch.

4.5.5.1 Autoboot

The Autoboot option causes the system to automatically boot from on of logical units zero through seven on power-up. To enable the autoboot option, set SW3-2 ON(1). Switches SW2-1 through SW2-3 specify which unit to boot from (see subsection 4.5.5.2).

NOTE

Autoboot cannot be enabled on either a MicroVAX or an LSI-11 with an 11/73B CPU module.

Switch	OFF	ON	Factory
SW3-2	Disable	Enable	OFF

The autoboot process requires that the LSI-11 CPU be configured for power-up mode 0. The following table lists the configuration settings for several popular LSI-11 CPUs.

CPU	Configuration Setting
11/73A	Install W3 and W7
11/23+	Remove J18-J19 and J18-J17
11/23	Remove W5 and W6
11/02	Remove W5 and W6

If the boot device is not powered-up or safe (i.e., it failed its self-test, etc.), the autoboot routine in the UC04 halts the CPU after four minutes. This causes the CPU to enter Console ODT. You can then examine the SA register for an error code (see Table 5-3 for a list of error codes) or bootstrap the system from an alternate device.

4.5.5.2 MSCP Device Number

If the UC04 is installed at the primary LSI-11 Bus address (772150), switches SW2-1 through SW2-3 select the logical unit to boot from, as shown below:

Logical Unit	SW2- 1	2	3	Factory
0	0	0	0	✓
1	1	0	0	
2	0	1	0	
3	1	1	0	
4	0	0	1	
5	1	0	1	
6	0	1	1	
7	1	1	1	

If the UC04 is installed as a second MSCP controller at an alternate address, these switches have a different function. Some operating systems require that no two MSCP drives have the same MSCP Unit number, even though the units may be attached to different controllers at different CSR addresses. See section 3.2.3 for a discussion of the requirements of various operating systems.

Switches SW2-1 through SW2-3 allow you to specify the MSCP Unit number of the first drive on the UC04 when your UC04 is being installed as a second MSCP controller (at an alternate LSI-11 Bus address). You may specify a unit number that is contiguous with the highest unit number on the MSCP controller at the primary LSI-11 Bus Address, or you may leave a gap. See Table 4-5 for switch settings.

Example: Your system operates under RSX-11M-PLUS and has two UC04 Host Adapters. The first UC04 is at the primary LSI-11 Bus address for MSCP controllers, 772150, and it supports two drives, DU0 and DU1. The second UC04 is assigned a floating address, and it also supports two drives. Under RSX-11M-Plus, these two drives must have unit numbers of 2 or greater. Set the switches on the second UC04 to specify a unit number of 2 for the first drive, as shown in Table 4-5.

This example would also apply if the first MSCP Server were a DEC RQDX1 with two logical drives.

Table 4-5. First Unit Number for a UC04 at an Alternate LSI-11 Bus Address

Starting MSCP Unit Number	SW2- 1	2	3
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1
8	0	0	0

4.5.5.3 Controller Type

If you are using the configuration switches to configure the UC04, this switch selects the type of disk controller attached to the UC04. When the UC04 is attached to an Emulex controller, SW3-3 must be ON. When a non-Emulex controller is used, SW3-3 must be OFF. This switch is meaningless if you are using the NOVRAM to configure the system.

Switch	OFF	ON	Factory
SW3-3	Non-Emulex	Emulex	NS

4.5.5.4 22-Bit Memory Addressing

Twenty-two-bit addressing capability is a standard feature on the UC04. To enable 22-bit addressing, you must install the 22-bit IC (included with the UC04) in the socket at location U56 and set switch SW2-6 ON.

WARNING

Some manufacturers of LSI-11 Bus backplanes use the backplane lines now devoted to extended addressing for power distribution. Installing a UC04 in such a system will damage the 22-bit addressing IC. Before enabling the option confirm that there is neither positive nor negative potential between lines BC1, BD1, BE1, BF1 and logic ground. A UC04 without the 22-bit IC will not be damaged.

Switch	OFF	ON	Factory
SW2-6	18-bit	22-bit	ON

4.5.5.5 Tape Drive Address Selection

This switch controls the SCSI address and SCSI LUN of the tape drive if the subsystem configuration is chosen with switches. It is meaningless if you are using NOVRAM to configure the system.

On all of the switch configurations that include a tape drive, the tape is assigned a SCSI Address of 4 and a LUN of 0. However, combination disk/tape controllers (such as the Emulex MS51), place the tape controller at SCSI Address 0 and the tape drive is assigned LUN 4. Switch SW1-3 is used with combination boards to allow use of the standard UC04 configurations (tape drive = 4,0) when the tape drive actually has a SCSI ID of 0,4.

If switch SW1-3 is OFF, the tape is assigned SCSI address 4, LUN 0 (standard configuration); if switch SW1-3 is ON it is assigned SCSI address 0, LUN 4 (for use with combination controllers).

Switch	OFF	ON	Factory
SW1-3	Address 4 LUN 0	Address 0 LUN 4	OFF

4.5.5.6 Burst Delay Selection

The UC04 firmware design includes a switch-selectable DMA burst delay to avoid data late conditions. Switch SW1-4 selects either a 4-microsecond or 8-microsecond delay between DMA bursts. Even with the UC04 adaptive DMA, some applications may require the longer burst delay to allow other devices adequate time on the bus.

Switch	OFF	ON	Factory
SW1-4	4 us	8 us	OFF

4.5.5.7 ULTRIX Compatibility

Switch SW1-2 allows the UC04 to operate under Ultrix-32m, V1.1 or above, or Ultrix 11, V3.0 or above. When this switch is ON, it forces all media to be identified as RA81 devices, regardless of the actual drive type. However, to format disks using the Emulex formatter programs, SW1-2 must be OFF. If you are working under an ULTRIX operating system and need to format disks, first format them with the switch OFF, then set the switch ON for operation. This switch must always be OFF for MicroVMS operation.

Switch	OFF	ON	Factory
SW1-2	Normal or Formatting	ULTRIX	OFF

4.6 PHYSICAL INSTALLATION

4.6.1 SLOT SELECTION

The UC04 may be assigned to any desired slot, as it uses the LSI four-level interrupt scheme for distributed interrupt arbitration.

Be sure to find out whether your backplane is straight or serpentine and choose a slot accordingly. On straight backplanes, the UC04 must be plugged into connecters A and B, since connectors C and D carry no signals. On a serpentine backplane, the UC04 can be plugged into either connectors A and B or connectors C and D. In either case, there must be no unused slots between the CPU and the UC04 and no unused slots between the UC04 and the last board in the system.

4.6.2 MOUNTING

The Host Adapter should be plugged into the LSI-11 backplane with components oriented in the same direction as the CPU and other modules. Always insert and remove the boards with the computer power OFF to avoid possible damage to the circuitry. Be sure that the board is properly positioned before attempting to seat the board.

4.7 CABLING

The UC04 Host Adapter interfaces with the SCSI Bus through J1, a 50-pin flat connector located on the outside edge of the PWB. You may make a custom cable to connect your SCSI subsystem to the UC04, or you may use one of the three cabling kits manufactured by Emulex. The cabling kits are designed to ease the installation of the UC04 in common DEC CPU cabinets, and to keep the radiation of electromagnetic interference (EMI) within the limits specified by FCC regulations.

As noted in subsection 4.1.3, the UC04 and SCSI subsystem can be installed in either of two configurations:

1. With the UC04 Host Adapter and the SCSI subsystem that it supports both mounted in the same cabinet, or

2. With the UC04 mounted in the CPU cabinet and the SCSI subsystem mounted in a separate cabinet.

The following paragraphs descibe the cabling of the UC04 and subsystem on that basis: same cabinet vs. separate cabinet. The separate cabinet installations rely on Emulex cabling kits to limit EMI and thus the procedures for installing the kits are described there.

4.7.1 SAME CABINET INSTALLATIONS

When the UC04 and the SCSI subsystem are installed in the same cabinet, it is possible that the cabinet itself provides sufficient shielding. In such cases, it is not necessary to shield the cable that carries the SCSI bus between the UC04 and the SCSI peripherals.

A custom 50-wire flat cable can be constructed to connect J1 to the SCSI peripherals. See Table 8-1 for J1 pin assignments; Figure 4-4 is an illustration of a common installation. Make sure that the last, and only the last, SCSI controller in the daisy chain provides proper termination for the SCSI bus.

NOTE

> If the cabinet in which the UC04 and LSI-11 CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsibility to take whatever steps are necessary to correct the interference.

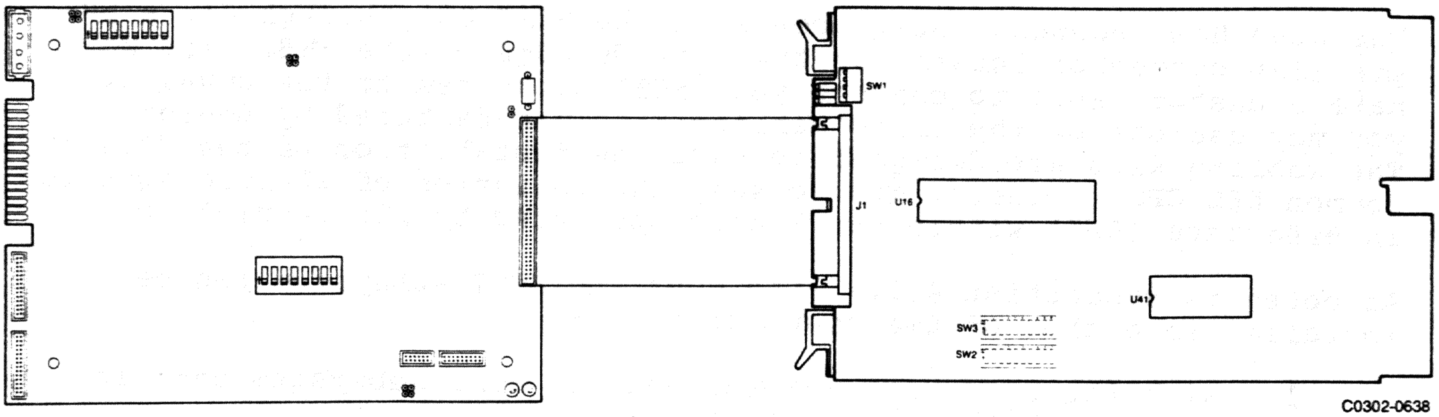


Figure 4-4. UC04 Cabling Diagram

4.7.2 SEPARATE CABINETS

If the SCSI peripheral subsystem is mounted in a separate cabinet from the UC04 Host Adapter, then the cable that connects the SCSI peripheral to the UC04 must be shielded, as it runs outside of the shielded cabinet environment.

Emulex makes three cabling kits that adapt shielded cables to the SCSI interface of the UC04 and that preserve the shield built into some DEC CPU cabinets. These kits also include a shielded SCSI cable that is fully compatible with the SCSI peripheral subsystems manufactured by Emulex. Each kit contains the all of the hardware necessary to complete an installation.

The cable kits are listed in Table 4-6 and illustrated in Figures 4-5, 4-6, 4-7, and 4-8. Note that each kit can be ordered with SCSI cables in various lengths; in the Universal RETMA mount kit, the flat cables can also be ordered in a variety of lengths.

Table 4-6. Cabling Kits

Cabling Kit	Top Assembly Part Number	Subsystem Supported
MICRO/PDP/VAX	PU0113002-XX	Decathlon Javelin SABRE
	PU0213001-XX	Medley, disk and tape
	PU0213006-XX	Medley, tape
Option	PU0120105	Emulex Patch Panel
Universal RETMA Rack-Mount	PU0113003-XX	Decathlon Javelin SABRE
	PU0213003-XX	Medley, disk
	PU0213002-XX	Medley, disk and tape
	PU0213004-XX	Medley, tape
Chassis Mount	PU0113004-XX	Javelin SABRE

The items listed in Table 4-5 can be ordered from your Emulex sales representative or directly from the factory. Contact:

Emulex Customer Service
3545 Harbor Boulevard
Costa Mesa, CA 92626
(714) 662-5600 TWX 910-595-2521

A procedure for installing each kit is given in the following subsections.

4.7.2.1 The MICRO/PDP/VAX Cabling Kits

The MICRO/PDP/VAX Cable kit is designed to use the patch panel at the rear of the Micro chassis. This kit can not be used with the Emulex CP24 or CP24B Distribution Panels. If you wish to install both the cable kit and the distribution panel, Emulex manufactures a replacement for the DEC patch panel. Order the Emulex patch panel in addition to the MICRO/PDP/VAX Cable kit.

Cabling

To install the cable kit in the Micro chassis, see Figures 4-5 and 4-6 and use the following procedure:

1. Align the header of the connector on the flat-ribbon cable with connector J1 on the UC04. Match the triangle marking on the header with the triangle marking on the J1 connector, as shown in Figure 4-5.

2. Seat the header in the J1 connector using the latches, as shown in Figure 4-5.

NOTE

> The connector is not keyed and can be physically reversed in the header. No damage should result, but the system will not operate.

3. Remove segments C and D from the DEC patch panel. Remove the support that divided segments C and D.

4. Attach the transadapter to the patch panel with the captive screws. See Figure 4-6.

5. Connect one end of the SCSI round shielded cable to the 50-pin opening in the transadapter plate. See Figure 4-6.

6. Thread the round shielded cable through the opening in the at the rear of the CPU chassis.

7. Re-connect the flat-ribbon cable that connects the CPU module to the patch panel.

8. Connect the other end of the SCSI round shielded cable to the 50-pin opening in the rear panel of the subsystem. For additional cabling instructions, refer to your subsystem manual.

If you are installing both a UC04 and an Emulex Communications Subsystem that uses the CP24 Distribution Panel, you will need the Emulex replacement for the DEC patch panel. The Emulex patch panel is designed to be used with the MICRO/PDP/VAX Cable kit. The patch panel comes with blank panels in all of its apertures. Prepare and install the Emulex patch panel by using the following procedure:

1. Remove the console distribution panel insert from section A of the DEC patch panel. Save the screws.

2. Install this console distribution panel insert in section A of the Emulex patch panel. Use the screws saved in Step 1.

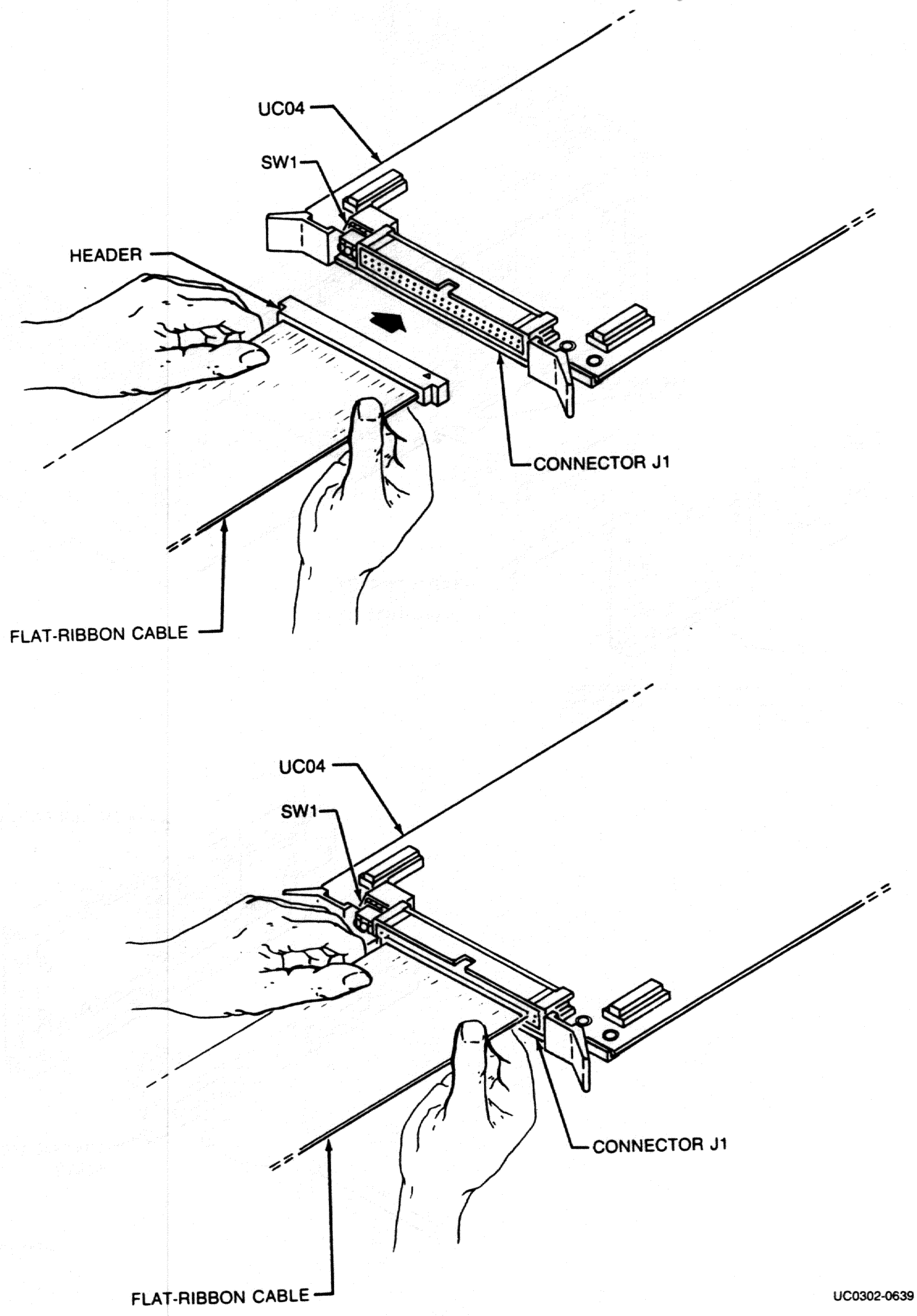


Figure 4-5. Plugging the Transadapter Flat Cable into J1.

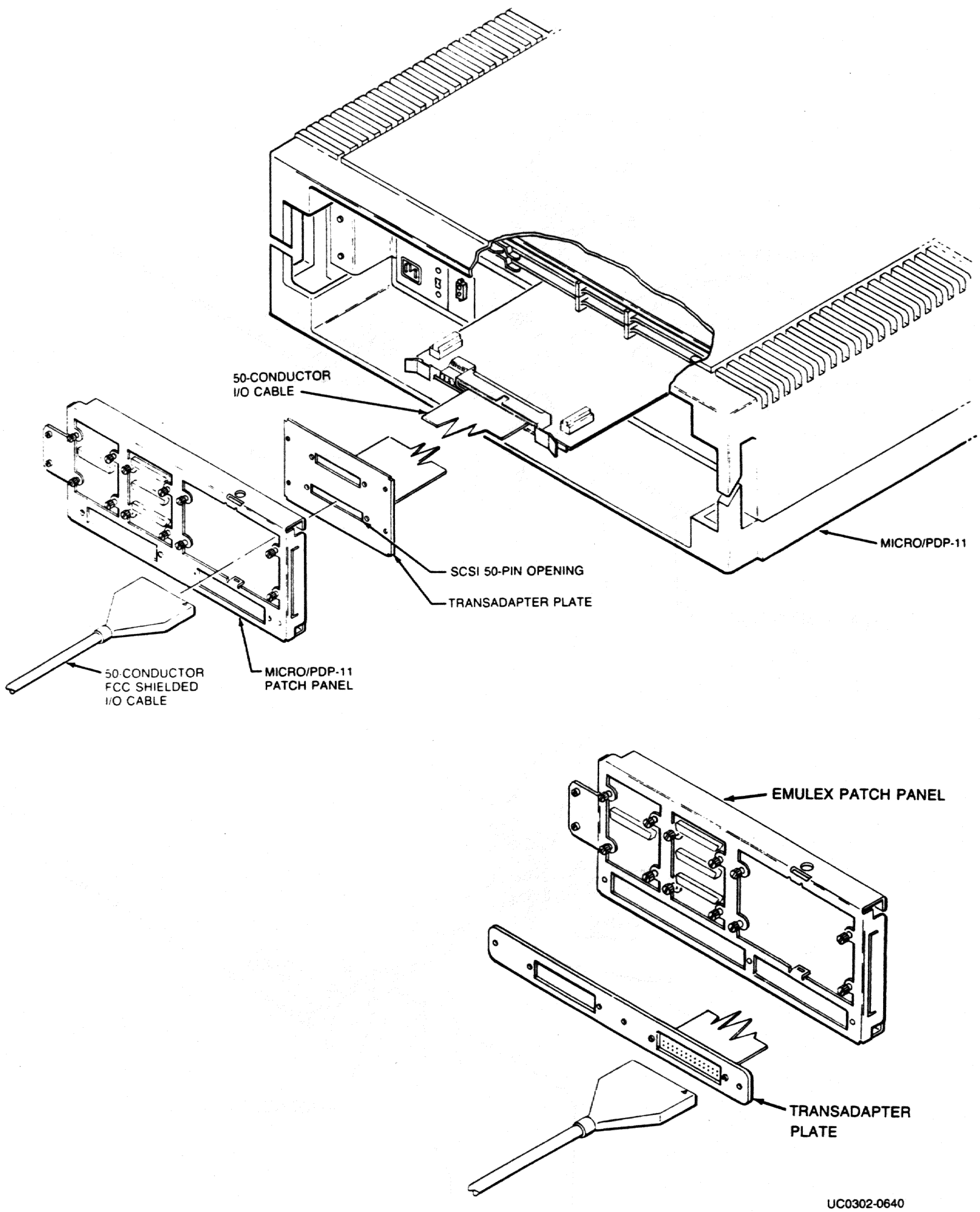


Figure 4-6. Installing the MICRO/PDP/VAX Cabling Kit

3. If you are planning to use the DEC DHV11, remove its distribution panel from section B of the DEC patch panel. Save the screws. Install this panel insert in section B of the Emulex I/O panel. Use the saved screws.

4. If you are installing an Emulex Communications Subsystem with the CP24/B Distribution Panel, install the panel in section B of the Emulex patch panel. You can leave the DEC equivalent in the old patch panel.

5. Remove the transadapter plate from the Emulex patch panel. Remove the blanking panel from the longer of the two slots.

6. Remove the cable assembly from the transadapter that is included in the MICRO/PDP/VAX Cabling kit.

7. Install the cable assembly in the transadapter plate from the Emulex patch panel. Re-install the transadapter in the patch panel.

4.7.2.2 The Univeral RETMA Rack Mount Cabling Kit

The Universal RETMA Rack Mount Cabling Kit can be used in any CPU cabinet that is based on the standard 19-inch RETMA rack. It is particularly useful with rack mounted LSI-11/23 and LSI-11/23-PLUS CPUs. To install the kit, see Figure 4-7 and use the following procedure.

1. Mount the CU22 Mounting Frame at the rear of the CPU cabinet using the supplied hardware. Make sure that the Frame is mounted close enough to the CPU so that the flat cable from the Transadapter can reach the UC04. (Transadapters are available with flat cables in four different lengths. See Table 4-5.) The rack should be wired to a good earth ground.

2. Install the Transadapter in the Mounting Frame using the eight captive screws.

3. Align the header of the connector on the flat-ribbon cable with connector J1 on the UC04. Match the triangle marking on the header with the triangle marking on the J1 connector, as shown in Figure 4-5.

4. Seat the header in the J1 connector using the latches as shown in Figure 4-5.

NOTE

> The connector is not keyed and can be physically reversed in the header. No damage should result, but the system will not operate.

5. Connect one end of the SCSI round shielded cable to the 50-pin opening in the transadapter plate. See Figure 4-7.

6. Dress the round shielded cable toward the bottom of the chassis.

7. Connect the other end of the SCSI round shielded cable to the 50-pin opening in the rear panel of the subsystem. For additional cabling instructions, refer to your subsystem manual.

