UD23 DISK CONTROLLER TECHNICAL MANUAL (MSCP COMPATIBLE)

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EMULEX PRODUCT/MANUAL REVISION HISTORY

PROM G86x[1], Location U22

PROM G86x REVISION	DESCRIPTION	MANUAL P/N
A	UD23 with optional diagnostics	UD2351001-00
B and above	UD23 with firmware-resident diagnostics	UD2351002-00

This manual has been extensively revised to incorporate changes to support the Firmware-Resident Diagnostics (F.R.D.) that have been added to the Revision B controller firmware PROM. Due to the nature of these firmware changes, a UD23 with a Revision B and above firmware PROM will no longer operate with previously supplied diagnostic software. In addition, some of the ODT functions (NOVRAM loading commands and Format Drive command) previously available are no longer available.

All of the functionality that was provided by software diagnostics and ODT commands has been incorporated in F.R.D. Be certain that your manual revision is appropriate for the revision level of your controller firmware, as noted in the table above. This firmware is easily identified by the label on integrated circuit U22 on the UD23.

WARNING

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

Printed in U.S.A.

[1] The small x indicates the PROM's revision level letter: A, B, C, etc.

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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 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.

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

Section 1
GENERAL DESCRIPTION

1.1 Introduction

The UD23 Disk Controller, designed and manufactured by Emulex Corporation, is an MSCP-compatible controller that interfaces ESDI disk drives with DEC's UNIBUS. This manual is designed to help you install and use your UD23 Disk Controller. It assumes that you have some knowledge of hardware configuration, UNIBUS architecture and terminology, and interpretations of error messages and device register contents. The contents of the eight sections and three appendices are described as follows:

- **Section 1 (General Description):** This section contains an overview of the UD23 Disk Controller.
- **Section 2 (Controller Specification):** This section contains the specification for the UD23 Disk Controller.
- **Section 3 (Planning the Installation):** This section contains the information necessary to plan your installation, including MSCP subsystem and operating system considerations.
- **Section 4 (Installation):** This section contains the information needed to set up and physically install the controller, including switch settings and cabling. It also describes the firmware-resident diagnostics and contains instructions for loading drive configuration parameters into the NOVRAM.
- **Section 5 (Troubleshooting):** This section describes fault isolation procedures that can be used to pinpoint trouble spots.
- **Section 6 (Registers and Programming):** This section describes the UD23's UNIBUS registers and presents 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 controller, UNIBUS and ESDI interfaces.
- **Appendix A (Autoconfigure):** This appendix describes the DEC algorithm for the assignment of CSR addresses and vector addresses.

- **Appendix B (PROM Removal and Replacement):** This appendix contains instructions to remove and replace the firmware so that the user can upgrade the UD23 Disk Controller in the field.

- **Appendix C (Disk Drive Configuration Parameters):** This appendix contains configuration parameters for supported ESDI disk drives.

1.2 Subsystem Overview

The UD23 Disk Controller connects high-capacity mass storage peripherals to the UNIBUS in computers manufactured by Digital Equipment Corporation (DEC). The UD23 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 UD23 uses the industry standard Enhanced Small Device Interface (ESDI) interface as its peripheral interface. The UD23 supports the magnetic disk drive and serial options of ESDI. For more information on the UD23's ESDI interface, see subsection 8.3.

1.2.1 Mass Storage Control Protocol (MSCP)

MSCP is a software interface designed to lower the host computer's mass storage overhead by offloading much of the work associated with file management into an intelligent mass storage subsystem. In concert with ESDI compatible peripherals, the UD23 provides just such a subsystem. The UD23 relieves the host CPU of many file maintenance tasks. The UD23 Disk Controller performs these MSCP functions: 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 (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 has been 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.

1.3 Physical Organization Overview

The UD23 Disk Controller is a modular, microprocessor-based disk controller that connects directly to the host computer's UNIBUS backplane. The microprocessor architecture ensures excellent reliability and compactness.

The UD23 is contained on a single quad-wide printed circuit board assembly (PCBA) that plugs directly into a UNIBUS backplane slot.

The UD23 supports up to four physical or eight logical disk drives. Aggregate data storage capacities are limited only by the capacities of the peripherals. Figure 1-1 shows one possible ESDI configuration.

