PRELIMINARY

UC03/M1 INTELLIGENT HOST ADAPTER TECHNICAL MANUAL (MSCP COMPATIBLE)

EMULEX
3545 Harbor Boulevard
Costa Mesa, California 92626
(714) 662-5600 TWX 910-595-2521

UC0351001 Rev 02
December, 1984

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 Commision (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.

TABLE OF CONTENTS

Section	Title	Page
ONE	**GENERAL DESCRIPTION**	
1.1	INTRODUCTION	1-1
1.2	SUBSYSTEM OVERVIEW	1-2
1.2.1	MASS STORAGE CONTROL PROTOCOL (MSCP)	1-2
1.2.2	SMALL COMPUTER SYSTEM INTERFACE (SCSI)	1-2
1.3	PHYSICAL ORGANIZATION OVERVIEW	1-4
1.4	SUBSYSTEM MODELS and OPTIONS	1-5
1.4.1	SUBSYSTEM OPTIONS	1-5
1.5	FEATURES	1-7
1.5.1	MICROPROCESSOR DESIGN	1-7
1.5.2	CONFIGURATION FLEXIBILITY	1-7
1.5.3	SELF-TEST	1-7
1.5.4	SEEK OPTIMIZATION	1-8
1.5.5	DISCONNECT/RECONNECT	1-8
1.5.6	COMMAND BUFFER	1-8
1.5.7	ADAPTIVE DMA	1-8
1.5.8	ERROR CONTROL	1-8
1.5.9	BLOCK-MODE DMA	1-8
1.5.10	TWENTY-TWO BIT ADDRESSING	1-9
1.6	COMPATIBILITY	1-9
1.6.1	DIAGNOSTICS	1-9
1.6.2	OPERATING SYSTEMS	1-9
1.6.3	HARDWARE COMPATIBILITY	1-9
1.7	PERFORMANCE	1-9
TWO	**SPECIFICATIONS**	
2.1	OVERVIEW	2-1
2.2	GENERAL SPECIFICATION	2-1
2.3	ENVIRONMENTAL SPECIFICATION	2-3
2.4	PHYSICAL SPECIFICATION	2-3
2.5	ELECTRICAL SPECIFICATION	2-5
THREE	**APPLICATION AND CONFIGURATION**	
3.1	OVERVIEW	3-1
3.1.1	CONFIGURATION DEFINED	3-1
3.2	MSCP SUBSYSTEM CONFIGURATION	3-2
3.2.1	ARCHITECTURE	3-2
3.2.2	PERIPHERAL NUMBERING	3-2
3.2.3	PERIPHERAL CAPACITIES	3-3
3.3	A DEC MSCP SUBSYSTEM	3-3
3.4	THE UC03 MSCP SUBSYSTEM	3-4
3.4.1	UC03 MSCP SUBSYSTEM LOGICAL CONFIGURATION	3-5
3.4.1.1	Logical Devices	3-5
3.4.1.2	Device Numbers	3-6
3.4.1.3	Device Identifiers	3-6
3.5	OPERATING SYSTEMS, DEVICE AND VECTOR ADDRESSES	3-7
3.5.1	RSTS/E OPERATING SYSTEMS (V8.0)	3-8
3.5.2	RT-11 OPERATING SYSTEMS (V5.0)	3-9
3.5.2.1	Installing a Single MSCP Server	3-9
3.5.2.2	Installing Multiple MSCP Servers	3-9
3.5.2.3	Disk Partitioning	3-10

TABLE OF CONTENTS

Section	Title	Page
3.5.3	RSX-11M OPERATING SYSTEMS (V4.1)	3-12
3.5.3.1	Installing a Single MSCP Server	3-12
3.5.3.2	Installing Multiple MSCP Servers	3-12
3.5.4	RSX-11M-PLUS OPERATING SYSTEMS (V2.1)	3-15
3.5.4.1	Installing a Single MSCP Server	3-15
3.5.4.2	Installing Multiple MSCP Servers	3-15
3.5.5	VMS OPERATING SYSTEMS	3-18
3.6	**PERFORMANCE CONSIDERATIONS**	3-20
FOUR	**INSTALLATION**	
4.1	**OVERVIEW**	4-1
4.1.1	SUBSYSTEM CONFIGURATIONS	4-1
4.1.2	DIP SWITCH TYPES	4-3
4.2	**INSPECTION**	4-4
4.2.1	UC03 HOST ADAPTER INSPECTION	4-4
4.3	**SCSI CONTROLLER PREPARATION**	4-4
4.3.1	SCSI MASS-STORAGE SUBSYSTEM PLACEMENT	4-5
4.3.2	CONTROLLER ADDRESSING	4-5
4.3.3	PERIPHERAL (DRIVE) UNIT NUMBERS	4-5
4.3.4	SCSI TERMINATION	4-5
4.4	**SYSTEM PREPARATION**	4-5
4.5	**HOST ADAPTER SETUP**	4-6
4.5.1	HOST ADAPTER BUS ADDRESS	4-8
4.5.2	INTERRUPT VECTOR ADDRESS	4-9
4.5.3	HOST ADAPTER SCSI ADDRESS	4-9
4.5.4	SUBSYSTEM CONFIGURATION SELECTION	4-9
4.5.5	OPTIONS	4-15
4.5.5.1	Autoboot	4-15
4.5.5.2	Logical Unit to Autoboot From	4-16
4.5.5.5	22-Bit Memory Addressing	4-17
4.6	**PHYSICAL INSTALLATION**	4-18
4.6.1	SLOT SELECTION	4-18
4.6.2	MOUNTING	4-18
4.7	**CABLING**	4-18
4.7.1	SAME CABINET INSTALLATIONS	4-19
4.7.2	SEPARATE CABINET INSTALLATIONS	4-20
4.8	**TESTING**	4-27
4.8.1	SELF-DIAGNOSTIC	4-27
4.8.2	FORMATTING	4-28
4.8.3	DIAGNOSTICS	4-28
FIVE	**TROUBLESHOOTING**	
5.1	**OVERVIEW**	5-1
5.1.1	SERVICE	5-1
5.2	**FAULT ISOLATION PROCEDURE**	5-2
SIX	**REGISTERS AND PROGRAMMING**	
6.1	**OVERVIEW**	6-1
6.2	**OVERVIEW OF MSCP SUBSYSTEM**	6-1
6.3	**PROGRAMMING**	6-2
6.3.1	EXPANDED COMMANDS	6-2

TABLE OF CONTENTS

Section	Title	Page
6.3.1.1	SCSI Pass-Through Command	6-3
6.3.2	UNSUPPORTED COMMANDS	6-6
6.3.2.1	Minimal Disk Subset	6-6
6.3.2.2	Diagnostic and Utility Protocol (DUP)	6-6
6.4	REGISTERS	6-6
6.4.1	BOOTSTRAPPING	6-7
SEVEN	FUNCTIONAL DESCRIPTION	
7.1	OVERVIEW	7-1
7.2	UC03 HOST ADAPTER ARCHITECTURE	7-1
EIGHT	INTERFACES	
8.1	OVERVIEW	8-1
8.2	LSI-11 BUS INTERFACE	8-1
8.2.1	INTERRUPT PRIORITY LEVEL	8-3
8.2.2	REGISTER ADDRESS	8-3
8.2.3	DCOK AND INIT SIGNALS	8-3
8.2.4	NPR OPERATIONS	8-3
8.3	UC03 SCSI BUS INTERFACE	8-3
8.3.1	SCSI INTERFACE PHYSICAL DESCRIPTION	8-3
8.3.1.1	Cable Requirements	8-3
8.3.1.2	Shielded Connector Requirements	8-5
8.3.2	SCSI INTERFACE ELECTRICAL DESCRIPTION	8-5
8.3.3	SCSI BUS SIGNALS AND TIMING	8-6
8.3.3.1	SCSI Bus Signals	8-7
8.3.3.2	SCSI Bus Timing	8-8
NINE	SCSI PROTOCOL	
9.1	OVERVIEW	9-1
9.2	SCSI BUS OVERVIEW	9-1
9.3	SCSI BUS PHASE SEQUENCING	9-4
9.4	SCSI BUS CONDITIONS	9-5
9.4.1	RESET	9-5
9.4.2	ATTENTION	9-6
9.5	SCSI COMMANDS	9-6
APPENDIX A		
A.1	OVERVIEW	A-1
A.2	DETERMINING THE CSR ADDRESS FOR USE WITH AUTOCONFIGURE	A-1
A.3	DETERMINING THE VECTOR ADDRESS FOR USE WITH AUTOCONFIGURE	A-3
A.4	A SYSTEM CONFIGURATION EXAMPLE	A-5
B.1	OVERVIEW	B-1

TABLE OF CONTENTS

Section	Title	Page
APPENDIX B		
B.2	EXCHANGING EMULATION PROMS	B-1
B.2.1	SWITCH SETTINGS	B-1
B.2.2	JUMPERS	B-1
APPENDIX C		
C.1	OVERVIEW	C-1

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, adaptors, 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 is 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.

Purchaser shall provide labor for removal of the defective product, shipping charges for return to Emulex and installation of its replacement. THE EXPRESSED WARRANTIES SET FORTH IN THIS AGREEMENT ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER WARRANTIES ARE HEREBY DISCLAIMED AND EXCLUDED BY EMULEX. THE STATED EXPRESS WARRANTIES ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF EMULEX FOR DAMAGES, INCLUDING BUT NOT LIMITED TO SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE PRODUCT.

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 UC03 Emulating Host Adapter in the most efficient and straightforward manner possible. The contents of the eight sections and six appendices are described briefly below.

Section 1 **General Description:** This section contains an overview of the UC03 Emulating Host Adapter.

Section 2 **Host Adapter Specification:** This section contains the specification for the UC03 Host Adapter.

Section 3 **Application and Configuration:** This section contains the information necessary to plan your installation.

Section 4 **Installation:** This section contains the information needed to set-up and physically install 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 **PROM Removal and Replacement:** This appendix contains PROM removal/replacement instructions to allow the user to upgrade the UC03 Host Adapter in the field. A list of firmware PROM numbers and their locations on the PCBAs is also provided here.

Appendix B **Autoconfigure, CSR and Vector Addresses:** This appendix contains a description of DEC algorithm for the assignment of CSR addresses and vector addresses.

Appendix C **Utilities and Diagnostics:** This appendix contains a list of the utilities and diagnostics that are applicable to the UC03.

1.2 SUBSYSTEM OVERVIEW

The UC03 Emulating Host Adapter connects high-capacity, mass storage peripherals to LSI-11 computers manufactured by Digital Equipment Corporation (DEC). The UC03 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 UC03 uses the versatile, ANSI standard, Small Computer System Interface (SCSI) as its peripheral interface. The SCSI interface supports both disk drives and tape transports in a large number of configurations. See Subsystem Configuration, subsection 3.x, for a detailed description of the configurations that are supported by the UC03/M1.

.2.1 MASS STORAGE CONTROL PROTOCOL (MSCP)

MSCP is a software interface designed to lower the host computer's mass-storage overhead by off-loading much of the work associated with file management into an intelligent mass-storage subsystem. In concert with SCSI compatible peripherals, the UC03 provides just such a subsystem. The MSCP functions that the UC03 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. This feature allows the host computer's operating system software to store data in logical blocks that are identified by simple logical block numbers (LBNs). Thus, the host does not need to have detailed knowledge of the peripheral's geometry (cylinders, tracks, sectors, etc.). This feature also makes autoconfiguration a simple matter. During system start-up, the host operating system queries the subsystem to find its capacity, in other words the number of logical blocks that the subsystem can store.

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 UC03 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 UC03, connect computers to the SCSI bus. Intelligent

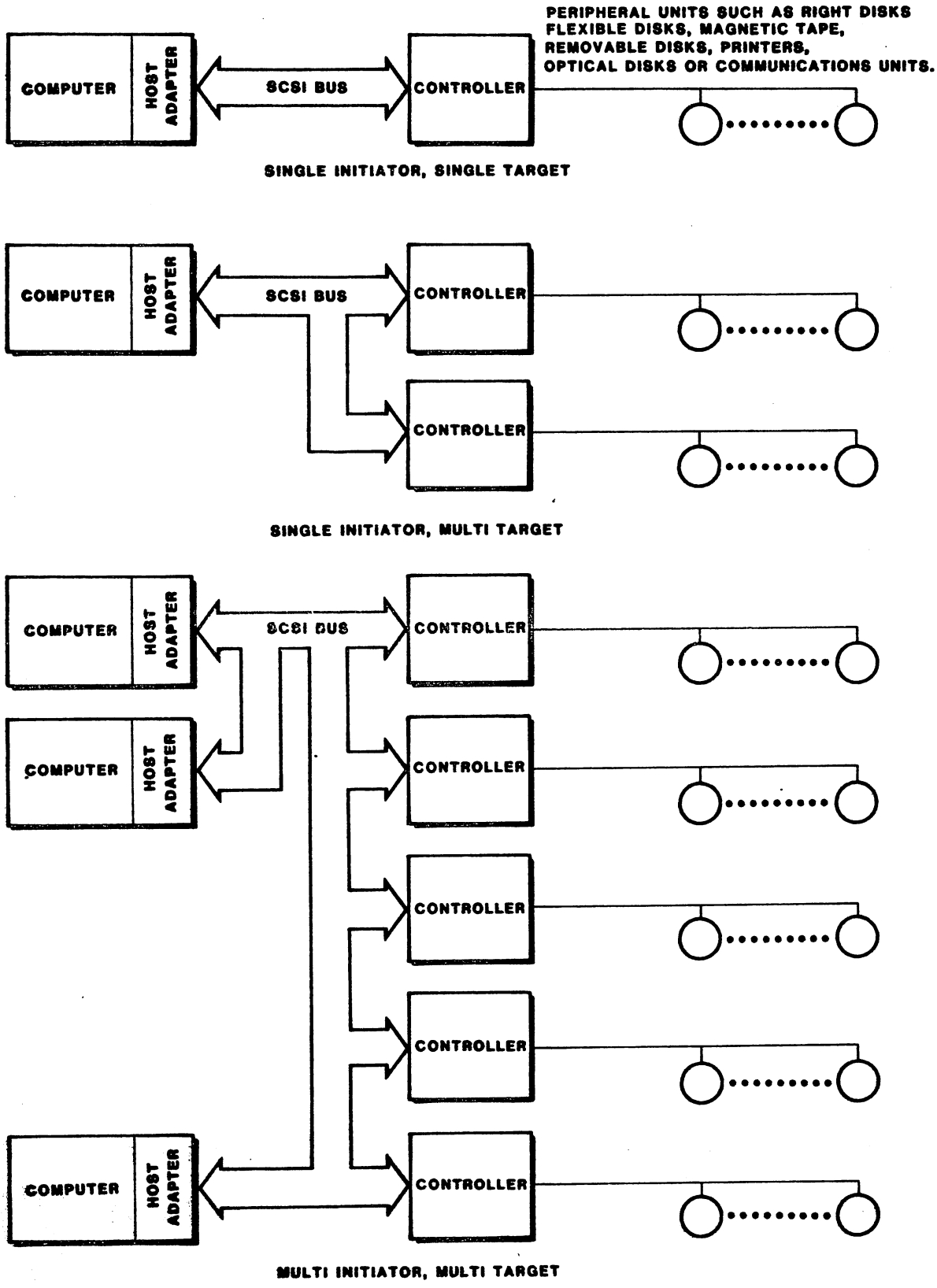


Figure 1-1. SCSI Bus Overview

peripheral controllers support mass-storage peripherals such as mini-winchester disk drives and small, streaming tape transports. The devices communicate over the SCSI bus using a device independent protocol which largely masks the data structure of the peripheral. Thus, SCSI architecture allows the host computer to become device independent within certain classes of devices.

The SCSI also provides for a large volume of data storage that can be configured in many ways. The bus supports data throughput in keeping with the speeds of modern winchester-technology disks, and the interface allows seeks and other types of positioning to be over-lapped if there is more than one peripheral controller on the bus.

1.3 PHYSICAL ORGANIZATION OVERVIEW

The UC03 Emulating Host Adapter is a modular, microprocessor-based emulating 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 UC03 to relieve the host CPU of many file maintenance tasks.

The UC03 is contained on a single quad-wide printed circuit board assembly (PCBA) which plugs directly into a LSI-11 Bus backplane slot.

The UC03 supports up to four peripherals. All of these devices may be supported by the same controller or each may be attached to its own. Aggregate data storage capacities are limited only by the capacities of the peripherals. Currently, drives are available that can be combined to provide up to one mega-byte of on-line storage with high speed back-up capability. In addition to peripheral controllers, it is also possible to connect one or more additional hosts via other host adapters. Figure 1-2 shows one possible SCSI configuration.

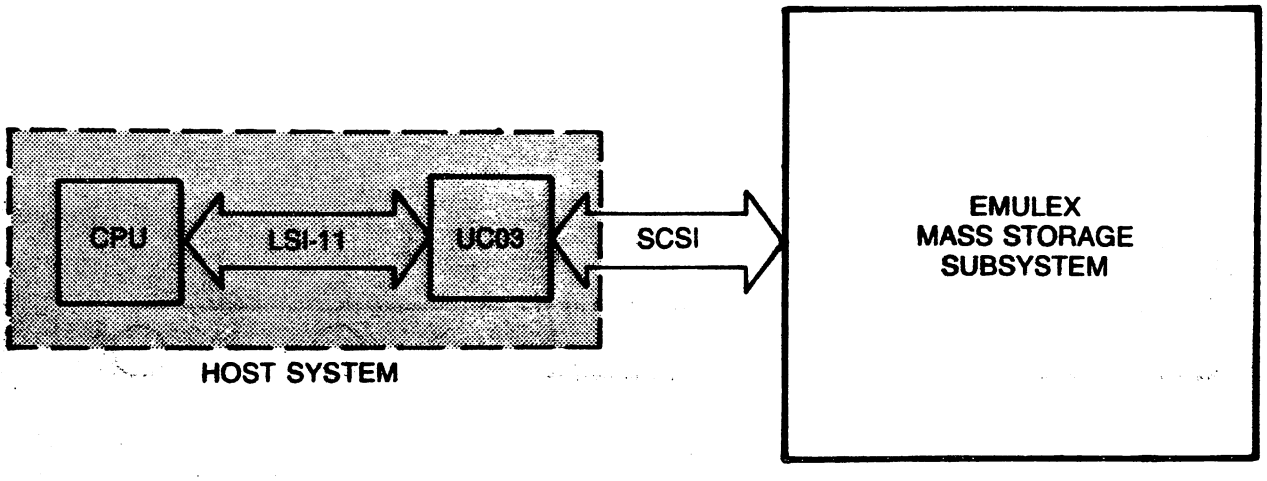


Figure 1-2. UC03 Subsystem Configuration

1.4 SUBSYSTEM MODELS and OPTIONS

The UC03 Emulating Host Adapter, with appropriate peripherals, provides a DEC MSCP-compatible mass-storage subsystem. The UC03 is pictured in Figure 1-3. A single model of the UC03 is offered, the UC03/M1.