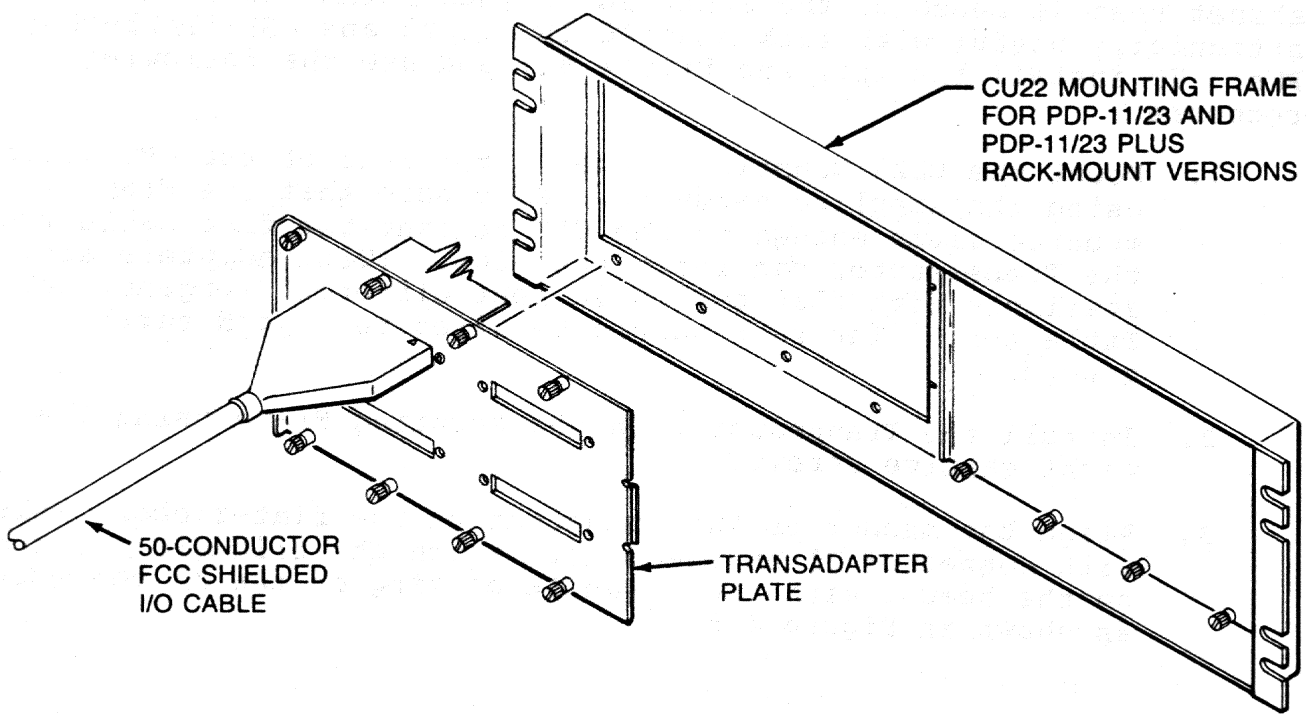


Figure 4-7. Installing the Universal Rack Mount Cabling Kit

4.7.2.3 The Chassis Mount Cabling Kit

The Chassis Mount Cabling Kit is designed for use with LSI-11/23 BC chassis. To install the Kit, see Figure 4-8 and use the following procedure:

1. Remove either cable clamp from the rear chassis cover.
2. Install the Transadapter so that the rectangular, 50-pin connector shows at the notch in the bottom of the chassis cover.
3. Align the header of the connector on the flat-ribbon cable with connector J1 on the UC04. Match the triangle marking on the header with the triangle marking on the J1 connector, as shown in Figure 4-5.
4. Seat the header in the J1 connector using the latches as shown in Figure 4-5.

NOTE

> The connector is not keyed and can be physically reversed in the header. No damage should result, but the system will not operate.

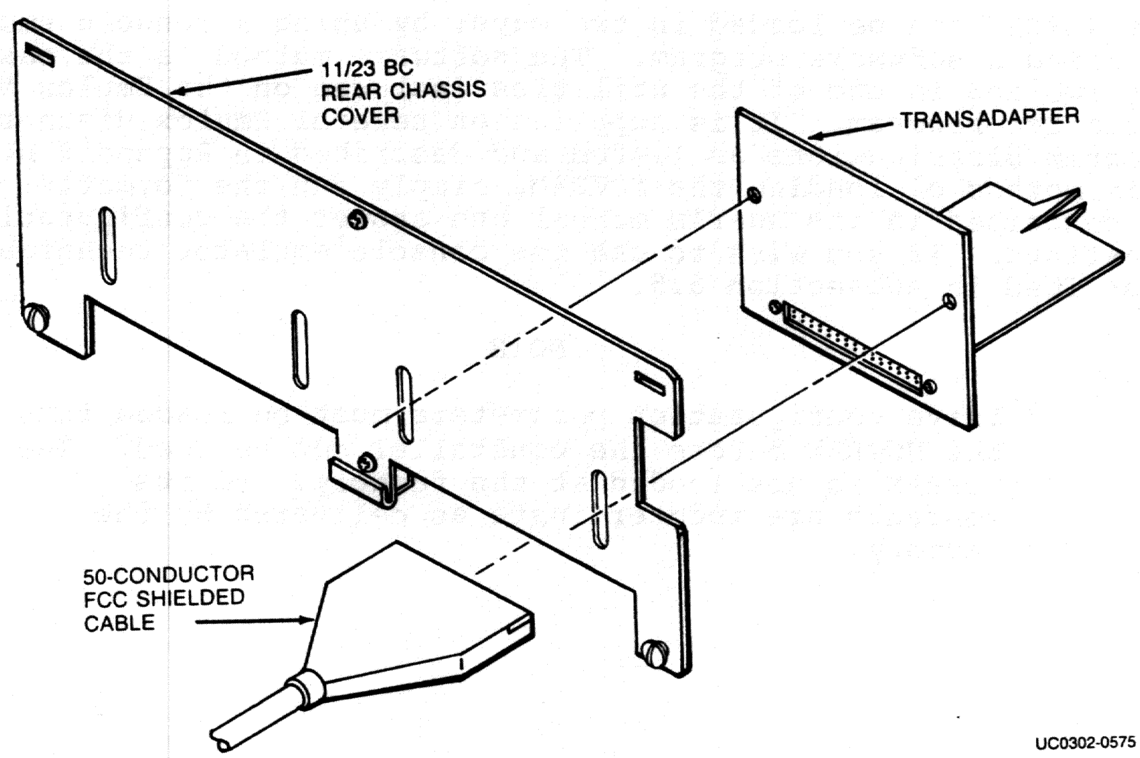


Figure 4-8. Installing the Chassis Mount Cabling Kit

5. Connect one end of the SCSI round shielded cable to the 50-pin opening in the transadapter plate. See Figure 4-8.

6. Dress the round shielded cable toward the bottom of the chassis.

7. Connect the other end of the SCSI round shielded cable to the 50-pin opening in the rear panel of the subsystem. For additional cabling instructions, refer to your subsystem manual.

4.8 INTEGRATION AND OPERATION

Before you can use the UC04, the configuration of the subsystem must be defined. If you have used the configuration switches (defined in Appendix B) to do this, you do not need to load the NOVRAM and can skip this section.

If you have not set the configuration switches, you must load the NOVRAM with the configuration parameters of the drives that are controlled with the UC04.

NOTE

> If you are using the NOVRAM to define the subsystem configiuation, the subsystem configuration switches (SW3-1 and SW3-6 through SW3-10) must all be OFF.

The NOVRAM can be loaded in two ways: by using a console emulator or by using a software program. The software method is the easier of the two and is one of the utilities included on the Emulex MSCP Formatter Program. It is supplied on several Emulex diagnostic program distributions as listed and described in Appendix D. To use this method of loading the NOVRAM, simply run the formatter program as described in its user's manual and answer the configuration questions. If you wish to use the console emulator technique, it is described in subsection 6.5.

NOTE

> Drive configuration parameters must be loaded into the NOVRAM before the controller can be used. The NOVRAM is not loaded at the factory, and its contents are indeterminate as delivered by the factory.

4.8.1 FORMATTING

Before the UC04 can be used or the diagnostics run, all disk peripherals attached to the subsystem must be formatted. Emulex provides the UC04 with a Disk Formatter Utility for that purpose. At this point in the installation process, run the Formatter Utility. Two formatters are available: U1MX8 (revision F or above) for the LSI-11, and FVD03M (revision 2.1 and above) for the MicroVAX. For the LSI-11, the **PDP/LSI UCXX MSCP Disk Formatter User's Manual** (PD9950902) explains how to load and run the formatter program. For the MicroVAX, the **UCXX MSCP Disk Formatter User's Guide** (VX9950917) describes how to load and run the formatter program. These formatters also serve as data reliability programs.

The UC04 can also be formatted through a firmware routine. See subsection 6.7 for details.

NOTE

> If you are formatting an optical disk, read Appendix E before formatting.

4.8.2 TESTING

4.8.2.1 Self-Diagnostic

If switch SW2-5 is OFF, the UC04 executes a self-test at the following times:

- on power-up
- after a reset condition
- after a bus initialization
- after a write operation to the IP register

The self-test routine consists of two test sequences, preliminary and self-test. The preliminary test sequence exercises the 8031 microprocessor chip and the NCR5385 SCSI chip. This test will fail if you have not defined the configuration with the switches and have also failed to load the NOVRAM. When the UC04 completes the preliminary test, LED3 illuminates. After the host CPU initializes the UC04's MSCP file server, the UC04 executes the second sequence in the self-test routine. This self-test sequence exercises the buffer controller chip, the HAC chip and its associated circuitry, the on-board RAM and the control memory PROM.

If the UC04 passes both sequences of its self-tests successfully, all the LED indicators on the edge of the UC04 are OFF. If a fatal error is detected, all three of the edge-mounted LED indicators are ON.

If the UC04 fails to pass its power-up self-tests, you can select a special diagnostic mode which causes the LED indicators to display an error code. See Section 5, Troubleshooting.

NOTE

> During normal operation, LED1 flashes to indicate LSI-11 bus activity and LED2 flashes to indicate SCSI bus activity.

Section 5
TROUBLESHOOTING

5.1 OVERVIEW

This section describes the several diagnostic features with which the UC04 is equipped, and outlines fault isolation procedures that use these diagnostic features.

5.1.1 SERVICE

Your Emulex UC04 Intelligent Host Adapter has been designed to give years of trouble-free service, and it was thoroughly tested before leaving the factory.

Should one of these fault isolation procedures indicate the UC04 is not working properly, the product must be returned to the factory or one of Emulex's authorized repair centers for service. Emulex products are not designed to be repaired in the field.

Before returning the product to Emulex, whether the product is under warranty or not, you must contact the factory or the factory's representative for instructions and a Return Materials Authorization (RMA) number.

DO NOT RETURN A COMPONENT TO EMULEX WITHOUT AUTHORIZATION. A component returned for service without an authorization will be returned to the owner at the owner's expense.

In the continental United States, Alaska, and Hawaii contact:

Emulex Technical Support
3545 Harbor Boulevard
Costa Mesa, CA 92626
(714)662-5600 TWX 910-595-2521

Outside the United States, contact the distributor from whom the subsystem was initially purchased.

To help you efficiently, Emulex or its representative requires certain information about our product and the environment in which it is installed. During installation, a record of the switch settings should have been kept on the Configuration Reference Sheet. This sheet is contained in the Installation Section, Figure 4-1.

After you have contacted Emulex and received an RMA, package the component (preferably using the original packing material) and send the the component **POSTAGE PAID** to the address given you by the Emulex representative. The sender must also insure the package.

5.2 FAULT ISOLATION PROCEDURE

If your UC04 Host Adapter appears to be not working properly, you should check the troubleshooting guide in Table 5-1 which, lists problem symptoms, possible explanations, and suggestions for remedies.

Table 5-1. UC04 Troubleshooting Guide

Symptom	Possible Cause	For More Help
The Fault LEDs are illuminated	The powerup self-test has detected an error.	Power-Up Self-Diagnostic, Subsection 5.3
System crashes on certain jobs	If CPU supports 22-bit addressing, verify that UC04 is also configured for 22-bit addressing (22-bit IC installed at U56 and switch SW2-6 ON).	22-Bit Addressing Subsection 4.5.5.4
Automatic bootstrap does not work	Verify automatic bootstrap is enabled.	Autoboot, Subsection 4.5.5.1
	Your LSI-11 Series CPU module is not set up for power-up mode zero.	
	Drive specified is not powered-up or operational.	Bootstrapping Subsection 6.4.1

5.3 POWER-UP SELF-DIAGNOSTIC

The UC04 executes an extensive self-diagnostic to ensure that the host adapter is in good working order. The self-diagnostic is divided into two parts.

The first part of the diagnostic consists of a series of tests that are performed on the internal components of the host adapter. These tests are executed immediately after power-up or bus INIT or after a write to the IP register. The UC04 indicates that the internal tests were executed successfully by turning LED3 ON. The LEDs are located on the top edge of the host adapter PWB.

To help determine the location of the problem, the operator can select a special diagnostic mode that causes the LEDs to display an error code. This diagnostic mode is enabled by setting SW2-5 ON (1). After setting SW2-5 ON, the host computer must be powered down or switch SW1-1 must be toggled (ON/OFF) and a host bus init issued to cause the UC04 to perform its self-test again. Upon encountering an error, the host microprocessor halts and the LEDs display an error code. The error codes are listed and described in Table 5-2.

Table 5-2. Error Codes

LED 3	LED 2	LED 1	Error Description
0	0	1	CPU Chip Test failed
0	1	0	SCSI Chip Test failed
1	0	0	Controller idle, waiting for initialization sequence to start
0	1	1	Buffer Controller or External Memory Test failed
1	0	1	HAC Test failed
1	1	0	Emulation PROM Checksum Test failed
0	0	0	Self-Diagnostic complete without errors

The second part of the self-diagnostic is executed by the UC04 during its initialization by the MSCP port driver. These tests are more extensive and include tests of the buffer controller, HAC chip, RAM refresh, and emulation PROM. Any errors detected during the initialization process are reported to the operating system via the UC04 SA register. See **Storage System Unibus Port Description**, DEC document number AA-L621A-TK.

5.4 MSCP FATAL ERROR CODES

If the UC04 encounters a fatal error any time during operation, all three LEDs are illuminated and an error code is posted in the low-byte of the SA register (base address plus 2). Table 5-3 lists the MSCP fatal error codes used by the UC04.

Table 5-3. MSCP Error Codes used by the UC04

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the UC04 attempted to read data from a message packet.
2	2	Possible parity or timeout error when the UC04 attempted to write data to a message packet.
4	4	UC04 diagnostic self-test indicated a controller RAM error.
5	5	UC04 diagnostic self-test indicated a controller checksum error.
6	6	Possible parity or timeout error when the UC04 attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the UC04 attempted to write an envelope address to a command ring.
11	9	Host did not communicate with UC04 within the time frame established while bringing the controller online. (If this code appears during firmware formatting, it indicates a seek timeout.)
12	A	Operating system sent more commands to the UC04 than the controller can accept.
13	B	UC04 attempted DMA operation and failed.

Table 5-3. MSCP Error Codes used by the UC04 (continued)

Octal Code	Hex Code	Description
14	C	UC04 diagnostic self-test indicated controller fatal error.
16	E	The MSCP connection identifier is invalid.
23	13	An error occurred during the MSCP initialization sequence.

BLANK

6.1 OVERVIEW

This section contains an overview of the UC04 device registers that are accessible to the LSI-11 Bus, and that are used to monitor and control the UC04 MSCP Server. The registers are functionally compatible with DEC implementations of MSCP Servers.

The following table outlines the contents of this section.

Subsection	Title
6.2	Overview of MSCP Subsystem
6.3	Programming
6.4	Registers
6.5	Drive Geometry Command (NOVRAM)
6.6	Bootstrapping
6.7	Firmware Formatting

6.2 OVERVIEW OF MSCP SUBSYSTEM

Mass Storage Control Protocol (MSCP) is the protocol used by a family of mass storage controllers and devices designed and built by Digital Equipment Corporation. MSCP allows a host system to be connected to disk drives with a variety of capacities and geometries. This flexibility is possible because MSCP defines data locations in terms of sequential, logical blocks, not in terms of a physical description of the data's location (i.e., cylinder, track, and sector). This scheme gives the MSCP controller the responsibility for converting MSCP logical block numbers into physical addresses that the peripheral device can understand.

This technique has several implications. First, the MSCP controller must have detailed knowledge of the peripheral's capacity, geometry and status. Second, the ability to make the translation between logical and physical addresses implies considerable intelligence on the part of the controller. Finally, the host is relieved of responsibility for error detection and correction, because its knowledge of the media is insufficient to allow efficient error control.

There are several advantages to this type of architecture. First, it provides the host with an "error free" media. Second, it provides for exceptional operating system software portability because, with the exception of capacity, the characteristics of all MSCP disk drives are the same from the operating system's point of view.

In terms of implementation, this protocol requires a high degree of controller intelligence. Essentially, this intelligence is a process that runs on a microprocessor and is referred to as the MSCP Server. The MSCP Server has all of the responsibilities outlined in the preceding paragraphs.

The host computer runs a corresponding process that takes calls from the operating system, converts them into MSCP commands, and causes the resulting commands to be transferred to the MSCP Server.

In summary, an MSCP subsystem is characterized by an intelligent controller that provides the host with a view of a perfect media. It is further characterized by host independence from a specific bus, controller, or device type.

6.3 PROGRAMMING

A complete description of MSCP commands and the corresponding status responses that the UC04 MSCP Server posts is beyond the scope of this manual. A comprehensive description of MSCP may be ordered from DEC's Software Distribution Center, Order Administration/Processing, 20 Forbes Rd., Northboro, Massachusetts 01532.

- UDA50 Programmer's Documentation Kit (QP905-GZ). This kit consists of the following three software manuals:
  - MSCP Basic Disk Function Manual (AA-L619A-TK)
  - Storage System Diagnostic and Utilities Protocol (AA-L260A-TK)
  - Storage System UNIBUS Port Description (AA-L621A-TK)

6.3.1 UNSUPPORTED COMMANDS

The UC04 MSCP Server executes the Minimal Disk Subset of MSCP Commands. No currently available MSCP Server supports the entire range of MSCP commands. The following subsections list and describe functions that the UC04 does not support.

6.3.1.1 Diagnostic and Utility Protocol (DUP)

The UC04 MSCP Server does not support any of the DUP commands or maintenance read/write functions.

6.3.1.2 Forced Error Modifier

The "forced error" modifier is not supported except with Emulex drive controllers (Medalist, Champion).

6.4 REGISTERS

During normal operation the UC04 is controlled and monitored using the command and status packets that are exchanged by the host and the UC04. The UC04 has two 16-bit registers in the LSI-11 Bus I/O page that are used primarily to initialize the subsystem. During normal operation, the registers are used only to initiate polling or to reset the subsystem. These registers are always read as words. The register pair begins on a longword boundary. The register names, addresses, and functions are:

IP	7xxxx0/4	Initialization and Polling
SA	7xxxx2/6	Status, Address and Purge

The IP register has two functions:

1. When written with any value, it causes a hard initialization of the MSCP Server.

2. When read while the port is operating, it causes the controller to initiate polling.

The SA register has four functions:

1. When read by the host during initialization, it communicates data and error information relating to the initialization process.

2. When written by the host during initialization, it communicates certain host-specific parameters to the port.

3. When read by the host during normal operation, it communicates status information including port- and controller-detected fatal errors.

4. When zeroed by the host during both initialization and normal operation, it signals the port that the host has successfully completed a bus adapter purge in response to a port-initiated purge request.

The detailed operation of these registers is discussed in the **Storage System UNIBUS Port Description** (AA-L621A-TK) available from DEC as described in subsection 6.3. Note that only word transfers to or from IP and SA are permissible; the behavior of byte transfers is undefined.

6.4.1 ACCESSING REGISTERS ON A MICROVAX

Formatting and bootstrapping on the UC04 can both be done by using procedures that write directly to the UC04 registers. On an LSI-11 this is straightforward. However, on a MicroVAX the addresses of the SA and IP registers must be offset. Table 6-1 translates the allowed octal addresses of the UC04 registers into the offset values required when using the console emulator on a MicroVAX.

Table 6-1. MicroVAX Offset

Octal Address	Hexadecimal Address	Hex Address With Offset
772150	F468	20001468
772152	F46A	2000146A
772154	F46C	2000146C
772156	F46E	2000146E
760334	E0DC	200000DC
760336	E0DE	200000DE
760340	E0E0	200000E0
760342	E0E2	200000E2
760344	E0E4	200000E4
760346	E0E6	200000E6
760350	E0E8	200000E8
760352	E0EA	200000EA
760354	E0EC	200000EC
760356	E0EE	200000EE
760360	E0F0	200000F0
760362	E0F2	200000F2

6.5 CONFIGURING THE NOVRAM

The UC04 allows the user to specify media geometry for the disk drives that it supports. The geometry data is stored in nonvolatile Random Access Memory (NOVRAM) on the UC04. When used with the UC04, the NOVRAM can store three configurations, thus supporting up to three different types of drives.

The NOVRAM is programmed by loading the drive geometry parameters into the host computer's memory and then causing the UC04 to read the parameters by using a special sequence of commands. The parameters are loaded and the commands are issued while the UC04 is installed in an LSI-11 or MicroVAX and while the computer is offline. Both operations can be performed manually by using the CPU console (or a console emulator such as ODT), or automatically by using a special utility. Emulex provides this utility for LSI-11 and MicroVAX processors as part of the disk formatter program.

The following paragraphs describe the geometry parameters that are required, their format, and the command sequence that causes the parameters to be stored in the NOVRAM.

6.5.1 DRIVE GEOMETRY PARAMETERS

Figure 6-1 is a worksheet that shows the drive parameters in the order you must enter them. The paragraphs following the worksheet explain each parameter. You should fill out this worksheet for each type of drive in your system before beginning the procedure for loading the information into the NOVRAM. Examples for several common ST-506 drives are listed in Appendix F. Appendix F also gives examples for some ESDI drives; however, although manual NOVRAM loading is possible, Emulex recommends that you use the formatter utility to load the NOVRAM for use with ESDI drives.

The Parameter Information Block (PIB) consists of 16 words of data. Each word contains a drive parameter. A separate block is required for each different type of drive on the controller, up to a maximum of three different drive types. The blocks may be placed anywhere in the first 64K of memory and must be contiguous (on a MicroVAX II the blocks must start at address 0). The first word of the parameter block can be stored at any address; the addresses of subsequent words (and parameter blocks) are contiguous and numerically higher.

NOTE

> A zero must be written into the word immediately following the last PIB. Following the zero, there must be two words for each drive in the system. These two words specify the SCSI address and Logical Unit Number of each drive. This is explained in more detail in subsection 6.5.2, which follows this one.

Parameter	Drive Type 1	Drive Type 2	Drive Type 3
Word 1 Number of Units Of this Type			
Word 2 Type Code			
Word 3 Sector Size			
Word 4 Number of Sectors Per Track			
Word 5 Number of Heads			
Word 6 Number of Cylinders			
Word 7 Number of Spare Sectors per Track			
Word 8 Number of Alternate Cylinders			
Word 9 Landing Zone			
Word 10 Split Code			
Word 11 Removable Media Flag			
Word 12 Hard/Soft Sector Flag			
Word 13 Reduced Write Current Cylinder			
Word 14 Write Precompensation Cylinder			
Word 15 Step Code			
Word 16 Reserved			
SCSI Addresses and LUNs for each drive			

Figure 6-1. Drive Configuration Parameter Block Worksheet

Number of Units of this Type (1)

This word specifies the number of physical disk drives that this parameter block defines. This number cannot be larger than 8. If this word is zero, the UC04 will stop reading information and limit the configuration to those previously read (see subsection 6.5.2).