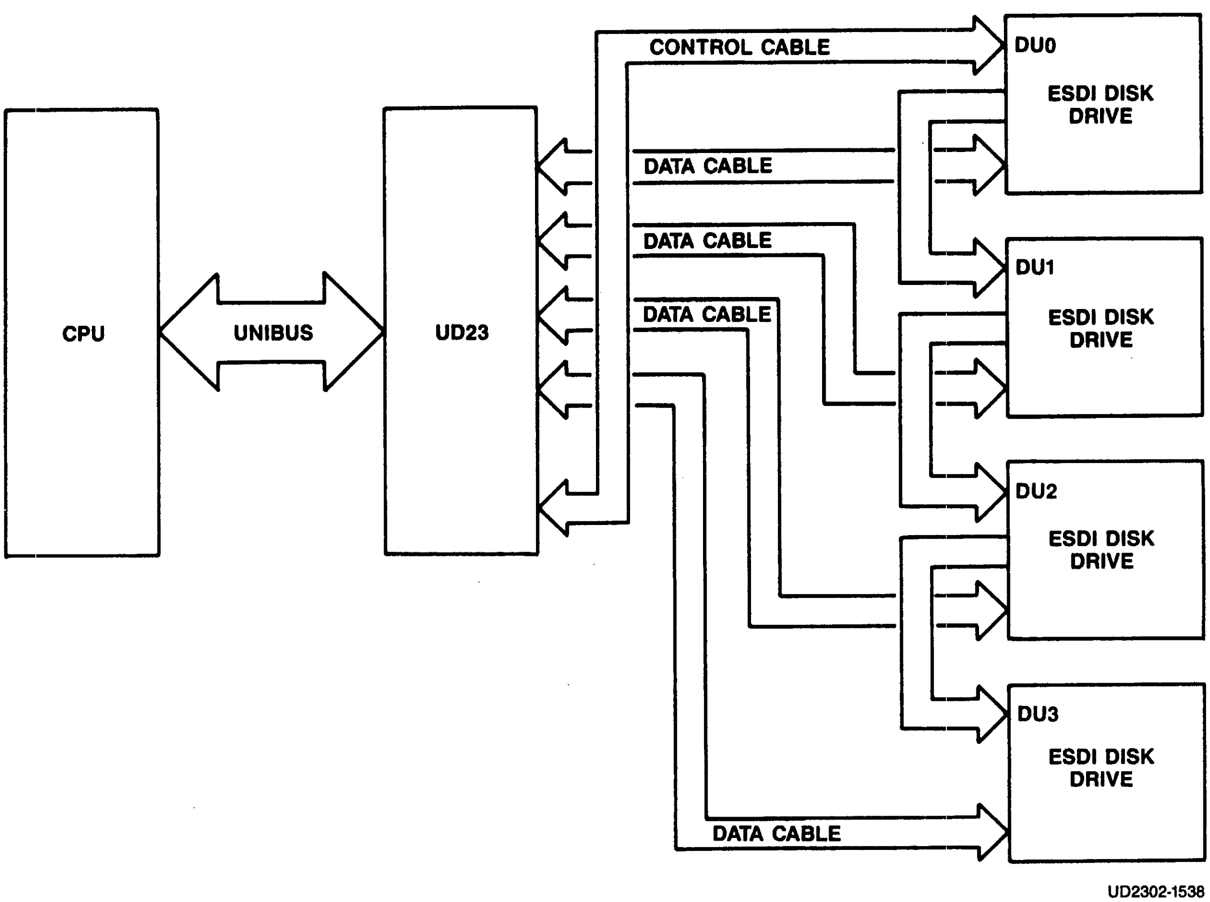


Figure 1-1. UD23 Subsystem Configuration

1.4 Subsystem Components

The UD23 Disk Controller, with appropriate peripherals, provides a DEC MSCP-compatible mass storage subsystem. The UD23 is pictured in Figure 1-2. The UD23 is identified by a top level assembly tag that is glued to the 8031 microprocessor chip on the PWB. The UD23 top level assembly number is given in Table 1-1 along with the part numbers of the items that are delivered with the UD23.

Table 1-1. Basic Contents

Itm	Qty	Description	Part Number
1	1	UD23 Disk Controller	UD2310201-00
2	1	UD23 Technical Manual	UD2351002-00

Cables are required; however, they are purchased separately. Emulex offers the UD23 Internal Cabling Kit (P/N UD2313001-00) which allows you to install the UD23 and the ESDI disk drive(s) in the CPU cabinet. Table 1-2 lists the components of this cabling kit.

In addition, Emulex offers the UD23 External Cabling Kit (P/N QD0113003).

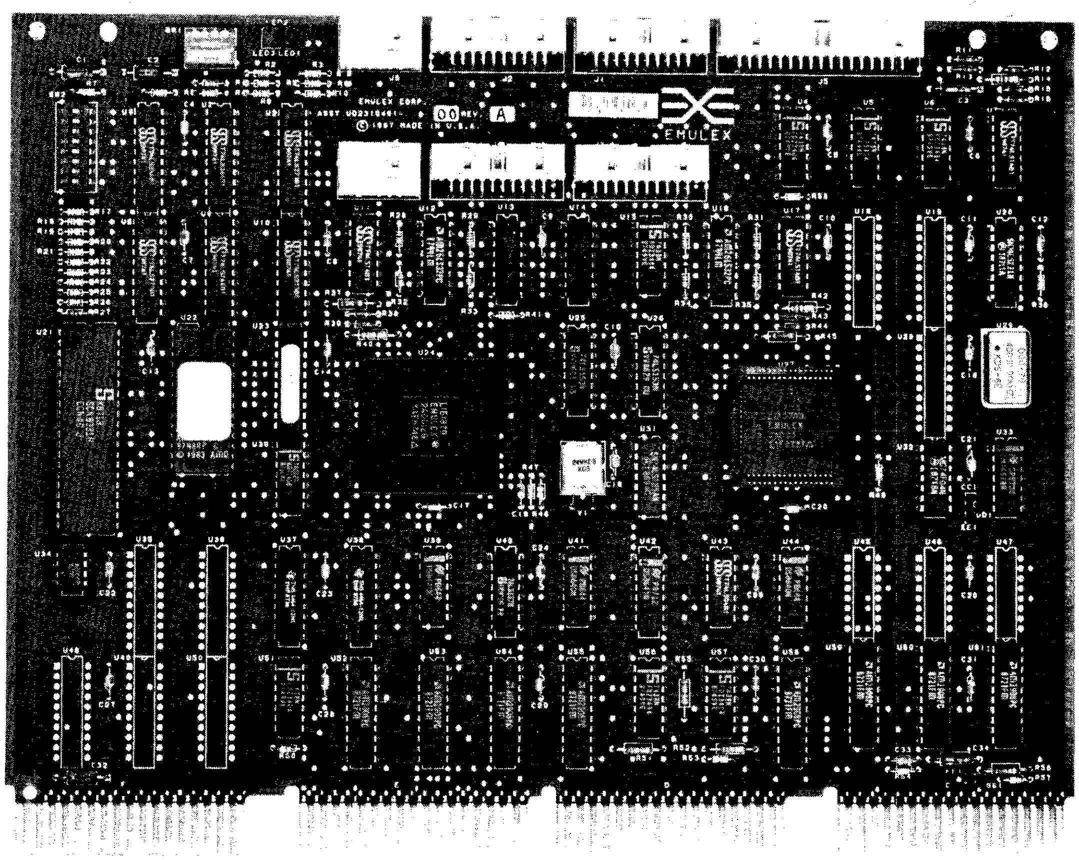
Table 1-2. UD23 Internal Cabling Kit (P/N UD2313001-00)