Table 1-1. Basic Subsystem Contents

Itm	Qty	Description	Part Number	Comment
1	1	UC03/M1 Host Adapter	UC0310201-M1X	X is Firmware Revision
2	1	22-Bit Addressing Kit	UC0313001	
3	1	UC03/M1 Technical Manual	UC0351001	

1.4.1 SUBSYSTEM OPTIONS

Table 1-7 lists the options that can be ordered to tailor your UC03 to your particular application.

Table 1-2. Subsystem Options

Option	Description
PX9960xxx*	Disk Formatter and Data Reliability Software. Media is per customer order. *See Appendix C for part no.
PU0213001	MicroPDP/VAX Cable Kit for MicroPDP/VAX chassis patch panels. Converts UC02 J2 to AMP xxxxxx connector. Includes SCSI cable, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.[1]
PU0120105	Micro PDP/VAX Patch Panel. Required for installation of Emulex CP24 Distribution Panel and UC03/TC05 Controllers. Ordered in addition to PU0213001, above.[1]

continued next page

Table 1-1. Subsystem Options

Option	Description
PU0113003	Rack mount cable kit for universal RETMA rack mount applications. Converts UC02 J2 to AMP xxxxxx connector. Includes SCSI cable, rack mount, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.[1]
PU0113004	LSI-11/23 Chassis Mount Kit for LSI-11/23 BC type chassis. Mounts AMP xxxxxx connector in LSI-11/23 BC chassis. Includes SCSI cable, adapter, and hardware. Fully compatible with all Emulex SCSI subsystems.[1]
PD9960303	Backup and Restore Program (BRP). Allows image backup and restoration of disk. Compatible with TM11, TS11, SCSI Tape and all DEC disks. Distributed on .5" tape, PE format with MS boot.

[1] See Table 4-8 for details such as cable length.

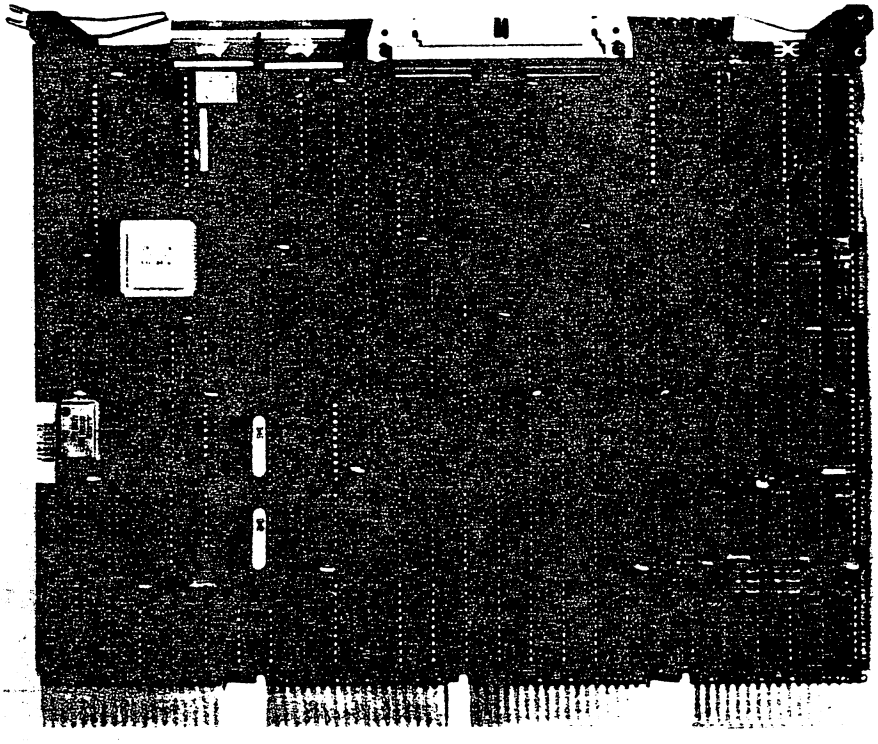


Figure 1-3. UC03 Emulating Host Adapter

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.	UC03/M1	Emulating Host Adaptor implementing DEC MSCP.
2.	PU0213001-02	MicroPDP/VAX Cable kit 10 ft SCSI cable.
3.	PU0120105	Emulex Patch Panel for use with item 2 and CP24 Distribution Panel
4.	PD9960303	Backup and Restore Program .5" tape, PE, MS boot

Figure 1-4. Sales Order Example

1.5 FEATURES

Eight features enhance the usefulness of the UC03 Emulating Host Adaptor.

1.5.1 MICROPROCESSOR DESIGN

The UC03 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 most importantly the ability to implement MCSP.

1.5.2 CONFIGURATION FLEXIBILITY

The UC03 Emulating Host Adaptor provides complete configuration flexibility. It is capable of supporting as many as four SCSI compatible controllers with disk drives of varying capacities.

1.5.3 SELF-TEST

The controller incorporates an internal self-test routine which is executed upon power-up. This test 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 four light emitting diodes (LED) ON and reports its failure to the host operating system.

1.5.4 SEEK OPTIMIZATION

The UC03 is able to pool the various seeks which 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.

1.5.5 DISCONNECT/RECONNECT

The UC03 fully support standard SCSI arbitration, including the disconnect/reconnect option. Using this option, drives which 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 UC03 to initiate four command 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.

1.5.6 COMMAND BUFFER

The UC03 contains a buffer which 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.

1.5.7 ADAPTIVE DMA

During each DMA data transfer burst, the UC03 monitors the LSI-11 Bus for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. In addition, burst length and burst delay are programmable, to ensure that CPU functions, including interrupt servicing are not locked out for excessive periods of time by high-speed disk transfers.

1.5.8 ERROR CONTROL

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

1.5.9 BLOCK-MODE DMA

The UC03 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 reduce the overhead associated with DMA by about 35 percent.

1.5.10 TWENTY-TWO BIT ADDRESSING

The UC03 supports full 22-bit addressing to utilize the full 4 Mbyte capacity of the LSI-11/23 PLUS.

1.6 COMPATIBILITY

1.6.1 DIAGNOSTICS

Emulex offers two diagnostic programs to support the use and maintenance of the UC03, a disk formatter and a data reliability program. These items are included with your UC03.

1.6.2 OPERATING SYSTEMS

The UC03 completely implements MSCP. MSCP is supported by the RT-11, RSX-11M, RSX-11M-PLUS, RSTS/E, and VMS operating systems.

1.6.3 HARDWARE COMPATIBILITY

The UC03 Emulating Host Adaptor complies with DEC LSI-11 Bus protocol, and it directly supports 22-bit addressing and block-mode DMA. The disk drives supported by the UC03 are not media compatible with comparable DEC MSCP products. The fixed nature of DEC's disk media, however, makes this an unimportant consideration.

1.7 PERFORMANCE

The UC03 Emulating Host Adaptor provides performance superior to that of DEC MSCP mass-storage subsystems for the LSI-11 Bus. The UC03 allows the user to select from a wide range of low cost peripherals that, when combined with the UC03, provide very cost effective solutions to mass-storage on LSI-11 Bus based computer systems.

Section 2
SUBSYSTEM SPECIFICATION

2.1 OVERVIEW

This section contains the general, environmental, physical, electrical, and port specifications for the UC03 Emulating Host Adaptor. 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

A general specification for the UC03 Emulating Host Adaptor is contained in Table 2-1.

Table 2-1. UC03 Emulating Host Adaptor General Specifications

Parameter	Description
FUNCTION	Providing mass data storage to LSI-11 computers manufactured by Digital Equipment
Logical CPU Interface	Complete implementation of DEC's Mass Storage Control
Diagnostic Software	Emulex xxxxx Disk Formatter and xxxxx Data Reliability Programs
Operating System Compatibility	RT-11, RSX-11M, RSX-11M PLUS, and RSTE

continued on next page

Table 2-1. UC03 Emulating Host Adaptor General Specifications (continued)

Parameter	Description
CPU I/O Technique	Direct Memory Access, including Adaptive Techniques
INTERFACE	
CPU Interface	Standard LSI-11 Bus interface.
Device CSR Address	
Standard Alternate	17772150 17772154
Vector Address	Programmable
Priority Level	BR5
Load	One LSI-11 Bus
Peripheral Interface	Small Compter System Interface (SCSI)
Driver Option	Single Ended
Maximum Length	18 ft (3 m)
SCSI Commands used with MSCP Implementation	00 Test Unit Ready 01 Rezero Unit 03 Request Sense 04 Format Unit (extended) 07 Reassign Block 08 Read 0A Write 0B Seek 12 Enquiry 15 Mode Select 16 Reserve Unit 17 Release Unit 18 Copy 1A Mode Sense 1B Start/Stop 1C Receive Diagnostic Results 1D Send Diagnostic

2.3 ENVIRONMENTAL SPECIFICATION

Table 2-2 contains the environmental specifications for the UC03 Emulating Host Adaptor.

Table 2-2. UC03/M1 Intelligent Host Adapter Environmental Specifications

Parameter	Description
OPERATING TEMPERATURE	10°C (50°F) to 40°C (104°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 dewpoint of 2°C (3.6°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 UC03 Emulating Host Adaptor.

Table 2-3. UC03 Emulating Host Adaptor Physical Specifications

Parameter	Description
PACKAGING	Single, quad-size, four-layer PCBA
Dimensions	15.7 x 8.7 in., see Figure 2-1
Shipping Weight	4 pounds

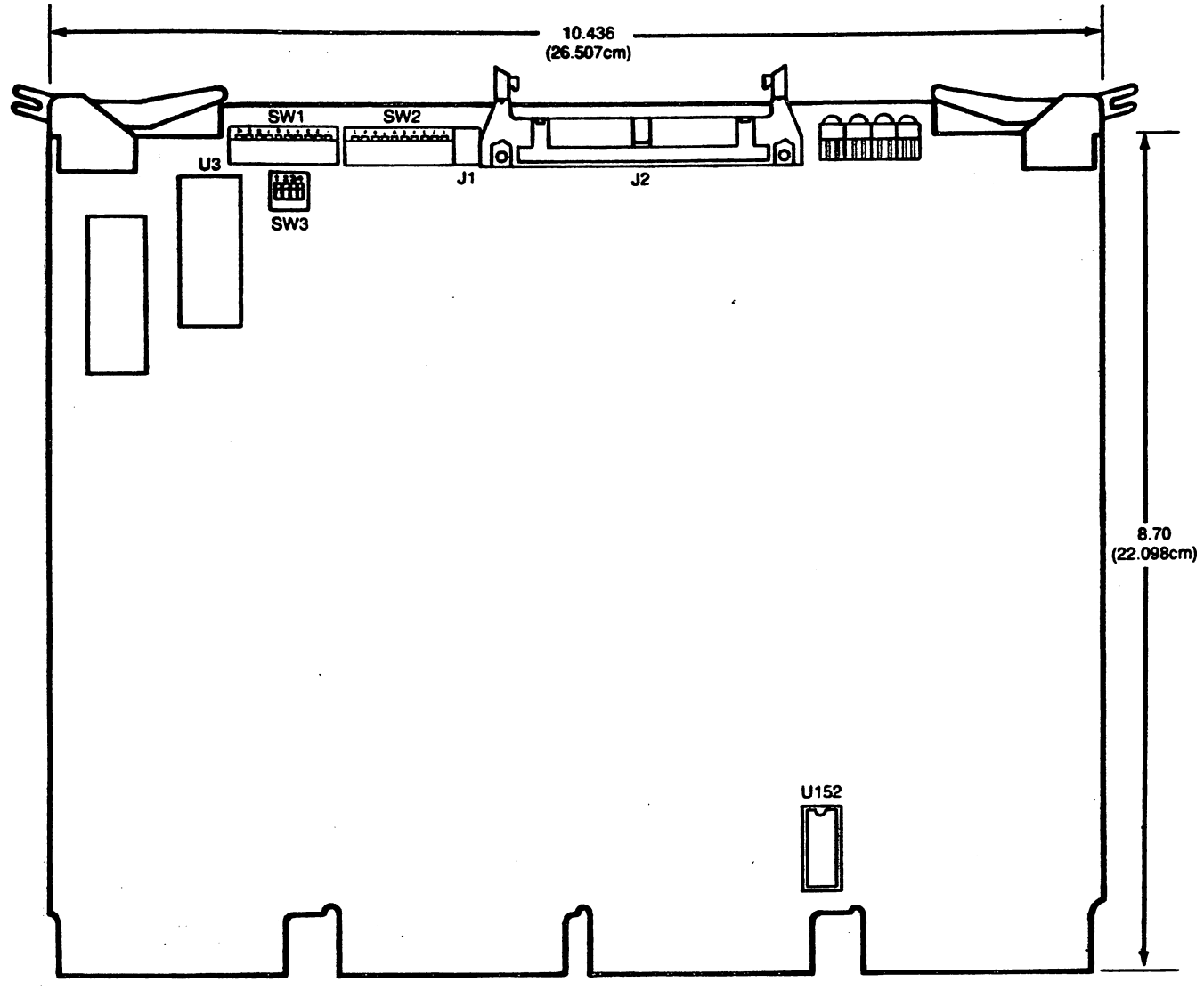


Figure 2-1. UC03 Host Adapter Dimensions

2.5 ELECTRICAL SPECIFICATION

Table 2-4 lists and describes the electrical specification for the UC03 Emulating Host Adaptor.

Table 2-4. UC03 Emulating Host Adaptor Electrical Specifications

Parameter	Description
POWER	5 Vdc ± 5%, 4.8 A

3.1 OVERVIEW

This section is designed to help you plan the installation of your UC03 Intelligent Host Adapter. Taking a few minutes and planning the configuration of your subsystem before beginning its installation will result in a smoother installation with less system down time. As a planning tool, this section explains some of the practical matters that need to be considered before you begin your installation.

This section contains UC03 application examples and configuration procedures. The subsections are listed in the following table:

Subsection	Title
3.2	MSCP Subsystem Configuration
3.3	A DEC MSCP Subsystem
3.4	The UC03 MSCP Subsystem
3.5	Operating Systems, Device and Vector Addresses Channel
3.6	Performance Considerations

Following the procedures contained in these subsections will help you get the most from your UC03 Intelligent Host Adapter.

3.1.1 CONFIGURATION DEFINED

As used in the computer industry, the term configuration is generally used to define the physical and logical arrangement of a system, or put another way, the manner in which the parts of a system relate to one another.

When used this way, the word configuration has quite a number of implications: size (capacity, speed, bandwidth), cabling (what is hooked to what), logical arrangement (which functions are combined on which components), location (bus slot, local/remote, bus address, vector, unit address), and so on.

Many of these factors can be affected by the user, either through the use of switches or by cabling the system one way instead of another. In other words, the configuration, and thus the function, of a system is defined and determined by the user.

3.2 MSCP SUBSYSTEM CONFIGURATION

The following paragraphs describe MSCP Subsystem concepts, including architecture, unit numbering, capacities, etc.

3.2.1 ARCHITECTURE

The main components in a mass storage subsystem that uses Digital Equipment Corporation's Mass Storage Control Protocol (MSCP) are the MSCP Server, the peripheral controller, and the actual peripherals themselves. The functions of the components are as follows:

- The MSCP Server is an intelligent co-processor that processes high level requests or commands from the host. The MSCP Server determines the type and number of the devices attached to it. The MSCP Server optimizes and prioritizes the requests from the host, transfers data to/from the host, transfers data to/from the peripheral controller, and buffers data as necessary. When the command is complete, the Server sends a response to the host.

- The peripheral controller must have detailed knowledge of the geometry of the devices attached to it. With its knowledge the peripheral's geometry, MSCP Server converts the logical block numbers that the host system uses to identify data into positioning and data transfer commands that the disk drive can understand. These commands are low level commands; i.e., the commands specify data locations in terms specific to the media at hand: cylinder, track, and sector, for example. In addition, the peripheral controller converts the parallel data from the host bus to serial data for writing on the drive, and converts the serial read from the drive to parallel format. The peripheral controller also handles error detection and correction.

- As with most peripheral devices, MSCP drives have a low degree of intelligence. They contain only the phase-locked-loop (PLL) circuitry that converts digital to analog data for recording on magnetic media, the timing electronics, the write and read amplifiers, and the positioning mechanism.

Depending on the MSCP subsystem, these functions can be executed by separate pieces of hardware, or combined.

3.2.2 PERIPHERAL NUMBERING

To the operating system, each MSCP peripheral on the system is identified by a unique unit number. MSCP devices are also identified by device class. The device class is indicated by a two letter prefix attached to the device's unit number. MSCP disk devices are indicated by prefix "DU". Together, the unit number and class prefix orm the specification used by the operating system to select a device.

Unlike other DEC mass storage subsystems, all of the MSCP peripherals on the system must have different MSCP Unit numbers, even if they are managed by separate MSCP Servers at separate LSI-11 Bus CSR addresses. Thus, if there are three peripherals on the first MSCP Server (at 772150), then the first peripheral on the second MSCP Server (at 772154 or in floating CSR address space) is numbered DU3.

3.2.3 PERIPHERAL CAPACITIES

The capacity of peripherals in an MSCP subsystem is measured in logical blocks. Each logical block contains 512 bytes of data. The MSCP Server reports the capacity of a peripheral to the operating system during configuration. A 10 mByte peripheral such as DEC's RD51 is able to store about 20,000 logical blocks.

3.3 A DEC MSCP SUBSYSTEM

A typical DEC MSCP subsystem for the LSI-11 Bus is organized as shown in Figure 3-1. This subsystem combines the Server and controller functions in a single piece of hardware, which is referred to as the RQDX1. The hard disk drive that attaches to the RQDX1 is referred to as the RD51, and the 5.25-inch floppy as the RX50. The RQDX1 plugs directly into the LSI-11 Bus and is attached to the disk drives via a disk-drive-native interface. These model numbers are not used to identify peripherals to the operating system, but are displayed to the operator by some operating systems during configuration for informational purposes.