Type Code (2)

This word indicates the controller type. The table below shows the allowable values:

Code	Controller
1	Medalist (MD01--ST506 interface
2	Adaptec 4000
3	Iomega
4	Tape (Titleist)
5	Optical Disk
6	Champion (MD21--ESDI interface)

If code 3, 4, or 5 is entered, words 2 through 15 are ignored.

Sector Size (3)

This field defines the sector size on the drive. 0 is the only valid entry (512-byte sectors).

Number of Sectors per Track (4)

This word specifies the number of logical sectors per physical track. Spare sectors are not included in this number. The valid range is from 1 through 128.

Number of Heads (5)

This word specifies the number of data heads per drive. The valid range is from 1 through 32.

Number of Cylinders (6)

This word specifies the number of logical cylinders per physical drive that are accessible to the UC04. For controller type 1 (Medalist), use the number of physical cylinders minus the number of spare cylinders minus two more. For controller type 2 (Adaptec), use the number of physical cylinders minus the number of spare cylinders. For controller type 6 (Champion), use the number of physical cylinders minus the number of spare cylinders minus three more. The valid range is from 1 through 4095.

Number of Spare Sectors per Track (7)

This word specifies the number of spare sectors reserved per track. This number plus the number of logical sectors per track (word 4) equals the total number of physical sectors per track. The valid range is 0 through 3. If 0 is specified, no spare sectors are reserved. You must specify at least one spare sector to allow the UC04 to perform the block replacement function.

Number of Alternate Cylinders (8)

This word specifies the number of spare cylinders per physical drive. This number plus the number of cylinders the controller reserves for its own use (Medalist reserves 2 cylinders and Champion reserves 3) plus the number of logical cylinders (word 6) equals the total number of physical cylinders. The valid range is from 0 through 256. If 0 is specified, no spare cylinders are reserved. If you are using an Adaptec controller, the number of spare cylinders should be 128/(number of heads x sectors per track), rounded up.

Landing Zone (9)

This word is currently reserved for future use. The only valid value is 0.

Split Code (10)

This word allows the drive defined by this parameter block to be split into two logical disk units. Only the first physical drive may be split. Therefore, a split drive is allowed only on the first PIB defined and word 1 of this PIB (number of drives of this type) must be 1. The relative sizes of the logical drives are defined as follows:

Code	Drive 0	Drive 1
0	8/8	0
1	4/8	4/8
2	7/8	1/8

Use of the split option disables seek-ordering and overlapped seek processing in the MSCP Server, which reduces performance, particularly when both logicals of a split physical drive are active. Therefore, we do not recommend using this option unless necessary to allow for convenient file backup and restoration when only one physical drive is available. The following splits are supported:

Code 0: No split.

Code 1: The disk capacity is split evenly between the two logical drives. Each logical drive is assigned half of the alternate cylinder capacity (specified by word 8).

Code 2: The total capacity of the disk is divided by 8. The first drive contains seven-eighths of the total, and the second contains one-eighth. Note that each drive has fixed and variable overhead areas (such as RCTs and alternate cylinders) which consume some of the user area, so the resulting sizes of the two logical drives only approximate one-eighth and seven-eighths.

Removable Media (11)

Bit 0 of this word indicates whether the disk media is fixed or removable. A 0 indicates fixed media; a 1 indicates removable media. No other values are valid.

Hard or Soft Sectored (12)

Bit 0 of this word indicates whether the disk drive is hard or soft sectored. A 0 indicates that the drive is soft sectored; a 1 indicates it is hard sectored.

Reduced Write Current Cylinder (13)

ST-506 drives (Medalist or Adaptec controller): This word specifies the physical cylinder at which the write current to the data heads is reduced. Some disk drives require that the write current to the heads be reduced above a certain cylinder to reduce the strength of the flux transition. This reduction prevents adjacent flux transitions in the higher cylinders (where they are closer together) from displacing one another to such an extent as to force data bits out of their data clock windows. Consult the drive manufacturer's technical manual for the proper cylinder. The valid range is from 1 through 4096. If no reduction is required, specify the total number of physical cylinders.

ESDI drives (Champion controller): This word is used with word 14 to represent the user size of the drive (word 13 is the low word and word 14 is the high word). User size is calculated as follows:

Logical cylinders x logical sectors per track x heads

Logical cylinders is defined as in word 6; logical sectors per track is defined as physical sectors per track minus spares (word 7).

Write Precompensation Cylinder (14)

ST-506 drives (Medalist or Adaptec controller): This word specifies the physical cylinder at which the timing of write data transmitted to the disk drive must be advanced or retarded (with reference to the disk data clock). This timing shift compensates for timing shifts that are caused by adjacent flux transitions in the higher cylinders (where they are closer together). Shifting the write data with respect to the data clock ensures that, when the data is read back, the data will fall within the clock window, despite the tendency of one transition to affect the apparent position of the adjacent transition. This shifting is called pre-compensation.

Consult the drive manufacturer's technical manual for the proper cylinder. The valid range is from 1 through 4096. If no pre-compensation is required, specify the total number of physical cylinders.

ESDI drives (Champion controller): This word is used with word 13 to represent the user size of the drive (word 13 is the low word and word 14 is the high word).

Step Code (15)

ST-506 drives (Medalist or Adaptec controller): This word specifies the stepping mode of the disk drive, as follows:

Step Code	Stepping Mode
0	Unbuffered, 3 msec
1	Buffered, 11 usec (Medalist), 28 usec (Adaptec)
2	Buffered, 12 usec (Adaptec only)

For most drives, Emulex recommends the fastest buffered step code available (1 for Medalist, 2 for Adaptec). Use a slower buffered step code or the unbuffered step code if your drive requires it.

ESDI drives (Champion controller): This word specifies the number of sectors by which sector 0 is offset from sector 0 of the previous track. Offsetting sector 0 from one track to the next is a technique that is used to reduce latency when performing write or read operations that cross a track boundary. When the drive is formatted, sector 0 of a track is offset a certain number of sectors from the position of sector 0 on the previous track. When this is done, spiral write and read operations are more efficient because the drive has time to switch from track to track before encountering sector 0. The valid range is from 0 through 255.

Reserved (16)

This word is reserved and must be zero.

6.5.2 DEFINING ADDRESSES FOR PHYSICAL DRIVES

A SCSI address and SCSI LUN must be defined for every drive in the system. This is done by writing data directly after the zero that comes after the last parameter block. Two words are written for each physical drive: the first word is the SCSI address of the controller and the second word is the drive's SCSI LUN. These words are written in the same order as the parameter blocks.

For example, if the first parameter block indicates (in Word 0) that there are three drives of this type, then the first six words following the final zero indicate the SCSI address and LUN or those three drives. The next two words would specify the SCSI address and LUN of the first drive defined by the second parameter block.

6.5.3 LOADING THE NOVRAM

After all the required words have been loaded into memory, a special sequence of commands causes the UC04 to load the parameter blocks from memory into the NOVRAM. The process uses the Initializing and Polling (IP) register (UC04 base address) and the Status and Address

(SA) register (base address plus 2). The sequence is shown below; be sure that you use the offset shown in Table 6-1 if you are using a MicroVAX. **The first three steps of the sequence are necessary only on a MicroVAX II.** For any other CPU, start with step 4.

1. Apply power to the system and initialize the MicroVAX by depositing 0 in internal memory register 37. If you have a running system, you must bring it down before executing this step.

   >>>D/I 37 0<return>

2. Enable external access to local memory by loading 20_{16} into the Interprocessor Communications Register (ICR) at address $20001F40_{16}$:

   >>>D/P/W 20001F40 20<return>

3. Set the map register for the first page in memory to 0 by deposting 80000000_{16} in map register 20088000_{16}:

   >>>D/P/L 20088000 80000000<return>

   This completes the sequence necessary to set up a MicroVAX II. Step 4 is the start of the NOVRAM loading sequence.

4. Initialize the UC04 by writing any value into the IP register. The UC04 performs its self-test and begins the initialization dialog.

Register	Octal	Hexadecimal
IP: Host Write	000001	0001

5. The UC04 indicates that initialization step 1 has begun by setting bit 11 in the SA register. The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set. If 22-bit addressing is enabled, bit 9 will be set.

Register	Octal	Hexadecimal	Addressing
SA: Host Read	004400 005400	0900 0B00	18-Bit 22-Bit

6. When the controller indicates that step 1 of the initialization dialog is begun, load the SA register with the initialization code:

Register	Octal	Hexadecimal
SA: Host Write	030003	3003

7. The controller acknowledges the initialization code with 00400:

Register	Octal	Hexadecimal
SA: Host Read	000400	0100

8. Write the Define Unit Geometry command into the SA register:

Register	Octal	Hexadecimal
SA: Host Write	041000	4200

9. The UC04 finishes its self-test (after about two seconds) before acknowledging with:

Register	Octal	Hexadecimal
SA: Host Read	001003	0203

You must wait until the UC04 acknowledges before proceeding.

10. Write the 16-bit memory address of the first word of the first parameter block into the SA register.

11. The UC04 begins loading the parameter blocks and the SCSI address and LUN information that comes after it.

After the UC04 has stored the parameter data in the NOVRAM, it reads the data from the NOVRAM and computes a one-byte checksum. It places the checksum in the SA register. The host knows that the checksum is available when bit 09 of SA is clear (0).

If the UC04 sets SA bit 15 after it clears bit 09, an error has occurred. The low byte contains the error code.

Error Code		Description
101_8	41_{16}	Checksum error (NOVRAM may be bad)
102_8	42_{16}	NOVRAM capacity exceeded (too many parameters)

6.6 BOOTSTRAPPING

To allow the system to be easily bootstrapped from peripherals attached to the UC04 Host Adapter, Emulex has incorporated a Bootstrap Command into the adapter. This feature is not part of the standard MSCP command set.

NOTE

> The Bootstrap Command is not compatible with either the MicroVAX I or II.

The bootstrap command can be issued from the console after the system is powered up, or it may be incorporated into a firmware routine that is located in a Bootstrap ROM. (The ROM would not be located on the UC04 PWB, but on some other module in the system.)

The Bootstrap Command causes the UC04 to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the UC04, load the SA register first with the value 30003_8 and then with the value $4000x_8$, where x is the MSCP logical unit number of the unit to boot from (see Section 3).

No other operation can be performed between the loading of the two numbers. After issuing the command to the UC04, the Processor Status Word must be loaded with 304_8 and CPU registers R0 and R1 must be loaded with the unit number and the CSR address of the UC04, respectively.

Figure 6-2 is an example of the Bootstrap Command as issued from the system console under Console ODT. The UC04's base address is 172150_8 and the MSCP logical unit number is zero. The system output is displayed in normal type; the operator input is displayed in **boldface**. The UC04 registers must contain the indicated values. However, the patterns indicated for the contents of the PSW and R0 and R1 are only examples; the initial contents of those registers (before the unit number and address are loaded) may be anything. Remember to use the offset value for the base address if you are using a MicroVAX.

```
@772150/00000<lf>             <lf>=LINE FEED
772152/005400 30003<cr>       <cr>=CARRIAGE RETURN
@/000400 40000<cr>
@RS/456332 304<cr>
@R0/103741 0<lf>
R1/001276 772150<cr>
@ØG
```

Figure 6-2. Bootstrap Command Example

6.7 FIRMWARE FORMATTING

The UC04 is capable of formatting drives using a routine built into the firmware. The procedure can be used on an LSI-11 using ODT or on the VMS monitor of a MicroVAX system. There are two steps to the procedure:

1. Calculate the format parameter word.
2. Follow the firmware format procedure. You will need to enter the format parameter word at some point in this procedure.

The following subsection describes how to calculate the format parameter word. Read it first. The next subsection describes the entire firmware formatting procedure.

6.7.1 CALCULATING THE FORMAT PARAMETER WORD

The format parameter word is 16 bits long, but bits <15:12> and <05:04> are not used. Note also that bits <04:15> apply only to IOMEGA drives. For all other drives, you need to specify only the interleave factor and the bad block file bit.

The following steps define the bits in the format parameter word. When you are done, convert the number to octal for an LSI-11 CPU or hexadecimal for a MicroVAX CPU.

Interleave Factor - Bits <02:00>

These bits specify the interleave factor on the disk drive to be formatted. Emulex recommends an interleave factor of one for drives supported by an Emulex Medalist or an Adaptec controller; and an interleave factor of two for IOMEGA drives supported by an IOMEGA controller.

Bit Status 02	01	00	Bit Definition
0	0	0	Defaults to interleave factor of one
0	0	1	Interleave factor of one
0	1	0	Interleave factor of two
0	1	1	Interleave factor of three

Bad Block File - Bit 03

Bit 03 specifies whether the format process should erase the present bad block file on drives supported by the Medalist or Adaptec. If the drive has not been previously formatted, this bit has no meaning.

Bit Status 03	Bit Definition
0	Leave present bad block file
1	Erase present bad block file

Not Used - Bits <05:04>

The status of these bits can be either one or zero.

ECC - Bit 06

This bit specifies whether ECC is enabled on IOMEGA drives.

Bit Status 06	Bit Definition
0	Enable ECC
1	Disable ECC

Post-Write CRC Check - Bit 07

This bit specifies whether the post-write CRC check is enabled on IOMEGA drives.

Bit Status 07	Bit Definition
0	Enable post-write CRC check
1	Disable post-write CRC check

Timer Count - Bits <11:08>

These bits form a binary number that indicates the amount of time that an IMOEGA drive remains spinning if no access is made to it. The dwell period is 2.5 minutes times the value loaded in these bits. Emulex recommends a dwell period of five minutes, which is specified by a count of two (0010 binary). The timer count has an allowable range of two to twelve counts (5 minutes to 30 minutes).

Bit Status 11	10	09	08	Bit Definition
0	0	1	0	Spin down after five minutes of inactivity

Not Used - Bits <15:12>

The status of these bits can be either one or zero.

6.7.2 FIRMWARE FORMAT PROCEDURE

The following procedure shows how to format a drive on either a MicroVAX or an LSI-11. Throughout the procedure, addresses are referred to as the IP register (the base address) and the SA address (base address plus two).

If you are formatting two logical drives on one physical drive, format unit 0 before formatting unit 1.

To format a drive:

1. Initialize the UC04 by writing any value to the IP register.

Register	LSI-11	MicroVAX
IP: Host Write	000001	0001

2. Examine the SA register. The value it should contain depends on the bus type, as shown below.

Register	LSI-11	MicroVAX	Addressing
SA: Host Read	004400	0900	18-Bit
	005400	0B00	22-Bit

3. Deposit the following value into the SA register:

Register	LSI-11	MicroVAX
SA: Host Write	030003	3003

4. Examine the SA register and make sure that it contains the following value:

Register	LSI-11	MicroVAX
SA: Host Read	000400	0100

5. Deposit the following value into the SA register, where xx is the MSCP unit number of the drive you want to format:

Register	LSI-11	MicroVAX
SA: Host Write	0420xx	44xx

6. Examine the SA register and make sure that it contains the following value:

Register	LSI-11	MicroVAX
SA: Host Read	001000	0200

7. Deposit a number in the SA register that represents the serial number of the drive you are formatting. You may choose any non-zero number.

Register	LSI-11	MicroVAX
SA: Host Write	xxxxxx	xxxx

8. Examine the SA register and make sure that it contains the following value:

Register	LSI-11	MicroVAX
SA: Host Read	002000	0400

9. Enter the format parameter word in either octal or hexadecimal, as appropriate.

NOTE

Use 0 as the format parameter word if either of the following are true:

- You are using this firmware format procedure to write the Replacement and Caching Table (RCT) on an optical disk.
- You do not wish to erase the present bad block file on a disk that has been previously formatted, and your subsystem uses either a Medalist or an Adaptec disk controller.

10. The edge-mounted LEDs flash for a few seconds while the UC04 performs its self-test and then go off momentarily. While the UC04 is formatting the drive, LED2 illuminates during the media format and both LED1 and LED2 illuminate during the RCT write command. At the end of a successful formatting operation, all three LEDs are off. If all LEDs are on, an error occurred during formatting.

11. Examine the SA register. If the high byte contains 0, the format operation has completed successfully.

Register	LSI-11	MicroVAX
SA: Host Read	0xxxxx	0xxx

If the SA register contains a word that starts with 1 (LSI-11) or 8 (MicroVAX), there may have been an error during the format process. The Emulex vendor unique error codes are described in the table below.

Error Code Octal	Hexadecimal	Description
100004	8004	RAM error
100005	8005	Firmware checksum error
100011	8009	Seek timeout
100100	8040	Drive not ready
100101	8041	NOVRAM checksum error
100103	8043	RCT write error
100104	8044	Mode select error
100105	8045	Format error
100106	8046	Drive write protected
100107	8047	FCT write error

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Section 7
FUNCTIONAL DESCRIPTION

7.1 OVERVIEW

This section contains a description of the UC04 Intelligent Host Adapter's architecture. The following table outlines the contents of this section.

Subsection	Title
7.1	Overview
7.2	UC04 Controller Architecture

7.2 UC04 HOST ADAPTER ARCHITECTURE

The UC04 is a microprocessor-based emulating host adapter which is located on a single dual-size PCBA. The UC04 has several major functional blocks as shown in Figure 7-1. The host adapter is organized around the eight-bit 8031 microprocessor and has an eight-bit internal data bus with 16-bit addressing capability. Both of the interface controllers and the buffer controller are addressed as memory (memory-mapped I/O).

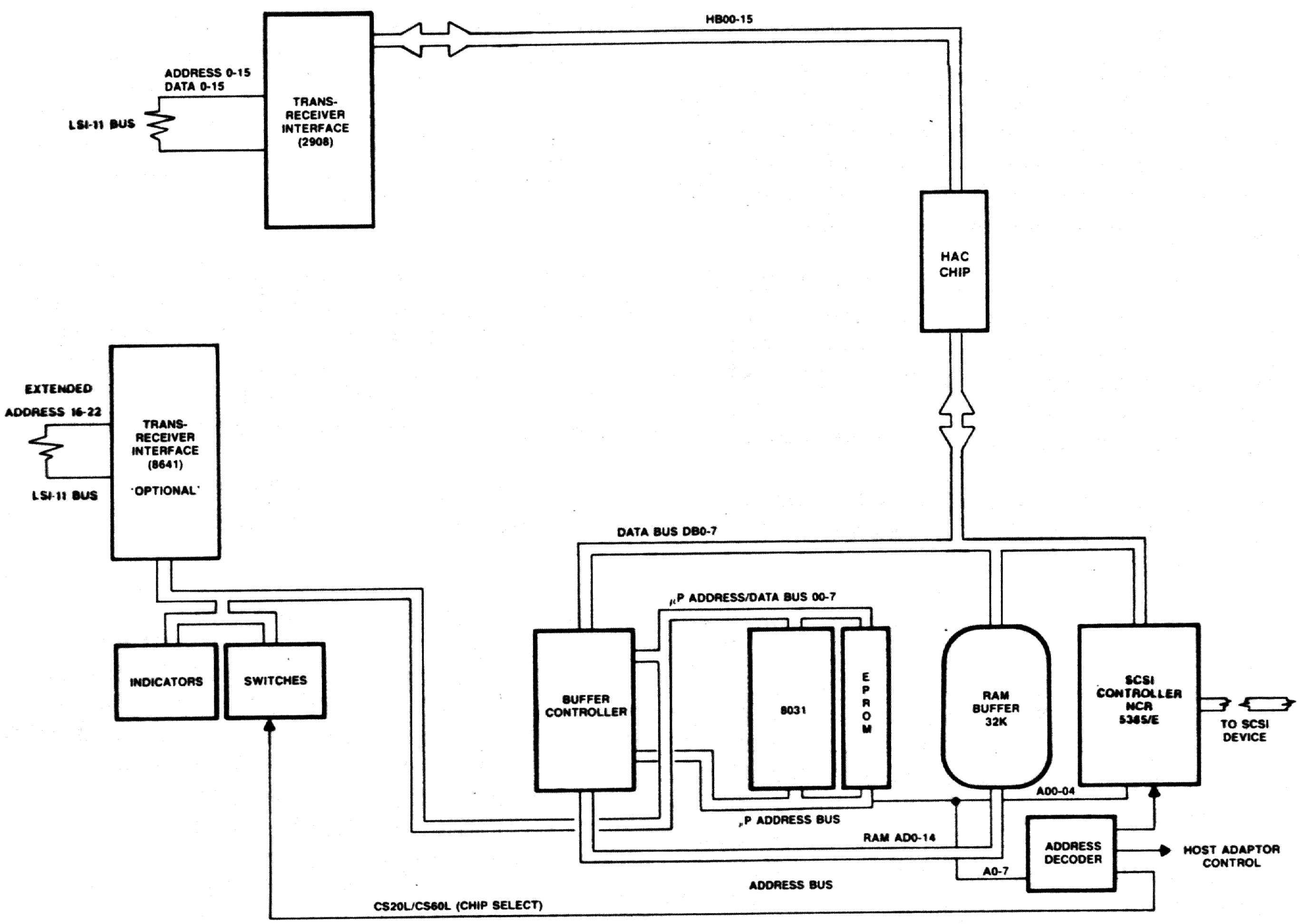
The 8031's primary task is to decode and implement commands from the host. At command completion, the microprocessor is also responsible for generating status and transmitting it to the host. A large part of the microprocessor's job while performing those duties involves setting up the LSI-11 Bus Interface Controller and the buffer controller for the large data transfers that are their specialties.

There are two blocks of memory on the UC04: a 16K EPROM and 32K of RAM. The EPROM contains the control program, and the RAM is used for data buffering and working storage.

The LSI-11 Bus Interface consists of a 16-bit bidirectional set of data lines and a 22-bit set of address lines. The Host Adapter Controller is used for programmed I/O, CPU interrupts, and DMA data transfers. The microprocessor responds to all programmed I/O and carries out the I/O functions required for the addressed host adapter register. The Interface Controller has automatic LSI-11 Bus address generation capability that, in conjunction with a byte counter, allows it to conduct LSI-11 Bus DMA transfers without direct microprocessor intervention. This auto DMA capability is used with the UC04 buffer controller to transfer large blocks of data from host memory directly into the UC04's RAM.

The SCSI Interface and Control is implemented using a single LSI chip. In response to commands from the microprocessor, the chip establishes and monitors SCSI bus phases appropriate to the command, and thus relieves the microprocessor of signal control and timing duties.

The buffer controller is implemented on a single chip. This four-channel controller is responsible for moving large blocks of data between the RAM and the SCSI Interface, and between the LSI-11 Bus Interface and the RAM. After being set up for an operation by the microprocessor, either interface requests DMA service by driving its individual DMA request signals active. The transfer then proceeds without direct supervision by the microprocessor. This allows high-speed data transfers to occur while the microprocessor is focused on other processes.