Qty	Part Number	Length	Cable Description
4	QU0111202-01	3 ft	20-conductor, flat ESDI data interface
3	QU0111201-01	1 ft	34-conductor, flat ESDI control interface daisy-chain
1	QU0111203-01	3 ft	34-conductor, flat ESDI control interface

As an alternative to the kit, you could build both control and data cables. Table 1-3 lists the components that are required.

Table 1-3. Disk Drive Interface and Cable Components

Connector Number	Controller Function	Cable Components: Header Type	Control Connector	Cable Type: Unshielded	Cable Type: Shielded	Drive Connector
J5	Control	3594	3414	3801/34	3517/34	3463
J1/J2/J3/J4	Data	3592	3421	3801/20	3517/20	3461
All component numbers are 3M. Equivalents may be used.						



UD2302-1626

Figure 1-2. UD23 Disk Controller

1.5 Features

The following features enhance the usefulness of the UD23 Disk Controller.

1.5.1 Microprocessor Design

The UD23 design incorporates an eight-bit, high-performance CMOS microprocessor to perform all controller functions. The microprocessor approach provides a reduced component count, high reliability, easy maintainability, and the microprogramming flexibility that allows MSCP to be implemented without expensive, dedicated hardware.

1.5.2 Firmware-resident Diagnostics

The UD23 disk controller firmware incorporates a self-contained set of disk preparation and diagnostic utilities. These utilities are contained in UD23 Revision B and above firmware. Controllers with this firmware are easily identified by a label on the PROM in location U22.

These utilities allow the user to communicate directly with the UD23 via a firmware-resident terminal driver that is compatible with either CRT or hardcopy devices connected to a UNIBUS console port. These firmware-resident diagnostics (F.R.D.) provide several important disk preparation functions, including the ability to:

- Configure the controller NOVRAM
- Format the drive
- Test the disk surface and replace defective blocks, and
- Perform reliability testing of the attached disk subsystem.

1.5.3 Custom Configuration Capability

An onboard NOVRAM can be programmed for four independent physical drive configurations. Using the firmware-resident utilities, you can control drive parameters, such as gap size, and the number of sectors per track.

1.5.4 Automatic Drive Configuration

This feature allows you to take advantage of the drive configuration information available from the attached ESDI drive to set the drive parameters. You can configure the UD23 to use this information instead of entering the parameters manually. This feature supports both hard and soft sector formats. (Note: Emulex recommends hard sectoring whenever possible.)

1.5.5 Self-test

The UD23 incorporates an internal self-test routine which exercises all parts of the microprocessor, the on-board memory, the buffer controller, and the Host Adapter Controller (HAC). Although this test does not completely test all circuitry, successful execution indicates a very high probability that the disk controller is operational. If the UD23 fails the self-test, it leaves three light-emitting diodes (LEDs) ON and sets an error bit in the Status and Address (SA) register (base address plus two).

1.5.6 Error Control

The disk controller presents error-free media to the operating system by correcting soft errors and retrying operations without intervention by the host.

1.5.7 Media Defect List Management

During format operations, the UD23 replaces all blocks on the disk that are labeled bad in the Manufacturer's Defect List. After formatting, the firmware-resident utilities can be used to test the entire disk surface with four worst-case data patterns and replace any pattern-sensitive blocks not found by the manufacturer. UD23 supports both 256- and 512-byte defect list formats.

1.5.8 Host-initiated Bad Block Replacement

The UD23 uses DEC-compatible host-initiated bad block replacement to dynamically replace any defective blocks that occur during the life of the system. For maximum reliability, the UD23 reports even corrected single bit errors as candidates for replacement.

1.5.9 Seek Optimization

The UD23 is able to pool the various seeks that need to be performed and determine the most efficient order in which to do them. This is an especially important feature in heavily loaded systems. The disk controller's ability to arrange seeks in the optimal order saves a great deal of time and makes the entire system more efficient.

1.5.10 Command Buffer

The UD23 contains a buffer that is able to store 13 MSCP commands. This large buffer allows the subsystem to achieve a higher throughput and to operate at a very efficient level.

1.5.11 Adaptive DMA

During each DMA data transfer burst, the UD23 monitors the UNIBUS for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. The host processor programs the DMA burst length during the MSCP initialization sequence or the UD23 defaults to 16 words per burst. In addition, the UD23 firmware design includes a switch selectable DMA burst delay to avoid data late conditions on other slower devices that may be on a given system. Because of these adaptive DMA techniques, the UD23 ensures that CPU functions, including interrupt servicing, are not locked out for excessive periods of time by high-speed disk transfers.

1.6 Compatibility

This section describes the operating systems and hardware components that are compatible with the UD23.

1.6.1 Operating Systems

The UD23 implements MSCP. Emulex supports its implementation of MSCP beginning with the indicated version of the following DEC operating systems:

Operating System	Version
VMS	3.2
RSTS/E	8.0
RSX-11M	4.1
RSX-11M-PLUS	2.1
RT-11	5.1
Ultrix-11	3.0
Ultrix-32m	1.1

1.6.2 Hardware

The UD23 Disk Controller complies with DEC UNIBUS protocol.

The UD23 supports the serial mode implementation of the ESDI interface on magnetic disk drives that have clocks up to 20 Megahertz.