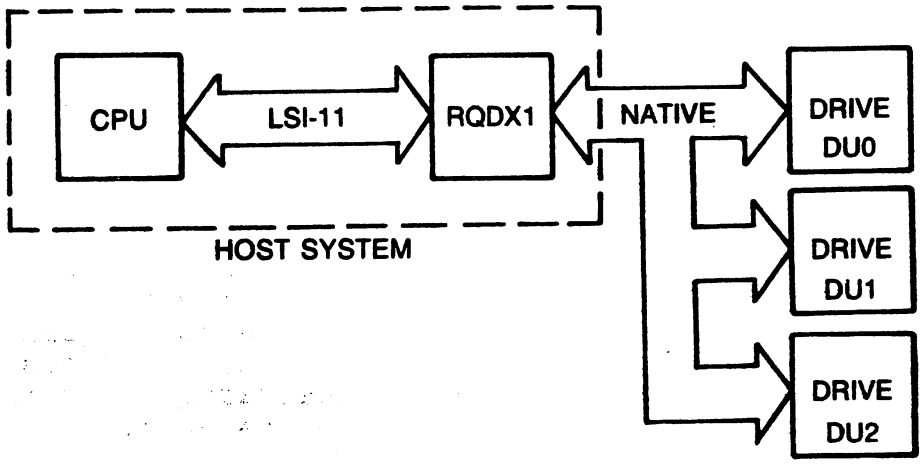


Figure 3-1. DEC MSCP Subsystem Logical and Physical Configuration

3.4 THE UC03 MSCP SUBSYSTEM

Figure 3-2 illustrates a typical UC03 MSCP subsystem. As with the DEC implementation, the UC03 is connected directly to the LSI-11 Bus. On the other side, however, the UC03 uses the SCSI bus to communicate with up to four intelligent peripheral controllers. The peripheral controllers are in turn connected to the drives that they support via the drive's native interface. One controller can have up to four drives attached, but no more than four drives can be supported using any combination of controllers and drives.

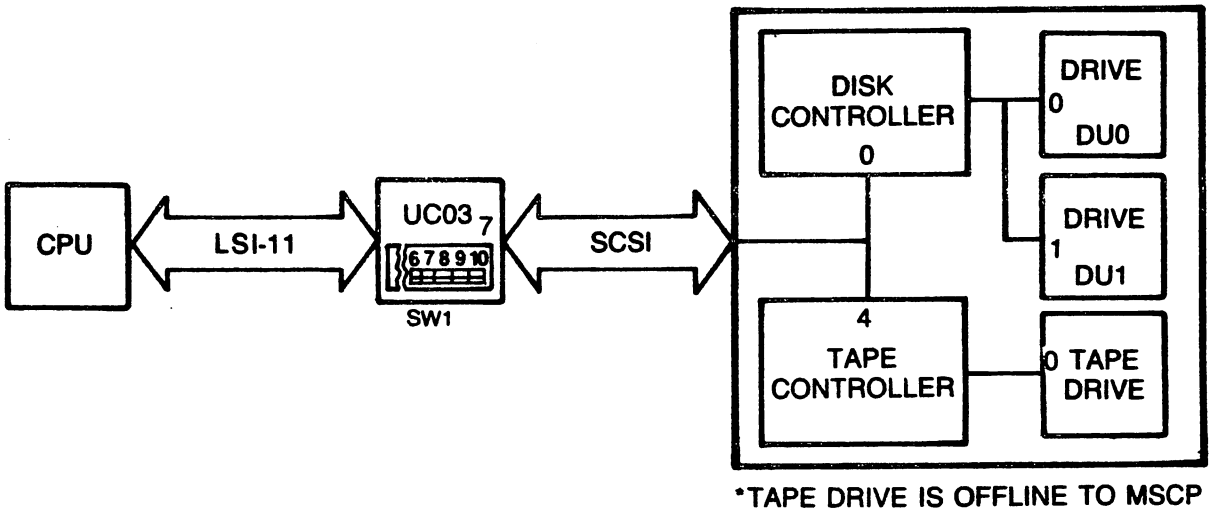


Figure 3-2. UC03 Subsystem Logical and Physical Configuration

The MSCP subsystem provided by the UC03 differs somewhat from the DEC subsystem in terms of architecture as well as physical configuration. As in the DEC subsystem, the UC03 MSCP Server connects directly to the LSI-11 Bus and performs many of the same functions as the RQDX1. As an MSCP Server, the UC03 receives requests from the host, optimizes the requests, generates SCSI commands to perform operations the operations, transfers data to/from the host, transfers data to/from the device, and buffers data as necessary. When the command is complete, the Server sends a response to the host.

Unlike the RQDX1, however, the UC03 does not require detailed knowledge of the drive geometry. Data blocks on the SCSI bus are identified by controller number, logical unit number, and logical

block numbers. The SCSI controllers are responsible for converting data from parallel to serial format and vice-versa, for error detection and correction, and for some of the other functions performed by the RQDX1 in the DEC implementation.

3.4.1 UC03 MSCP SUBSYSTEM LOGICAL CONFIGURATION

This subsection explains the algorithm used by the UC03 to map logical MSCP peripherals on to the physical data storage devices provided by the UC03 subsystem.

3.4.1.1 Logical Devices

The phrase "logical MSCP peripheral" refers to the peripheral as it is appears to the operating system. That is, the operating system associates a peripheral of known type (in this case, a MSCP peripheral) with a unit number and a capacity. That information is presented to the operating system during initialization by the UC03 MSCP Server.

Because the MSCP Server is responsible for establishing the relationship between unit number and capacity, it is possible for the Server to divide its physical peripherals into more than one logical unit. That is, if a physical peripheral has a capacity of 234,090 blocks, the MSCP Server can divide that capacity into unequal parts, let us say of 208,080 blocks and 26,010 blocks. Each part is then assigned separate unit numbers and the the unit number and capacity of each is presented to the operating system. The operating system then sees the two parts as separate peripherals, even though the data is actually stored on the same physical drive. The two parts are called logical peripherals, and the numbers that identify them are called MSCP unit numbers.

(This technique of dividing physical units into smaller logical units is designed to make file management easier. For example, the larger of the two logical units could be used as the system disk or the main data storage disk. The smaller unit would be used as a scratch pad. Data to be stored off-line on tape could be transferred from the larger disk to the smaller and then the smaller disk could be copied in its entirety to the tape. This would eliminate having to back up the entire disk, a time-consuming operation.)

The UC03's SCSI interface, which it uses as a device interface, is capable of supporting up to four physical peripherals. The peripherals may be on separate controllers or on the same controller.

3.4.1.2 Device Numbers

As with any MSCP subsystem, the drives on the UC03 are identified using unit numbers.

Drives are assigned MSCP unit numbers beginning with zero (DU0). This number is assigned to the first drive on the first controller on the first UC03, where "first" means the Server located at the standard CSR address. Unit number 1 would be the second drive on the first controller, etc. If there are two MSCP Servers on the system, the units installed on the second begin numbering at n+1, where n equals the highest unit number of the first MSCP Server.

Table 3-1 is an MSCP unit numbering example and shows the MSCP number verses the actual physical addresses assigned to all the components.

Table 3-1. Subsystem Configuration Example

UC03 Address	Device Description	SCSI Addr	Drive Unit Number	Device Ident	Device Name
172150	Emulex MD01 Controller/Atasi 3046 Drive	0	0	AT30	DU0
	IOMEGA Alpha-10.5	1	-	IO10	DU1
172154	Emulex MD01 Controller/Two Maxtor XT1140 Drives	0	0	MX14	DU2
		0	1	MX14	DU3

3.4.1.3 Device Identifiers

MSCP peripherals (not the MSCP Server itself) identify themselves by model number. This information is usually displayed during configuration and is really not significant. Model numbers for devices supported by the UC03 are listed in Table 3-2.

Table 3-2. Device Identifiers

Model Number	Formatted Capacity (mBytes)	Description
AT30	31.2	Atasi 3064
IO10	10.4	IOMEGA Alpha-10.5
MX14	110.0	Maxtor XT1140

3.5 OPERATING SYSTEMS, DEVICE AND VECTOR ADDRESSES

Before the installation of any peripheral device can be considered complete the computer's operating system must be made aware of the new resource. Consequently, this section provides that information as part of the configuration planning process.

An operating system can be made aware of a new resource in three ways: the operating system can poll the computer's I/O device address space, the device can be manually connected using CONNECT or CONFIGURE statements, or the user can tell the operating system about a device during an interactive SYSGEN procedure. The first technique is referred to a autoconfigure, and it is essentially automatic. The second technique requires that CONNECT statements be placed in a special command file that is executed each time the computer is powered-up. The third technique, interactive SYSGEN, creates a configuration file that the operating system references when the system is powered up. All techniques accomplish the same thing, they associate a specific device-type with a bus address and interrupt vector.

All recent versions of DEC operating systems use autoconfigure to some extent, and all try to follow the same rules. There are some differences between operating systems, however, especially with regard to MSCP servers at alternate CSR addresses. The following paragraphs address these differences on a operating-system-by-operating-system basis. Choosing appropriate LSI-11 Bus CSR addresses and interrupt vectors for the subsystem is part of that discussion.

CSR Addresses:

The operating system discussions below give procedures for choosing CSR addresses for the first MSCP Server and any subsequent Servers in the host configuration. No instructions are provided for programming the chosen address into the UC03. See subsection 4.5.1 detailed switch setting information.

MSCP-type Servers contain two registers that are visible to the LSI-11 Bus I/O page. They are the initializing and polling (IP) register and the status and address (SA) register. All of the operating systems described below use the standard CSR address of 1772150_8 for the first Server on the host system.

Vector Addresses:

Vector addresses for MSCP Servers are not selected by using switches on the Server PWB, but are programmed into the Server during the SYSGEN process. Many operating system select the vector address

automatically. If manual input of the vector is required by an operating system, that fact is noted in the procedure.

Device Names:

Again, although DEC has attempted to standardize treatment of peripherals by operating systems, some differences do exist. Table 3-3 lists and describes the device names assigned to MSCP devices under five operating systems. Two controller names and drive names are given to infer the numbering scheme.

Table 3-3. Device Names

Operating System	Controller	Drive
RSTS/E	DUA, DUB	DU0, DU1
RT-11	Port1, Port2	DU0, DU1
RSX-11M	DUA, DUB	DU0, DU1
RSX-11M-PLUS	DUA, DUB	DU0, DU1
VAX/VMS	PUA, PUB	DU0, DU1

Assumptions:

The following discussions make these assumptions:

- This is the first pass that is being made through SYSGEN, therefore, no saved answer file exists. Answer NO to question 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). All of the operating systems discussed here use some type of autoconfigure algorithm to identify devices in the host system. The procedures which follow use autoconfigure as much as possible.
- You are generating a mapped version of the operating system on the appropriate hardware.

3.5.1 RSTS/E OPERATING SYSTEMS (V8.0)

RSTS/E scans the hardware to determine configuration each time the system is boot strapped. The scanning program is called INIT.SYS and it relies on the same hardware configuration conventions as do the other DEC operating systems.

The RSTS/E Operating System can support two MSCP Servers. The first MSCP Server must be located at the standard CSR address, 772150. According to DEC documentation, the second unit should be located in floating address space. Experience has shown, however, that, if the second unit is contiguous with the first (772154), RSTS/E locates and properly identifies it.

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

3.5.2 RT-11 OPERATING SYSTEMS (V5.0)

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

3.5.2.1 Installing a Single MSCP Server

If you host system includes only one MSCP Server, install it with a CSR address of 772150. The RT-11 version of autoconfigure will find and install the handler (driver) for that Server. In single MSCP Server 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, however, you must modify the system start up command file, STARTx.COM, to properly partition the disk drives. See subsection 3.5.2.3.

3.5.2.2 Installing Multiple MSCP Servers

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

1. Initiate SYSGEN:

   R SYSGEN.COM<cr>

   Answer questions 1 through 25 appropriately.

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

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

The start-up command file is required to allow additional MSCP Server CSR addresses to be specified and to partition the disks consistently when the system in boot strapped. Answer questions 27 through 32 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>
```

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 questions 33 through 66 appropriately.

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

```
67.  How many ports are to be
     supported (1)? 2<cr>
```

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

5. You must specify the addresses of all MSCP Servers (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. Edit the command file to include the following statements:

```
SET DU CSR=772150
SET DU CSR2=772154
SET DU VECTOR=154
SET DU VEC2=300
```

The CSR and vector address for the second device can be any unused address in the I/O page or vector page.

3.5.2.3 Disk Partitioning

RT-11 is unable to handle DU-type drives with a capacity of more than 65,535 blocks (33.5 Mbytes). 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 ensures that the drives are automatically partitioned every time the system is boot strapped, and that the partitions are always the same. Use the following procedure to determine the total number of logical drives to assigned to each physical drive.

1. Consult Table 4-7. Find the configuration that you intend to use. Note down the capacity given in the MSCP Disk Capacity column for each MSCP Unit (except tape units, ignore those). If the UC03 is at an alternate CSR address (not 772150), then you must specify an MSCP Unit number offset by using switches SW2-1 and SW2-2 (see subsection 4.5.5.3). Add the selected offset to the MSCP Unit number from Table 4-7 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, that assign logical names to each partition. The statements have the following format:

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

where "n" is the logical device name, "y" is physical MSCP unit number (taken form Table 4-7), and "x" is the partition number. 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 4-7. MSCP Unit 0 has a capacity of 219,283 blocks; unit 1 has a capacity of 20,002 blocks.

$$\frac{219,283}{65,535} = 3.35 \text{ (4 logical units)}$$

$$\frac{20,002}{65,535} = 0.31 \text{ (1 logical unit)}$$

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 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 assignments are made as follows:

```
SET DU0 UNIT=0 PART=1
SET DU1 UNIT=0 PART=2
SET DU2 UNIT=0 PART=3
SET DU3 UNIT=0 PART=4

SET DU4 UNIT=1 PART=1
```

3.5.3 RSX-11M OPERATING SYSTEMS (V4.1)

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 are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the UC03 may invoke.

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

3.5.3.1 Installing a Single MSCP Server

If you have only one UC03, 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.

3.5.3.2 Installing Multiple MSCP Servers

If you have two MSCP Servers, say an RQDX1 and a UC03, we recommend that you use autoconfigure to connect the first at the standard address (772150). We recommend that the RQDX1 be installed at the standard CSR address. Locating the UC03 at the alternate CSR address does not prevent it being used as the system device. The second MSCP Server is connected to the operating system after the initial SYSGEN is complete and system is running. To connect the second Server, use the Add a Device option of SYSGEN. 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 the to the following question:

```
* 1.   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:

```
* 2.   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 questions 1 through 14 appropriately (since autoconfigure was requested, the defaults presented for these questions should be accurate for your system).

4. In response to question 15, Devices, indicate that you have two MSCP-type controllers:

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

This 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. (Unless you indicated that you wished to override other autoconfigure results when you responded to the Devices question (15), then 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 contr 0 and once for contr 1, since we have specified two DU-type controllers.

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

The standard vector address for MSCP Servers in 154. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300 and 774

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

```
* SU120   Do you want to do a complete SYSGEN?
          [Y/N D:Y]: N<cr>

* SU130   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:

```
* SU150   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:

```
* SU160   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.

There is an exception: if your system has MASSBUS controllers (RH-type), specify the proper number when asked. Answer zero, however, to all the questions that follow about MASSBUS devices that are attached to the MASSBUS controller (DB, DR, DS, EM, and MM types).

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

```
* CP3004   How many MSCP disk controllers do you
           have? [D R:0.-63. D:0.] 2<cr>
```

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

```
* CP3008   How many MSCP disk drives do you have?
           [D R:0.-n. D:1.] 5<cr>
```

The answer to this question will depend on the configuration that you have selected for the UC03 and on the number of drives that are attached to any DEC MSCP controllers.

When you select a configuration for the UC03, you are taking into account the number of physical disk drives that you are attaching to the UC03's SCSI interface. When you select a configuration, you are also specifying a logical arrangement for the UC03 MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. The MSCP Unit column of the configuration table, Table 4-7, gives the number of MSCP units. 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.

The following types of disk drives can be attached to DEC MSCP controllers:

RX50
RD51
RC25
RA60
RA80
RA81

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

6. SYSGEN then asks you to specify controllers per disk drives.

```
* CP3044  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.

7. Enter the vector address for each MSCP controller:

```
* CP3068  Enter the vector address of DUA
          [O R:60-774 D:154]
```

The standard vector address for MSCP Servers in 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 B for an description of DEC's algorithm for assigning floating vectors.

8. Enter the CSR address for each MSCP controller:

```
* CP3072  What is its CSR address?
          [O R:160000-177700 D:172150]
```

The standard CSR address for MSCP Servers is 772150. The second unit can be located at 772154, or in floating CSR address space. See Appendix B for a description of the DEC algorithm for assigning floating addresses.

9. Specify the number of command rings for each MSCP Server:

```
* CP3076  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.

10. Specify the number of response rings for each MSCP Server:

```
* CP3076  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.

3.5.5 VMS OPERATING SYSTEMS

VAX/VMS supports MSCP Servers at the standard address, 772150, and in floating address space. VMS has a software utility called SYSGEN 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 VAX/VMS computer system is required to use this utility. If you do not have access to a running system, you will have to determine the LSI-11 Bus addresses and vector addresses manually (although autoconfigure can still be used to automatically connect the devices to the computer on power up). See Appendix B for a description of the algorithm used by SYSGEN to determine LSI-11 Bus addresses.

The following procedure tells how to use VMS SYSGEN to determine LSI-11 Bus CSR addresses and interrupt vectors as well as how to use autoconfigure to CONNECT the UC03.

1. Login to the system manager's account (this procedure requires system manager privileges). Set your default to SYS$SYSROOT:[SYSEXE].

2. Run the SYSGEN utility:

```
$ RUN SYSGEN<cr>
SYSGEN>
```

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

3. Obtain a list of devices already installed on the VAX LSI-11 Bus by typing:

```
SYSGEN> SHOW/CONFIGURATION<cr>
```

SYSGEN will list the devices already installed in the LSI-11 Bus by logical name. Make a note of the devices with floating addresses (greater than 760000) or floating vectors (greater than 300) that you plan to re-install with your UC03.

4. To determine the LSI-11 Bus addresses and vectors that autoconfigure expects for that device type, execute the CONFIGURE command:

```
SYSGEN> CONFIGURE<cr>
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 Servers under MicroVMS is "UDA").

```
DEVICE> UDA,2<cr>
```

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.

For the installation of the UC03, you need only specify devices that have floating addresses or vectors. Devices with fixed addresses or vectors will not affect the address or vector assignments of devices with floating addresses and vectors.