UC1302-0647

Figure 7-1. UC04 Block Diagram

Section 8
INTERFACES

8.1 OVERVIEW

This section describes the interfaces which the UC04 Intelligent Host Adapter incorporates. It includes information on the UC04 implementation of SCSI bus specification electrical and mechanical requirements. Excluding this overview, the section is divided into the following subsections:

Subsection	Title
8.2	UC04 LSI-11 Bus Interface
8.3	UC04 SCSI Bus Interface

8.2 LSI-11 BUS INTERFACE

The LSI-11 Bus between the LSI-11 CPU and the UC04 Host Adapter contains 42 bidirectional signal lines and two unidirectional signal lines. LSI-11 Bus interface pin assignments are listed and described in Figure 8-1. These signal lines provide the means by which the LSI-11 CPU and the UC04 Host Adapter communicate with each other. The LSI-11 Bus interface is used for programmed I/O, CPU interrupts, and DMA Data Transfer operations. Addresses, data, and control information are sent along these signal lines, some of which contain time-multiplexed information. The LSI-11 Bus interface lines are grouped in the following categories:

a. Twenty-two Data/Address lines - <BDAL00:BDAL21>. The four Data/Address lines which carry the most significant bits (MSB) are lines BDAL21:BDAL18. They are used for addressing only and do not carry data. Lines BDAL17 and BDAL16 reflect the parity status of the 16-bit data word during a Write or Read Data Transfer operation via the LSI-11 Bus cycle.

b. Six Data Transfer Control lines - BBS7, BDIN, BDOUT, BRPLY, BSYNC, and BWTBT.

c. Six Direct Memory Access (DMA) Control lines - BDMR, BSACK, BDMGI, and BDMGO (connector A).

d. Seven Interrupt Control lines - BEVNT, BIAKI, BIAKO, BIRQ4, BIRQ5, BIRQ6, and BIRQ7.

e. Five System Control lines - BDCOK, BHALT, BINIT, BPOK, and BREF.

Connector	Side 2 (Solder Side)	Pin	Side 1 (Component Side)
B	+5V	A	BDCOK
B		B	BPOK
B	GND	C	BDAL18
B		D	BDAL19
B	BDAL02	E	BDAL20
B	BDAL03	F	BDAL21
B	BDAL04	H	
B	BDAL05	J	GND
B	BDAL06	K	
B	BDAL07	L	
B	BDAL08	M	GND
B	BDAL09	N	BSAK
B	BDAL10	P	BIRQ7
B	BDAL11	R	BEVNT
B	BDAL12	S	
B	BDAL13	T	GND
B	BDAL14	U	
B	BDAL15	V	
A	-5V	A	BIRQ5
A		B	BIRQ6
A	GND	C	BDAL16
A		D	BDAL17
A	BDOUT	E	
A	BRPLY	F	
A	BDIN	H	
A	BSYNC	J	GND
A	BWTBT	K	
A	BIRQ4	L	
A	BIAKI	M	GND
A	BIAKO	N	BDMR
A	BBS7	P	BHALT
A	BDMGI	R	BREF
A	BDMGO	S	
A	BINIT	T	GND
A	BDAL00	U	
A	BDAL01	V	

Figure 8-1. LSI-11 Bus Interface Pin Assignments

8.2.1 INTERRUPT PRIORITY LEVEL

The UC04 is hardwired to issue both level 4 and level 5 interrupt requests. The level 4 request is necessary to allow compatibility with either an LSI-11 or LSI-11/2 CPU.

8.2.2 REGISTER ADDRESS

The UC04 Host Adapter has two registers visible to the LSI-11 Bus. Their addresses are determined by DIP switches SW3-4, SW3-5, and SW2-4. See Section 4 for detailed address and switch setting information.

8.2.3 SCATTER/GATHER

The UC04 Host Adapter supports the MicroVAX I I/O technique of scatter-write operations and gather-read operations.

8.2.4 DMA OPERATIONS

All DMA Data Transfer operations are performed under microprocessor control. When doing a read from memory operation, a check is made for memory parity errors, and if an error is detected, the LSI-11 Bus Parity Error (UPE) error status bit is set.

8.3 UC04 SCSI BUS INTERFACE

Information on the UC04 implementation of SCSI bus electrical and mechanical requirements is provided in this subsection.

8.3.1 SCSI INTERFACE PHYSICAL DESCRIPTION

SCSI bus devices are daisy-chained together using a common cable. Both ends of the cable are terminated. All signals are common between all bus devices. The UC04 supports the SCSI specification single-ended option for drivers and receivers. The maximum cable length allowed is six meters (primarily for interconnection outside the subsystem cabinet in which the UC04 resides).

8.3.1.1 Cable Requirements

A 50-conductor flat cable or 25-twisted-pair flat cable must be used to connect SCSI bus hosts and controllers. The maximum cable length is six meters. The maximum length of the cable past the terminator is 0.1 meter. SCSI bus termination can be internal to the SCSI devices that are located at the ends of the bus cable (such as the subsystem that contains the SCSI device controller and its peripheral). The UC04 single-ended pin assignments are shown in Table 8-1.

8.3.1.2 Shielded Connector Requirements

The SCSI bus shielded connector is a 50-conductor cable connector that consists of two rows of 25 female contacts on 100 mil centers. The connector shielding system must provide a DC resistance of less than 10 milliohms from the cable shield at its termination point to the SCSI device enclosure.

8.3.2 SCSI INTERFACE ELECTRICAL DESCRIPTION

The UC04 SCSI Host Adapter interfaces to SCSI controllers via the SCSI bus. A 50-pin male IDC connector at location J1 on the UC04 board plugs directly into the SCSI bus (refer to Figure 4-3). All signals use open collector or three-state drivers. Each signal driven by a SCSI device has the following output characteristics when measured at the SCSI device's connection:

- Signal assertion = 0.0 VDC to 0.4 VDC
- Minimum driver output capability = 48 milliamperes (sinking) at 0.5 VDC
- Signal negation = 2.5 VDC to 5.25 VDC

All assigned signals are terminated with 220 ohms to +5 volts (nominal) and 330 ohms to ground at each end of the SCSI cable as shown in Figure 8-2.

Each signal received by a SCSI device has the following input characteristics when measured at the SCSI device's connection:

- Signal true = 0.0 VDC to 0.8 VDC
- Maximum total input load = -0.4 milliamperes at 0.4 VDC
- Signal false = 2.0 VDC to 5.25 VDC
- Minimum input hysteresis = 0.2 VDC

Table 8-1. UC04 SCSI Bus Pin Assignments

Pin	Signal Name	Input/Output
1	GND	--
2	-D0	Input/Output
3	GND	--
4	-D1	Input/Output
5	GND	--
6	-D2	Input/Output
7	GND	--
8	-D3	Input/Output
9	GND	--
10	-D4	Input/Output
11	GND	--
12	-D5	Input/Output
13	GND	--
14	-D6	Input/Output
15	GND	--
16	-D7	Input/Output
17	GND	--
18	-DP (Data parity)	Input/Output
19	GND	--
20	GND	--
21	GND	--
22	GND	--
23	GND	--
24	GND	--
27	GND	--
28	GND	--
29	GND	--
30	GND	--
31	GND	--
32	-ATN	Input/Output
33	GND	--
34	GND	--
35	GND	--
36	-BSY	Input/Output
37	GND	--
38	-ACK	Input/Output
39	GND	--
40	-RST	Input/Output
41	GND	--
42	-MSG	Input/Output
43	GND	--
44	-SEL	Input/Output
45	GND	--
46	-C/D	Input/Output
47	GND	--
48	-REQ	Input/Output
49	GND	--
50	-Input/Output	Input/Output

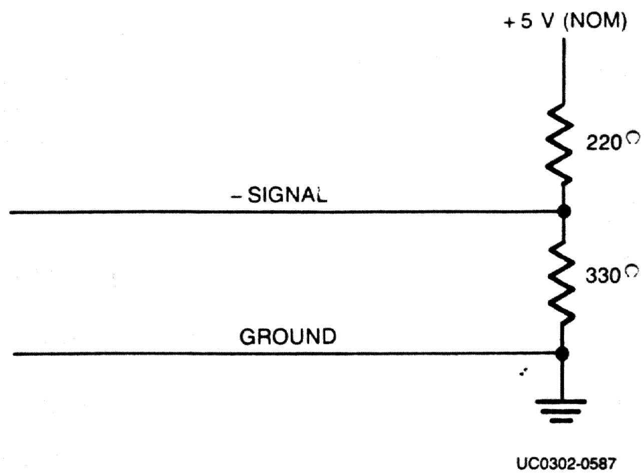


Figure 8-2. UC04 SCSI Bus Signals Termination

8.3.3 SCSI BUS SIGNALS AND TIMING

SCSI bus activities involve one or more of the following SCSI phases of operation:

- Arbitration Phase
- Selection Phase
- Reselection Phase
- Command Phase
- Data Phase
- Status Phase
- Message Phase

The phases are described in Subsection 9.3. When the SCSI bus is not involved in one of the above phases, it is in the Bus Free Phase. SCSI phase sequencing is accomplished by asserting or de-asserting the SCSI signals; the signals are described in Subsection 8.3.3.1.

8.3.3.1 SCSI Bus Signals

There are 18 signals on the SCSI bus. Nine signals are control signals that coordinate transfer of data between SCSI hosts/controllers; nine signals are for an eight-bit data bus with parity. The signals are defined in Table 8-2.

In Table 8-2, the eight data bit signals are represented by DB0 through DB7; DB7 is the most significant bit and has the highest priority during the Arbitration Phase. Bit number, significance, and priority decrease downward to DB0. The parity bit, represented by DBP, is odd. The UC04 generates parity but does not have parity detection enabled. Parity is not guaranteed valid during the Arbitration Phase.

The UC04 SCSI bus pin assignments are listed in Table 8-2; the UC04 supports only the SCSI single-ended option.

Table 8-2. SCSI Bus Signals

Mnemonic Name	Signal	Description
DB0	Data Bus	Data Bus Bit 0
DB1	Data Bus	Data Bus Bit 1
DB2	Data Bus	Data Bus Bit 2
DB3	Data Bus	Data Bus Bit 3
DB4	Data Bus	Data Bus Bit 4
DB5	Data Bus	Data Bus Bit 5
DB6	Data Bus	Data Bus Bit 6
DB7	Data Bus	Data Bus Bit 7
DBP	Data Bus	Data Bus Parity
ACK	Acknowledge	Indicates acknowledgement for a REQ/ACK data transfer handshake.
REQ	Request	Indicates a request for a REQ/ACK data transfer handshake.
ATN	Attention	Indicates the ATTENTION condition (i.e., the Initiator has a message to send to the Target). The ATTENTION condition is described in Subsection 9.5.2.
RST	Reset	Indicates the RESET condition (i.e., clears the SCSI bus of all activity). The RESET condition is described in Subsection 9.5.1.

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Table 8-2. SCSI Bus Signals (continued)

Mnemonic Name	Signal	Description
SEL	Select	Used to select/reselect a SCSI bus device.
BSY	Busy	Indicates the SCSI bus is being used.
C/D	Control/Data	Indicates command/status information transfer or data in/data out transfer.
I/O	Input/Output	Indicates the direction of data movement on the data bus with respect to an Initiator.
MSG	Message	Indicates the SCSI bus is in the Message Phase.

8.3.3.2 SCSI Bus Timing

Except where noted, the delay time measurements for each SCSI device (host or controller) are calculated from signal conditions existing at that device's SCSI bus connection. Normally, these measurements do not consider delays in the SCSI cable. The SCSI timings are listed in Table 8-3.

The timing diagram shown in Figure 8-3 indicates the typical relationship between SCSI bus signals and SCSI phase sequencing.

Table 8-3. SCSI Bus Timings

Timing	Duration	Description
Arbitration Delay	2.2 us	The minimum time a SCSI host or controller waits from asserting the BSY signal for arbitration until the data bus can be examined to see if arbitration has been won. There is no maximum time.

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Table 8-3. SCSI Bus Timings (continued)

Timing	Duration	Description
Bus Clear Delay*	800 ns	The maximum time for a SCSI host or controller to stop driving all bus signals after 1) a Bus Free Phase is detected, 2) the SEL signal is received from another SCSI host or controller during the Arbitration Phase.
Bus Free Delay	800 ns	The minimum time a SCSI host or controller waits from its detection of the Bus Free Phase until it asserts the BSY signal when going to the Arbitration Phase.
Bus Set Delay	1.8 us	The maximum time for a SCSI host or controller to assert the BSY signal and its SCSI ID bit on the data bus after it detects a Bus Free Phase for entering the Arbitration Phase.
Bus Settle Delay	400 ns	The time to wait for the SCSI bus to settle after changing certain control signals.
Cable Skew Delay	10 ns	The maximum difference in propagation time allowed between any two SCSI bus signals when measured between any two SCSI devices.
Deskew Delay	45 ns	This time is used to calculate the minimum time required for deskew of signals.
Reset Hold Time	25 us	The minimum time for which the RST signal is asserted. There is no maximum time.

* In the Bus Clear Delay, for condition 1) the maximum time for a SCSI device to clear the bus is 1200 ns from the BSY and SEL signals both first becoming false. If a SCSI device requires more than a Bus Settle Delay to detect the Bus Free Phase, it clears the bus within a Bus Clear Delay minus the excess time.

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Table 8-3. SCSI Bus Timings (continued)

Timing	Duration	Description
Selection Abort Time	200 us	The maximum time a Target (or Initiator) takes from its most recent detection of being selected (or reselected) until it asserts the BSY signal. This timeout is required to ensure that a Target (or Initiator) does not assert the BSY signal after a Selection (or Reselection) Phase has been aborted. This is not the Selection timeout.
Selection Timeout Delay	250 ms	The minimum recommended time that an Initiator (or Target) should wait for a BSY response during the Selection or Reselection Phase before starting the timeout procedure.

ms = milliseconds
us = microseconds
ns = nanoseconds

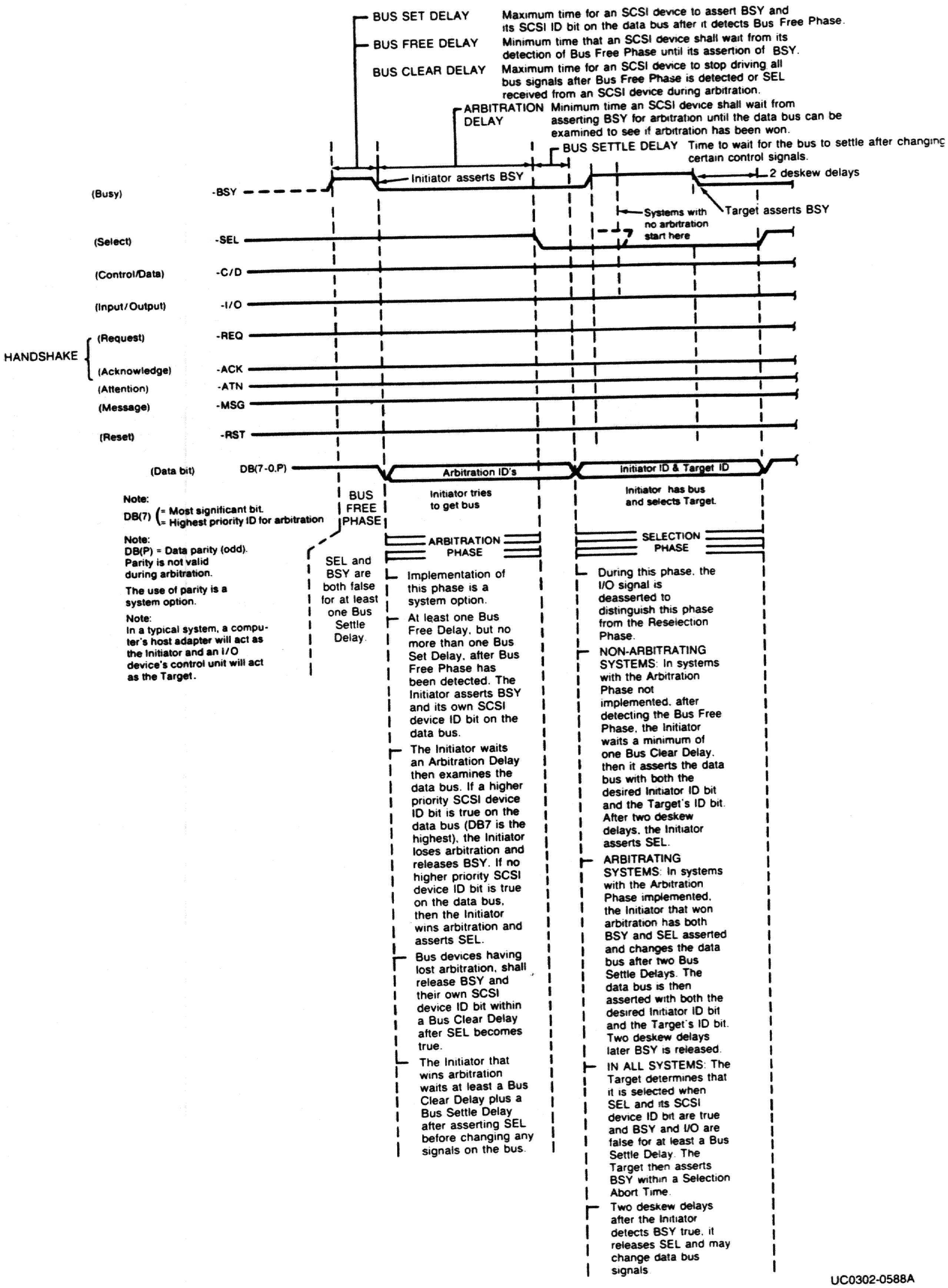
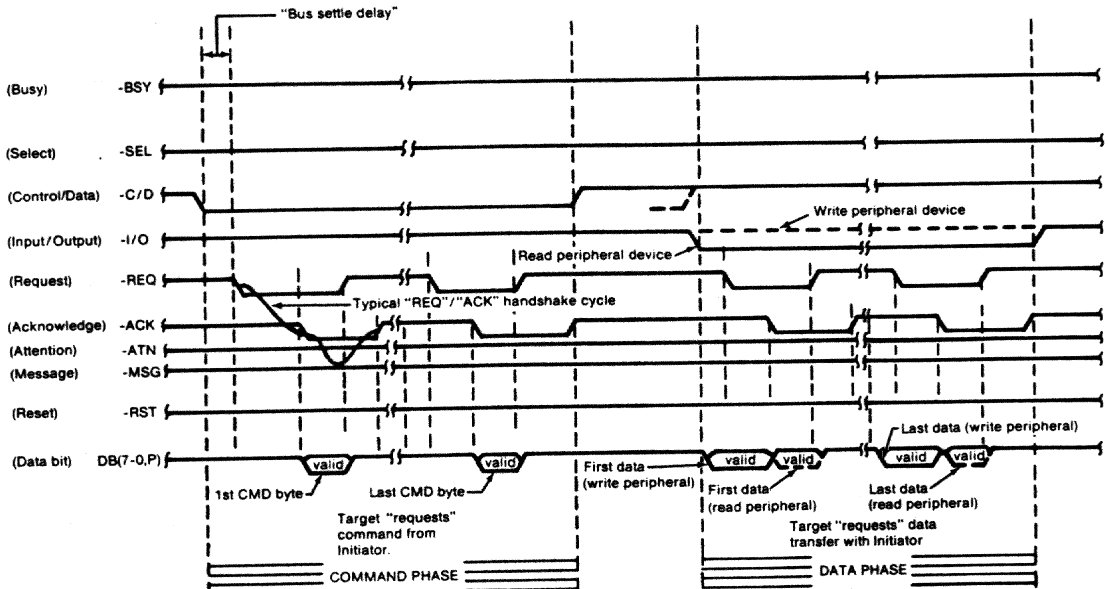


Figure 8-3. SCSI Bus Timing Diagram (Sheet 1 of 3)



The Target asserts, C/D and deasserts I/O and MSG for all of the handshakes of this phase.

The transfer is from Initiator to Target.

HANDSHAKE PROCEDURE:

The Target asserts REQ. The Initiator drives data (7-0,P) to their desired values, waits at least one deskew delay plus a cable skew delay, and asserts ACK. The Initiator continues to drive data (7-0,P) until REQ is false.

When ACK is true at the Target, the Target reads the data (7-0,P), then asserts REQ.

When REQ becomes false at the Initiator, the Initiator may change or release data (7-0,P) and deassert ACK.

The Target continues requesting command bytes. The number of bytes depends on the command group code detected from the first command byte received.

DATA IN PHASE: Read Peripheral.

Data is to be sent from Target to Initiator.

Target asserts I/O, deasserts C/D, and MSG during the REQ/ACK handshake of this phase.

HANDSHAKE PROCEDURE:

The Target first drives data (7-0,P) to their desired values, waits at least one deskew delay plus a cable skew delay, then asserts REQ. Data (7-0,P) shall remain valid until ACK is true at the Target.

The Initiator shall read data (7-0,P) after REQ is true, then asserts ACK.

When ACK becomes true at the Target, the Target may change or release data (7-0,P) and deassert REQ.

After REQ is false, the Initiator deasserts ACK. After ACK is false, the Target may continue the transfer by drawing data (7-0,P) and asserting REQ.

DATA OUT PHASE: Write Peripheral.

Data is to be sent from Initiator to Target.

Target deasserts C/D, I/O and MSG during the REQ/ACK handshake of this phase. Refer to the handshake procedure of the Command Phase.

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Figure 8-3. SCSI Bus Timing Diagram (Sheet 2 of 3)

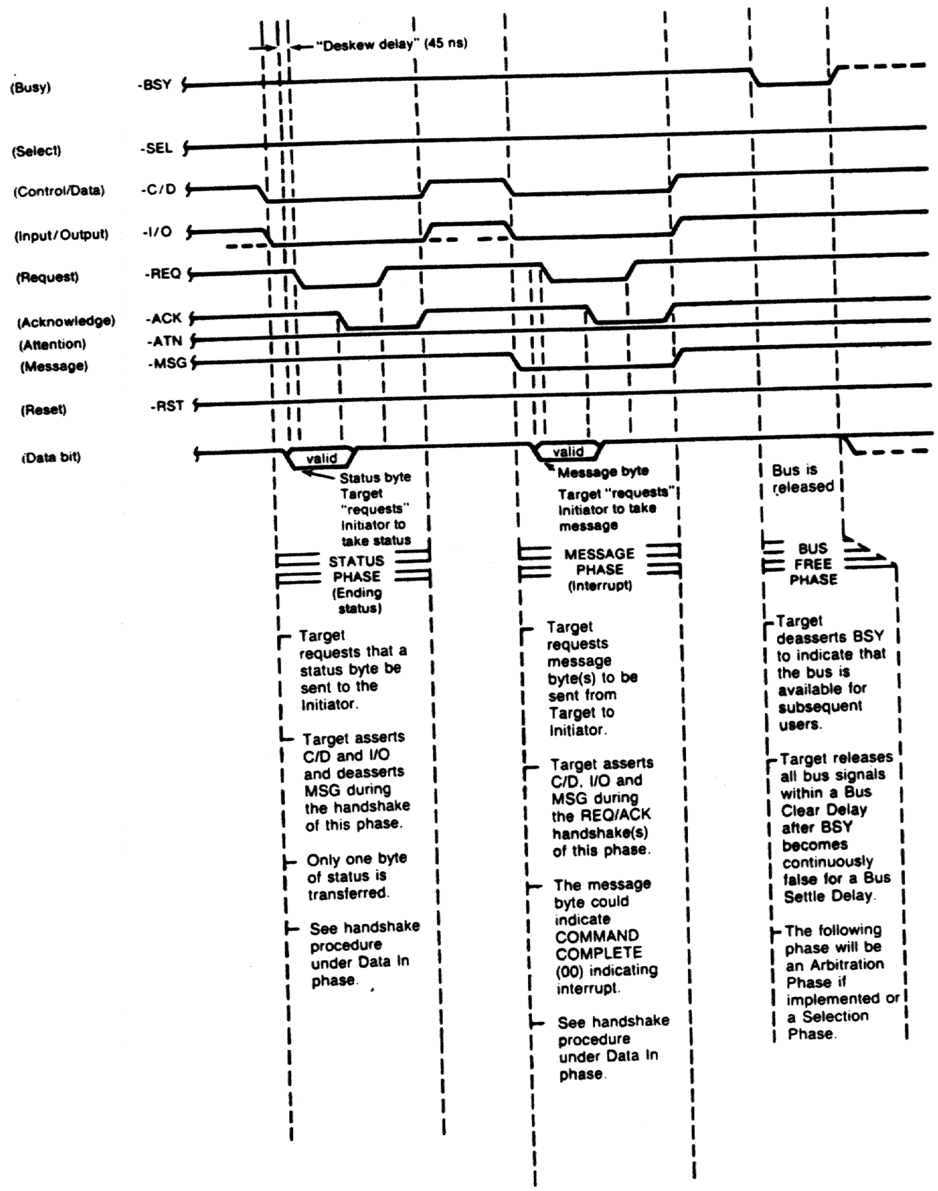

Figure 8-3. SCSI Bus Timing Diagram (Sheet 3 of 3)

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Section 9
SCSI PROTOCOL DESCRIPTION

9.1 OVERVIEW

This section describes the SCSI bus; it includes information on SCSI bus phases and phase sequencing, as well as the procedures for passing control and status information between SCSI bus hosts and controllers using SCSI memory address pointers. Finally, it also describes in detail the SCSI commands issued by the UC04. This section is divided into the following subsections:

Subsection	Title
9.2	SCSI Bus Overview
9.3	SCSI Bus Phases
9.4	SCSI Bus Phase Sequencing
9.5	SCSI Bus Conditions
9.6	SCSI Commands
9.7	SCSI Group 0 Command Descriptions
9.8	SCSI Group 7 Command Descriptions

9.2 SCSI BUS OVERVIEW

The Small Computer System Interface (SCSI) is a standard interface established to support mass storage, printer output, and network communication for microcomputers and minicomputers. The interface is an eight-port, daisy-chained bus. The UC04 SCSI command standard is based on the ANSI X3T.2/82-2 Revision 14 (24 April 84) SCSI Interface Specification.