The disk drives supported by the UD23 are not media compatible with comparable DEC MSCP products; this is not a problem, due to the fixed nature of most DEC drives.

2.1 Overview

This section contains the general, environmental, physical, and electrical specifications for the UD23 Disk Controller.

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

2.2 General Specification

Table 2-1 contains a general specification for the UD23 Disk Controller.

Table 2-1. UD23 General Specifications

Parameter	Description	
FUNCTION	Providing mass data storage to Digital Equipment Corporation (DEC) computers that use the UNIBUS	
Logical CPU Interface	Emulates DEC's Mass Storage Control Protocol (MSCP)	
Diagnostics	Embedded diagnostics	
Operating System Compatibility	VMS	V3.2 and above
	RSTS/E	V8.0 and above
	RSX-11M	V4.1 and above
	RSX-11M PLUS	V2.1 and above
	RT-11	V5.1 and above
	Ultrix-11	V3.0 and above
	Ultrix-32m	V1.1 and above

(continued on next page)

Table 2-1. UD23 General Specifications (continued)

Parameter	Description
CPU I/O Technique	Direct Memory Access (DMA), including adaptive techniques
INTERFACE	
CPU Interface	Standard UNIBUS interface
Device Base Address	
Standard	772150_8
Alternates	772154_8 760334_8 760340_8 760344_8 760350_8 760354_8 760360_8
Vector Address	NOVRAM Programmable (normally set to 154)
Priority Level	BR5
Bus Loading	1 dc Load, 2.5 ac Loads
Peripheral Interface	Enhanced Small Disk Interface (ESDI) for disks up to 15 MHz
Number of Physical Drives Supported	4
Drive Sectoring	Hard or Soft Sectored
Interface Cables	34-line control cable (daisy-chain), maximum 10 ft. (3 m); 20-line data cables (radial), maximum 10 ft. (3 m).
Firmware Diagnostic Access Path	
VAX	Standard console terminal

2.3 Environmental Specification

Table 2-2 contains the environmental specifications for the UD23 Disk Controller.

Table 2-2. UD23 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 UD23 Disk Controller.

Table 2-3. UD23 Physical Specifications

Parameter	Description
PACKAGING	Single, quad-wide, four-layer PCBA
Dimensions	10.436 by 8.70 inches 26.507 by 22.098 centimeters (see Figure 2-1)
Shipping Weight	4 pounds

2.5 Electrical Specification

Table 2-4 lists and describes the electrical specification for the UD23 Disk Controller.