5. Indicate that all devices have been entered by pressing the CTRL and Z keys simultaneously:

```
DEVICE> ^Z
```

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

```
SYSGEN>  CONFIGURE
DEVICE> DHV11
DEVICE> UDA,2
DEVICE> ^Z
Device: UDA     Name: PUA    CSR: 772150    Vector: 154    Support: yes
Device: UDA     Name: PUB    CSR: 760334*   Vector: 300*   Support: yes
Device: DHV11   Name: TXA    CSR: 760500*   Vector: 310*   Support: yes
```

Figure 3-3. CONFIGURE Command Listing

*Floating address or vector.

6. 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 that manufacturer's documentation. For the UC03, program the address given for the UC03 (lowest numerical address) into the board as described in subsection 4.5.1.

7. Although autoconfigure is essentially automatic, a command to start the autoconfigure process must be included in one of several start-up command files on the system. Generally, these command files are located in two places: the main system account, SYS$SYSROOT:[SYSEXE]; and the system manager's account, SYS$SYSROOT:[SYSMGR]. The command file in SYS$SYSROOT:[SYSEXE] is called STARTUP.COM, and the file in SYS$SYSROOT:[SYSMGR] is called SYSTARTUP.COM.

   When autoconfigure is started in SYS$SYSROOT:[SYSEXE] STARTUP.COM, communications equipment is generally excluded. This is done because the configuration commands for comm equipment are numerous and lengthy, and because they are changed often. Edit SYS$SYSROOT:[SYSEXE]STARTUP.COM to exclude the CSM32/MF Subsystem. Use the /SELECT switch as shown below (Note that TX-type devices are not included):

```
$ RUN SYS$SYSTEM:SYSGEN
AUTOCONFIGURE ALL/SELECT=(DR,DM,LP,DU)
```

3.6 PERFORMANCE CONSIDERATIONS

In most applications, the UC03 MSCP Server out performs comparable DEC MSCP Servers. The only performance consideration involves the sector interleave ratio of disk-type devices that are connected to the UC03. Table 3-4 lists the sector interleave ratios recommended by Emulex to achieve the best performance from the subsystem.

Table 3-4. 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 UC03 Disk Formatter Utility that was provided with your UC03 to format the disk drives. Remember, the Formatter is an off-line utility, so format several IOMEGA cartridges at the same time.

4.1 OVERVIEW

The procedure for installing the UC03 Emulating Host Adapter is described in this section. The subsection titles are listed below to serve as an outline of the procedure.

Subsection	Title
4.1	Overview
4.2	Inspection
4.3	UC03 Host Adapter Setup
4.4	Subsystem Cabling
4.5	Subsystem Power-Up and Verification

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 READING SECTION 3, APPLICATION and CONFIGURATION, BEFORE ATTEMPTING TO INSTALL THIS SUBSYSTEM.**

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

UC03 SETUP RECORD

GENERAL INFORMATION

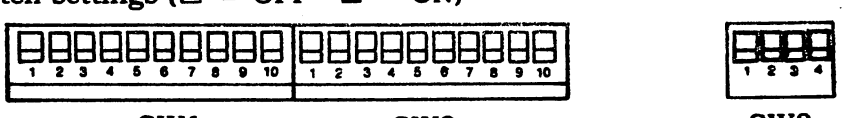
1. Host computer type _____
2. Host computer operating system _____
   Version_____
3. Subsystem Model _____
   Controller(s) _____
   _____
   _____

   Disk drive(s) _____
   _____
   _____

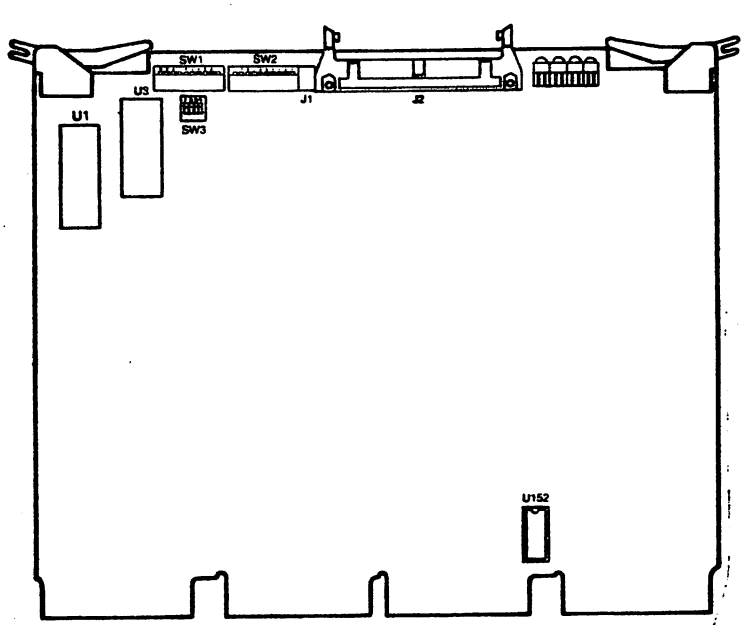
   Tape drive(s) _____

UC03/M1 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. 22-bit addressing IC (AMD 8641) installed (Y or N) _____
7. Switch settings (□ = OFF ■ = ON)



SW1 SW2 SW3



U1 label identifies top assembly and serial numbers.
U3 label identifies firmware revision.

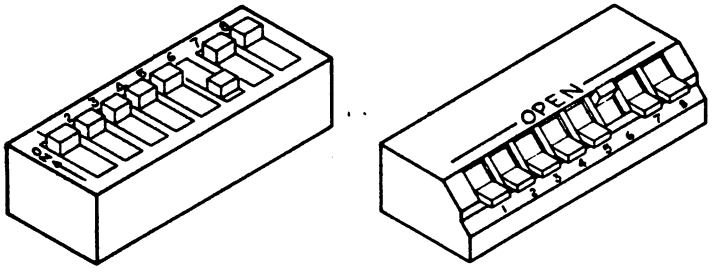
Use Pencil

Figure 4-1. UC03 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.

The two DIP switch types used in this product are shown in Figure 4-2. Both are set 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 UC03 Intelligent Host Adapter with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the UC03 does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the UC03 and its associated SCSI peripheral subsystem can be installed:

1. With the UC03 Host Adapter and the SCSI subsystem both mounted in the same cabinet, and

2. With the UC03 mounted in the CPU cabinet and the SCSI subsystem mounted in a separate cabinet.

To limit radiated interference, DEC completely encloses the components of their computers that generate or could conduct radio frequency interference (RFI) with a grounded metal shield (earth ground). When installing the UC03, nothing must be done that would reduce this shield's effectiveness. That is, when the UC03 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 which must be taken to maintain the integrity of the shield and to limit conducted interference are explained fully in the following subsections:

Subsection	Title
4.12	Subsystem Cabling

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 UC03 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 shipping invoice. Paragraph 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 UC03 HOST ADAPTER INSPECTION

Visually inspect the UC03 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 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 UC03. 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 place before beginning the installation of the UC03. This allows the SCSI cable routing and length to be accurately judged. If more than one subsystem is being connected to the UC03, place them side-by-side to make daisy-chaining the SCSI cable simpler. 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 subsystem may contain more than one controller). To determine the address that each controller should be assigned, the user must first decide on the particular configuration that will be used (see subsection 4.5.4). 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 4-7. Take care that no two controllers are assigned the same address.

4.3.3 PERIPHERAL (DRIVE) UNIT NUMBERS

Some peripherals, such as the ATASI and MAXTOR disk drives, must have unit numbers assigned to them during installation. To determine the unit number that each drive should be assigned, check the Drive UN (logical unit number) column of Table 4-7. Use the row that corresponds to the configuration that you are using. Check the manual supplied with the drive for instructions on how program the unit number into the drive.

4.3.4 SCSI TERMINATION

The last controller on the SCSI bus must electrically terminate the bus. Most SCSI controllers provide termination as an option. See the controller or subsystem manual for instructions. Disable this option if the controller is not the last device on the bus.

4.4 SYSTEM PREPARATION

To prepare your CPU to accept the UC03, use the following procedures:

MicroPDP/VAX Preparation:

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

2. Remove the rear cover from the chassis so that 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 screws from the patch panel using a standard screwdriver. Save the screws for re-assembling the system.

4. Remove the patch panel.

5. Find the flat-ribbon cable which connects the CPU module to the patch panel. (The CPU module is always in the first backplane slot.) Diconnect 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 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 UC03 Host Adapter before inserting it into the chassis. These are made by option switches SW1 and SW2.

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

NOTE

If a switch position is changed on the UC03, either reset the unit using switch SW1-1 or remove and restore the unit's power. This reset is required because the switches are read by an initialization routine in the unit's firmware.

Table 4-1 defines the function and factory configuration of all switches on the UC03 controller. The factory configuration switch settings are representative of most UC03 Host Adapter applications.

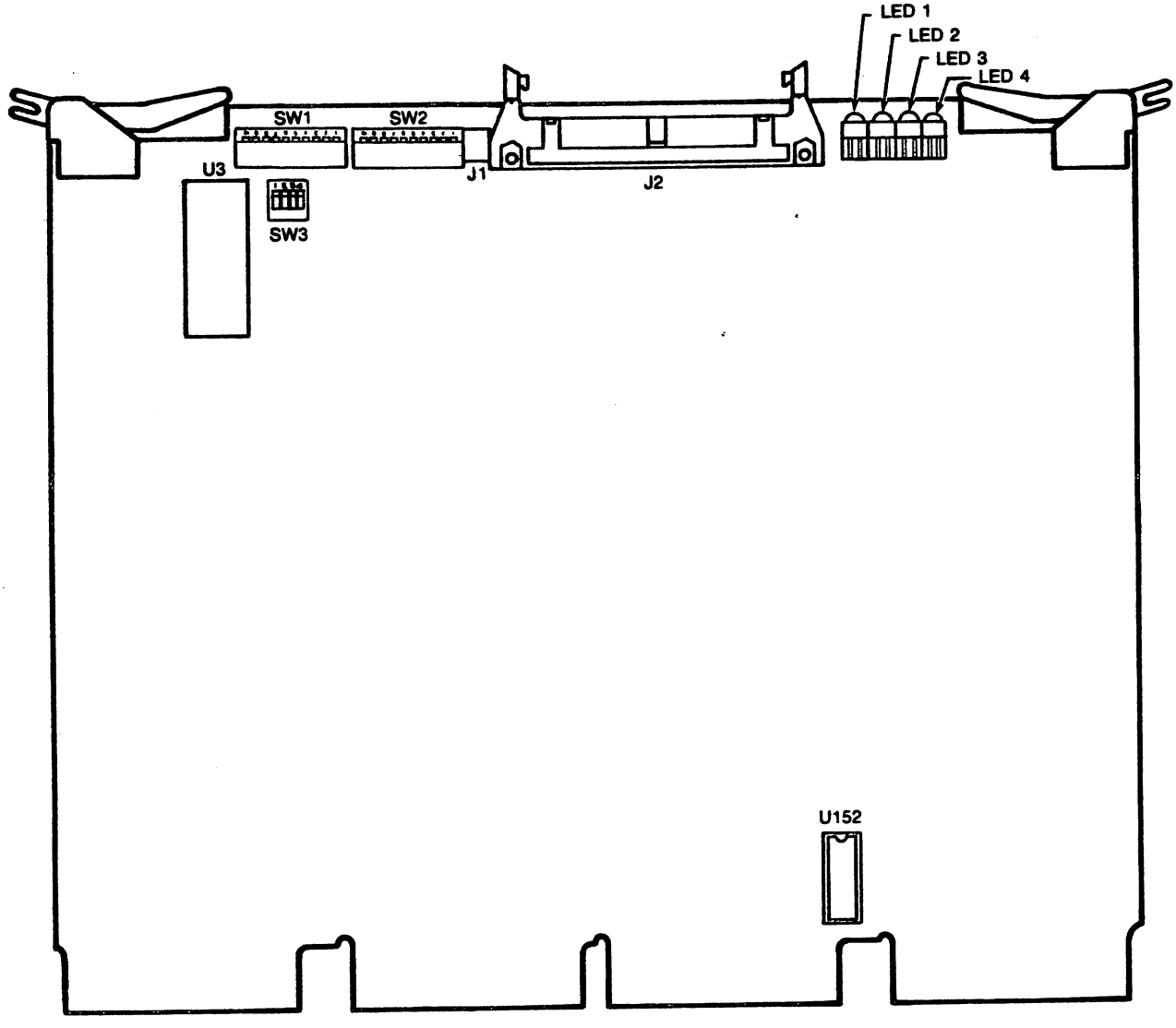


Figure 4-3. UC03 Host Adapter Assembly

Table 4-1. UC03 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)	Autoboot	4.5.5.1
SW1-3	Zero	One	OFF(0)	Unit to Autoboot From	4.5.5.2
SW1-4	-	-	NS	Host Adapter LSI Bus Address	4.5.1
SW1-5	-	-	NS	Host Adapter LSI Bus Address	4.5.1
SW1-6	-	-	NS	Subsystem Configuration	4.5.4
SW1-7	-	-	NS	Subsystem Configuration	4.5.4
SW1-8	-	-	NS	Subsystem Configuration	4.5.4
SW1-9	-	-	NS	Subsystem Configuration	4.5.4
SW1-10	-	-	NS	Subsystem Configuration	4.5.4
SW2-1	-	-	OFF(0)	First LUN on Alternate UC03	4.5.5.3
SW2-2	-	-	OFF(0)	First LUN on Alternate UC03	4.5.5.3
SW2-3	Disable	Enable	OFF(0)	Disconnect/Reconnect	4.5.5.4
SW2-4	772150	772154	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	OFF(0)	Twenty-Two-Bit Addressing	4.5.5.5
SW2-7	-	-	OFF(0)	Host Adapter SCSI Address	4.5.3
SW2-8	-	-	OFF(0)	Host Adapter SCSI Address	4.5.3
SW2-9	-	-	OFF(0)	Host Adapter SCSI Address	4.5.3
SW2-10	-	-	OFF(0)*	Hardware Configuration	
SW3-1	-	-	OFF(0)	Not Used	
SW3-2	-	-	OFF(0)	Not Used	
SW3-3	-	-	OFF(0)	Not Used	
SW3-4	-	-	OFF(0)	Not Used	

ON(1) = Closed
OFF(0) = Open
* = Switch must be in factory setting
NS = no standard
FACT = Factory switch setting

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 UC03's two LSI-11 Bus registers is selected by DIP switch SW2-4. See Table 4-2 for register address switch settings.

Table 4-2. Controller Address Switch Settings

CSR Address	-SW1- 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 UC03 is programmed into the device by the operating system during power-up. See subsection 3.x for a discussion of device configuration.

4.5.3 HOST ADAPTER SCSI ADDRESS

The UC03 must be assigned a SCSI address. This address is programmed into the UC03 using switches SW2-7 to SW2-9. See Table 4-3. for switch setting information.

Table 4-3. UC03 SCSI Address Selection

SCSI Address	- SW2 - 7	8	9	Fact	SCSI Address	- SW2 - 7	8	9	Fact
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	✓

Fact = Factory

4.5.4 SUBSYSTEM CONFIGURATION SELECTION

The UC03 Host Adapter must have the characteristics of the disk or tape subsystem(s) to which it is connected specified using switches. Switches SW1-4 through SW1-10 are used for that purpose. Use the following procedure to determine the proper configuration for your subsystem.

1. Find the type of disk you wish to use in that Table 4-4. Both the Adaptec ACB-4000 and the Emulex Medalist can support two drives per controller, but both drives must be of the same type. Note down the configuration numbers associated with the selected drive type.

2. If you want to include a tape transport in your subsystem, consult Table 4-5 for the transport types that are supported by the UC13. The UC13 supports only the Emulex Titleist family of SCSI tape transport controllers. Note down the configuration numbers associated with the selected transport type.

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. Look up the configurations that you have listed in step 3 in Table 4-7. Table 4-7 fully describes the subsystem that the UC13 supports when that configuration is selected. Select the configuration that best suits your application. Table 4-7 has eight columns. Those columns are described below.

   Column 1 (Config Number), is used to make cross referencing between the configuration and type tables easier.

   Column 2 (Drive Key), indicates the type of drive supported by this configuration.

   Columns 3 (SCSI Address), 4 (Drive LUN), and 5 (MSCP Unit), relate to the number of drives supported by the UC13. The SCSI address in column three must be programmed into the disk or tape controller. Each address corresponds to one controller and each controller can support one or two physical drives (LUNs--Logical Unit Numbers). In addition, each LUN 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), so both controllers must therefore be either Emulex Medalists or Adaptec 4000s or 5000s (see Table 4-6). The controller at SCSI Address 0 supports two physical drives (LUN 0 and 1) and the controller as SCSI Address 5 supports one physical drive (LUN 0). The MSCP unit number 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 transport at SCSI Address 4 is type 104 (Cipher 540), which requires an Emulex Titleist controller. It is MSCP unit number 3.

EXAMPLE 2: Refer to configuration 9. This configuration supports only one controller, at SCSI Address 0. It is drive type 100 (Atasi 3046), so the controller must be either an Emulex Medalist or an Adaptec 4000 or 5000 (see Table 4-6). 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 transport at SCSI Address 4 is type 104 (Cipher 540), which requires an Emulex Titleist controller. It is MSCP unit number 2.

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, since the UC13 does not report the presence of tape transports to the operating system.

If the UC03 is located a non standard CSR address (not 772150), then you must specify an MSCP Unit number offset (see subsection 4.5.5.3). To obtain the correct MSCP Unit number for a given confiruation, add the offset to the unit number given in column 5.

Column 6 (MSCP Unit Capacity), is the capacity of the logical MSCP unit. So, a physical drive with a capacity of, say, 70000, could be split into two logical drives (as in example two), each with an MSCP Unit Capacity of 35000.

Column 8 (Rev Level), is the revision level of the firmware which 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 eight.