Up to eight SCSI hosts and/or controllers can be supported by the SCSI bus. Each controller can be connected to a maximum of eight devices (called Logical Unit Numbers, or LUNs). The UC04 hardware supports any combination of host systems, intelligent controllers or intelligent peripherals. Three basic SCSI configurations are supported with the UC04 and the SCSI bus; they are listed below:

- single initiator, single target,
- single initiator, multi-target,
- multi-initiator, multi-target.

Communication on the SCSI bus occurs between a host and a controller. (The UC04 also supports communication between two controllers, as in a copy operation.) When a host and a controller communicate, one acts as the Initiator and one as the Target. The Initiator (usually the host, the UC04) originates an operation and the Target (usually a peripheral controller) performs the operation. Sample system configurations supported by UC04 hardware are shown in Figure 9-1.

Some SCSI bus functions are assigned to the Initiator and some functions to the Target. The Initiator can arbitrate for control of the SCSI bus and select a specific Target. The Target can request the transfer of command, data, status, or other information on the SCSI data bus. In some cases, the Target can arbitrate for control of the SCSI bus to reselect an Initiator and continue an operation. Sometimes, the Target becomes an Initiator and arbitrates for control of the SCSI bus, e.g., when it performs a copy operation.

SCSI bus data transfers are asynchronous and follow a defined REQ/ACK (request/acknowledge) handshake protocol. (This protocol is defined in the ANSI SCSI specification.) One eight-bit byte of information can be transferred with each handshake.

The SCSI bus consists of 18 signals. Nine signals are for an eight-bit data bus with parity; the other nine signals are for control signals that coordinate data transfer between the host and SCSI controllers. SCSI bus signals are described in detail in subsection 8.3.

9.2.1 TECHNICAL MANUAL CONVENTIONS

To avoid possible confusion with other uses of the same words, throughout this section we use the following conventions:

- All SCSI commands (such as **READ, MODE SELECT,** and **INQUIRY**) and diagnostic subcommands (such as **READ BAD SECTOR FILE** and **WRITE LONG**) are printed in uppercase boldface.
- All SCSI status and error messages (such as CHECK CONDITION and DRIVE NOT READY) are printed in uppercase.
- All SCSI bus phases and conditions (such as Arbitration Phase) and SCSI Command Descriptor Block names (such as Extended Sense Byte) are printed in initial caps.
- All SCSI command and message codes are given in their hexadecimal values.

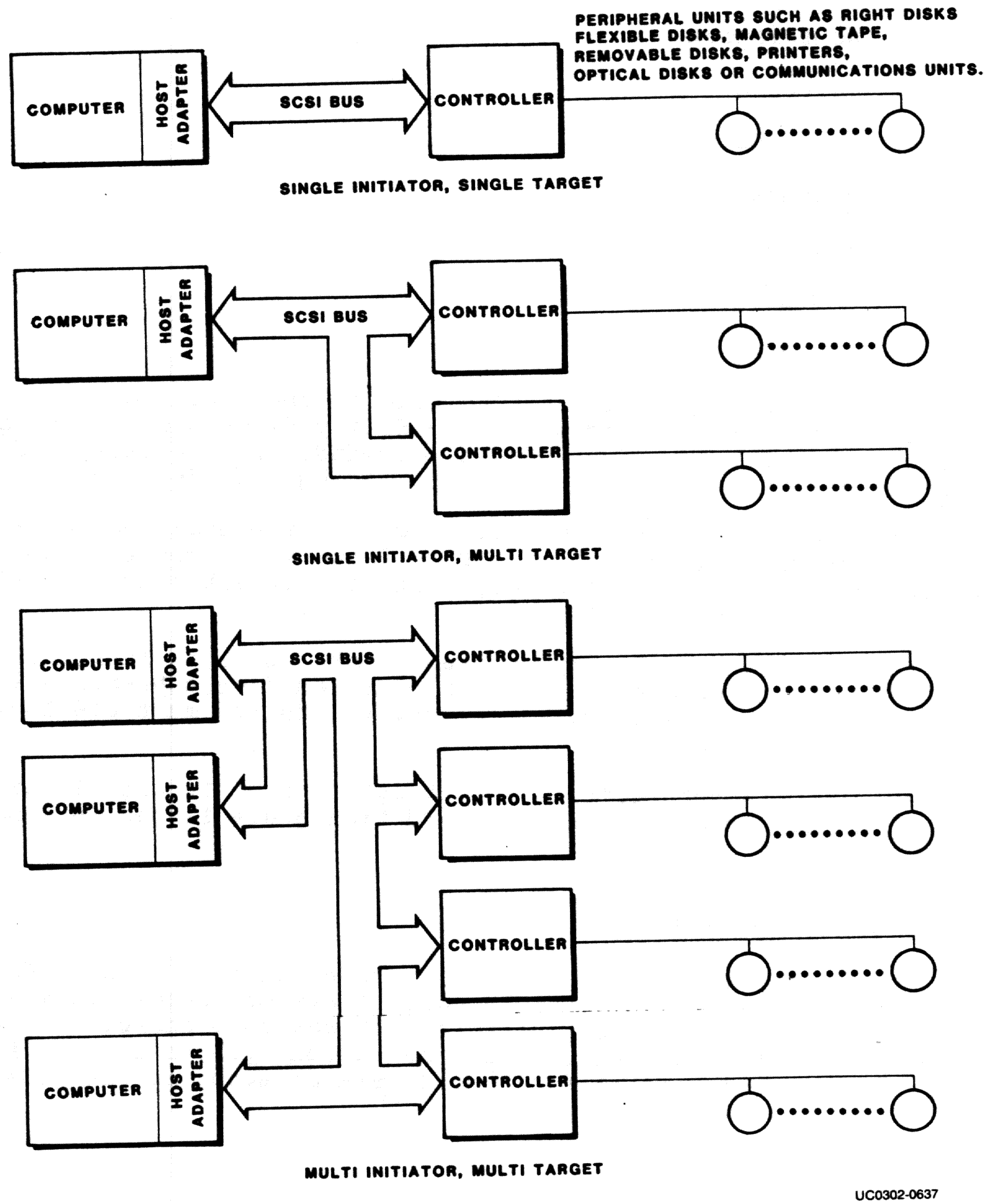

Figure 9-1. Sample SCSI Bus Configurations

9.3 SCSI BUS PHASES

The activities on the SCSI bus can be divided into the following phases of operation:

- Arbitration
- Selection
- Reselection
  - Command
  - Data
  - Status
  - Message

These phases are supported as specified by the ANSI SCSI specification. The phases are individually discussed in subsequent subsections. The last four phases (Command, Data, Status, and Message) are grouped together as Information Transfer Phases.

When the SCSI bus is not involved in one of the SCSI bus phases, it is in a Bus Free Phase. The Bus Free Phase indicates that no host adapter or controller is actively using the SCSI bus and the SCSI bus is available for subsequent users.

The SCSI bus activities, implemented by the UC04, include the disconnect function and reselection function (see subsection 9.3.2). Overlapped operations on multiple controllers and multiple logical units are supported.

In the following subsections, no attempt is made to detail the SCSI bus signal sequences; the signals and timing are listed in subsection 8.3.3.

9.3.1 ARBITRATION PHASE

The Arbitration Phase is an optional implementation on the SCSI bus. This phase is used when multiple controllers or processors vie for SCSI bus ownership. Since multiple host adapters and/or controllers may desire control of the SCSI bus concurrently, arbitration for the SCSI bus is a requirement for controllers attached to the UC04.

9.3.2 SELECTION AND RESELECTION PHASES

The SCSI bus Selection and Reselection phases provide methods for establishing a link between the Initiator and a desired Target.

After the UC04 selects a target to perform some function (e.g., read or write data), the target has the option of disconnecting from the SCSI bus. When the target needs to re-establish the link to its original Initiator, it reselects that Initiator.

The SCSI Selection and Reselection Phases can be terminated for any one of three conditions:

1. The preceding Selection or Reselection Phase is successfully completed by using the Selection/Reselection handshake protocol.

2. A Selection/Reselection timeout occurs. The timeout results if any Target or Initiator does not respond to the Selection/Reselection Phase within a timeout period of two seconds.

3. A Reset (-RST) signal occurs on the SCSI bus. When this signal is asserted, all SCSI bus sequences are immediately terminated and the SCSI bus signals are released by all Initiators and Targets.

The Initiator uses the Attention (-ATN) signal to notify the target that a message is ready. To guarantee that the Target recognizes the Attention condition before the Command Phase is entered, the -ATN signal level is held true before the Selection or Reselection Phase is completed.

If an IDENTIFY message is used during the Selection Phase sequence, the specified Logical Unit Number (LUN) has precedence over the LUN field in the Command Descriptor Block (CDB). (CDBs are described in detail in subsection 9.7.) The IDENTIFY message also informs the Target if the Initiator supports the disconnect function.

9.3.3 INFORMATION TRANSFER PHASES

The Command, Data, Status, and Message Phases are grouped together as Information Transfer Phases because they are all used to transfer data or control information via the SCSI data bus. The Information Transfer Phases are described in the following subsections.

9.3.3.1 Command Phase

The Command Phase allows the Target to request command information from the Initiator. An Initiator issues SCSI commands to a Target by transferring a command packet, called a Command Descriptor Block (CDB). The length of the SCSI command and the meaning of the information in the command packet depends on which command is being transferred. (See subsection 9.6 for definitions of SCSI commands and all SCSI CDBs supported by the UC04.)

The Command Phase is interrupted only for the following exception conditions:

- **Reset Condition.** This condition can occur when the SCSI Reset (-RST) signal is asserted or a power fail or power-off condition in the Target occurs. In this case, the Command Phase and the connection established during the Selection/Reselection Phase is terminated by the Target with the release of the -BSY signal.

- **Parity Error Condition.** The Target detects a parity error on the SCSI bus during the command transfer operation. At this time, the target controller releases the -BSY signal, terminates the connection, and the SCSI bus returns to the Bus Free phase.

9.3.3.2 Data Phase

The Data Phase of a connection controls the transfer of data between the Initiator and Target devices. The Data Phase includes both the Data In Phase and the Data Out Phase. The Data In Phase allows the Target to request sending of data to the Initiator from the Target. The Data Out Phase allows the Target to request sending of data to the Target from the Initiator. The direction of the data transfer operation depends on the command being processed. Some commands may have no data to be transferred and therefore have a null Data Phase. Only the asynchronous data transfer mode is supported by the UC04.

The Data Phase is interrupted only for the following exception conditions:

- **Reset Condition.** This condition can occur when the SCSI Reset (-RST) signal is asserted or when a power fail or power-off condition in the Target occurs. In this condition, the Data Phase and the connection established during the Selection/Reselection Phase are terminated by the Target with the release of the -BSY signal.

- **Data Out Parity Error Condition.** The Target detects a parity error on the SCSI bus during the data transfer operation from the Initiator to the Target.

- **Data In Parity Error Condition.** The Initiator detects a parity error on the SCSI bus during the data transfer operation from the Target to the Initiator. The Initiator can then assert the -ATN signal along with the Acknowledge (-ACK) signal. The Target detects this condition and enters the message out phase to receive a message. The Initiator sends an Initiator-detected error message in response.

9.3.3.3 Status Phase

The Status Phase is used by the Target to send completion information to the Initiator. The status is sent in a single byte, the format of which is defined in subsection 9.3.3.3.1.

The Target can initiate the Status Phase when any one of the following conditions occur:

- **Busy Status.** The Selection Phase is completed and the Target is in a BUSY state and unable to process any commands for an extended period of time. The Target can initiate the Status Phase immediately after this condition occurs. The Status Byte transferred has the BUSY status code set.
- **Reservation Conflict Status.** The Command or Reselection Phase is completed and the specified LUN is reserved for another Initiator. The Status Byte transferred has the RESERVATION CONFLICT status code set.
- **Terminated Status.** At the termination of a command, the Status Byte transferred has the GOOD STATUS code set to indicate the success of the command.

NOTE

In multi-Initiator environments, the Initiator delays a minimum of 200 microseconds before attempting another selection of a Target if a BUSY status code for that Target is received.

9.3.3.3.1 Status Byte Format. The format of the Status Byte used by the Target to send completion information to the Initiator is defined below.

Byte	Bit	07	06	05	04	03	02	01	00
00		0	0	0	Status Code				NED

Status Code - Bits <04:01>

These bits are used to specify the status code. Table 9-1 lists and describes the status codes that are recognized by the UC04.

Nonexistent Device (NED) - Bit 00

When the NED bit is set to one, the Initiator selected a LUN that is not configured in the system.

Table 9-1. Status Codes

Bits 04 03 02 01	Status	Description
X 0 0 0	GOOD STATUS	The target controller successfully completed the command.
0 0 0 1	CHECK CONDITION	An error, exception, or abnormal condition occurred.
0 1 0 0	BUSY	The target controller is busy.
1 = Set	0 = Cleared	X = Don't Care

9.3.3.4 Message Phase

The Message Phase is used to transfer information about exception conditions between the Initiator and the Target. The Message Phase includes both the Message In and the Message Out Phases. The Message In Phase allows a Target to request that messages be sent to the Initiator from the Target. The Message Out Phase allows a Target to request that messages be sent from the Initiator to the Target. Messages from the target controller are a single byte in length. Table 9-2 lists the error messages that are supported by the UC04. Unsupported messages will cause the UC04 to abort and restart the command.

Table 9-2. UC04 SCSI Messages

Code	Message	Description
00	COMMAND COMPLETE	Issued by the Target just before releasing the -BSY signal at the end of a command execution. This message is generally sent immediately after a Status Phase.
02	SAVE DATA POINTER	Issued by the Target to direct the Initiator to save a copy of the present active data pointer.
04	DISCONNECT	Issued by the Target just before releasing the -BSY signal to indicate to the Initiator that the present physical connection is temporarily broken. The current data, command, and status pointers are not saved.
06	ABORT	Issued by the Initiator to the Target to clear the specified LUN and cause the SCSI bus to go to the Bus Free Phase.
07	MESSAGE REJECT	Issued by the Initiator or Target in response to a received message that was undefined.

continued on next page

Table 9-2. UC04 Controller SCSI Messages (continued)

Code	Message	Description
0C	BUS DEVICE RESET	Issued by the Initiator to the Target to reset all current I/O activities on the SCSI bus. This message generates a hard Reset Condition (see subsection 9.5.1).
80-FF	IDENTIFY *	Issued by the Target or Initiator to establish a connection to a particular LUN. The following bits have particular meaning: Bit 07 - Always set to one. Bit 06 - Set if the Initiator can support Disconnect and Reconnect sequences. Bits <02:00> - Specify LUN address (hexadecimal) in a Target.

* If the disconnect function is supported, this message will be issued by the UC04 at the beginning of every command sequence.

9.4 SCSI BUS PHASE SEQUENCING

The status of the SCSI bus is a function of the control signals. These signals place the bus in one of four phases: Arbitration, Selection/Reselection, Information Transfer, and Bus Free. (SCSI bus phases are described in Subsection 9.3.) The order in which SCSI bus phases are used follows a prescribed sequence, shown in Figure 9-2.

All SCSI command sequences start with the Bus Free Phase. The normal progression is from the Bus Free Phase to the Arbitration Phase. During arbitration, hosts/controllers contest for control of the SCSI bus; priority is given to the one with the highest SCSI bus address.

SCSI Bus Phase Sequencing

Once a host or controller has control of the SCSI bus, the bus enters the Selection/Reselection Phase. This phase allows the master of the bus to select a specific device for communication. An Initiator can select a Target to initiate an operation, or a Target can reselect an Initiator to continue an operation.

After a physical path between an Initiator and a Target is established, the bus moves into one of the Information Transfer Phases. These phases include six types of information exchange:

- Data Out Phase
- Data In Phase
- Command Phase
- Status Phase
- Message In Phase
- Message Out Phase

These types of SCSI bus information exchange are described in more detail in subsection 9.3.

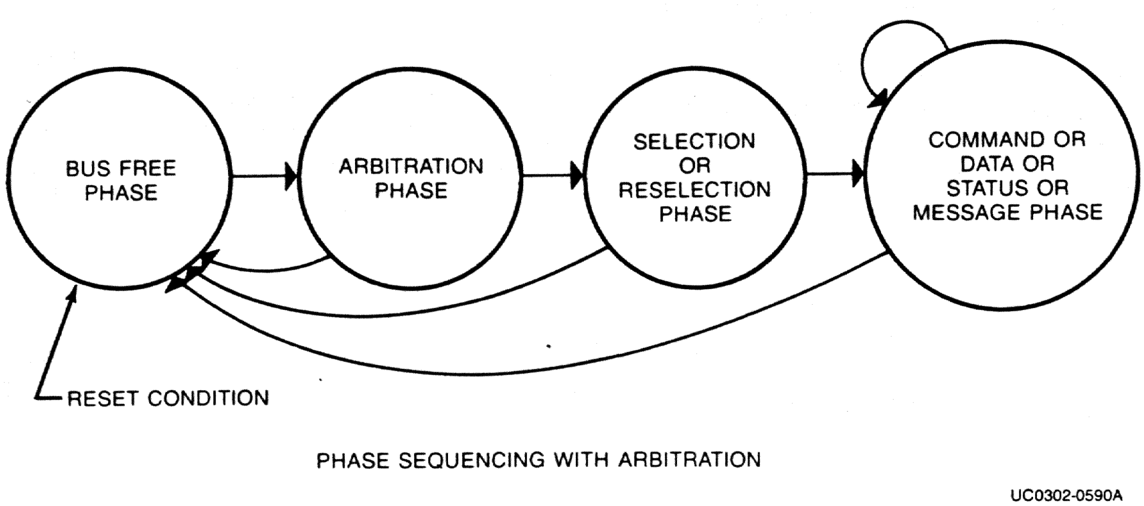

Figure 9-2. SCSI Bus Phase Sequences

9.5 SCSI BUS CONDITIONS

The SCSI bus has the following asynchronous conditions:

- Reset Condition
- Attention Condition

These conditions cause certain SCSI device actions and can alter the phase sequence. The two conditions are discussed in the subsections below.

9.5.1 RESET

The Reset Condition is used to immediately clear all bus masters from the SCSI bus. This condition takes precedence over all other SCSI bus phases and conditions. During the Reset Condition, no bus signal except RST is guaranteed to be valid.

The UC04 supports a "hard" reset option. When the target detects a Reset Condition, it should perform the following actions:

- Clear all uncompleted commands
- Release device reservations
- Return device operating modes (such as the **MODE SELECT** command) to their default conditions

The UC04 will re-submit outstanding commands to the target after the reset condition clears.

9.5.2 ATTENTION

The Attention Condition allows an Initiator to inform a Target that the Initiator has a message ready. The Target can obtain this message in the Message Phase.

9.6 SCSI COMMANDS

An Initiator (such as the UC04) issues SCSI commands to a Target device by transferring a command packet, called a Command Descriptor Block (CDB). The command contained in the CDB determines the length of the CDB. The first byte of a CDB contains the command. This byte, called the Operation Code, has two components: the Group Code and the Command Code.

The UC04 issues only Group Code 0 and Group Code 7 SCSI commands to the target controller. Group Code 0 CDBs contain six bytes. Group Code 7 CDBs, which are vendor unique and issued only to Emulex SCSI controllers, are 10 bytes long. The Command Code defines the type of SCSI command. SCSI command types are defined as specific CDB bit patterns in the ANSI SCSI specification; CDBs issued by the UC04 follow the guidelines listed in the ANSI SCSI specification.

NOTE

> The commands listed apply to Emulex controllers (Medalist and Champion). Other controllers may handle some of the commands slightly differently. See the manufacturer's manuals for details.

The structure of each SCSI command packet that can be issued by the UC04 is shown in the applicable descriptions in subsection 9.7 (Group Code 0 CDBs) and 9.8 (Group Code 7 CDBs). The following table lists, by subsection number, command names and operation codes for SCSI commands issued by the UC04:

Subsection	UC04 SCSI Command	Code
9.7.1	**FORMAT UNIT**	04
9.7.2	**MODE SELECT**	15
9.7.3	**READ**	08
9.7.4	**RE-ASSIGN BLOCK**	07
9.7.5	**REQUEST SENSE**	03
9.7.6	**TEST UNIT READY**	00
9.7.7	**WRITE**	0A
9.8.1	**READ LONG**	E8
9.8.2	**WRITE LONG**	EA

Three other SCSI commands are used by the Emulex MSCP/SCSI Formatter and are passed through by the UC04. They are:

- **INQUIRY** (12)
- **MODE SENSE** (1A)
- **SEND DIAGNOSTIC** (1D)

Target controllers do not need to support these commands if the Emulex formatter is not used. These commands are not described in this manual.

9.7 SCSI GROUP CODE 0 COMMAND DESCRIPTIONS

This subsection provides detailed descriptions of SCSI Group Code 0 commands, including CDB formats, hexadecimal operation code, byte and bit functions, and any necessary effects produced by the commands. Each SCSI command is described in a separate subsection.

A sample Group 0 CDB is shown in Figure 9-3. The first byte of a command (Byte 00) contains two fields: the Group Code in the high-order three bits (bits <07:05>), and the Command Code in the low-order five bits (bits <04:00>). The Group Code determines the length of the command packet in the CDB, and together the Group and Operation Codes determine the operation to be performed.

Bits <07:05> of byte 01 in the CDB contain the LUN of the device being addressed. The UC04, acting as a SCSI bus Initiator, supports up to nine LUNs: eight disk drives and one tape drive. The LUN must be specified for all commands. The definition of the low-order bits in byte 01 is based on the current command.