Table 2-4. UD23 Electrical Specification

Parameter	Description
POWER	+5 Vdc $\pm$ 5%, 2.6 amperes (A) MAX

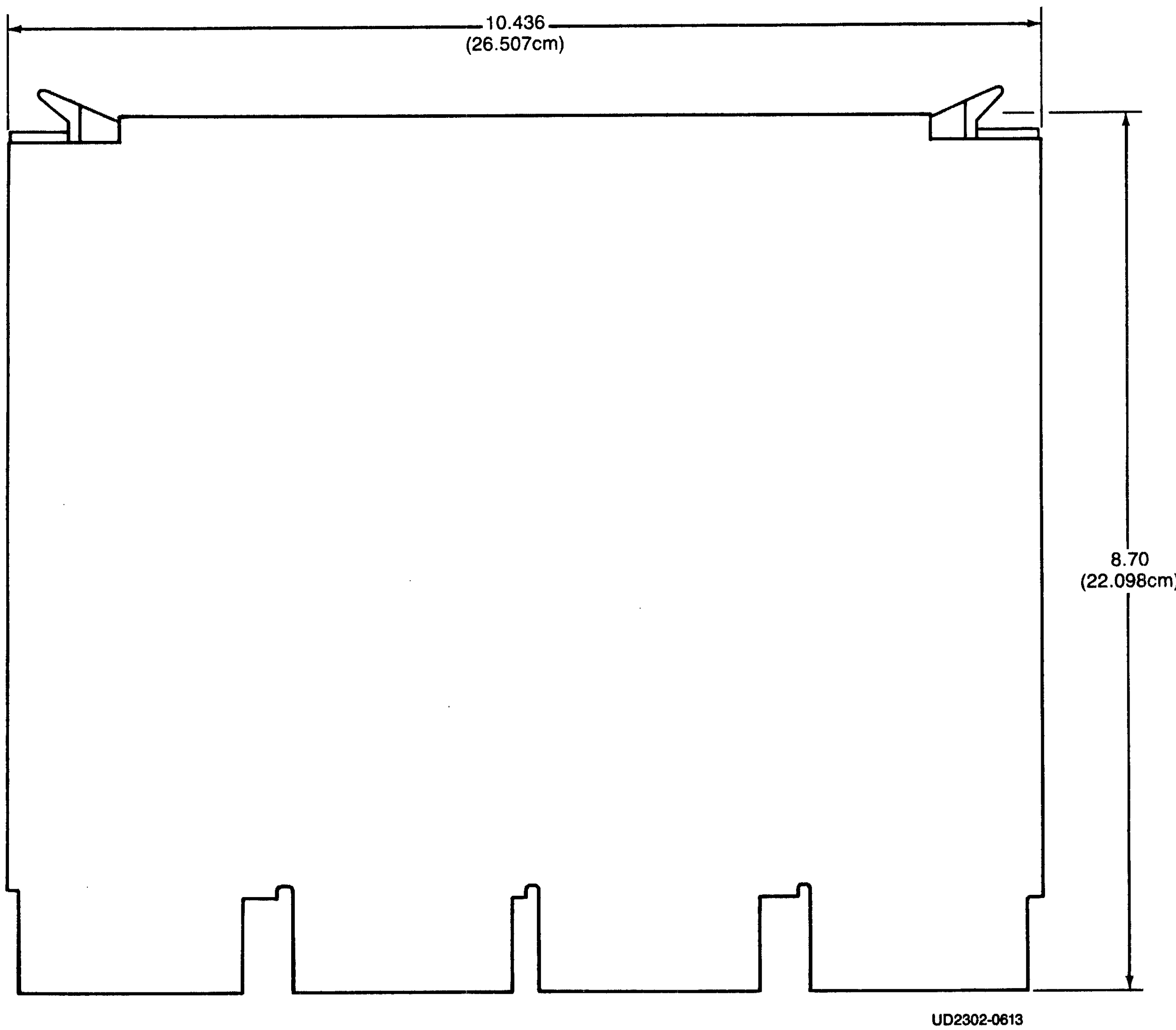


Figure 2-1. UD23 Disk Controller Dimensions

Section 3
PLANNING THE INSTALLATION

3.1 Overview

This section is designed to help you plan the installation of your UD23 Disk Controller. Taking a few minutes to plan the configuration of your subsystem before beginning its installation should result in a smoother installation with less system downtime. This section contains UD23 application examples and configuration procedures. The subsections are listed in the following table:

Subsection	Title
3.1	Overview
3.2	MSCP Subsystem Configuration
3.3	A DEC MSCP Subsystem
3.4	The UD23 MSCP Subsystem
3.5	Operating Systems, Device and Vector Addresses

3.2 MSCP Subsystem Configuration

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

3.2.1 Architecture

MSCP is a protocol designed by DEC for mass storage subsystems using Digital Storage Architecture (DSA). In an MSCP mass storage subsystem, DSA comprises three functional and physical layers:

- **Host Layer.** An MSCP class-driver in the host system receives requests from the operating system and then relays data and commands to the controller in MSCP message packets.

- **Controller Layer.** The MSCP controller communicates with both the host layer and the mass storage layer. The controller transmits MSCP message packets to and from the host MSCP class-driver and performs data-handling functions for the mass storage devices. The UD23 functions as the controller layer.

- **Mass Storage Layer.** The mass storage peripheral devices communicate with the MSCP controller and send or receive data as specified by the MSCP controller.

MSCP defines the form of the message packets that are exchanged by the host and the MSCP controller. The UD23 implements MSCP in mass storage subsystems using ESDI as the peripheral interface.

3.2.2 Peripheral Numbering

Each MSCP peripheral on the system is identified to the operating system by an MSCP device name. An MSCP device name consists of a device class identifier and a unit number. The device class is indicated by a two-letter prefix; MSCP disk devices are indicated by the prefix DU.

With the exception of VMS systems, DEC operating systems require that all MSCP peripherals on a system have different MSCP device numbers, even if they are managed by separate MSCP controllers at separate UNIBUS device addresses. For example, under RSX-11M-PLUS, if there are three peripherals on the first MSCP controller (at 772150_8), then the first peripheral on the second MSCP controller (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 controller can report the capacity of a peripheral to the operating system. For example, a Maxtor 4380 disk drive supported by the UD23 is able to store 584,000 logical blocks.

3.3 A DEC MSCP Subsystem

Figure 3-1 shows the organization of a typical DEC MSCP subsystem for the UNIBUS. The MSCP host and controller functions are combined in a single piece of hardware, in this example the DEC UDA50. The UDA50 supports RA series hard disk drives. The UDA50 plugs directly into the UNIBUS and is attached to disk drives via a disk-drive-native interface.