5. When you have decided on a configuration, set UC13 switches SW1-6 through SW1-10 as indicated for that configuration.

Table 4-4. Disk Drive Type

Manufacturer	Model	Drive Key	Formatted Capacity	Configuration
Atasi	3046	100	31.2	01, 05, 09, 13, 17, 21, 25, 29
Fujitsu	M2243AS	101	70	03, 07, 11, 15, 19, 23, 27, 31
Maxtor	XT1140	102	110	02, 06, 10, 14, 18, 22, 26, 30
IOMEGA	Alpha-10.5	103	10.5	01, 02, 03, 16
Rodime		105		20, 28

Table 4-5. Tape Transport Type

Manufacturer	Model	Drive Key	Formatted Capacity	Configuration
Cipher	540	104	Varies	05, 06, 07, 09, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31

Table 4-6. SCSI Controller Type

Manufacturer	Model	Units Supported
Emulex	Medalist MD01	100, 101, 102, 105
Adaptec	4000, 5000	100, 101, 102, 105
IOMEGA	Alpha-10.5	103
Emulex	Titleist MT01, MT02	104

Table 4-7. Drive Configuration

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	SW1 6	7	8	9	10	Rev Level
01	100 103	0 1	0 0	0 1	71747 20002	0	0	0	0	1	A
02	102 103	0 1	0 0	0 1	219283 20002	0	0	0	1	0	A
03	101 103	0 1	0 0	0 1	131939 20002	0	0	0	1	1	A
05	100 100 104	0 4	0 1 0	0 1 2	71747 71747 Varies	0	0	1	0	1	A
06	102 102 104	0 4	0 1 0	0 1 2	219283 219283 Varies	0	0	1	1	0	A

continued next page

Table 4-7. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	---- SW1 ----- 6	7	8	9	10	Rev Level
07	101 101 104	0 4	0 1 0	0 1 2	131939 131939 Varies	0	0	1	1	1	A
09	100 104	0 4	0 0	0 1 2	35746 35746 Varies	0	1	0	0	1	A
10	102 104	0 4	0 0	0 1 2	109378 109378 Varies	0	1	0	1	0	A
11	101 104	0 4	0 0	0 1 2	65774 65774 Varies	0	1	0	1	1	A
13	100 104	0 4	0 0	0 1 2	62556 8936 Varies	0	1	1	0	1	A
14	102 104	0 4	0 0	0 1 2	191412 27334 Varies	0	1	1	1	0	A
15	101 104	0 4	0 0	0 1 2	115105 16443 Varies	0	1	1	1	1	A
16	103 104	1 4	0 0	0 1	20002 Varies	1	0	0	0	0	A
17	100 104	0 4	0 0	0 1	71747 Varies	1	0	0	0	1	A
18	102 104	0 4	0 0	0 1	219283 Varies	1	0	0	1	0	A
19	101 104	0 4	0 0	0 1	131939 Varies	1	0	0	1	1	A
20	105 105 105 104	0 5 4	0 1 0 0	0 1 2 3	81665 81665 81665 Varies	1	0	1	0	0	A

continued next page

Table 4-7. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	---- SW1 ----- 6	7	8	9	10	Rev Level
21	100	0	0	0	71747	1	0	1	0	1	A
	100		1	1	71747						
	100	5	0	2	71747						
	104	4	0	3	Varies						
22	102	0	0	0	219283	1	0	1	1	0	A
	102		1	1	219283						
	102	5	0	2	219283						
	104	4	0	3	Varies						
23	101	0	0	0	131939	1	0	1	1	1	A
	101		1	1	131939						
	101	5	0	2	131939						
	104	4	0	3	Varies						
25	100	0	0	0	71747	1	1	0	0	1	A
	100	5	0	1	71747						
	104	4	0	2	Varies						
26	102	0	0	0	219283	1	1	0	1	0	A
	102	5	0	1	219283						
	104	4	0	2	Varies						
27	101	0	0	0	131939	1	1	0	1	1	A
	101	5	0	1	131939						
	104	4	0	2	Varies						
28	105	0	0	0	81665	1	1	1	0	0	A
	105	5	0	1	81665						
	105	2	0	2	81665						
	104	4	0	3	Varies						
29	100	0	0	0	71747	1	1	1	0	1	A
	100	5	0	1	71747						
	100	2	0	2	71747						
	104	4	0	3	Varies						
30	102	0	0	0	219283	1	1	1	1	0	A
	102	5	0	1	219283						
	102	2	0	2	219283						
	104	4	0	3	Varies						

continued next page

Table 4-7. Drive Configuration (continued)

Config Number	Drive Key	SCSI Addr	Drive LUN	MSCP Unit	MSCP Unit Capacity	---- SW1 ----- 6	7	8	9	10	Rev Level
31	101	0	0	0	131939	1	1	1	1	1	A
	101	5	0	1	131939						
	101	2	0	2	131939						
	104	4	0	3	Varies						

0 = OFF, open
1 = ON, closed
Config = Configuration
Cntrl = Controller
Addr = Address
LUN = Logical Unit Number

4.5.5 OPTIONS

There are other UC03 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 logical unit zero or one on power-up or reset. To enable this option, set SW1-2 ON(1).

Switch	OFF	ON	Factory
SW1-2	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
11/73	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 UC03 halts the CPU

after one minute. This causes the CPU to enter Console ODT. You can then examine the SA register for an error code (see Table 5-2 for a list of error codes) boot the system from an alternate device, etc.

4.5.5.2 Logical Unit to Autoboot From

This switch allows the user to select either logical unit zero or one as the unit from which to boot when autoboot is enabled (SW1-2 ON).

Switch	OFF	ON	Factory
SW1-3	Zero	One	OFF

4.5.5.3 First Logical Unit Number for a UC03 at an Alternate Address

The UC03 can be installed as a second MSCP Server at an alternate LSI-11 Bus address (772154). MSCP requires that no two MSCP drive have the same MSCP Unit number, even though the units may be attached to different Servers at differnet CSR addresses.

SW2-1 and SW2-2 allow you to specify the MSCP Unit number of the first drive on the UC03 when your UC03 is being installed as a second MSCP Server (at an alternate LSI-11 Bus address). You may specify an Unit number that is contiguous with the last Unit number supported by the MSCP Server at the primary LSI-11 Bus Address (772150), or you may leave a gap. See Table 4-8 for switch settings.

EXAMPLE: Your system has two UC03 Host Adapters. The first UC03 is at the primary LSI-11 Bus address for MSCP Servers, 772150, and it supports two drives, Unit 0 and Unit 1. The second UC03 is at the alternate LSI-11 Bus address, and it also supports two drives. According to MSCP, these two drives must have Unit numbers of 2 or greater. Set SW2-1 OFF (0) and SW2-2 is ON (1) on the second UC03 to specify a LUN of two for the first drive.

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

Table 4-8. First LUN for a UC03 at an Alternate LSI-11 Bus Address

Starting MSCP Unit Number	SW-2 1 2	Factory
1	1 0	
2	0 1	
3	1 1	
4	0 0	✓

4.5.5.4 Disconnect/Reconnect

When ON(1), SW2-3 selects the Disconnect/Reconnect option for the UC03. With one exception, Emulex recommends selecting this option if any of the SCSI controllers in the subsystem support or tolerate it.

All Emulex SCSI controllers support this option, and the Adaptec ACB-4000 tolerates it. Select this option if your subsystem contains all Emulex controllers or a combination of Emulex and Adaptec ACB-4000 controllers. Do **NOT** use this option if the subsystem contains an IOMEGA Alpha-10 as it is severely confused by the UC03's attempts to use this option.

Switch	OFF	ON	Factory
SW2-3	Disable	Enable	OFF

Disconnect/reconnect is an optional feature of the SCSI protocol. In subsystems that have more than one SCSI controller, the option allows the Host Adapter to start commands in more than one SCSI controller. This is possible because on lengthy commands such as seeks, the SCSI controller can disconnect from the Host Adapter to free up the SCSI bus. With the bus free, the Host Adapter is able to use the bus to command another SCSI controller. That controller too may disconnect and so on. When a SCSI controller is ready to continue a command, it reconnects to the Host Adapter. The disconnect/reconnect option ensures efficient use of the SCSI bus and provides maximum overall subsystem throughput.

4.5.5.5 22-Bit Memory Addressing

Twenty-two-bit addressing capability is a standard option for the UC03. To enable 22-bit addressing, install the single AMD8641 IC provided with the host adapter in socket U152 on the UC03 PCBA and set SW2-6 ON (1).

WARNING

Some manufacturers of LSI-11 Bus backplanes use the backplane lines now devoted to extended addressing for power distribution. Installing an UC03 with the extended addressing option in such a system will damage the option IC. Before installing the option confirm that there is neither positive nor negative potential between lines BC1, BD1, BE1, BF1 and logic ground. An UC03 without the addressing option will not be damaged if power is present on those lines.

4.6 PHYSICAL INSTALLATION

4.6.1 SLOT SELECTION

The UC03 may be assigned to any desired slot since it uses the LSI four-level interrupt scheme to perform distributed interrupt arbitration. There must be no unused slots, however, between the CPU and the UC03.

4.6.2 MOUNTING

The Host Adapter PWB 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 in the throat of the connector before attempting to seat the board by means of the extractor handles.

4.7 CABLING

The UC03 Host Adapter interfaces with the SCSI Bus through J2, 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 UC03, or you may use one of the three cabling kits manufactured by Emulex. The cabling kits are designed to ease the installation of the UC03 in common DEC CPU cabinets, and to keep the radiation of electromagnetic interference (EMI) with in the limits specified by FCC regulations.

As noted in subsection 4.1.2, the UC03 and SCSI subsystem can be installed in two configurations:

1. With the UC03 Host Adapter and the SCSI subsystem that it supports both mounted in the same cabinet, and

2. With the UC03 mounted in the CPU cabinet and the SCSI subsystem mounted in a separate cabinet.

The following paragraphs descibe the cabling of the UC03 and subsystem on that basis: same cabinet, separate cabinet. The separate cabinet installations rely on Emulex cabling kits to limit EFI and thus the procedures for installing the kits are desribed there.

4.7.1 SAME CABINET INSTALLATIONS

When the UC03 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 sheild the cable that carries the SCSI bus between the UC03 and the SCSI peripherals.

A custom 50-wire flat cable can be constructed to connect J2 to the SCSI peripherals. See Table 8-3 for J2 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 UC03 and LSI-11 CPU are installed was manufactured before 1 October 1983, it may not provide sufficient sheilding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsiblity to take what ever steps are necessary to correct the interference.

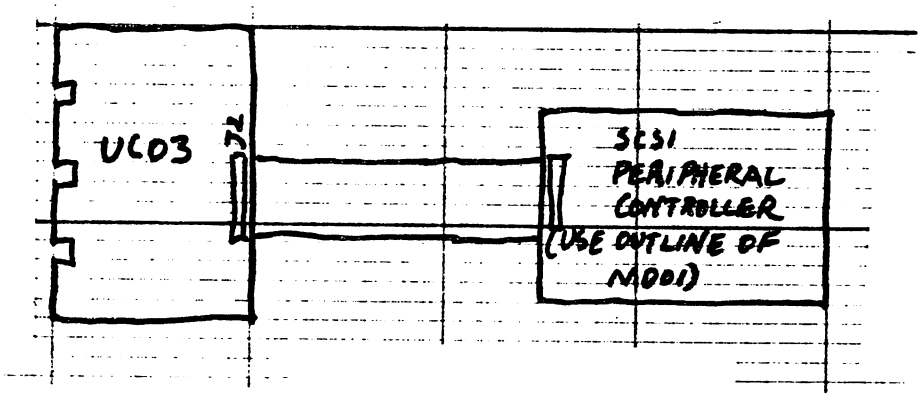


Figure 4-4. UC03 Cabling Diagram

4.7.2 SEPARATE CABINETS

If the SCSI peripheral subsystem is mounted in a separate cabinet from the UC03 Host Adapter, then the cable that connects the SCSI peripheral to the UC03 must be shielded since it runs outside of the shielded cabinet environment.

Emulex makes three cabling kits that adapt shielded cables to the SCSI interface of the UC03 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 manuafactured by Emulex. Each kit contains the all of the hardware necessary to complete an installation.

The cable kits are described in Table 4-9 and illustrated in Figures 4-5, 4-6, and 4-7. Note that each kit can be ordered with SCSI cables in various lengths; in the Universal RETMA mount kit (3), the flat cables can also be ordered in a varity of lengths.

Table 4-9. Cabling Kits

Item	Part Number	Cable Lengths (in feet) SCSI	Flat	Description
1.	PU0213001-01 PU0213001-02 PU0213001-03 PU0213001-04	5 10 15 20	1 1 1 1	MicroPDP/VAX Cable Kit for Micro chassis patch panels. Includes items 1, 2 in Figure 4-5.
2.	PU0120105	NA	NA	Micro PDP, VAX Patch Panel. Required for installation of Emulex CP24 Distribution Panel and UC03/TC05 Controllers. Ordered in addition to Micro Kit. Includes items 3, 4 in Figure 4-5 (cable assembly shown in item 4 is from Micro Kit).
3.	PU0113003-01 PU0113003-02 PU0113003-03 PU0113003-04 PU0113003-05 PU0113003-06 PU0113003-07 PU0113003-08 PU0113003-09 PU0113003-10	5 10 15 20 5 10 15 20 5 10	1 1 1 1 3 3 3 3 6 6	Rack mount cable kit for universal RETMA rack mount applications. Includes items 1, 2, 3 in Figure 4-6.

continued next page

Table 4-9. Cabling Kits (continued)

Item	Part Number	Cable Lengths (in feet) SCSI	Flat	Description
3.	PU0113003-11	15	6	
	PU0113003-12	20	6	
	PU0113003-13	5	9	
	PU0113003-14	10	9	
	PU0113003-15	15	9	
	PU0113003-16	20	9	
4.	PU0113004-01	5	1	LSI-11/23 Chassis Mount Kit for LSI-11/23 BC type chassis. Includes items 1, 2 in Figure 4-7.
	PU0113004-02	10	1	
	PU0113004-03	15	1	
	PU0113004-04	20	1	

The items listed in Table 4-9 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 MicroPDP/VAX Cabling Kits

The MicroPDP/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 MicroPDP/VAX Cable kit.

To install the Cable Kit in the Micro chassis, see Figure 4-6, and use the following procedure:

1. Align the header of the connector on the flat-ribbon cable with connector J2 on the UC03. Match the triangle marking on the header with the triangle marking on the J2 connector, as shown in Figure 4-5.

2. Seat the header in the J2 connector using the latches as shown in Figure 4-5.

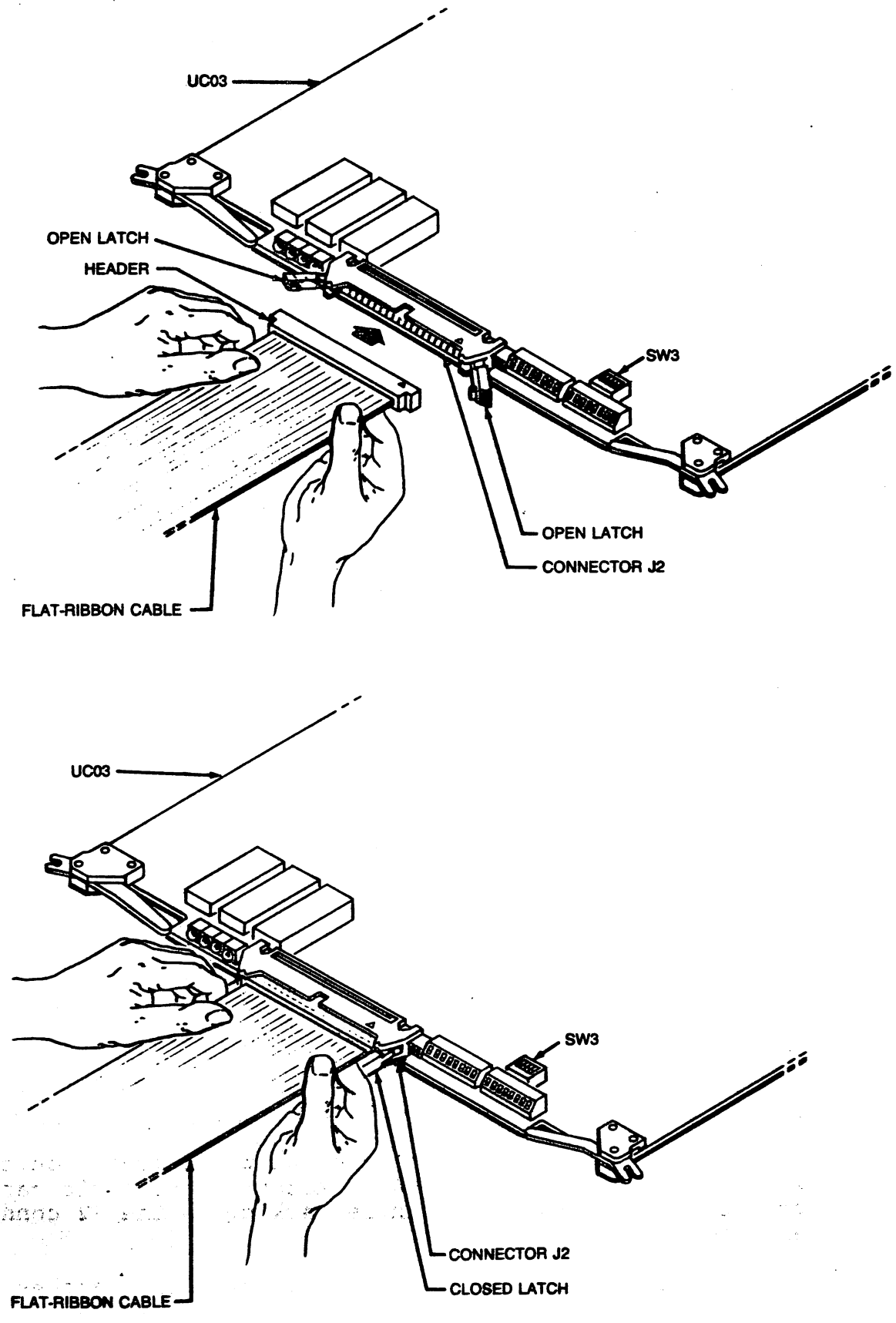


Figure 4-5. Plugging the Transadapter Flat Cable into J2.