The UC04 uses bits 06 and 07 of the last byte (vendor unique) to control retrys and error correction attempts in the target. Bits 00 and 01 of the last byte are normally used to link commands. However, the UC04 never links commands, so these bits are always zero.

Byte	Bit 07	06	05	04	03	02	01	00
00	Group Code			Command Code				
01	LUN			Command-Dependent Parameters				
02	Command-Dependent Parameters							
03	Command-Dependent Parameters							
04	Command-Dependent Parameters							
05	0	0	0	0	0	0	0	0

Figure 9-3. Sample Group 0 Command Descriptor Block

9.7.1 FORMAT UNIT 04

The **FORMAT UNIT** CDB, shown below, is used to write header and data blocks on the entire disk. This command normally writes all header fields and initializes data fields. This command is described as it relates to Medalist and Champion controllers. Other controller types are similar, but consult the manufacturer's manuals for differences.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	1	0	0
01	LUN			FMD	CPL	Defect List Format		
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	Interleave Code (LSB)							
05	0	0	0	0	0	0	0	0

The command in this CDB may disconnect from the Initiator.

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

Format Data (FMD) - Byte 01, Bit 04

When the FMD bit status is set to one, **FORMAT UNIT** data is supplied during the Data Out Phase of the command. No defect list will be supplied with this data. See Table 9-3 for an explanation of how this bit affects the format mode.

Complete List (CPL) - Byte 01, Bit 03

This bit is always set to one, and indicates that any previous Defect Map or defect data is erased. The Target must create a Defect List as it formats the media.

Defect List Format - Byte 01, Bits <02:00>

These bits specify additional information related to the format of the Defect List. Together with the FMD and CPL bits, these bits specify the mode of a Format operation. The Format modes are listed in Table 9-3. Only the block address mode is supported.

Table 9-3. UC04 Controller Format Modes

Bits 04	03	02	01	00	Mode
0	0	0	0	0	Not used.
0	1	0	0	0	**Format Mode.** The target controller performs a complete format of the specified disk and destroys the old Bad Sector File. A new Bad Sector File may be supplied by the user. This mode may be used during the format operation on an uninitialized disk drive.
1	0	0	0	0	Not used.
1	1	0	0	0	**Format Mode with Update.** In this mode, the target uses the Bad Sector File already on the disk and adds to it. This mode may also be used to format an uninitialized disk drive.

Interleave Code - Bytes 03 through 04

The code in the Interleave field requests that the logical blocks be related in a specific fashion to the physical blocks to compensate for differences in execution time between the host processor and the target Controller, if necessary. Emulex recommends that a 1:1 sequential interleave be used for winchester drives and a 2:1 interleave for Iomega drives.

The most significant byte of the Interleave field (Byte 03) must be zero. An Interleave value of zero (hexadecimal) requests that the Target use its default interleave.

If a value greater than 1 is specified in the Interleave field, that number indicates where the next logical block in sequence is located with respect to the logical block just before it. For example, if an interleave code of 3 is specified and n is a logical block, then n+1 is the third contiguous block from n.

9.7.2 MODE SELECT 15

The **MODE SELECT** CDB, shown below, enables an Initiator to specify device parameters to the target controller. This command is used only during drive formatting operations.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	1	0	1	0	1
01	LUN			0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	Parameter List Length							
05	0	0	0	0	0	0	0	0

The target controller must not disconnect from the Initiator while executing this command.

<u>Logical Unit Number (LUN) - Byte 01, Bits <07:05></u>

These bits specify the LUN of the addressed device for this command.

<u>Parameter List Length - Byte 04</u>

This byte specifies the length in bytes of the Parameter List sent during the Data Out Phase of this command. For Medalist and Champion controllers, this vaule will be 15 hex. For other controllers, consult the manufacturer's manual.

9.7.2.1 Mode Select Parameter List

The Mode Select Parameter List, shown below, is sent during the Data Phase of the **MODE SELECT** command to specify parameters for ST506-compatible disk drives. The parameter list is shown for Medalist and Champion controllers. Other controllers are similar, but consult the manufacturer's manual for differences.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	Block Descriptor Length							
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0
06	0	0	0	0	0	0	0	0
07	0	0	0	0	0	0	0	0
08	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0
0A	0	0	0	0	0	0	0	0
0B	0	0	0	0	0	0	0	0
0C	Number of Alternate Cylinders							
0D	Number of Heads				SSZ		SST	BFS
0E	Logical Number of Sectors/Track							
0F	Logical Number of Cylinders (MSB)							
10	Logical Number of Cylinders (LSB)							
11	Write Precompensation Cylinder Number (MSB)							
12	Write Precompensation Cylinder Number (LSB)							
13	Reduced Write Current Cylinder Number (MSB)							
14	Reduced Write Current Cylinder Number (LSB)							

Block Descriptor Length - Byte 03

This byte specifies the length of the Block Descriptor in decimal bytes, starting at Byte 04. Valid lengths are 0 and 17 (decimal).

Density Code - Byte 04

This byte defines the density of the media on the addressed LUN. The Density Code has a value of zero to indicate the LUN is a hard disk drive.

Number of Alternate Cylinders - Byte 0C

This byte specifies the number of cylinders to be used for alternate addressing. Bad tracks are mapped on the alternate cylinders.

Number of Heads - Byte 0D, Bits <07:04>

These bits specify the number of heads on the disk drive.

Sector Size (SSZ) - Byte 0D, Bit 03

This bit indicates the sector size. If the SSZ bit is set to one, the sector size is 256 bytes. If the SSZ bit is reset to zero, the sector size is 512 bytes. The UC04 uses 512-byte sectors.

Spare Sectors/Track (SST) - Byte 0D, Bits <02:01>

These bits indicate the number of spare sectors/track. The bit patterns are listed and described in Table 9-4.

Table 9-4. Spare Sectors/Track Bits

Bits 01	Bits 02	Number of Spare Sectors/Track
0	0	0
0	1	1
1	0	2
1	1	3

Buffered Step (BFS) - Byte 0D, Bit 00

This bit indicates if the disk drive Step operation (involving the time intervals in which the Step signal pulses occur) is or is not to be buffered. If the BFS bit is set to one, the Step operation is buffered. If the BFS bit is reset to zero, the Step operation is non-buffered.

Logical Number of Sectors/Track - Byte 0E

This byte specifies the logical number of sectors per track which can be accessed by the user. The value of this field plus the value of the spare sectors per track field equals the total number of physical sectors per track.

Logical Number of Cylinders - Bytes 0F through 10

The value in this field minus 2 (for Medalist) or minus 3 (for Champion) specifies the logical number of cylinders in the user's address space. The subtracted cylinders are dedicated to the Bad Sector File and to diagnostic data. The value in this field plus the value of the Number of Alternate Cylinders field equals the total number of physical cylinders.

Write Precompensation Cylinder Number - Bytes 11 through 12

For Medalist controllers, these bytes specify the number of the first cylinder at which the disk drive begins writing data using a time-precompensated format.

For Champion controllers, byte 11 specifies the number of sectors by which sector 0 is offset from sector 0 of the previous track. Byte 12 is not used.

Reduced Write Current Cylinder Number - Bytes 13 through 14

For Medalist controllers, these bytes specify the number of the cylinder at which the disk drive supplies a different amount of current to the head during a write operation. These bytes are not used by Champion controllers.

9.7.3 READ 08

The **READ** CDB, shown below, causes the transfer of data from the Target device to the Initiator. The **READ** command specifies the starting block number and the number of data blocks to be read. The **READ** command terminates when the number of data blocks to be read is transferred.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	1	0	0	0
01	LUN			Logical Block Address (MSB)				
02	Logical Block Address							
03	Logical Block Address (LSB)							
04	Number of Blocks to Transfer (LSB)							
05	ECC	ERTY	0	0	0	0	0	0

If the disconnect function is enabled, the target controller can disconnect from the Initiator while executing this command.

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

Logical Block Address - Bytes 01 through 03

These bytes specify the logical block address where the read operation is to begin.

Number of Blocks to Transfer - Byte 04

This byte specifies the number of contiguous logical blocks of data to be transferred. When this byte is zero, 256 logical blocks of data are transferred. Any other value between 1 and 256, inclusive, indicates that number of logical blocks is to be transferred.

Error Correction Code (ECC) - Byte 05, Bit 07

This bit indicates if ECC Checking operations are or are not disabled. If the ECC bit is set to one, ECC Checking operations are disabled. If the ECC bit is reset to zero, ECC Checking operations are enabled.

Error Retry (ERTY) - Byte 05, Bit 06

This bit indicates whether Error Retry operations are or are not disabled. If the ERTY bit is set to one, Error Retry operations are disabled. If the ERTY bit is reset to zero, Error Retry operations are enabled.

9.7.4 RE-ASSIGN BLOCK 07

The **RE-ASSIGN BLOCK** CDB, shown below, sends a defect block to the Target during the Data Phase of the command. The defect block is a single logical block addresses that is to be re-assigned.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	1	1	1
01	LUN			0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

9.7.4.1 Re-assign Block Header

During the Data Out Phase of the **RE-ASSIGN BLOCK** command, data is sent in two pieces. The first piece is the Block Header, shown below, which defines the length of the defect list. Since the UC04 re-assigns only a single block at a time, this length is always four bytes.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	0
02	Length of Defect List (MSB)							
03	Length of Defect List (LSB)						0	0

Length of Defect List - Bytes 02 through 03

The value in the Length of Defect List field specifies the total number of bytes (not the total number of defect descriptors) sent during the Data Out Phase of the **RE-ASSIGN BLOCK** command. It is always four.

9.7.4.2 Re-assign Block Defect Descriptor Format

The **RE-ASSIGN BLOCK** defect descriptor is shown below.

Byte	Bit 07	06	05	04	03	02	01	00
00	Defect Block Address (MSB)							
01	Defect Block Address							
02	Defect Block Address							
03	Defect Block Address (LSB)							

The Defect Block Address bytes are converted to the appropriate track and block addresses by the target controller. Block addresses that specify previously detected or specified addresses are processed and produce duplicate entries in the Bad Sector File if the re-assignment results in the use of another spare block.

If the LUN has insufficient capacity to re-assign the defective logical block, the target controller terminates the **RE-ASSIGN BLOCK** command with a CHECK CONDITION status code and sets the Sense Key in the Extended Sense Byte to MEDIUM ERROR. The Logical Block Address is returned in the Information Bytes of the sense data.

Defect List Block Address - Bytes 00 through 03

These bytes specify the address of the block that contains the defect.

9.7.5 REQUEST SENSE 03

The **REQUEST SENSE** CDB, shown below, is used to obtain more detailed information after execution of a command. Typically, a **REQUEST SENSE** command is issued after a previous command has completed and a CHECK CONDITION status code has been issued to the Initiator.

An Initiator normally issues a **REQUEST SENSE** command as soon as it receives a CHECK CONDITION status code to obtain the Sense data saved by the target controller.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	1	1
01	LUN			0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	Number of Requested Sense Bytes							
05	0	0	0	0	0	0	0	0

The target controller must not disconnect from the Initiator while executing this command.

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

Number of Requested Sense Bytes - Byte 04

This byte contains the number of bytes of data the Initiator has allocated for the sense information. The UC04 always allocates ten bytes for the sense data, although it normally looks only at the first seven bytes. The target controller does not have to return this many bytes. Although the UC04 asks for ten bytes, it will accept any number between four and ten.

9.7.5.1 Extended Sense Byte Format

The Extended Sense Byte format is shown below. Note that the format is only seven bytes long, although the controller can actually return up to ten bytes. If it does, the last three bytes will be ignored.

Byte	Bit 07	06	05	04	03	02	01	00
00	VADD	1	1	1	Vendor Unique Code			
01	0	0	0	0	0	0	0	0
02	0	0	0	0	Sense Key			
03	Logical Block Address (MSB)							
04	Logical Block Address							
05	Logical Block Address							
06	Logical Block Address (LSB)							

Valid Address (VADD) - Byte 00, Bit 07

If this this bit is set, the Logical Block Address (Bytes 03 through 06) contains valid information related to the error code.

Sense Key - Byte 02, Bits <03:00>

The Sense Key bits indicate status information about any errors detected during the operation. The errors are listed and defined in Table 9-5

Table 9-5. Extended Sense Byte Sense Keys

Hex Code	Error	Description
00	NO SENSE	There is no Sense Key information to be reported for the designated LUN. This code occurs for a successfully completed command.
01	RECOVERED ERROR	The last command was completed successfully, but with some recovery action performed by the Target.
02	NOT READY	The addressed LUN cannot be accessed. Operator intervention may be required.
03	MEDIUM ERROR	The command terminated with a nonrecoverable-error condition which was probably caused by a flaw in the media or by an error in the recorded data.
04	HARDWARE ERROR	A nonrecoverable hardware error (e.g., controller failure, device failure, parity error, etc.) was detected while the Target was performing the command or while the Target was performing a Self-Test operation.

continued on next page

Table 9-5. Extended Sense Byte Sense Keys (continued)

Hex Code	Error	Description
05	ILLEGAL REQUEST	There was an illegal parameter in the command or in the additional required parameters supplied as data for some related commands.
06	UNIT ATTENTION	The addressed LUN has been reset. This error is reported the first time any command is issued after the condition is detected; then the requested command is not performed. This condition is cleared when the next command is issued by the same host adapter. UNIT ATTENTION is reported to all SCSI devices that subsequently issue a command to the LUN.
07	DATA PROTECT	A write operation was attempted on a write-protected device.
08-FF	DRIVE ERROR	These codes are interpreted by the UC04 as nonrecoverable and nonretryable drive errors.

Logical Block Address - Bytes 03 through 06

These bytes specify the Logical Block Address where the error specified by the Sense Key Error Code occurred.

9.7.6 TEST UNIT READY 00

The **TEST UNIT READY** CDB, shown below, causes a test to be performed to ensure the disk drive is powered-on and ready. This condition is indicated by a GOOD status code being returned in response to this command. If the disk drive is not ready, a **REQUEST SENSE** command can be issued to obtain detailed information about the reason the disk drive is not ready (unavailable).

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	0
01	LUN			0	0	0	0	0
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0

The target controller must not disconnect during execution of this command.

<u>Logical Unit Number (LUN) - Byte 01, Bits <07:05></u>

These bits specify the LUN of the addressed device for this command.

9.7.7 WRITE 0A

The **WRITE** CDB, shown below, causes data to be transferred from the Initiator to the Target device. The amount of data written is a multiple of the block length. The **WRITE** command specifies the starting logical block number and the number of blocks to be written.

Byte	Bit 07	06	05	04	03	02	01	00
00	0	0	0	0	1	0	1	0
01	LUN			Logical Block Address (MSB)				
02	Logical Block Address							
03	Logical Block Address (LSB)							
04	Number of Blocks in Transfer							
05	0	ERTY	0	0	0	0	0	0

If the disconnect function is enabled, the target controller may disconnect from the Initiator while executing this command.

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

Logical Block Address - Bytes 01 through 03

These bytes specify the logical block where the write operation is to begin.

Number of Blocks to Transfer - Byte 04

This byte specifies the number of contiguous logical blocks of data to be transferred. When this byte contains all zeros, 256 logical blocks of data are transferred. Any other Number of Blocks to Transfer value indicates that number of blocks are to be transferred.

Error Retry (ERTY) - Byte 05, Bit 06

This bit indicates whether Error Retry operations are or are not disabled. If the ERTY bit is set to one, Error Retry operations are disabled. If the ERTY bit is reset to zero, Error Retry operations are enabled.

9.8 SCSI GROUP CODE 7 COMMAND DESCRIPTIONS

SCSI Group code 7 commands are vendor-unique SCSI commands. Group code 7 command names and operation codes are issued by the UC04 to support the Emulex family of SCSI controllers.

This subsection provides detailed descriptions of the commands, including CDB formats, hexadecimal operation code, byte and bit functions, and any necessary event-sequence descriptions (i.e., effects produced by the commands). Each Emulex-unique SCSI command is described in a separate subsection.

A sample Group 7 CDB is shown in Figure 9-4. The first byte of a command (Byte 00) contains two fields: the Group Code in the high-order three bits (bits <07:05>), and the Command Code in the low-order five bits (bits <04:00>). The Group Code determines the length of the command packet in the CDB, and together the Group and Command Codes determine the operation to be performed.

Bits <07:05> of byte 01 in the CDB contain the LUN of the device being addressed. The UC04, acting as a SCSI bus Initiator, supports up to eight LUNs: seven disk drives and one tape drive. The LUN must be specified for all commands. If a LUN value issued by the Initiator in an IDENTIFY message differs from the value specified in the CDB, that value supersedes the value specified in the CDB. The definition of the low-order bits in byte 01 is based on the current command.

The last byte is reseved and is always zero. The remaining bytes in the CDB are primarily command-dependent.

NOTE

> Bits 00 and 01 of the last byte are normally used to link commands. However, the UC04 never links commands, so these bits are always zero.

Byte	Bit 07	06	05	04	03	02	01	00
00	Group Code			Command Code				
01	LUN			Command-Dependent Parameters				
02	Command-Dependent Parameters							
03	Command-Dependent Parameters							
04	Command-Dependent Parameters							
05	Command-Dependent Parameters							
06	Command-Dependent Parameters							
07	Command-Dependent Parameters							
08	Command-Dependent Parameters							
09	0	0	0	0	0	0	0	0

Figure 9-4. Sample Group 7 Command Descriptor Block

9.8.1 READ LONG E8

The **READ LONG** command, shown below, causes the target controller to perform a read operation of one data block, beginning at the specified block address. The data and the six Error Correction Code (ECC) bytes of the specified block are transferred to the Initiator. The ECC bytes follow the data.

Byte	Bit 07	06	05	04	03	02	01	00
00	1	1	1	0	1	0	0	0
01	LUN			0	0	0	0	0
02	0	Block Address (MSB)						
03	Block Address							
04	Block Address							
05	Block Address (LSB)							
06	0	0	0	0	0	0	0	0
07	0	0	0	0	0	0	0	0
08	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0

Block Address - Bytes 02 through 05

These bytes specify the block address where the read long operation is to begin.

9.8.2 WRITE LONG EA

The **WRITE LONG** command, shown below, causes the target controller to perform a write operation of one data block, starting at the specified logical block address. The data and the six ECC bytes of the specified logical block are written for each logical block specified in the logical block address. The ECC bytes follow the data.

Byte	Bit 07	06	05	04	03	02	01	00
00	1	1	1	0	1	0	0	1
01	LUN			0	0	0	0	0
02	0	Block Address (MSB)						
03	Block Address							
04	Block Address							
05	Block Address (LSB)							
06	0	0	0	0	0	0	0	0
07	0	0	0	0	0	0	0	0
08	0	0	0	0	0	0	0	0
09	0	0	0	0	0	0	0	0

<u>Block Address - Bytes 02 through 05</u>

These bytes specify the block address where the write long operation is to begin.

Appendix A
ASSIGNING BUS AND VECTOR ADDRESSES

A.1 OVERVIEW

A host operating system must know what devices are attached to the bus if it is to make use of them. One way it can get this information is to ask the user, who assigns bus and vector addresses and enters this information during the SYSGEN process. The CPU then looks for devices at the addresses it was told it would find them.

Another way to get this information is for the operating system to poll the bus when the system is bootstrapped to find out what is there. The DEC routine that does this polling is called autoconfigure and it is the subject of this appendix.

Autoconfigure works this way: DEC has compiled a list of all devices with floating addresses supported by its operating systems (Table A-1). The autoconfigure routine starts by searching for the first device on the list (DJ11). If it finds one, it assigns it an address. Then it searches for the next device and continues until it has searched for the last device on the list. When it is done, it has searched for every device that DEC supports and has assigned an address to all the devices it has found.

The autoconfigure routine also assigns interrupt vector addresses, but note that the order in which it assigns vector addresses is different from bus addresses. Table A-2 shows the search order for vector addresses.

Because of the nature of the autoconfigure routine, the address assigned to a device depends on what other devices are on the system. If a new device is added to the system, every device that comes after it on one of the lists is moved down and assigned a higher address than it had before.

NOTE

> Some DEC devices have fixed bus and vector addresses. For example, the first UDA50 in a system is assigned a fixed bus address (772150) and a fixed vector address (154), so it does not affect any other devices in the system. However, starting with the second UDA50, they are assigned addresses in the floating range.
>
> Devices with fixed addresses will not change when other devices are added to the system. For the purposes of assigning floating bus and vector addresses, these devices can be ignored.

Calculating Bus and Vector Addresses

The operating system expects to find a device at whatever address was assigned to it during the autoconfigure process. Therefore, whatever addresses it assigned to that device must be physically programmed into the device before the system is brought online. If this is not done, the system will hang, because the CPU looks for the device at the address assigned to it but the device does not respond.

If you choose the autoconfigure option during SYSGEN, you must be careful to calculate the exact bus and address vectors that will be assigned during the autoconfigure process. Therefore, before you install the UC04, you must:

- Calculate the bus address that the DEC autoconfigure routine is going to assign to it.
- Figure out if the addresses for any of the other devices on your system are going to change.
- Make sure these addresses are programmed correctly into the devices.

In the case of the UC04, the bus address is programmed with switches, as described in subsection 4.5.1. The vector address is programmed into the device by the operating system during power-up, so no switches must be set. If the addresses of any of your other devices are going to change, you must also program the new addresses into them, as described in their technical manuals.

When calculating the bus and vector addresses, keep the following points in mind:

- The UC04 emulates one UDA50. If it is the only MSCP controller on your system, you can assign it a fixed bus address (772150) and a fixed vector address (154) and skip the rest of this appendix. If you have another MSCP controller on your system, you should assign it the fixed address and calculate a floating address for the UC04.
- Only the bus address needs to be programmed into the UC04. The vector address is loaded automatically at power-up.

A.2 CALCULATING BUS AND VECTOR ADDRESSES

A.2.1 THE BUS ADDRESS

The bus address for a floating-address device is selected according to the algorithm used during autoconfigure. The algorithm is used in conjunction with a SYSGEN Device Table, Table A-1. Floating bus addresses start at 760010 and go up sequentially.

Table A-1. SYSGEN Device Table

Rank	Device	Number of Registers	Octal Modulus	Rank	Device	Number of Registers	Octal Modulus
1	DJ11	4	10	16	KW11-C	4	10
2	DH11	8	20	17	Reserved	4	10
3	DQ11	4	10	18	RX11[2]	4	10
4	DU11,DUV11	4	10	18	RX211[2]	4	10
5	DUP11	4	10	18	RXV11[2]	4	10
6	LK11A	4	10	18	RXV21[2]	4	10
7	DMC11	4	10	19	DR11-W	4	10
7	DMR11	4	10	20	DR11-B[3]	4	10
8	DZ11[1]	4	10	21	DMP11	4	10
8	DZV11	4	10	22	DPV11	4	10
8	DZS11	4	10	23	ISB11	4	10
8	DZ32	4	10	24	DMV11	8	20
9	KMC11	4	10	25	DEUNA[2]	4	10
10	LPP11	4	10	26	UDA50[2]	2	4
11	VMV21	4	10	27	DMF32	16	40
12	VMV31	8	20	28	KMS11	6	20
13	DWR70	4	10	29	VS100	8	20
14	RL11[2]	4	10	30	Reserved	2	4
14	RLV11[2]	4	10	31	KMV11	8	20
15	LPA11-K[2]	8	20	32	DHV11	8	20

[1]DZ11-E and DZ11-F are treated as two DZ11s.
[2]The first device of this type has a fixed address. Any extra devices have a floating address.
[3]The first two devices of this type have a fixed address. Any extra devices have a floating address.

There are four rules that pertain to the assignment of bus addresses in floating address space:

1. Devices with floating addresses must be attached in the order in which they are listed in Table A-1. That is, a device higher on the list always has a higher bus address.