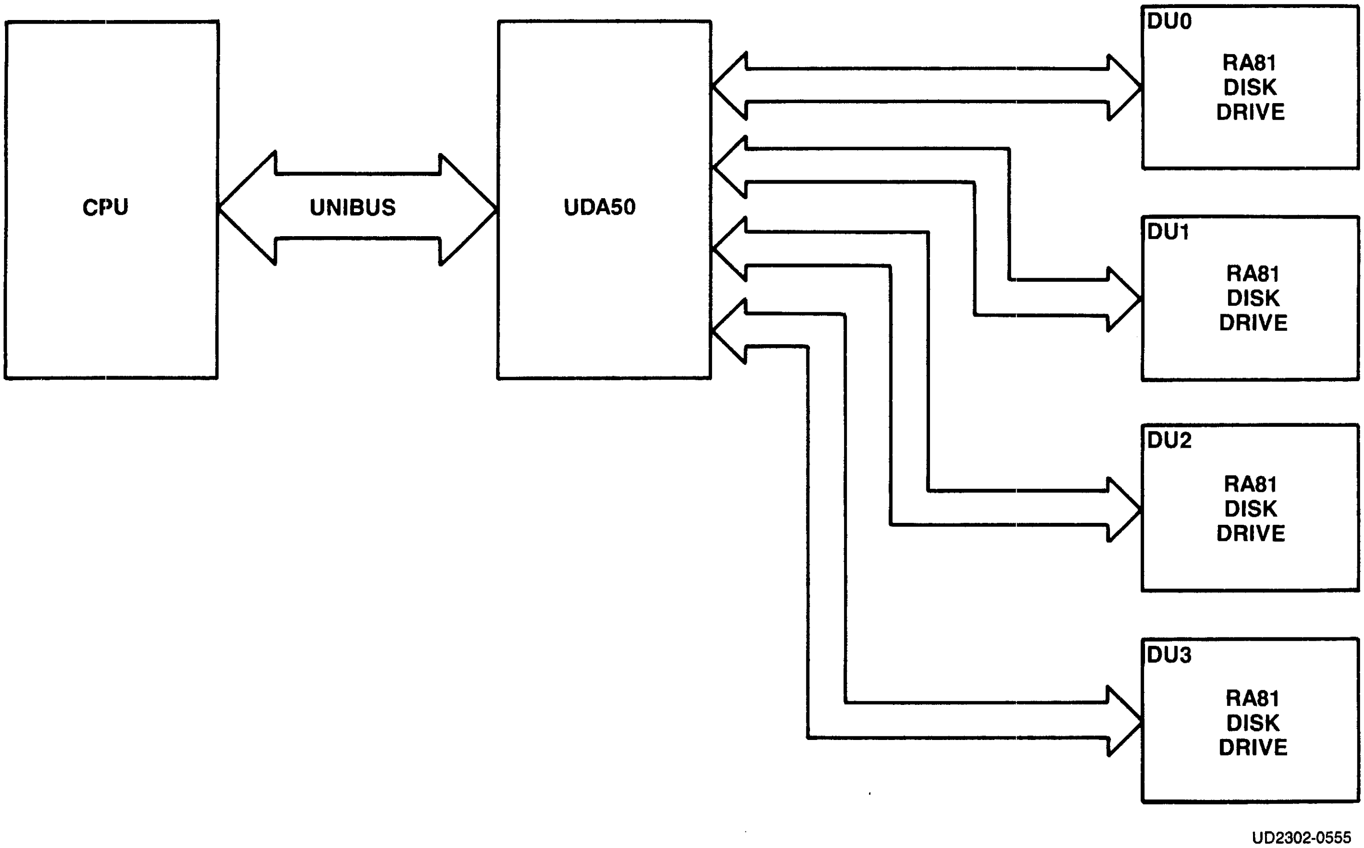


Figure 3-1. DEC MSCP Subsystem Logical and Physical Configuration

3.4 The UD23 MSCP-Class Subsystem

Figure 3-2 illustrates a typical UD23 MSCP-class subsystem. As with the DEC implementation, the UD23 is connected directly to the UNIBUS; however, the UD23 uses the ESDI peripheral interface to communicate with up to four disk drives.

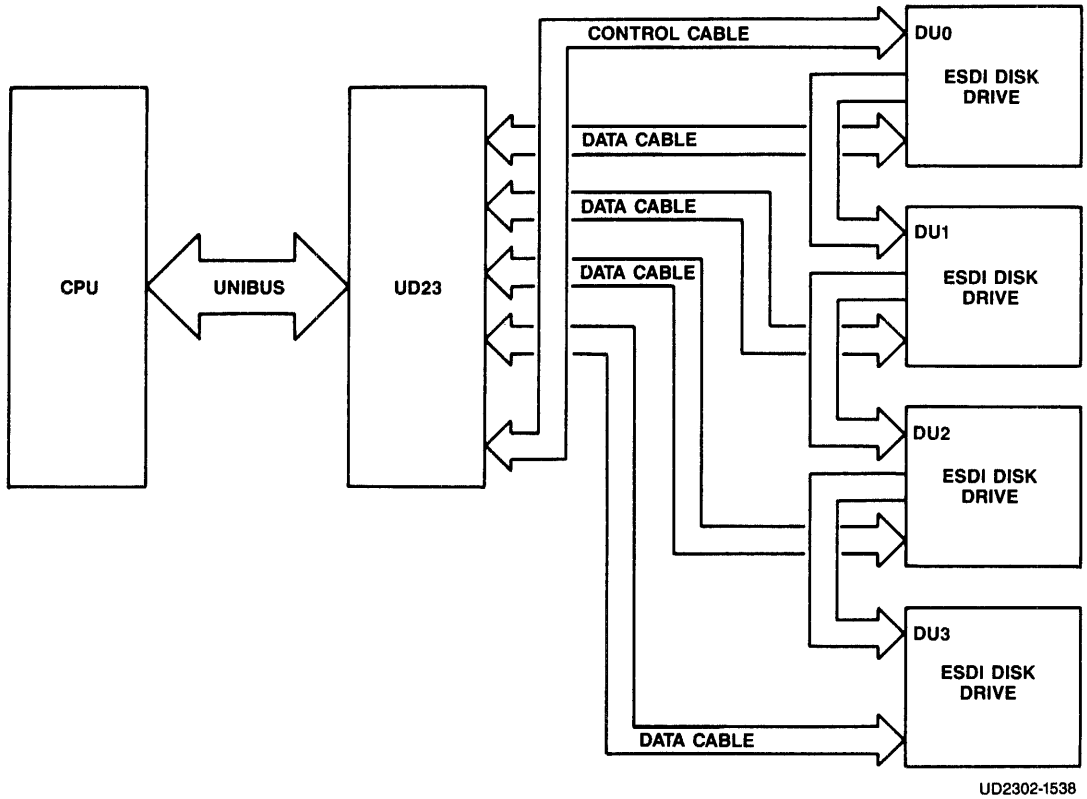


Figure 3-2. UD23 Subsystem Configuration

The MSCP subsystem provided by the UD23 is essentially analogous to the DEC MSCP subsystem. As in the DEC subsystem, the UD23 MSCP-class controller connects directly to the UNIBUS. As an MSCP-class controller, the UD23 receives requests from the host, optimizes the requests, generates ESDI commands to perform the operations, transfers data to and from the host, transfers data to and from the device, and buffers data as necessary. When the command is complete, the controller sends a response to the host.

The UD23 also performs all of the functions of the peripheral controller, including serialization and deserialization of data. The UD23 connects to the peripherals it supports via the ESDI interface.

3.4.1 Logical Unit Numbers

As noted in subsection 3.2.2, most DEC operating systems do not allow any MSCP disk devices on one system to have the same unit number, even though they may be controlled by separate MSCP controllers at different base addresses.