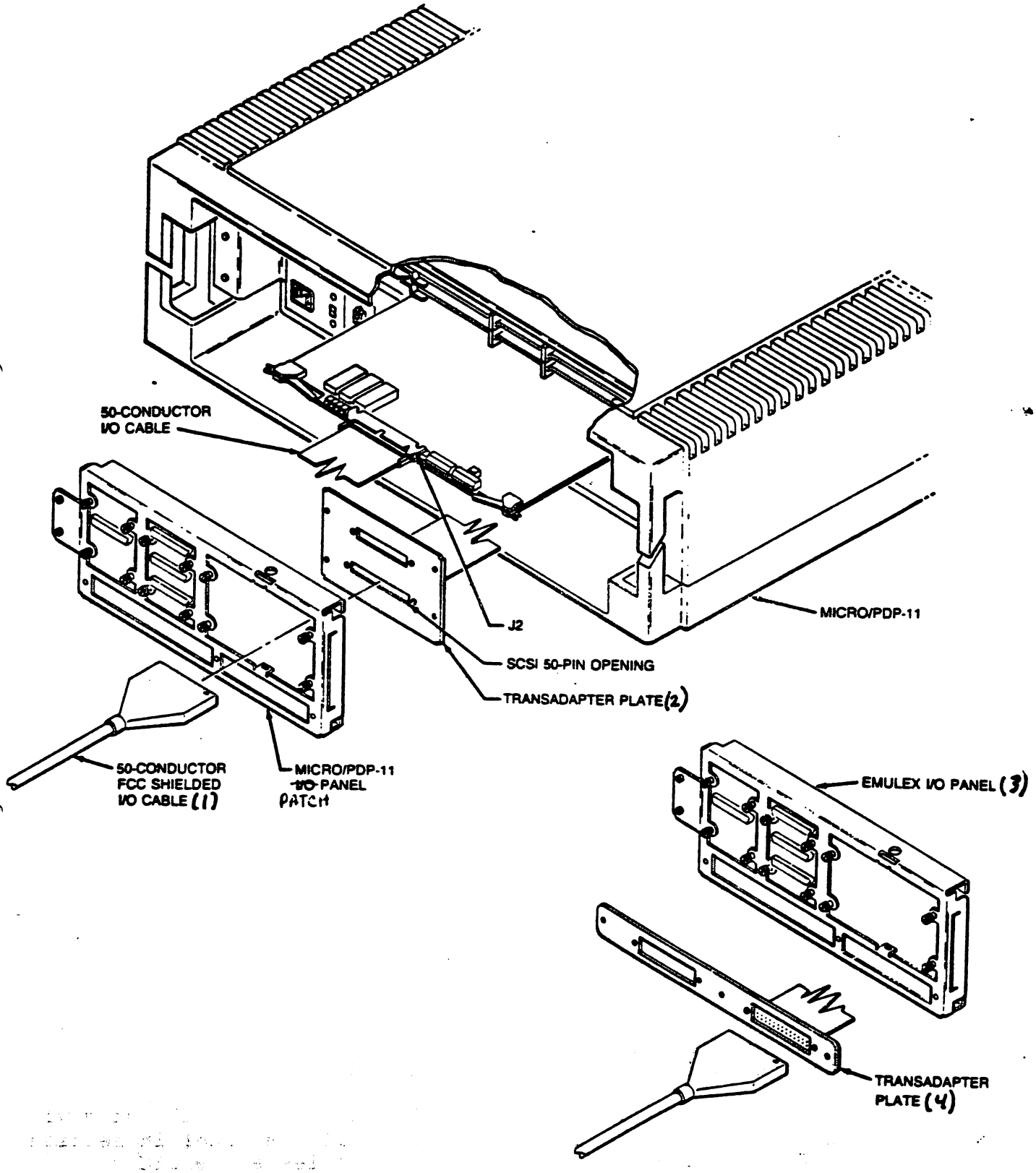


Figure 4-6. Installing the MicroPDP/VAX Cabling Kit

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 form 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.

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

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

6. Re-connect the flat-ribbon cable which connects the CPU module to the patch panel.

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.

If you are installing both a UC03 and an Emulex Communications Subsystem that uses the CP24 Distribtuion Panel, you will need the Emulex replacement for the DEC patch panel. The Emulex patch panel is designed to be used with the MicroPDP/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.

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 a 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 equivelent 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 MicroPDP/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 cab be used in any CPU cabinet that is based on the standard 19 inch RETMA rack. I t is particulary useful in 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 form the Transadapter can reach the UC03. (Transadapters are available with flat cables in four different lengths. See Table 4-9.) The rack should be wired to a good earth ground.

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

3. Align the header of the connector on the flat-ribbon cable with connector J2 on the UC03. Match the triangle marking on the header with the triangle marking on the J2 connector, as shown in Figure 4-5.

4. Seat the header in the J2 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.

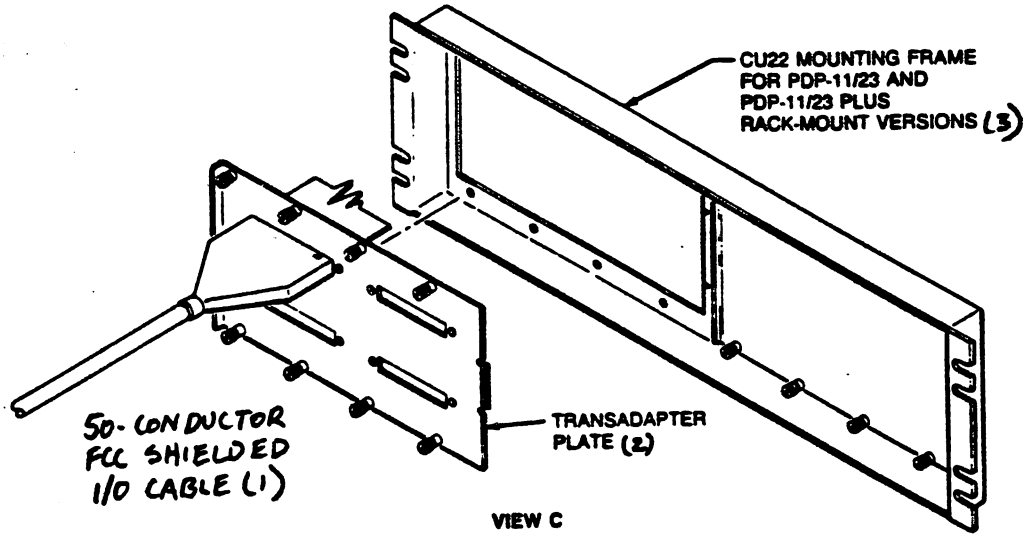


Figure 4-7. Installing the Universal Rack Mount Cabling Kit

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, reference 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 rectanglular, 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 J2 on the UC03. Match the triangle marking on the header with the triangle marking on the J2 connector, as shown in Figure 4-5.
4. Seat the header in the J2 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.

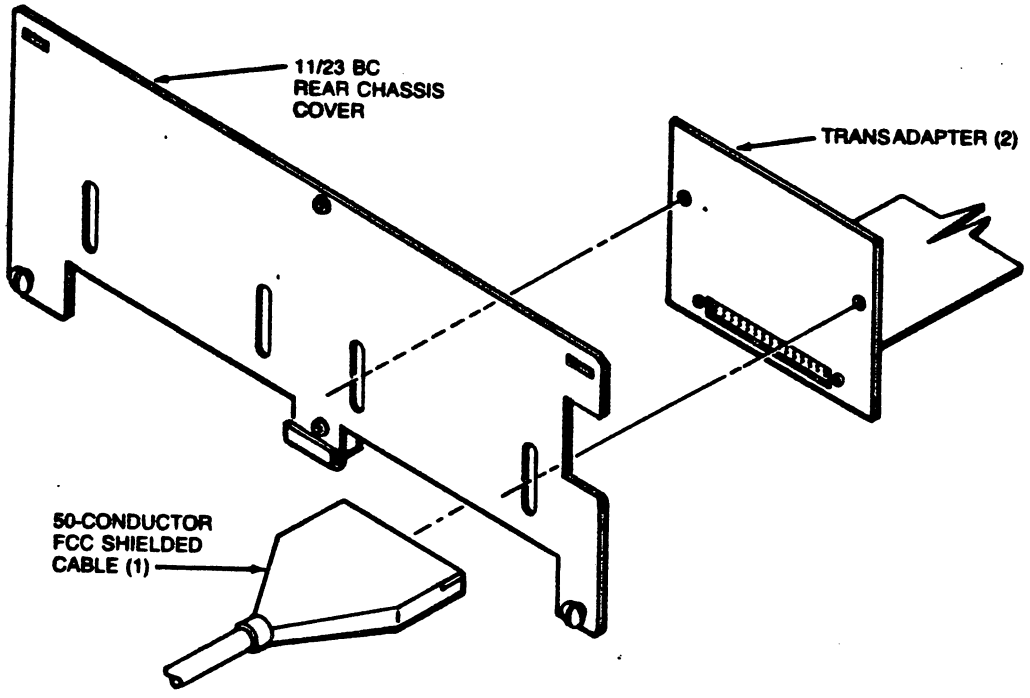


Figure 4-8. Installing the Chassis Mount Cabling Kit

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 TESTING

4.8.1 SELF-DIAGNOSTIC

When power is applied to the CPU, the Host Adapter automatically executes a built-in self-test (SW2-5 OFF). This self-test is executed with every bus INIT and on powering up. If the self-test has been executed successfully, LED1 and LED4 on the top edge of the Host Adapter PWB will be ON. When the host computer initializes the MSCP file server in the UC03, the UC03 will execute another self-test. If a fatal error is detected, all four of the edge-mounted LEDs will be illuminated.

During normal operation, LED1 and LED2 will flicker occasionally. These LEDs are use to indicate LSI-11 Bus activity and SCSI bus activity, respectively.

If the UC03 fails its power-up self-test (all LEDs illuminated), the operator can select a special diagnostic mode which causes the LEDs to display an error code. See Section 5, Troubleshooting.

4.8.2 FORMATTING

Before the UC03 can be used or diagnostics run, all disk peripherals attached to the subsystem must be formatted. The UC03 is provided with a Disk Formatter Utility from Emulex for that purpose. At this point in the installation process, run the Formatter Utility. The **UC03 Intelligent Host Adapter User's Guide** (UC0350901) explains how to load and run the program.

4.8.3 DIAGNOSTICS

If you have successfully formatted the drive(s), it is highly probable the the UC03 and it peripherals are fully functional. To add an additional level of confidence, however, you may run the Disk Reliability test provided by Emulex with the UC03. This program requires that the drive(s) be formatted before it can be run. The **UC03 Intelligent Host Adapter User's Guide** (UC0350901) explains how to load and run the program.

5.1 OVERVIEW

This section describes the several diagnostic features with which the UC03/M1 is equipped, and outlines fault isolation procedures that use these diagnostic features.

Subsection	Title
6.1	Overview
6.2	Fault Isolation Procedures
6.3	Power-Up Self-Diagnostics

5.1.1 SERVICE

Your Emulex UC03 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 UC03 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 of the United States, contact the distributer 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 setting should heve been made 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

This fault isolation procedure is provided in flow chart format. The procedure is based on the self-diagnostics incorporated into the UC03. The procedure is designed to be used if the products self-diagnostic fails or if many errors are flagged by the subsystem during normal operation. If neither of these events happen, it is not necessary to follow these procedures.

The Fault Isolation Chart is shown in Figure 5-1. The chart symbols are defined in Table 5-1.

If the fault isolation procedure indicates that a component needs to be returned to Emulex, see subsection 5.1.1 for instructions on how to do so.

Table 5-1. Flow Chart Symbol Definitions

Figure 5-1. Fault Isolation Chart (sheet 1 of 2)

Figure 5-x. Fault Isolation Chart (Sheet 2 of 2)

5.2.1 POWER-UP SELF-DIAGNOSTIC

The UC03 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 test that are performed on the internal components of the Host Adapter. These tests are executed immediately after power up or after a bus INIT. The UC03 indicates that the internal tests were executed successfully by turning LED1 and LED4 ON. The LEDs are located on the top edge of the Host Adapter PWB.

If the UC03 fails the first part of its power-up self-diagnostic, all are LEDs illuminated. To help determine the location of the problem, the operator can select a special diagnostic mode which 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 UC03 switch SW1-1 must be toggeled (turned ON and then OFF) to cause the UC03 to again perform its self-test. Upon encountering an error, the host microprocessor will halt and the LEDs will display an error code. The error codes are listed an described in Table 5-2.

Table 5-2. Error Codes

LED 4	3	2	1	Error Description
0	0	0	1	Addressing/Data Test on internal RAM failed
0	0	1	0	Push and Pop Stack Test failed
0	0	1	1	Logic Function Test failed
0	1	0	0	Addition and Subtraction Test failed
0	1	0	1	Multiplication and Division Test failed
0	1	1	0	RAM Bank Selection via PSW Test failed
0	1	1	1	Boolean Instruction Test failed
1	0	0	0	Untested 8031 Instruction Test failed
1	0	0	1	SCSI Protocol Controller Chip failed
1	0	1	0	Emulex Buffer Controller Test failed
1	0	1	1	External RAM Addressing and Data Test failed
1	1	0	0	Host Adapter Controller Test failed
1	1	0	1	External RAM Refresh Test failed
1	1	1	0	Checksum Test failed
0	0	0	0	Self-Diagnostic complete without errors Entering main program

The second part of the self-diagnostic is executed by the UC03 during its initialization by the MSCP port driver. These tests are more extensive and include tests of the SCSI interface and bus, the SCSI controllers and drives, the LSI-11 Bus interface, and the host computer memory. Any errors detected during the initialization process are reported to the operating system via the UC03 SA register. See **Storage System Unibus Port Description**, DEC document number AA-L621A-TK.

Section 6
DEVICE REGISTERS and PROGRAMMING

6.1 OVERVIEW

This section contains an overview of the UC03 device registers that are accessible to the LSI-11 Bus, and that are used to monitor and control the UC03 MSCP Server. The registers are functionally compatible with DEC implementations of MSCP Servers.

The following table outlines the contents of this section.

Subsection	Title
8.1	Overview
8.2	Multiplexer Operation
8.3	Controller Registers
8.4	Multiplexer Maintenance

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 subsystems 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 subsystem 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 subsystem 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 subsystem. Finally, the host is relieved of responsibility for error detection and correction because its knowledge of the media is insufficient to allow error control to be done efficiently.

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 subsystems are the same from the operating system's point-of-view.

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

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

In summary, an MSCP subsystem is characterized by and intelligent controller that provides the host with the 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 which the UC03 MSCP Server posts is beyond the scope of this manual. A comprehensive description of MSCP may be ordered from the 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)

The UC03 MSCP Server executes the Minimal Disk Subset of MSCP Commands. This subsection contains a description of the extra commands that the UC03 executes and a list of the MSCP functions that are not supported by the UC03 MSCP Server.

6.3.1 EXPANDED COMMANDS

The following subsection describes the MSCP-type commands that the UC03 MSCP Server executes in addition to the Minimal Disk Subset described in the **MSCP Basic Disk Functions Manual.**

6.3.1.1 SCSI Pass-Through Command

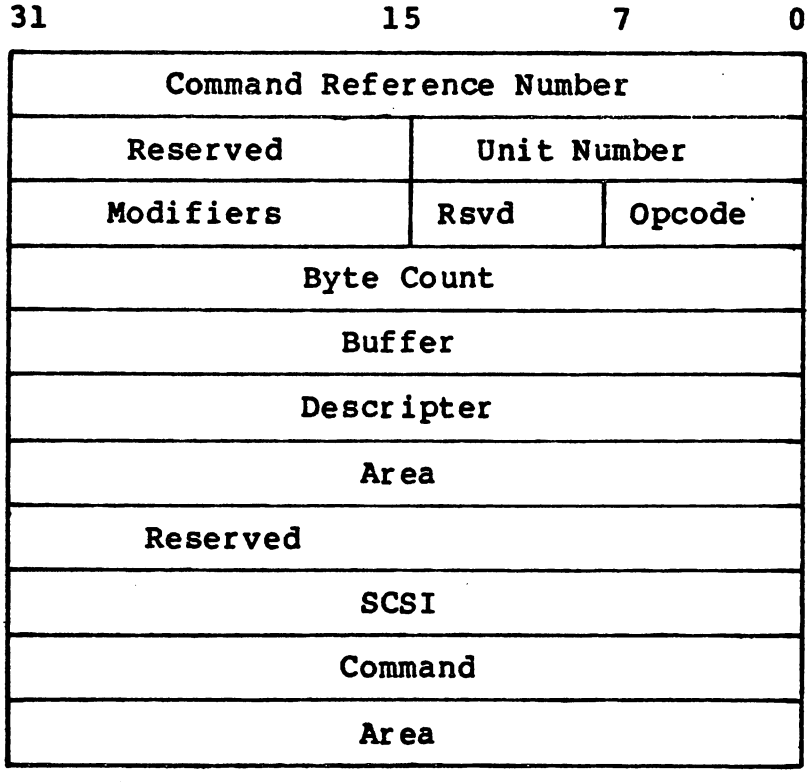
This command is used to pass a SCSI Command Packet generated on the host computer through the UC03 to the SCSI bus. The UC03 handles all SCSI bus phase control including the arbitration, selection, and information transfer phases. The optional reconnect feature is also supported by the UC03, and should a disconnect/reconnect cycle occur during the execution of a SCSI command, the process is transparent to the host.

All SCSI command and status bytes/bits begin with the least significant byte/bit of the field which contains that SCSI data.

Command Category

??????

Command Message Format



Unit Number

Each physical peripheral device on the SCSI bus is referred to by a logical unit number (LUN). This field contains the LUN of the peripheral that is the target of the SCSI Command.

Opcode

The opcode for the SCSI Pass Through Command is 130_8, which is a subset of the Attention Message Codes. Attention Messages are only generated by MSCP Servers, so there is no conflict with the DEC MSCP Specification.

Modifiers

There are NO allowable modifiers for use with this command.

Byte Count

When a SCSI data transfer command (command indicators 105_8 and 106_8) is specified, this field indicates number of data bytes to be transferred.

Buffer Descriptor

When a SCSI data transfer command (command indicators 105_8 and 106_8) is specified, this field indicates the location of the first byte of data in host memory.

Data being transferred from the data buffer in host memory to a SCSI peripheral is fetched and transferred from the lowest numerical address in the buffer first. The first byte fetched becomes the first byte of the record. Data being transferred from the peripheral to host memory is deposited in the lowest numerical address in the buffer first. The first byte read from the record is the first byte transferred.

SCSI Command Area

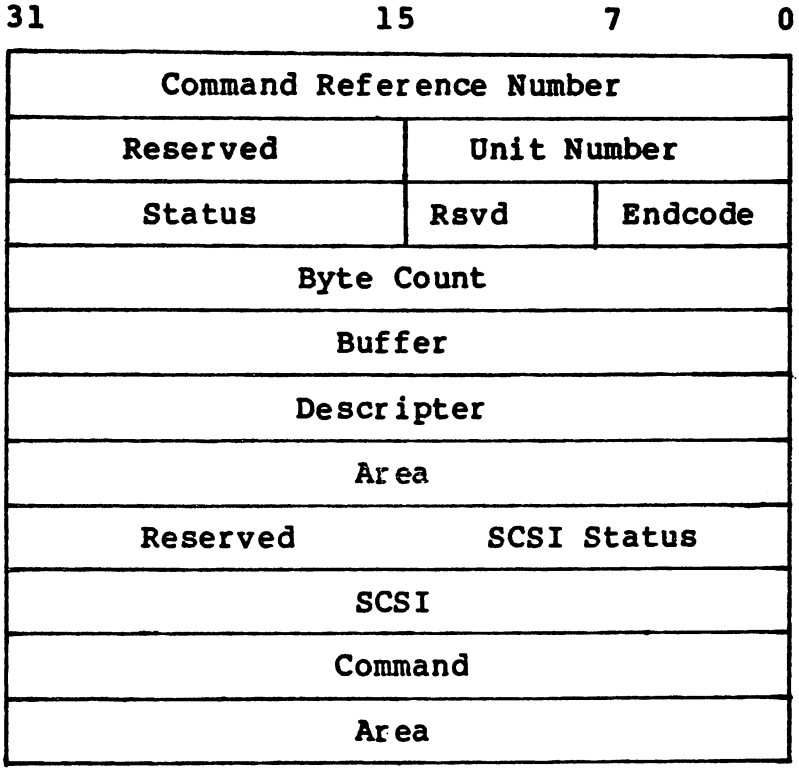
This field contains the SCSI Command that is to be passed through to the SCSI bus. See the ANSI SCSI Specification or appropriate SCSI controller technical manual for a description of the available commands and their format.