2. The bus address for a given device type is assigned on boundaries according to the number of registers that the device has. The boundaries are shown in the Octal Modulus column of Table A-1. The following table relates the number of device registers to possible boundaries.

Device Registers	Possible Boundaries
1	Any Word
2	XXXXX0, XXXXX4
3,4	XXXXX0
5,6,7,8	XXXX00,XXXX20,XXXX40,XXXX60
9 through 16	XXXX00,XXXX40

For example, the UDA50 has two registers, so its bus address may be any address ending in 0 or 4.

3. A gap of at least eight-bytes must follow the register block of any installed device to indicate that there are no more of that type of device. An eight-byte gap must also be reserved in floating address space for each device type that is not installed in the current system. The gap must start on the proper boundary for the type of device the gap represents.

   For example, a single DJ11 installed at 760010 would be followed by a gap starting at 760020 to show a change of device types. A gap to show that there are none of the next device on the list, a DH11, would begin at 760040, the next legal boundary for a DH11-type device.

   NOTE

   Several devices have the same ranking in the SYSGEN Device Table (for example, the DMC11 and DMR11). When computing gaps, count these devices only once.

A worksheet for calculating bus addresses is contained in subsection A.2.3. An example of calculating bus and vector addresses is contained in subsection A.2.4. The example should make the process clear if the preceding explanation did not.

A.2.2 THE INTERRUPT VECTOR ADDRESS

The algorithm for assigning floating vector addresses is similar to the one used for assigning bus addresses. Vector addresses are assigned in order starting at 300_8 and proceeding upward to 777_8. Table A-2 shows the assignment sequence. (Note that the sequence is different from the SYSGEN table used for bus addresses.)

The vector address for a device is assigned on the boundary indicated in the Octal Modulus column of Table A-2. That is, if the modulus is 4 the vector address may end with 0 or 4 (XX0, XX4); if the modulus is 10 the vector must end in 0, and so forth. The amount of space required for each device depends on the number of vectors it has. The UDA50 uses only one vector, so it takes up only two bytes.

Vector addresses go up sequentially and no gaps are needed (as there are with the bus addresses). If the first device on your system were a UDA50, it would be assigned a starting vector address of 300. Since a UDA50 only requires two bytes, a second UDA50 would be assigned an address of 304 (vector addresses must end in 0 or 4). Because no gaps are needed, the next device on your system, no matter how far down the table it was, would be assigned a vector address of 310. The address of the device after that would depend on how many vector addresses were taken up by the device at 310.

NOTE

There is an apparent bug in the VMS and MicroVMS autoconfigure routines that cause vectors for UDA50s to be assigned differently than described above. UDA50 vectors under VMS and MicroVMS are assigned as follows:

1. If a UDA50 is used as the boot device, it is assigned a vector of 774, regardless of its bus address.

2. The next UDA50 is assigned a vector of 154 if it has a bus address of 772150 (the standard address for the first UDA50) or a floating vector if it has a floating address.

3. Subsequent UDA50s are assigned vectors normally in the floating range.

As an example, if three UDA50s are installed and nothing else is on the bus, they would be assigned the following vectors, assuming the primary UDA50 is used as the boot device:

Controller	Bus Address	Vector Address
UDA50 #1	772150	774
UDA50 #2	760334	300
UDA50 #3	760340	304

If the same setup were used but the second UDA50 was the boot device, vectors would be assigned as follows:

Controller	Bus Address	Vector Address
UDA50 #1	772150	154
UDA50 #2	760334	774
UDA50 #3	760340	300

Table A-2. Priority Ranking for Floating Vector Addresses (footnotes at end of table)

Rank	Device	Number of Vectors	Octal Modulus
1	DC11	4	10
1	TU58	4	10
2	KL11[1]	4	10
2	DL11-A[1]	4	10
2	DL11-B[1]	4	10
2	DLV11-J[1]	16	40
2	DLV11,DLV11-F[1]	4	10
3	DP11	4	10
4	DM11-A	4	10
5	DN11	2	4
6	DM11-BB/BA	2	4
7	DH11 modem control	2	4
8	DR11-A, DRV11-B	4	10
9	DR11-C, DRV11	4	10
10	PA611 (reader+punch)	8	20
11	LPD11	4	10
12	DT07	4	10
13	DX11	4	10
14	DL11-C to DLV11-F	4	10
15	DJ11	4	10
16	DH11	4	10
17	VT40	8	20
17	VSV11	8	10
18	LPS11	12	40
19	DQ11	4	10
20	KW11-W, KWV11	4	10
21	DU11, DUV11	4	10
22	DUP11	4	10
23	DV11 + modem control	6	20
24	LK11-A	4	10
25	DWUN	4	10
26	DMC11	4	10
26	DMR11	4	10
27	DZ11/DZS11/DZV11	4	10
27	DZ32	4	10
28	KMC11	4	10
29	LPP11	4	10
30	VMV21	4	10
31	VMV31	4	10
32	VTV01	4	10
33	DWR70	4	10
34	RL11/RLV11[2]	2	4

(continued on next page)

Table A-2. Priority Ranking for Floating Vector Addresses (continued)

Rank	Device	Number of Vectors	Octal Modulus
35	TS11[2], TU80[2]	2	4
36	LPA11-K	4	10
37	IP11/IP300[2]	2	4
38	KW11-C	4	10
39	RX11[2]	2	4
39	RX211[2]	2	4
39	RXV11[2]	2	4
39	RXV21[2]	2	4
40	DR11-W	2	4
41	DR11-B[2]	2	4
42	DMP11	4	10
43	DPV11	4	10
44	ML11[3]	2	4
45	ISB11	4	10
46	DMV11	4	10
47	DEUNA[2]	2	4
48	UDA50[2]	2	4
49	DMF32	16	40
50	KMS11	6	20
51	PCL11-B	4	10
52	VS100	2	4
53	Reserved	2	4
54	KMV11	4	10
55	Reserved	4	10
56	IEX	4	10
57	DHV11	4	10

1 A KL11 or DL11 used as a console has a fixed vector.
2 The first device of this type has a fixed vector. Any extra devices have a floating vector.
3 ML11 is a MASSBUS device that can connect to a UNIBUS via a bus adapter.

A.2.3 SYSTEM CONFIGURATION WORKSHEET

Figure A-1 shows a worksheet for calculating bus addresses. To calculate the bus addresses for all the devices on your system, make a list of your devices (including the UDA50) in the order in which they appear in Table A-1 and use the following procedure:

1. Starting with the DJ11 column, mark the unit number of each DJ11 in your system in the unshaded boxes, moving downward. For example, if you had three DJ11s, you would mark a 0 at 760010, a 1 at 760020, and a 2 at 760030. Skip over the shaded boxes (they represent illegal addresses). In the next legal address (760040 in this example), mark an X. (If you had no DJ11s, you would only need to mark an X in the first possible address, 760010.)

2. Move over one column to DH11 and assign addresses moving downward. To continue the example: In step 1 you marked an X next to address 760040 in the DJ11 column, so you would move over to the DH11 column and go down to the next legal address, 760060. If you have no DH11s in your system, you would mark an X at address 760060.

3. So far, we have used the addresses up to 760060. The next legal address in the DQ11 column is 760070. If you have no DQ11s on your system, mark an X there and move to the DU11 column.

4. Continue this process until you have assigned bus addresses to all the devices in your system. Remember that you must reserve one extra legal address (by marking an X in the box) for every possible device, even if you don't have one installed.

Calculating vector addresses is similar. List all your devices in the order in which they appear in Table A-2. (Do not include any devices that are not on that list.) The first device has a vector address of 300 and takes up as much room as listed in the Octal Modulus column of Table A-2. For example, if you had a DC11 in your system, it would be assigned a vector of 300 and, because its modulus is 10, it would take up 10 (octal) bytes. Thus, the next device in the system would be assigned a vector of 310.

ADDRESS	DJ11	DH11	DQ11	DU11	DUP11	LK11	DMC11	DZ11	KMC11	LPP11	VMV21	VMV31	DWR70	RL11	LPA11	KW11	RESERVED	RX11	DR11W	DR11B	DMP11	DPV11	ISB11	DMV11	UNA	UDA50	DMF32	KMS11	VS100	RESERVED	KMV11	DHV11
760000																															
760004																															
760010																															
760014																															
760020																															
760024																															
760030																															
760034																															
760040																															
760044																															
760050																															
760054																															
760060																															
760064																															
760070																															
760074																															
760100																															
760104																															
760110																															
760114																															
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760330																															
760334																															
760340																															
760344																															
760350																															
760354																															
760360																															
760364																															
760370																															
760374																															

DJ11 DH11 DQ11 DU11 DUP11 LK11 DMC11 DZ11 KMC11 LPP11 VMV21 VMV31 DWR70 RL11 LPA11 KW11 RESERVED RX11 DR11W DR11B DMP11 DPV11 ISB11 DMV11 UNA UDA50 DMF32 KMS11 VS100 RESERVED KMV11 DHV11

UC0302-0731A

Figure A-1. Bus Address Worksheet (Page 1 of 2)

ADDRESS	DJ11	DH11	DQ11	DU11	DUP11	LK11	DMC11	DZ11	KMC11	LPP11	VMV21	VMV31	DWR70	RL11	LPA11	KW11	RESERVED	RX11	DR11W	DR11B	DMP11	DPV11	ISB11	DMV11	UNA	UDA50	DMF32	KMS11	VS100	RESERVED	KMV11	DHV11
760400																																
760404																																
760410																																
760414																																
760420																																
760424																																
760430																																
760434																																
760440																																
760444																																
760450																																
760454																																
760460																																
760464																																
760470																																
760474																																
760500																																
760504																																
760510																																
760514																																
760520																																
760524																																
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760534																																
760540																																
760544																																
760550																																
760554																																
760560																																
760564																																
760570																																
760574																																
760600																																
760604																																
760610																																
760614																																
760620																																
760624																																
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760634																																
760640																																
760644																																
760650																																
760654																																
760660																																
760664																																
760670																																
760674																																
760700																																
760704																																
760710																																
760714																																
760720																																
760724																																
760730																																
760734																																
760740																																
760744																																
760750																																
760754																																
760760																																
760764																																
760770																																
760774																																
761000																																

DJ11 DH11 DQ11 DU11 DUP11 LK11 DMC11 DZ11 KMC11 LPP11 VMV21 VMV31 DWR70 RL11 LPA11 KW11 RESERVED RX11 DR11W DR11B DMP11 DPV11 ISB11 DMV11 UNA UDA50 DMF32 KMS11 VS100 RESERVED KMV11 DHV11

UC0302-0731B

Figure A-1. Bus Address Worksheet (Page 2 of 2)

A.2.4 A SYSTEM CONFIGURATION EXAMPLE

The following example of a system configuration includes the following devices:

- One DU11
- One DMC11
- Two UDA50s
- Two DHV11s

Table A-3 shows how the bus addresses were calculated. Note that the UDA50 has fixed bus and vector addresses for the first device, so only the second UDA50 has been assigned floating addresses. Work out the example on the worksheet if it is not clear how the addresses were assigned.

Table A-4 shows how the vector addresses were assigned.

Table A-3. Floating Address Computation

Installed	Device		Address
	DJ11	Gap	760010
	DH11	Gap	760020
	DQ11	Gap	760030
--->	**DU11**		**760040**
	DU11	Gap	760050
	DUP11	Gap	760060
	LK11	Gap	760070
--->	**DMC11**		**760100**
	DMC11	Gap	760110
	DZ11	Gap	760120
	KMC11	Gap	760130
	LPP11	Gap	760140
	VMV21	Gap	760150
	VMV31	Gap	760160
	DWR70	Gap	760170
	RL11	Gap	760200
	LPA11	Gap	760220
	KW11	Gap	760230
	Reserved	Gap	760240
	RX11	Gap	760250
	DR11	Gap	760260
	DR11-B	Gap	760270
	DMP11	Gap	760300
	DPV11	Gap	760310
	ISB11	Gap	760320
	DMV11	Gap	760340
	DEUNA	Gap	760350
--->	**UDA50**		**772150***
--->	**UDA50**		**760354**
	UDA50	Gap	760360
	DMF32	Gap	760400
	KMS11	Gap	760420
	VS100	Gap	760440
	Reserved	Gap	760450
	KMV11	Gap	760460
--->	**DHV11**		**760500**
--->	**DHV11**		**760520**

*This is the fixed address assigned by DEC to the first UDA50 in any system.

Table A-4. Interrupt Vector Address Example

Device	Vector
1 DU11	300
1 DMC11	310
2 UDA50s	154*
	320
2 DHV11s	330
	340

*This is the fixed address assigned by DEC to the first UDA50 in any system.

BLANK

Appendix B
SUBSYSTEM CONFIGURATION SELECTION

B.1 OVERVIEW

The configuration of the subsystem (i.e., what model of disk drives you are using and how many of each) must be defined either by the NOVRAM or by setting the subsystem configuration switches on the UC04 PCBA. The NOVRAM was discussed in Section 4. However, if you wish to select the subsystem configuration with switches instead, this appendix explains how to do it.

B.2 SELECTING THE SUBSYSTEM CONFIGURATION

The characteristics of the disk or tape drives attached to the UC04 are specified using switch SW3-1 and switches SW3-6 through SW3-10. Switch SW3-3 is used to select the controller type. Use the following procedure to determine the proper configuration for your subsystem.

1. Find the type of disk drive you wish to use in Table B-1. The UC04 supports eight physical or logical drives. Note the configuration numbers associated with the selected drive type.

   NOTE

   If you choose a configuration that includes optical disks, see Appendix E for additional installation and configuration information.

   Table B-2 lists the SCSI controller device types. Both the Adaptec ACB-4000 and the Emulex Medalist disk controllers can support two drives per controller, but each drive must be the same device type.

2. If you want to include a tape drive in your subsystem, consult Table B-3 for the types of tape drives that are supported by the UC04. Note the configuration numbers associated with the selected tape drive. The UC04 supports only the Emulex Titleist family of SCSI tape drive controllers.

3. If you have selected both disk and tape devices, compare the configuration numbers that you have noted for each device type, selecting only those that appear on both lists.

4. If you want to map two logical drives onto one physical drive in any single disk drive subsystem, you must select one of the following configurations: 9, 9A, 10, 10A, 11, 11A, 13, 13A, 14, 14A, 15, 15A, 35, 35A, 36, or 36A.

Table B-1. Disk Drive Type

Manufacturer	Model	Drive Key	Formatted Capacity in M bytes	Configuration
Atasi	3046	100	36.7	01, 01A, 05, 05A, 09, 09A, 13, 13A, 17, 17A, 21, 21A, 25, 25A, 29, 29A
Fujitsu	M2243AS	101	67.5	03, 03A, 07,07A, 11, 11A, 15, 15A, 19, 19A, 23, 23A, 27, 27A, 31, 31A
Maxtor	XT1140	102	110	02, 02A, 06,06A, 10, 10A, 14, 14A, 18, 18A, 22, 22A, 24, 24A, 26, 26A, 30, 30A
IOMEGA	Alpha-10.5	103	10.5	01, 01A, 02, 02A, 03, 03A, 16, 24, 24A, 33, 33A, 39
Rodime	208	105	41.8	20, 20A, 28, 28A, 33, 33A, 34, 34A, 35, 35A, 36, 36A, 37, 37A, 38, 38A
CDC	9415-5-36 (Wren I)	106	28.2	45, 45A, 46, 46A 47, 47A, 48, 48A
CDC	9415-5-86 (Wren II w/ 917 cylinders)	107	67	45, 45A, 46, 46A
CDC	9415-5-86 (Wren II w/ 925 cylinders)	108	67	47, 47A, 48, 48A
Thompson Optimem	Gigadisk 1000	Optical	1000	40, 41, 42, 43

Table B-2. SCSI Controller Type

Manufacturer	Model	Units Supported
Emulex	Medalist MD01	100, 101, 102, 105 106, 107, 108
Adaptec	4000, 5000	100, 101, 102, 105 106, 107, 108
IOMEGA	Alpha-10.5	103
Emulex	Titleist MT01, MT02	104

Table B-3. Tape Drive Type

Manufacturer	Model	Drive Key	Formatted Capacity	Configuration
Cipher	540	104	Varies	05, 05A, 06, 06A, 07, 07A, 09, 09A, 10, 10A, 11, 11A, 13, 13A, 14, 14A, 15, 15A, 17, 17A, 18, 18A, 19, 19A, 20, 20A, 21, 21A, 22, 22A, 23, 23A, 25, 25A, 26, 26A, 27, 27A, 28, 28A, 29, 29A, 30, 30A, 31, 31A, 34, 34A, 35, 35A, 36, 36A, 37, 37A, 38, 38A

5. Look up the configurations that you have listed in step 4 in Table B-4. Table B-4 fully describes the subsystem that the UC04 supports when that configuration is selected. Select the configuration that best suits your application. Table B-4 has eight columns:

Column 1 (Config Number) is used to make cross referencing between the configuration and device type tables easier.

Column 2 (Drive Key) indicates the type of drive supported by this configuration. The drive key followed by /M indicates that the drive uses a Medalist disk controller; the drive key followed by /A indicates that the drive uses an Adaptec disk controller.

Columns 3 (SCSI Address), 4 (Drive LUN), and 5 (MSCP Unit), relate to the number of drives supported by the UC04. The SCSI address in column 3 must be programmed into the disk or tape controller. Each address corresponds to one controller, and each controller can support either one or two physical drives (LUNs--Logical Unit Numbers). In optical disk configurations, each controller can support up to eight drives. In addition, the first LUN in a configuration may be partitioned into two logical drives (MSCP Units). Two examples will make this clear:

EXAMPLE 1: Refer to configuration 21. This configuration supports two disk controllers at SCSI addresses 0 and 5. Both controllers support drive type 100 (Atasi 3046); the /M indicates that both controllers must be Emulex Medalists. The controller at SCSI Address 0 supports two physical drives (LUN 0 and 1), and the controller at SCSI Address 5 supports one physical drive (LUN 0). The MSCP unit numbering counts all storage devices, regardless of which SCSI Address they are at, so the two drives on the first controller are MSCP units 0 and 1 and the drive on the second controller is MSCP unit 2. The tape drive at SCSI Address 4 is type 104 (Cipher 540), which requires an Emulex Titleist controller. It is designated MSCP unit number 3. (The MSCP designation is for numbering purposes only; tape drives are actually reported as off-line devices to the operating system.)

EXAMPLE 2: Refer to configuration 9. This configuration supports only one controller, at SCSI Address 0. It is drive type 100 (Atasi 3046); /M indicates that the controller must be an Emulex Medalist. There is only one physical drive, LUN 0, but it is split into two logically separate drives. These logical drives have MSCP unit numbers 0 and 1. The tape drive at SCSI Address 4 is type 104 (Cipher 540), which requires an Emulex Titleist controller. It is designated MSCP unit number 2. (The MSCP designation is for numbering purposes only; tape drives are actually reported as off-line devices to the operating system.)

There are no configurations with just one Winchester disk drive. All configurations with a single Winchester are paired with either tape drives or IOMEGA cartridge drives. If you plan to use only a Winchester drive, select the configuration that contains the tape drive; the UC04 will report the tape drive as an offline device to the operating system.

Column 6 (MSCP Unit Capacity) is the capacity of the logical MSCP unit when used with the disk controller. A physical drive with a capacity of 70,000 logical blocks could be split into two logical drives (as in example 2), each with an MSCP Unit Capacity of 35,000 logical blocks.

Column 8 (Rev Level) is the revision level of the firmware that is required to support the indicated configuration. To use a configuration, your firmware must be equal to or higher than the level shown in column 8.

6. When you have decided on a configuration, set UC04 switch SW3-1 and switches SW3-6 through SW3-10, as indicated for that configuration in Table B-4.

Table B-4. Drive Configuration

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	------ SW3 ------							Rev
						3	6	7	8	9	10	1	
01	100/M 103	0 1	0 0	0 1	71408 20301	1	0	0	0	0	1	0	A
01A	100/A 103	0 1	0 0	0 1	71747 20301	0	0	0	0	0	1	0	A
02	102/M 103	0 1	0 0	0 1	218432 20301	1	0	0	0	1	0	0	A
02A	102/A 103	0 1	0 0	0 1	219283 20301	0	0	0	0	1	0	0	A
03	101/M 103	0 1	0 0	0 1	131376 20301	1	0	0	0	1	1	0	A
03A	101/A 103	0 1	0 0	0 1	131939 20301	0	0	0	0	1	1	0	A
05	100/M 100 104	0 4	0 1 0	0 1 2	71408 71408 Varies	1	0	0	1	0	1	0	A
05A	100/A 100 104	0 4	0 1 0	0 1 2	71747 71747 Varies	0	0	0	1	0	1	0	A
06	102/M 102 104	0 4	0 1 0	0 1 2	218432 218432 Varies	1	0	0	1	1	0	0	A
06A	102/A 102 104	0 4	0 1 0	0 1 2	219283 218432 Varies	0	0	0	1	1	0	0	A

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0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
07	101/M 101 104	0 4	0 1 0	0 1 2	131376 131376 Varies	1	0	0	1	1	1	0	A
07A	101/A 101 104	0 4	0 1 0	0 1 2	131939 131939 Varies	0	0	0	1	1	1	0	A
09*	100/M 104	0 4	0 0	0 1 2	35576 35576 Varies	1	0	1	0	0	1	0	A
09A*	100/A 104	0 4	0 0	0 1 2	35746 35746 Varies	0	0	1	0	0	1	0	A
10*	102/M 104	0 4	0 0	0 1 2	108960 108960 Varies	1	0	1	0	1	0	0	A
10A*	102/A 104	0 4	0 0	0 1 2	109378 109378 Varies	0	0	1	0	1	0	0	A
11*	101/M 104	0 4	0 0	0 1 2	65504 65504 Varies	1	0	1	0	1	1	0	A
11A*	101/A 104	0 4	0 0	0 1 2	65774 65774 Varies	0	0	1	0	1	1	0	A
13*	100/M 104	0 4	0 0	0 1 2	62282 8886 Varies	1	0	1	1	0	1	0	A

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0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3							Rev
						3	6	7	8	9	10	1	
13A*	100/A 104	0 4	0 0	0 1 2	62569 8923 Varies	0	0	1	1	0	1	0	A
14*	102/M 104	0 4	0 0	0 1 2	190700 27220 Varies	1	0	1	1	1	0	0	A
14A*	102/A 104	0 4	0 0	0 1 2	191425 27331 Varies	0	0	1	1	1	0	0	A
15*	101/M 104	0 4	0 0	0 1 2	114644 16364 Varies	1	0	1	1	1	1	0	A
15A*	101/A 104	0 4	0 0	0 1 2	115118 16430 Varies	0	0	1	1	1	1	0	A
16	103 104	1 4	0 0	0 1	20301 Varies	0	1	0	0	0	0	0	A
17	100/M 104	0 4	0 0	0 1	71408 Varies	1	1	0	0	0	1	0	A
17A	100/A 104	0 4	0 0	0 1	71747 Varies	0	1	0	0	0	1	0	A
18	102/M 104	0 4	0 0	0 1	218432 Varies	1	1	0	0	1	0	0	A
18A	102/A 104	0 4	0 0	0 1	219283 Varies	0	1	0	0	1	0	0	A