DEC MSCP-class drives can accept unit identification plugs that define addresses from 0 to 255. Disk drives controlled by the UD23 do not have this flexibility; the UD23 can detect only four unique drive addresses at its ESDI interface -- 0, 1, 2, and 3. To prevent a unit-number conflict between the UD23's drives and another MSCP controller's drives, the UD23 employs switches to change the drive logical unit number that is reported to the operating system.

Example 3-1 *An MSCP controller at a standard base address is supporting four disk drives; a UD23 at an alternate base address is supporting three disk drives. An offset of 4 is specified for the first drive on the UD23. This causes the UD23 disk with address 0 to be reported to the operating system as logical unit number (LUN) 4. The UD23 disk 1 is reported as LUN 5, and UD23 disk 2 is reported as LUN 6.*

The offset for the logical unit number is specified by using switches SW1-2 through SW1-4 on the UD23. See subsection 4.3.3.2.2 for switch setting information.

3.4.2 UD23 MSCP-Class Subsystem Logical Configuration

This subsection explains the algorithm used by the UD23 to map logical MSCP-class peripherals onto the physical disk drives provided by the UD23 subsystem.

3.4.2.1 Logical Devices

The phrase "logical MSCP disk drive" refers to the disk drive as it appears to the operating system. That is, the operating system associates a disk drive of known type (in this case, an MSCP disk drive) with a unit number and a capacity. The UD23 MSCP-class controller presents that information to the operating system after initialization on command.

Because the MSCP controller is responsible for establishing the relationship between unit number and capacity, it is possible for the controller to divide its physical disk drives into more than one logical unit. For example, if a physical disk drive has a capacity of 584,000 blocks, the MSCP controller can divide that capacity into two parts of 292,000 blocks each. (Each part may have a different capacity.) Each part is then assigned a separate unit number, and the unit number and capacity of each part is presented to the operating system.

The operating system then sees the two parts as separate disk drives, even though the data is actually stored on the same physical drive. The two parts are called logical disk drives, and the numbers that identify them are called MSCP unit numbers.

A drive configuration that supports multiple logical units is specified by the data that is stored in the configuration Nonvolatile Random Access Memory (NOVRAM). Information for programming the configuration NOVRAM is given in Section 6, REGISTERS and PROGRAMMING. The field that causes a drive to be divided into multiple logical units is called the Split Code (word 11). There are four types of split codes: no split, cylinder split, head split, and reverse head split:

- When no split is specified, the entire physical drive is one logical drive.
- Cylinder split codes divide a physical drive by cylinders. A Starting Cylinder Offset field in the NOVRAM specifies the first cylinder of the second logical drive. For example, a Maxtor 4375, which has 1224 cylinders, might be divided so that the first logical unit is assigned cylinders 0 through 611 and the second logical unit assigned cylinders 612 through 1223. In this example, the Starting Cylinder Offset has a value of 612.
- Head split codes divide the drive by data heads. A Starting Head Offset field in the NOVRAM specifies the first head of the second logical drive. When the drive is split by data heads, each logical drive has its own platter(s). For example, a Maxtor 4375 with a total of 15 heads might be divided so that the first logical unit is assigned heads 0 through 7, and the second logical unit is assigned heads 8 through 14. The Starting Head Offset has a value of 8.
- Reverse head split codes also divide the drive by data heads, but assign the lower numbered heads to drive 1 and the higher numbered heads to drive 0. If you entered a reverse split code for the previous Maxtor 4375 example, the first logical unit is assigned heads 8 through 14 and the second logical unit is assigned heads 0 through 7. The Starting Head Offset has a value of 8.

For best performance, Emulex recommends the use of head split vs. cylinder split.

3.4.2.2 Device Numbers

The drives supported by the UD23 are assigned MSCP device names by the operating system. As described in subsection 3.2.2, an MSCP device name consists of a device class prefix and a device unit number. Drives are assigned MSCP device numbers beginning with zero (0). The conventions for numbering multiple MSCP drives vary by operating system.

Under RSX-11M, RSX-11M-PLUS and RT-11, DU0 is assigned to the first drive on the first MSCP controller, where "first" means the controller located at the standard base address. Unit number 1 would be the second drive on the first controller, etc. If there are two MSCP controllers 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 controller.

RSTS/E requires that drives supported by a standard MSCP controller be numbered starting at 0 and drives supported by an alternate MSCP controller be numbered starting at 4.

Because MSCP device names under VMS designate the supporting MSCP controller, the unit numbering is less restricted. For example, two drives which are supported by a standard MSCP controller might be DUA0 and DUA1 and a third drive supported by an alternate MSCP controller might be DUB0.

Table 3-1 is an MSCP unit numbering example under the RSX-11M operating system which shows the MSCP number versus the actual physical addresses assigned to all the components. The physical disk drive (unit number 1) of the second controller is split into two logical units. Note that two device names are associated with that drive.

Table 3-1. Subsystem Configuration Example

UD23 Address	Device Description	Drive Unit Number	Device Name
772150	Fujitsu M2246E	0	DU0
	Fujitsu M2246E	1	DU1
760334 (Floating)	Maxtor EXT-4380 (head split)	0	DU2 DU3
	Fujitsu M2246E	1	DU4

NOTE

All of the MSCP peripherals supported by the UD23 use the same device identifier - RA81. Unique device identifiers are not available to the host.

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. The information provided in this section is intended to supplement your DEC operating system resources and to be used as an aid in planning the installation of your UD23. Be aware that not all DEC operating systems support the maximum eight logical drives permitted by the UD23.

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.
- The user can tell the operating system about a device during an interactive SYSGEN procedure.

The first technique is referred to as 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 bootstrapped. The third technique, interactive SYSGEN, creates a configuration file that the operating system references when the system is bootstrapped. All techniques accomplish the same result: they associate a specific device type with a bus address and interrupt vector.