RSVD

This field, which is reserved under standard MSCP, is used to indicate whether or not the SCSI command is a data transfer command and, if so, the direction of the data transfer. The following table lists and describes the three possible command indicators.

Indicator (Octal)	Description
105	No data transfer
106	SCSI to host transfer
107	Host to SCSI transfer

End Message Format



Endcode

The endcode for this command is 230_8.

Status Codes

?????

SCSI Status

This field contains the two status bytes from the SCSI Completion Status Packet. See the ANSI SCSI Specification or appropriate SCSI controller technical manual for a description of the 16 bits in this field.

6.3.2 UNSUPPORTED COMMANDS

No currently available MSCP Server supports the entire range of MSCP commands. The following subsections list and describe the MSCP commands that the UC03 does not support.

6.3.2.1 Minimal Disk Subset

The UC03 MSCP Server does not support the commands listed in Table 6-1.

Table 6-1. Unsupported Minimal Disk Subset Commands

Opcode	Preferred Mnemonic 16 bit	32 bit	Description
24_8	OP.RPL	MSCP$K_OP_REPLC	REPLACE Command

6.3.2.2 Diagnostic and Utility Protocol (DUP)

The UC03 MSCP Server does not support any of the DUP commands or functions.

6.4 REGISTERS

During normal operation the UC03 MSCP Server is controlled and monitored using the command and status packets that are exchanged by the Class Driver (host) and the MSCP Server. The UC03 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 only used 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 as detailed below:

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 as listed below:

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-specfic 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.x. Note that only word transfers to/from IP and SA are permissible; the behavior of byte transfers is undefined.

6.4.1 BOOTSTRAPPING

To allow the system to be easily bootstrapped from peripherals attached to the UC03 Host Adapter, Emulex has incorporated a Bootstrap Command into the Adapter. This feature is not part of the standard MSCP command set.

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 UC03 PWB, but on some other module in the system.)

The Bootstrap Command causes the UC03 to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the UC03, load the SA register with the following values:

1. 30003_8

2. $4000x_8$, where x is the MSCP logical unit number (see Section 3).

No other operation can be performed between the loading of the two numbers. After issuing the command to the UC03, CPU registers R0 and R1 must be loaded with the unit number and the CSR address of the UC03, respectively.

Figure 6-1 is an example of the Bootstrap Command as issued from the system console under Console ODT. The UC03'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 UC03 registers must contain the indicated patterns. However, the patterns indicated for the contents of R0 and R1 are only examples; the initial contents of those registers (before the unit number and address are loaded) may be anything.

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

Figure 6-1. Bootstrap Command Example

7.1 OVERVIEW

This section contains a description of the UC03 Intelligent Host Adapter's architecture. The following table outlines the contents of this section.

Subsection	Title
4.1	Overview
4.2	UC03 Controller Architecture

7.2 UC03 HOST ADAPTER ARCHITECTURE

The UC03 is a microprocessor-based emulating host adapter which is located on a single quad PCBA. The UC03 has six major functional blocks as shown in Figure 7-1. The host adapter is organized around the eight-bit 8031 microprocessor. The board has an eight-bit internal data bus with 16-bit addressing capability. Both of the interface controllers and the DMA 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 DMA Controller for the large data transfers that are their specialties.

There are two 16k blocks of memory on the UC03: EPROM and 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 LSI-11 Bus Interface Controller is used for programmed I/O, CPU interrupts, and NPR 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 the Interface to conduct LSI-11 Bus NPR transfers without direct microprocessor intervention after the Interface is set up for a transfer. This auto NPR capability is used with the UC03 DMA Controller to transfer large blocks of data from host memory directly in to the UC03's RAM.

UC03 Host Adapter Architecture

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 DMA Controller is implemented on a single chip. This four-channel controller is responsible for moving large blocks of data between 16k RAM and the SCSI Interface, and between the LSI-11 Bus Interface and the 16k RAM. After being setup for an operation by the microprocessor, either interface requests DMA service by driving their individual DMA request signals active. The transfer then proceeds without direct supervision on the part of the microprocessor. This allows high speed data transfers to occur while the microprocessor is focused on other process.

8.1 OVERVIEW

This section describes the interfaces which the UC03 Intelligent Host Adapter incorporates. It includes information on the UC03 implementation of SCSI bus specification electrical and mechanical requirements. Excluding this overview, the section is divided into the following subsections.

Subsection	Title
8.2	UC03 LSI-11 Bus Interface
8.3	UC03 SCSI Bus Interface

8.2 LSI-11 BUS INTERFACE

The LSI-11 Bus between the LSI-11 CPU and the UC03 Host Adapter contains 42 bidirectional signal lines and two unidirectional signal lines on connectors A and B, and two unidirectional signal lines on connector C. LSI-11 Bus interface pin assignments are listed and described in Table 8-1. These signal lines provide the means by which the LSI-11 CPU and the UC03 Host Adapter communicate with each other. The LSI-11 Bus interface is used for programmed I/O, CPU interrupts, and NPR 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 (connectors A and C).

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

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

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

Connector A Signal			Connector B Signal		
Component Side	Pin	Solder Side	Component Side	Pin	Solder Side
BIRQ5	A	+5V	BDCOK	A	+5V
BIRQ6	B		BPOK	B	
BDAL16	C	0V (GND)	BDAL18	C	0V (GND)
BDAL17	D		BDAL19	D	
	E	BDOUT	BDAL20	E	BDAL02
	F	BRPLY	BDAL21	F	BDAL03
	H	BDIN		H	BDAL04
0V (GND)	J	BSYNC	0V (GND)	J	BDAL05
	K	BWTBT		K	BDAL06
	L	BIRQ4		L	BDAL07
0V (GND)	M	BIAKI	0V (GND)	M	BDAL08
BDMR	N	BIAKO	BSACK	N	BDAL09
BHALT	P	BBS7	BIRQ7	P	BDAL10
BREF	R	BDMGI	BEVNT	R	BDAL11
	S	BDMGO		S	BDAL12
0V (GND)	T	BINIT	0V (GND)	T	BDAL13
	U	BDAL00		U	BDAL14
	V	BDAL01		V	BDAL15

Connector C Signal			Connector D Signal		
Component Side	Pin	Solder Side	Component Side	Pin	Solder Side
	A	+5V		A	+5V
	B			B	
	C	0V (GND)		C	0V (GND)
	D			D	
	E			E	
	F			F	
	H			H	
0V (GND)	J		0V (GND)	J	
	K			K	
	L			L	
0V (GND)	M	BIAKI	0V (GND)	M	
	N	BIAKO		N	
	P			P	
	R	BDMGI		R	
	S	BDMGO		S	
0V (GND)	T		0V (GND)	T	
	U			U	
	V			V	

All signals, except BDCOK and BPOK, are low active.

8.2.1 INTERRUPT PRIORITY LEVEL

The UC03 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 UC03 Host Adapter has two registers visible to the LSI-11 Bus. Their addresses are determined by DIP switch SW2-4. See Section 4 for detailed address and switch setting information.

8.2.3 DCOK AND INIT SIGNALS

The DCOK and INIT signals can each perform a Controller Clear operation. The Self-Test function is performed only when DC power is initially applied (Power-Up mode).

8.2.4 NPR 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 UC03n SCSI BUS INTERFACE

Information on the UC03 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 UC03 supports the SCSI specification single-ended option for drivers and receivers. The maximum cable length allowed is six meters (primarily for interconnection outside of the subsystem cabinet in which the UC03 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. Each SCSI bus connection must have a 0.1 meter maximum stub length. 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 UC03 single-ended pin assignments are shown in Table 8-2.

Table 8-2. UC03 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

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 UC03 SCSI Host Adapter interfaces to SCSI controllers via the SCSI bus. A 50-pin male IDC connector at location J2 on the UC03 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 8-1.

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

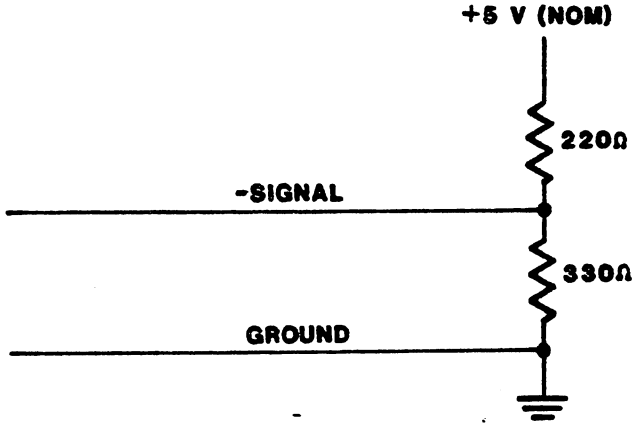


Figure 8-1. UC03 SCSI Bus Signals Termination

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 7.2.3.1.

<EN=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 8-3.

In Table 8-3, 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. All SCSI hosts/controllers on the bus generate parity and have parity detection enabled. Parity is not guaranteed valid during the Arbitration Phase.

The UC03 SCSI bus pin assignments are listed in Table 8-2; the UC03 supports only the SCSI single-ended option.

Table 8-3. 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 9.4.2.
RST	Reset	Indicates the RESET condition (i.e., clears the SCSI bus of all activity). The RESET condition is described in Subsection 9.4.1.

Continued next page

Table 8-3. 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) is 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 8-4.

The timing diagram shown in Figure 8-2 indicates the typical relationship between SCSI bus signals and SCSI phase sequencing.

Table 8-4. 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.

continued on next page

Table 8-4. 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 certain 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.

continued on next page

Table 8-4. 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		

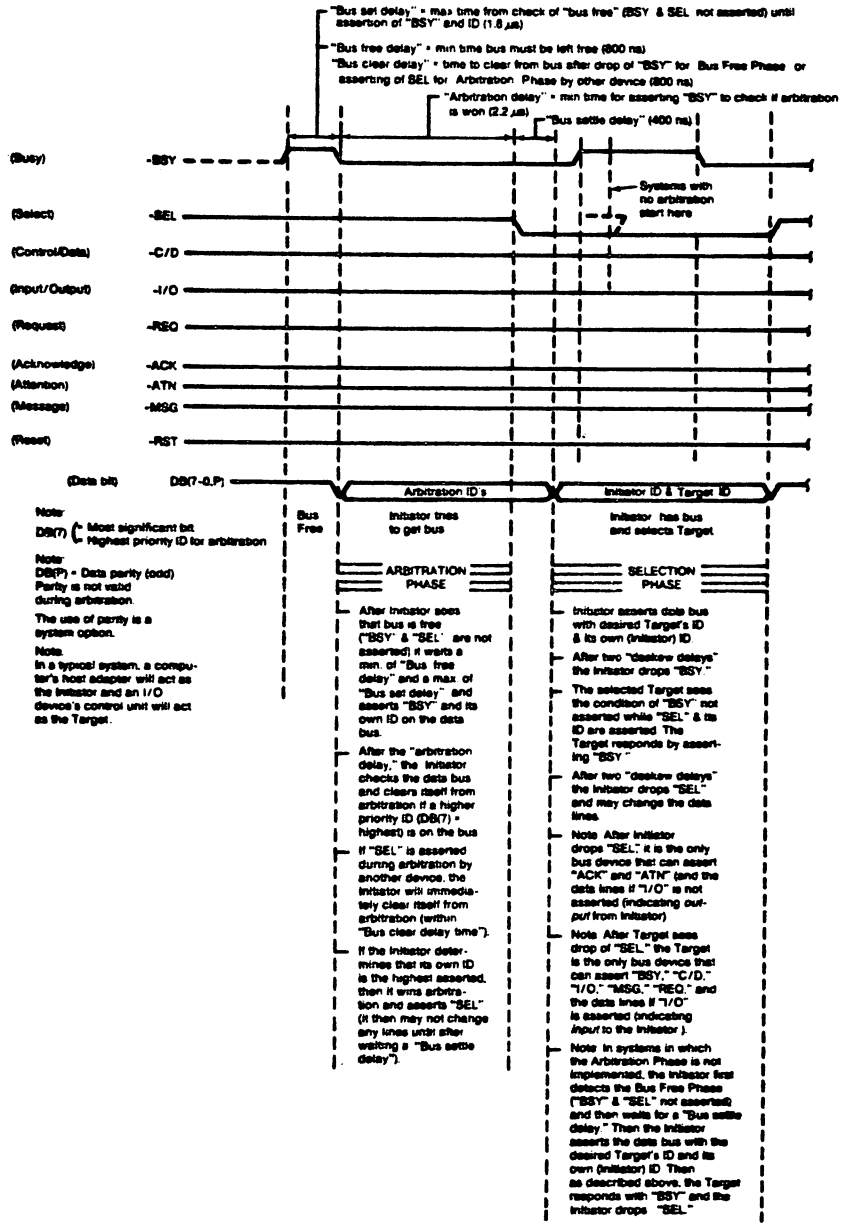


Figure 8-2. SCSI Bus Timing Diagram (Sheet 1 of 3)

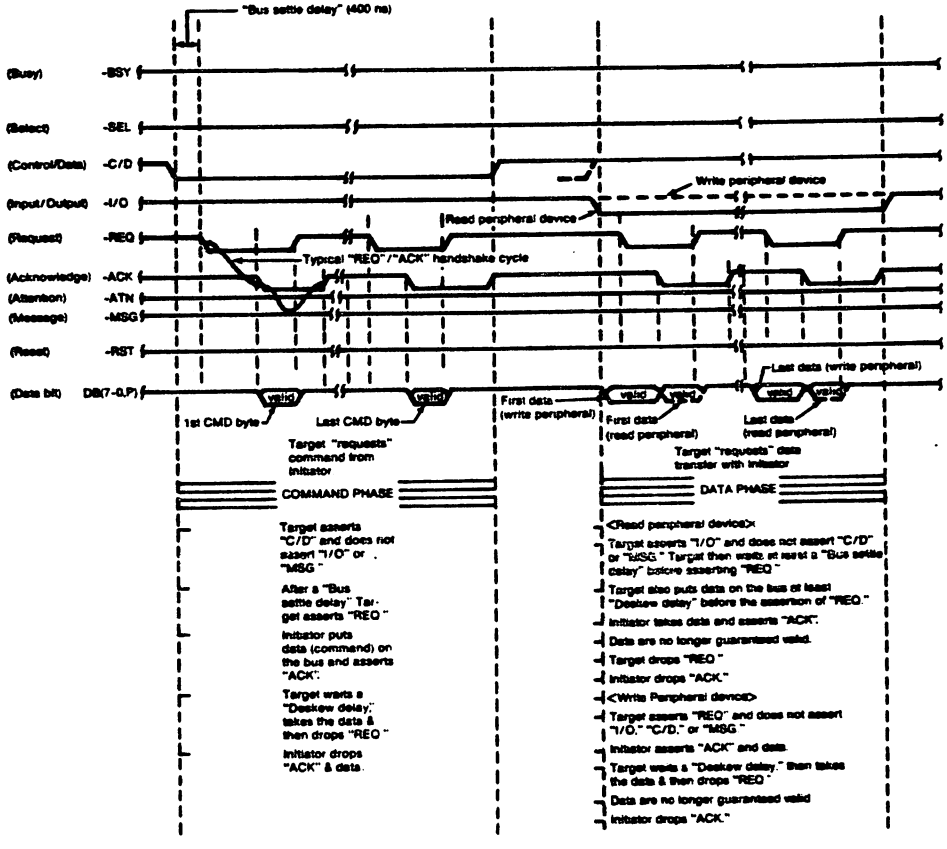


Figure 8-2. SCSI Bus Timing Diagram (Sheet 2 of 3)

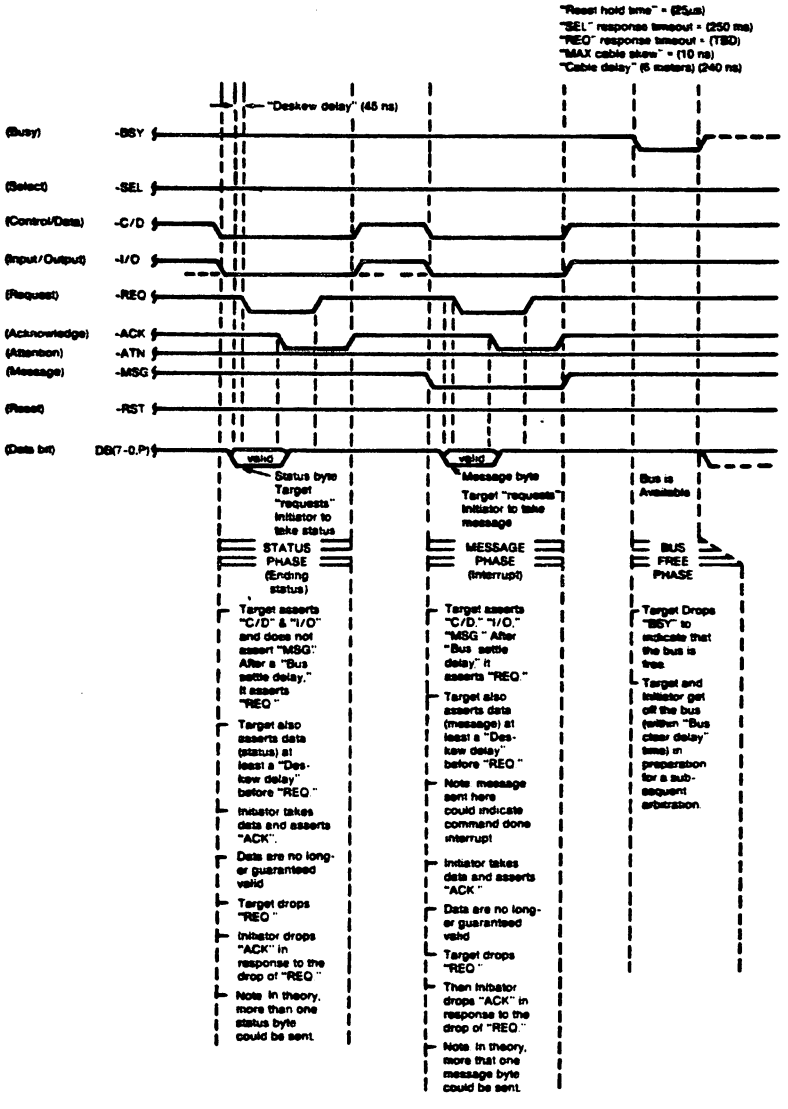


Figure 8-2. SCSI Bus Timing Diagram (Sheet 3 of 3)

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 queuing SCSI commands and for passing control and status information between SCSI bus hosts and controllers using SCSI memory address pointers. Excluding this overview, the section is divided into the following subsections.