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0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
19	101/M 104	0 4	0 0	0 1	131376 Varies	1	1	0	0	1	1	0	A
19A	101/A 104	0 4	0 0	0 1	131939 Varies	0	1	0	0	1	1	0	A
20	105/M 105 105/M 104	0 5 4	0 1 0 0	0 1 2 3	80976 80976 80976 Varies	1	1	0	1	0	0	0	A
20A	105/A 105 105/A 104	0 5 4	0 1 0 0	0 1 2 3	81665 81665 81665 Varies	0	1	0	1	0	0	0	A
21	100/M 100 100/M 104	0 5 4	0 1 0 0	0 1 2 3	71408 71408 71408 Varies	1	1	0	1	0	1	0	A
21A	100/A 100 100/A 104	0 5 4	0 1 0 0	0 1 2 3	71747 71747 71747 Varies	0	1	0	1	0	1	0	A
22	102/M 102 102/M 104	0 5 4	0 1 0 0	0 1 2 3	218432 218432 218432 Varies	1	1	0	1	1	0	0	A
22A	102/A 102 102/A 104	0 5 4	0 1 0 0	0 1 2 3	219283 219283 219283 Varies	0	1	0	1	1	0	0	A

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
23	101/M	0	0	0	131376	1	1	0	1	1	1	0	A
	101		1	1	131376								
	101/M	5	0	2	131376								
	104	4	0	3	Varies								
23A	101/A	0	0	0	131939	0	1	0	1	1	1	0	A
	101		1	1	131939								
	101/A	5	0	2	131939								
	104	4	0	3	Varies								
24	102/M	0	0	0	218432	1	1	1	0	0	0	0	A
	102/M	5	0	1	218432								
	103	1	0	2	20301								
24A	102/A	0	0	0	219283	0	1	1	0	0	0	0	A
	102/A	5	0	1	219283								
	103	1	0	2	20301								
25	100/M	0	0	0	71408	1	1	1	0	0	1	0	A
	100/M	5	0	1	71408								
	104	4	0	2	Varies								
25A	100/A	0	0	0	71747	0	1	1	0	0	1	0	A
	100/A	5	0	1	71747								
	104	4	0	2	Varies								
26	102/M	0	0	0	218432	1	1	1	0	1	0	0	A
	102/M	5	0	1	218432								
	104	4	0	2	Varies								
26A	102/A	0	0	0	219283	0	1	1	0	1	0	0	A
	102/A	5	0	1	219283								
	104	4	0	2	Varies								

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3							Rev
						3	6	7	8	9	10	1	
27	101/M	0	0	0	131376	0	1	1	0	1	1	0	A
	101/M	5	0	1	131376								
	104	4	0	2	Varies								
27A	101/A	0	0	0	131939	0	1	1	0	1	1	0	A
	101/A	5	0	1	131939								
	104	4	0	2	Varies								
28	105/M	0	0	0	80976	1	1	1	1	0	0	0	A
	105/M	5	0	1	80976								
	105/M	2	0	2	80976								
	104	4	0	3	Varies								
28A	105/A	0	0	0	81665	0	1	1	1	0	0	0	A
	105/A	5	0	1	81665								
	105/A	2	0	2	81665								
	104	4	0	3	Varies								
29	100/M	0	0	0	71408	1	1	1	1	0	1	0	A
	100/M	5	0	1	71408								
	100/M	2	0	2	71408								
	104	4	0	3	Varies								
29A	100/A	0	0	0	71747	0	1	1	1	0	1	0	A
	100/A	5	0	1	71747								
	100/A	2	0	2	71747								
	104	4	0	3	Varies								
30	102/M	0	0	0	218432	1	1	1	1	1	0	0	A
	102/M	5	0	1	218432								
	102/M	2	0	2	218432								
	104	4	0	3	Varies								

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
30A	102/A 102/A 102/A 104	0 5 2 4	0 0 0 0	0 1 2 3	219283 219283 219283 Varies	0	1	1	1	1	0	0	A
31	101/M 101/M 101/M 104	0 5 2 4	0 0 0 0	0 1 2 3	131376 131376 131376 Varies	1	1	1	1	1	1	0	A
31A	101/A 101/A 101/A 104	0 5 2 4	0 0 0 0	0 1 2 3	131939 131939 131939 Varies	0	1	1	1	1	1	0	A
33	105/M 103	0 1	0 0	0 1	80976 20301	1	0	0	0	0	1	1	A
33A	105/A 103	0 1	0 0	0 1	81665 20301	0	0	0	0	0	1	1	A
34	105/M 105/M 104	0 0 4	0 1	0 1 2	80976 80976 Varies	1	0	0	0	1	0	1	A
34A	105/A 105/A 104	0 0 4	0 1	0 1 2	81665 81665 Varies	0	0	0	0	1	0	1	A
35*	105/M 104	0 4	0 1	0 1 2	40352 40352 Varies	1	0	0	0	1	1	1	A
35A*	105/A 104	0 4	0 1	0 1 2	40688 40688 Varies	0	0	0	0	1	1	1	A

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
36*	105/M 104	0 4	0 1	0 1 2	70624 10064 Varies	1	0	0	1	0	0	1	A
36A*	105/A 104	0 4	0 1	0 1 2	71217 10159 Varies	0	0	0	1	0	0	1	A
37	105/M 104	0		0 1	80976 Varies	1	0	0	1	0	1	1	A
37A	105/A 104	0		0 1	81665 Varies	0	0	0	1	0	1	1	A
38	105/M 105/M 104	0 5 4	0 0	0 1 2	80976 80976 Varies	1	0	0	1	1	0	1	A
38A	105/A 105/A 104	0 5 4	0 0	0 1 2	81665 81665 Varies	0	0	0	1	1	0	1	A
39	103 103	0 1	0 0	0 1	20301 20301	0	0	0	1	1	1	1	A
40	Optical Optical	0 1	0 1 2 3 0 1 2 3	0 1 2 3 4 5 6 7	1999850 1999850 1999850 1999850 1999850 1999850 1999850 1999850	0	0	1	0	0	0	1	A

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	-------- SW3 -------							Rev
						3	6	7	8	9	10	1	
41	Optical	0	0	0	1999850	0	0	1	0	0	1	1	A
			1	1	1999850								
			2	2	1999850								
			3	3	1999850								
			4	4	1999850								
			5	5	1999850								
			6	6	1999850								
			7	7	1999850								
42	103	1	0	0	20301	0	0	1	0	1	0	1	A
	Optical	0	0	1	1999850								
			1	2	1999850								
			2	3	1999850								
			3	4	1999850								
			4	5	1999850								
			5	6	1999850								
			6	7	1999850								
43	102	0	0	0	219283	0	0	1	0	1	1	1	A
	Optical	1	0	1	1999850								
			1	2	1999850								
			2	3	1999850								
			3	4	1999850								
			4	5	1999850								
			5	6	1999850								
			6	7	1999850								
44	102/M	0	0	0	218432	1	0	1	1	0	0	1	A
	102		1	1	218432								
	103	1	0	2	20301								
44A	102/A	0	0	0	219283	0	0	1	1	0	0	1	A
	102		1	1	219283								
	103	1	0	2	20301								
45	107/M	0	0	0	130912	1	0	1	1	0	1	1	A
	107		1	1	130912								
	106/M	5	0	2	55152								
	104	4	0	3	Varies								

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

Table B-4. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW3 3	6	7	8	9	10	1	Rev
45A	107/A	0	0	0	131725	0	0	1	1	0	1	1	A
	107		1	1	131725								
	106/A	5	0	2	55573								
	104	4	0	3	Varies								
46	107/M	0	0	0	130912	1	0	1	1	1	0	1	A
	107		1	1	130912								
	106/M	5	0	2	55152								
	103	1	0	3	20301								
46A	107/A	0	0	0	131725	0	0	1	1	1	0	1	A
	107		1	1	131725								
	106/A	5	0	2	81665								
	103	1	0	3	20301								
47	108/M	0	0	0	132064	1	0	1	1	1	1	1	A
	108		1	1	132064								
	106/M	5	0	2	55152								
	104	4	0	3	Varies								
47A	108/A	0	0	0	132877	0	0	1	1	1	1	1	A
	108		1	1	132877								
	106/A	5	0	2	55573								
	104	4	0	3	Varies								
48	108/M	0	0	0	132064	1	1	0	0	0	0	1	A
	108		1	1	132064								
	106/M	5	0	2	55152								
	103	1	0	3	20301								
48A	108/A	0	0	0	132877	0	1	0	0	0	0	1	A
	108		1	1	132877								
	106/A	5	0	2	81665								
	103	1	0	3	20301								

0 = OFF, open
1 = ON, closed
Config = Configuration
Addr = Address
LUN = Logical Unit Number
* = This configuration may be used to map two logical drives onto one physical drive in any single disk drive subsystem. See step 4 of the procedure for further information.

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C.1 OVERVIEW

It may be necessary for maintenance reasons to change the emulation PROM on the UC04 PCBA. This appendix provides instructions for removing and replacing the UC04 emulation PROMs.

C.2 EXCHANGING EMULATION PROMS

The existing emulation PROM is located in the socket labeled U41. Pry the existing PROM from the socket, using an IC puller or an equivalent tool. The new PROM, labeled A26, should be inserted in its place. Make certain that the PROM is firmly seated and that no pins are bent or misaligned. (If the two rows of PROM pins are too far apart to fit in the socket, grasp the PROM at its ends using your thumb and forefinger, and bend one of the pin rows inward by pressing it against a table top or other flat surface.)

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Appendix D
UTILITIES AND DIAGNOSITCS

D.1 OVERVIEW

This appendix contains a list of the diagnostic and utility software that is available for use with the UC04. The list includes a description of the function of the software and a description of the media on which the software is distributed. This information is contained in Table D-1.

All of the diagnostic and utility media listed contain all of the software provided for the UC04 by Emulex.

Table D-1. Utility and Diagnostic Software

Part Number	Media Type	Boot Type	Description
PX9951801-01	.5" tape/800bpi	MT	All LSI-11 disk, communications, and subsystem software
PX9951801-02	.5" tape/1600bpi	MT	All LSI-11 disk, communications, and subsystem software
PX9951801-03	.5" tape/1600bpi	MS	All LSI-11 tape, disk, communications, and subsystem software
PX9951801-04	.25" cartridge tape	MS	All LSI-11 tape, disk, communications, and subsystem software
PX9951802-01	Iomega Disk Cartridge	DL	Emulex LSI-11 Subsystem software (subset of above)
PX9951802-02	.25" cartridge tape	MS	Emulex LSI-11 Subsystem software (subset of above)
PX9951802-03	Iomega Disk Cartridge	DU	Emulex LSI-11 Subsystem software (subset of above)

continued on next page

Table D-1. Utility and Diagnostic Software

Part Number	Media Type	Boot Type	Description
VX9951804	5.25-inch floppy		Diagnostic software for MicroVAX
PD9951802-01	.5" tape/1600 bpi	MS	Backup and Restore Program for LSI-11
PD9951802-02	.25" tape/TKQ25 format	MS	Backup and Restore Program for LSI-11
PD9951801	.25" tape cartridge	Titleist	Disk utilities for Javelin and Decathlon packaged subsystem

Appendix E
INSTALLING AND CONFIGURING OPTICAL DISKS

E.1 OVERVIEW

The UC04 firmware includes four subsystem configurations that support optical disks. Two optical disks are supported: the Alcatel Thompson Gigadisk and the Optimem Model 1000.

The basic configuration procedure for optical disks is essentially the same as for magnetic disks. Instructions for setting switches on the UC04 are covered in detail in Appendix B and you should follow these instructions, choosing configuration 40, 41, 42, or 43. (Alternatively, you can specify the configuration via NOVRAM using either the formatter utility or the manual method described in section 6.5.) Emulex suggests that you use either configuration 40 or 41 as a starting point, since all the drives in these configurations are optical. Configuration 42 and 43 are mixes of optical and magnetic disks.

NOTE

> Because the Optimem and Thompson optical disks contain their own controllers, the controller select switch on the UC04 (SW3-3) must be OFF when using any of these configurations.
>
> Also, make sure the jumpers on the disk controller board match the SCSI address listed in the configuration table.

Up to this point, the installation of the optical disk is the same as the installation of a magnetic disk. However, there are several programming and formatting considerations that you must be aware of with optical disks. The following two sections discuss these considerations. Read them before you attempt to format an optical disk.

E.2 OPTICAL DISK FORMATTING

Before you attempt to use an optical disk, read all the appropriate manuals carefully (including this section). A mistake in formatting an optical disk will ruin an expensive disk pack. If possible, check out the UC04 subsystem for proper operation with a magnetic disk before proceeding with the optical disk format.

The optical disk must be formatted using the firmware format built into the UC04. The firmware format writes a valid Replacement Caching Table with a valid serial number onto the disk pack.

CAUTION

> Once the disk has been formatted, any attempt to reformat it will render the disk useless. Make sure you mark disk packs as formatted for future reference.

Before you start the format procedure, make sure the UC04 configuration switches are set for configuration 40, 41, 42, or 43. These are the only configurations that include optical disks. You must also make sure you have assigned the optical disk the correct unit number. If you make a mistake and assign the optical disk an address that corresponds to a magnetic disk, the firmware format will format the entire disk, which ruins the disk pack. The firmware format procedure is described in section 6.4.3.

With the introduction of revision C firmware on the UC03, Emulex started reserving the last 20 cylinders of the disk pack for future diagnostic use. If you have written an RCT to a disk pack with a UC03 prior to firmware revision C, you will have to reformat it to put the RCT at the new last cylinder. If you have packs that are unusable because of improperly written RCTs, you can reformat them and use them again since the old RCT now falls in the diagnostic section of the pack.

E.3 OPTICAL DISK PROGRAMMING CONSIDERATIONS

Both the Thompson Gigadisk and the Optimem 1000 have a hard sector size of 1024 bytes. DEC operating systems are designed to work only with disks that have a sector size of 512 bytes. Because of this, the UC04 maps two logical sectors onto one physical sector. Despite this, no write splices can be performed because the disk drive cannot write half a physical sector and then later write the other half. Therefore, all writes must start on even 512 byte sectors numbers and must be exact multiples of 1024 bytes. This restriction does not apply to reads. Reads may start on any sector and may be of any length; the UC04 performs the read splice transparently.

Appendix F
CONFIGURATION PARAMETERS FOR DISK DRIVES

F.1 OVERVIEW

This appendix contains sample configuration parameters and sector settings for the ST-506 and ESDI Winchester type drives that have been certified by Emulex for UC04 support. Parameters and checksums are listed in tables. For each ST-506 drive, two tables are included, one for use with Emulex Medalist controllers and one for use with Adaptec controllers, as follows:

Disk Drive	Medalist Table	Adaptec Table
Atasi 3046	F-1	F-2
Fujitsu M2243AS	F-3	F-4
Maxtor XT1140	F-5	F-6
Rodime 208	F-7	F-8
CDC Wren I	F-9	F-10
CDC Wren II (917 cylinders)	F-11	F-12
CDC Wren II (925 cylinders)	F-13	F-14

For each ESDI drive there is one table, for use with Emulex Champion controllers, as follows:

Disk Drive	Table
Micropolis 1350	F-15
Hitachi DK512-17	F-16
Fujitsu 2246E	F-17
Maxtor Ext-4175	F-18

The drive configuration parameters listed in this appendix relate to the physical geometry of the disk drives; options such as logical splits are left to the user. The NOVRAM checksums, which indicate a correctly defined configuration, are listed in octal for PDP/LSI systems and hexadecimal for MicroVAX systems. The user capacity for each drive is stated in logical blocks before each parameter table.

F.2 CONFIGURATION TABLES

The drive configuration parameters listed in this appendix are based on the following parameters:

- One spare sector per track for Medalist controllers, zero spare sectors per track for Adaptec controllers, and one spare sector per track for Champion contrllers.
- A SCSI address and LUN of 0,0.

The drive configuration tables list the parameters to be entered under a console emulator in octal for PDP/LSI systems and hexadecimal for MicroVAX I and II systems. A decimal reference is included for Emulex software, but refer to the software manual for parameter word definitions, since the values requested by the software are sometimes slightly different than the values entered under a console emulator.

NOTE

> If you are entering the parameters under a console emulator (rather than via the formatter software), make sure the memory location following the last parameter block is 0 and the next several words indicate the SCSI address and LUN of each drive (see section 6.5.2 for details).

If configured as shown in Table F-1 (Medalist), the Atasi 3046 has a user capacity of 71408 logical blocks. If configured as shown in Table F-2 (Adaptec), it has a user capacity of 76262 logical blocks.

Table F-1. Atasi 3046 NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	7	7	7	Heads
6	641	1201	281	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	320	500	140	Reduced Write Current
14	320	500	140	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		315	CD	NOVRAM Checksum

Table F-2. Atasi 3046 NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	7	7	7	Heads
6	643	1203	283	Cylinders
7	0	0	0	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	320	500	140	Reduced Write Current
14	320	500	140	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		134	5C	NOVRAM Checksum

If configured as shown in Table F-3 (Medalist), the Fujitsu M2243AS has a user capacity of 131376 logical blocks. If configured as shown in Table F-4 (Adaptec), it has a capacity of 140420 logical blocks.

Table F-3. Fujitsu M2243AS NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	11	13	0B	Heads
6	750	1356	2EE	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	754	1362	2F2	Reduced Write Current
14	754	1362	2F2	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		067	37	NOVRAM Checksum

Table F-4. Fujitsu M2243AS NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	11	13	0B	Heads
6	753	1361	2F1	Cylinders
7	0	0	0	Spare Sectors per Track
8	1	1	1	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	754	1362	2F2	Reduced Write Current
14	754	1362	2F2	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		140	60	NOVRAM Checksum

If configured as shown in Table F-5 (Medalist), the Maxtor XT1140 has a user capacity of 218432 logical blocks. If configured as shown in Table F-6 (Adaptec), it has a user capacity of 233308 logical blocks.

Table F-5. Maxtor XT1140 NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	15	17	0F	Heads
6	914	1622	392	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	918	1626	396	Reduced Write Current
14	919	1627	397	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		155	6D	NOVRAM Checksum

Table F-6. Maxtor XT1140 NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	15	17	0F	Heads
6	917	1625	395	Cylinders
7	0	0	0	Spare Sectors per Track
8	1	1	1	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	918	1626	396	Reduced Write Current
14	919	1627	397	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		240	A0	NOVRAM Checksum

If configured as shown in Table F-7 (Medalist), the Rodime 208 has a user capacity of 80976 logical blocks. If configured as shown in Table F-8 (Adaptec), it has a user capacity of 86615 logical blocks.

Table F-7. Rodime 208 NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	8	10	8	Heads
6	636	1174	27C	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	640	1200	280	Reduced Write Current
14	640	1200	280	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		134	5C	NOVRAM Checksum

Table F-8. Rodime 208 NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	8	10	8	Heads
6	639	1177	27F	Cylinders
7	0	0	0	Spare Sectors per Track
8	1	1	1	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	640	1200	280	Reduced Write Current
14	640	1200	280	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		041	21	NOVRAM Checksum

If configured as shown in Table F-9 (Medalist), the CDC Wren I has a user capacity of 55152 logical blocks. If configured as shown in Table F-10 (Adaptec), it has a capcity of 58888 logical blocks.

Table F-9. CDC Wren I NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	5	5	5	Heads
6	693	1265	265	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	697	1271	269	Reduced Write Current
14	0	0	0	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		343	E3	NOVRAM Checksum

Table F-10. CDC Wren I NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	5	5	5	Heads
6	695	1267	267	Cylinders
7	0	0	0	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	697	1271	269	Reduced Write Current
14	0	0	0	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		162	72	NOVRAM Checksum

If configured as shown in Table F-11 (Medalist), the CDC Wren II (917 cylinders) has a user capacity of 130912 logical blocks. If configured as shown in Table F-12 (Adaptec), it has a capacity of 139825 logical blocks.

Table F-11. CDC Wren II (917 cylinders) NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	9	11	9	Heads
6	913	1621	391	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	917	1625	395	Reduced Write Current
14	0	0	0	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		072	3A	NOVRAM Checksum

Table F-12. CDC Wren II (917 cylinders) NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	9	9	9	Heads
6	916	1624	394	Cylinders
7	0	0	0	Spare Sectors per Track
8	1	1	1	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	917	1625	395	Reduced Write Current
14	0	0	0	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		257	AF	NOVRAM Checksum

If configured as shown in Table F-13 (Medalist), the CDC Wren II (925 cylinders) has a user capacity of 132064 logical blocks. If configured as shown in Table F-14 (Adaptec), it has a capacity of 141049 logical blocks.

Table F-13. CDC Wren II (925 cylinders) NOVRAM Parameters (Medalist)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	1	1	1	Type Code
3	0	0	0	Sector Size
4	16	20	10	Sectors per Track
5	9	11	9	Heads
6	921	1631	399	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	925	1635	39D	Reduced Write Current
14	0	0	0	Write Precompensation
15	1	1	1	Step Code
16	0	0	0	Reserved
--		327	D7	NOVRAM Checksum

Table F-14. CDC Wren II (925 cylinders) NOVRAM Parameters (Adaptec)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	2	2	2	Type Code
3	0	0	0	Sector Size
4	17	21	11	Sectors per Track
5	9	11	9	Heads
6	924	1634	39C	Cylinders
7	0	0	0	Spare Sectors per Track
8	1	1	1	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	925	1635	39D	Reduced Write Current
14	0	0	0	Write Precompensation
15	2	2	2	Step Code
16	0	0	0	Reserved
--		102	42	NOVRAM Checksum

If configured as shown in Table F-15, the Micropolis 1350 has a user size of 276352 logical blocks.

Table F-15. Micropolis 1350 NOVRAM Parameters (Champion)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	6	6	6	Type Code
3	0	0	0	Sector Size
4	34	42	22	Sectors per Track
5	8	10	8	Heads
6	1019	1773	3F6	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	1	1	1	Hard/Soft Sector
13	14208	33600	3780	User Size
14	4	4	4	User Size
15	0	0	0	Sector 0 Offset
16	0	0	0	Reserved
--		307	C7	NOVRAM Checksum

If configured as shown in Table F-16, the Hitachi DK512-17 has a user size of 285250 logical blocks.

Table F-16. Hitachi DK512-17 NOVRAM Parameters (Champion)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	6	6	6	Type Code
3	0	0	0	Sector Size
4	35	43	23	Sectors per Track
5	10	12	A	Heads
6	818	1462	332	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	1	1	1	Hard/Soft Sector
13	23106	55102	5A42	User Size
14	4	4	4	User Size
15	0	0	0	Sector 0 Offset
16	0	0	0	Reserved
--		332	DA	NOVRAM Checksum

If configured as shown in Table F-17, the Fujitsu 2246E has a user size of 277100 logical blocks.

Table F-17. Fujitsu 2246E NOVRAM Parameters (Champion)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	6	6	6	Type Code
3	0	0	0	Sector Size
4	34	42	22	Sectors per Track
5	10	12	A	Heads
6	818	1462	332	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	14956	35154	3A6C	User Size
14	4	4	4	User Size
15	0	0	0	Sector 0 Offset
16	0	0	0	Reserved
--		262	B2	NOVRAM Checksum

If configured as shown in Table F-18, the Maxtor Ext-4175 has a user size of 280896 logical blocks.

Table F-18. Maxtor Ext-4175 NOVRAM Parameters (Champion)

Word	Dec	Oct	Hex	Description
1	1	1	1	Number of Units
2	6	6	6	Type Code
3	0	0	0	Sector Size
4	33	41	21	Sectors per Track
5	7	7	7	Heads
6	1219	2303	4C3	Cylinders
7	1	1	1	Spare Sectors per Track
8	2	2	2	Spare Cylinders
9	0	0	0	Reserved
10	0	0	0	Split Code
11	0	0	0	Removable Media Flag
12	0	0	0	Hard/Soft Sector
13	18752	44500	4940	User Size
14	4	4	4	User Size
15	0	0	0	Sector 0 Offset
16	0	0	0	Reserved
--		004	04	NOVRAM Checksum

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