Subsection	Title
9.2	SCSI Bus Overview
9.4	SCSI Bus Phase Sequencing
9.7	SCSI Bus Conditions

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 UC03 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 UC03 hardware supports any combination of host systems, intelligent controllers or intelligent peripherals. Three basic SCSI configurations are supported with the UC03 and 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 UC03 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 UC03) originates an operation and the Target (usually a peripheral controller) performs the operation. Sample system configurations supported by UC03 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.

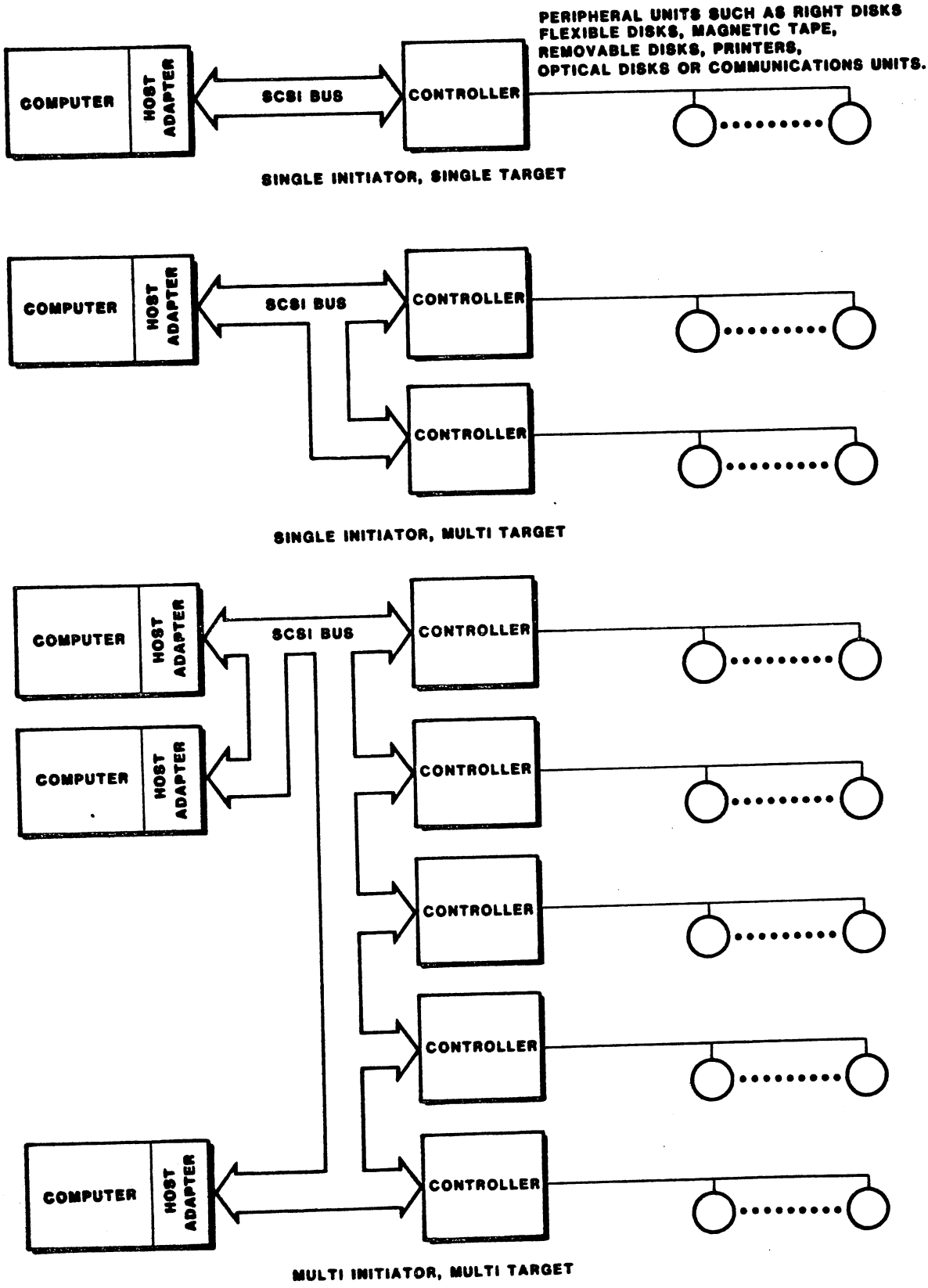


Figure 9-1. Sample SCSI Bus Configurations

9.3 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. The sequence is 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.

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 Phase. These phases include six types of information exchange; the phases are listed below.

- 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 the peripheral controller techncial manual.

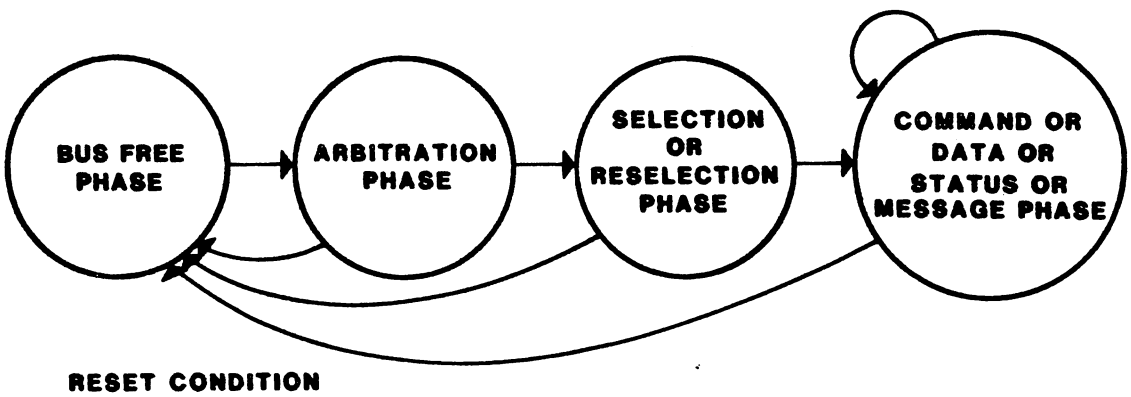


Figure 9-2. SCSI Bus Phase Sequences

9.4 SCSI BUS CONDITIONS

The SCSI bus has the following asynchronous conditions:

- Attention Condition
- Reset Condition

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

9.4.1 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 UC03 supports a "hard" reset option; when it detects a Reset Condition, the UC03 performs the following actions:

- clears all uncompleted commands,

- releases device reservations,
- returns device operating modes (such as the **MODE SELECT** command) to their default conditions.

The hard reset is the same as power-on in its effect on the UC03; all Initiator-defined parameters must be re-submitted to the UC03 controller.

9.4.2 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.

9.5 SCSI COMMANDS

The UC03 issues a subset of the total SCSI command set for sequentially accessed devices. These commands are listed in Table 9-1. All of these commands conform to the ANSI specification. Peripheral controllers intended for use with the UC03 must implement these commands per the ANSI SCSI Specification.

Table 9-1. UC03 SCSI Command Set

Command Code (hex)	Description
00	Test Unit Ready
01	Rezero Unit
03	Request Sense
04	Format Unit (extended)
07	Reassign Block
08	Read
0A	Write
0B	Seek
12	Enquiry
15	Mode Select
16	Reserve Unit
17	Release Unit
18	Copy
1A	Mode Sense
1B	Start/Stop
1C	Receive Diagnostic Results
1D	Send Diagnostic

Appendix A
AUTOCONFIGURE, CSR and VECTOR ADDRESSES

A.1 OVERVIEW

The following discussion presents the algorithm for assignment of floating addresses and vectors for all DEC operating systems. Bus addresses are discussed in subsection 3.3.2.

A.2 DETERMINING THE CSR ADDRESS FOR USE WITH AUTOCONFIGURE

The term Autoconfigure refers to a software utility that is run when the computer is bootstrapped. This utility finds and identifies I/O devices in the I/O page of system memory.

Some devices (like the DM11) have fixed addresses reserved for them. Autoconfigure detects their presence by simply testing their standard address for a response. Specifically, the control/status register (CSR) address, which is usually the first register of the block, is tested.

Addresses for those devices not assigned fixed numbers are selected from the floating CSR address space (760010 - 763776) of the Unibus input/output (I/O) page. This means that the presence or absence of floating devices will affect the assignment of addresses to other floating-address devices. Similarly, many devices have floating interrupt vector addresses. According to the DEC standard, vectors must be assigned in a specific sequence and the presence of one type of device will affect the correct assignment of vectors for other devices.

The CSR address for a floating-address device is selected according to the algorithm used during autoconfigure. The algorithm is used in conjunction with a Device Table, Table A-1.

Essentially, Autoconfigure checks each valid CSR address in the floating CSR address space for the presence of a device. Autoconfigure expects any devices installed in that space to be in the order specified by the Device Table. Also, the utility expects an eight-byte block to be reserved for each device that is not installed in the system. Each empty block tells Autoconfigure to look at the next valid address for the next device on the list.

When a device is detected, a block of addresses is reserved for the device according to the number of registers it employes. The utility then looks at the next CSR for that device type. If there is a device there, it is assumed to be of the same type as the one before it and a block is reserved for that device. If there is no response at the next address, that space is reserved to indicate that there

are no more devices of that type. Then the utility checks the CSR address (at the appropriate boundary) for the next device in the table.

Table A-1. SYSGEN Device Table

Rank	Device	Registers	Rank	Device	Registers
1	DJ11	4	15	LPA11	8
2	DH11	8	16	KW11C	4
3	DQ11	4	17	Reserved	4
4	DU11	4	18	RX211	4
5	DUP11	4	19	DR11W	4
6	LK11	4	20	DR11B	4
7	DMC11/DMR11	4	21	DMP11	4
8	DZ11	4	22	DPV11	4
9	KMC11	4	23	ISB11	4
10	LPP11	4	24	DMV11	8
11	VMV21	4	25	UNA	4
12	VMV31	8	26	UDA50	2
13	DWR70	4	27	DMF32	16
14	RL11	4	28	KMS11	8

In summary, there are four rules that pertain to the assignment of device addresses in floating address space:

1. Devices with floating addresses must be attached in the order in which they are listed in the Device Table, Table B-1.

2. The CSR address for a given device type is assigned on word boundaries according to the number of Unibus- accessible registers that the device has. The following table relates the number of device registers to possible word boundaries.

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

The Autoconfigure utility inspects for a given device type only at one of the possible boundaries for that device. That is, the utility does not look for a DMF32 (16 registers) at an address that ends in 20.

3. A gap must follow the register block of any installed device to indicate that there are no more of that type of device. This gap must start on the proper CSR address boundary for that type of device.

4. An gap must 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 word boundary for the type of device the gap represents. That is, 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.

A.3 DETERMINING THE VECTOR ADDRESS FOR USE WITH AUTOCONFIGURE

There is a floating vector address convention that is used for communications and other devices which interface with the Unibus. These vector addresses are assigned in order starting at 300 and proceeding upwards to 777. Table A-2 shows the assignment sequence. For a given system configuration, the device with the highest floating vector rank would be assigned to vector address 300. Additional devices of the same type would be assigned subsequent vector addresses according to the number of vectors required per device, and according to the starting boundary assigned to that device type.

Table A-2. Priority Ranking for Floating Vector Addresses (starting at 300 and proceeding upwards)

Rank	Option	Number of Vectors	Octal Modulus (address)
1	DC11	2	10
1	TU58	2	10(See Note 1)
2	KL11(extra)	2	10
2	DL11-A(extra)	2	10
2	DL11-B(extra)	2	10
3	DP11	2	10
4	DM11-A	2	10
5	DN11	1	4
6	DM11-BB	1	4
7	DH11modem control	1	4
8	DR11-A	2	10
9	DR11-C	2	10
10	PA611(reader+punch)	4	10

continued next page

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

Rank	Option	Number of Vectors	Octal Modulus (address)
11	LPD11	2	10
12	DT11	2	10
13	DX11	2	10
14	DL11-C	2	10
14	DL11-D	2	10
14	DL11-E	2	10
15	DJ11	2	10
16	DH11	2	10
17	GT20	4	10
17	VSV11	4	10
18	LPS11	6	10
19	DQ11	2	10
20	KW11-W	2	10
21	DU11	2	10
22	DUP11	2	10
23	DV11+modem control	3	10
24	LK11-A	2	10
25	DWUN	2	10
26	DMC11	2	10
26	DMR11	2	10
27	DZ11	2	10
28	KMC11	2	10
29	LPP11	2	10
30	VMV21	2	10
31	VMV31	2	10
32	VTV01	2	10
33	DWR70	2	10
32	RL11/RLV11	1	4(after the first)
35	RX02	1	4
36	TS11	1	4(after the first)
37	LPA11-K	2	10
38	IP11/IP300	2	4
39	KW11-C	2	10
20	RX11	1	4(after the first)
21	DR11-W	1	4
22	DR11-B	1	4(after the first)
23	DMP11	2	10
22	DPV11	2	10
25	ISB11	2	10
26	DMV11	2	10
27	UNA	1	4
28	UDA50	1	4
29	DMF32	8	4

There is no standard configuration for systems with both DC11 and TU58.

Vector addresses are assigned on the boundaries indicated in the modulus column of Table A-2. That is, if the modulus is 10, then the first vector address for that device must end with zero (XX0). If the modulus is 4, then the first vector address can end with zero or 4 (XX0, XX4).

Vector addresses always fall on modulo 4 boundaries (XX0, XX4). That is, a vector address never ends in any number but four or zero. Consequently, if a device has two vectors and the first must start on a modulo 10 boundary, then, using 350 as a starting point, the vectors will be 350 and 354.

A.4 A SYSTEM CONFIGURATION EXAMPLE

Table A-3 contains an example of a system configuration that includes devices with fixed addresses and vectors, and floating addresses and/or vectors.

Table A-4 shows how the device addresses for the floating address devices in Table A-3 were computed, including gaps.

Table A-3. CSR and Vector Address Example

Controller	Vector	CSR
1 DN11	300	775200
1 DU11	310	760040
1 DV11	320	775000
1 DMC11	340	760100
2 DZ11s	350	760120
	360	760130
2 TS11s	224	772520
	370	772524
3 DR11Bs	124	772410
	400	772430
	410	760300

Table A-4. Floating Address Computation

Installed	Device	Address	Installed	Device	Address
	DJ11 Gap	760010		LPP11 Gap	760160
	DH11 Gap	760020		VMV21 Gap	760170
	DQ11 Gap	760030		VMV31 Gap	760200
--->	DU11	760040		DWR70 Gap	760210
	DU11 Gap	760050		RL11 Gap	760220
	DUP Gap	760060		LPA11 Gap	760230
	LK11 Gap	760070		KWC11 Gap	760240
--->	DMC11	760100		Reserved	760250
	DMC11 Gap	760110		RX211 Gap	760260
--->	DZ11	760120		DR11W Gap	760270
--->	DZ11	760130	--->	DR11B	760300
	DZ11 Gap	760140		DR11B Gap	760310
	KMC11 Gap	760150			

Appendix B
PROM REMOVAL AND REPLACEMENT

B.1 OVERVIEW

It may be necessary, either for maintenance reasons or because you wish to change your Emulex controller from one emulation to another, to remove and replace the UC03's firmware PROM set. This appendix provides instructions for changing from a UC03/XX emulation to a UC03/M1 emulation or for simply replacing the PROMs for maintenance reasons.

B.2 EXCHANGING EMULATION PROMS

You may wish to take advantage of the flexibility of Emulex hardware by replacing your existing emulation PROM set with the UC03/M1 emulation PROM set. The PROM set consists of the emulation firmware set and the configuration PROMs.

The 3 existing emulation PROMs are located in sockets labeled PROM 0 through PROM 2. Pry the existing PROMs from their sockets using an IC puller or an equivalent tool.

The UC03/M1 PROM set is identified by the part numbers on top of the PROMS (906-911). Place the UC03/M1 PROMs in numerical order beginning with the socket labeled PROM 0 (see Table B-1). Make certain that the PROMs are 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.)

B.2.1 SWITCH SETTINGS

Set the controller switches as indicated in Section 4 of this manual.

B.2.2 JUMPERS

Wire-wrap pins B and C, located adjacent to U50 on the CC32 PCBA, should be jumpered together. Wire-wrap pins D and E, located adjacent to U116, and pin A, located adjacent to U50, should be unconnected.

Table B-1. UC03 PROM Locations

PROM Number	Socket	PCBA Location
906	PROM 0	U21
907	PROM 1	U22
908	PROM 2	U65

C.1 OVERVIEW

This appendix contains a list of the diagnostics and utilities software that are available for use with the UC03/M1. 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 C-1.

All of the diagnotic and utility media listed contain all of the software provided for the UC03 by Emulex.

Table C-1. Utility and Diagnostic Software

Part Number	Media Type	Boot Type	Description
PX9960305	.5" tape/800bpi	TM11	All tape, disk, communications and subsystem software
PX9960306	.5" tape/1600bpi	TM11	All tape, disk, communications and subsystem software
PX9960307	.5" tape/1600bpi	TS11	All tape, disk, communications and subsystem software
PX9960418	.25" cartridge tape	MS	All tape, disk, communications and subsystem software
PX9960413	Iomega Disk Cartridge	DL	Emulex Subsystem software (subset of above)
PX9960420	Iomega Disk Cartridge	DU	Emulex Subsystem software (subset of above)

continued next page

Table C-1. Utility and Diagnostic Software (continued)

Part Number	Media Type	Boot Type	Description
PX9960419	.25" cartridge tape	MS	Emulex Subsystem software (subset of above)
RX9960516	RX02 Floppy	DY	Emulex Subsystem Software
RX9960514	RX02 Floppy	DY	Disk and Tape Software only
RX9960515	RX02 Floppy	DY	Communications Software only