Most recent versions of DEC operating systems use autoconfigure to some extent, and try to follow the same rules. The RT-11 operating system does not use autoconfigure, but can locate devices that reside at a standard address. There are some differences among operating systems, however, especially with regard to MSCP controllers at alternate UNIBUS addresses. The following paragraphs address these differences for each supported operating system. This discussion includes information on choosing appropriate UNIBUS device addresses and interrupt vectors for the subsystem. No instructions are provided for programming the chosen address into the UD23. See subsection 4.5.1 for detailed switch setting information.

MSCP-class controllers contain two registers that are visible to the UNIBUS I/O page. They are the Initialization and Polling (IP) register (base address) and the Status and Address (SA) register (base address plus 2). The terms IP register, CSR address, UNIBUS address and base address all refer to the same register. All of the operating systems described in the following subsections use the standard UNIBUS address of 772150_8 for the first controller on the host system.

Vector addresses for MSCP controllers are not selected by using switches on the controller, but are programmed into the controller during the Initialization process. Many operating systems select the vector address automatically. If an operating system requires manual input of the vector, the procedure notes that fact.

Again, although DEC has attempted to standardize treatment of peripherals by operating systems, some differences do exist. Table 3-2 lists and describes the device names assigned to MSCP devices under different operating systems. Two controller names and two drive names are given to indicate the numbering scheme.

Table 3-2. Device Names

Operating System	**Controller First, Second**	**Drives Supported by First Controller**
RSTS/E	RU0, RU1	DU0, DU1
RSX-11M	----, ----	DU0, DU1
RSX-11M-PLUS	DUA, DUB	DU0, DU1
RT-11	Port0, Port1	DU0, DU1
VMS	PUA, PUB	DUA0, DUA1
Ultrix-11	uda0, uda1	ra0, ra1
Ultrix-32	uda0, uda1	ra0, ra1

The information regarding operating systems in these subsections is subject to change. The following discussions are based on three assumptions:

- This is the first pass that is being made through SYSGEN; therefore, no saved answer file exists. Answer **N** (no) to questions such as "Use as input saved answer file?"
- Your host system configuration conforms to the standard UNIBUS device configuration algorithm (otherwise autoconfigure results are not reliable).
- You are generating a mapped version of the operating system on the appropriate hardware (unless you are using RT-11).

3.5.1 RSTS/E Operating Systems (v8.0 and above)

RSTS/E scans the hardware to determine configuration each time the system is bootstrapped. 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 controllers. The first MSCP controller must be located at the standard UNIBUS address, 772150_8. According to DEC documentation, the second unit should be located in floating address space. For an alternate UD23, Emulex suggests specifying a UNIBUS address of 760334_8 using the HARDWARE option of the INIT.SYS program.

The INIT.SYS program uses a user-specified table, located in the currently installed monitor, to make exceptions to the autoconfigure algorithm. This table is modified by the HARDWARE option of the INIT.SYS program. Use of this table allows an MSCP controller to be placed at virtually any address on the I/O page. Note that this table must be reset any time a new monitor is installed. Emulex suggests using a UNIBUS address of 760334_8 for an alternate UD23. An MSCP controller must be located at the standard address to be a bootstrap device.

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

3.5.1.1 Adding MSCP Support

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

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

3.5.2 RT-11 Operating Systems (v5.1 and above)

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

3.5.2.1 Installing a Single MSCP Controller

If your host system includes only one MSCP controller, install it with a UNIBUS address of 772150_8. RT-11 will find and install the handler (driver) for that controller. In single MSCP controller configurations, it is not necessary to run SYSGEN. You may use one of the pregenerated monitors that are provided with the RT-11 Distribution. Emulex recommends that you 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 Controllers

If your host system includes more than one MSCP controller, you may either modify the MSCP handler as described in the *RT-11 Software Support Manual* or you may perform a SYSGEN. The following procedure describes the SYSGEN technique (user input is in **boldface** print):

1. Initiate SYSGEN:

   IND SYSGEN<return>

   Answer the next group of questions appropriately.

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

   Do you want the start-up indirect file (Y)?

   Y<return>

   The start-up command file is required to allow additional MSCP controller UNIBUS bus addresses to be specified and to partition the disks consistently when the system is bootstrapped. Answer the next set of questions appropriately.

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

   Enter the device name you want support for [dd]:

   DU<return>

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

   ```
   How many ports are to be supported (1)?
   ```

   2<return>

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

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

```
Enter the device name you want support for [dd]:
 .<return>
```

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

SET DU CSR=772150	(Default)
SET DU CSR2=760334_8	(Floating)
SET DU VECTOR=154	(Default)
SET DU VEC2=300	

The UNIBUS for the second device can be any unused address in the I/O page which is supported by UD23 address switch settings; the vector address can be any unused address in the vector page. Default statements are not required.

7. Complete SYSGEN according to the DEC documentation.

3.5.2.3 Disk Partitioning

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

1. Determine the drive configuration(s) that you intend to use. You need to know the LUN of each logical drive and the data storage capacity (in logical blocks) of each logical unit. Refer to Appendix C for the logical block capacity of supported ESDI drives. If the UD23 is at an alternate UNIBUS address (not 772150_8), then you must specify an MSCP device number by using switches SW1-2 through SW1-4 (see subsection 4.3.3.2.2).

2. Divide the capacity for each MSCP unit by 65,535. If the result is a number greater than 1, then that MSCP unit should be partitioned into multiple logical units. (The last partition on a disk may be smaller than 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 assigns logical names to each partition. Each statement has the following format:

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

where **n** is the logical device name, **y** is the physical MSCP unit number, **x** is the partition number, and **z** is the controller number (specify the controller number when two or more controllers are present; do not specify the port when only one controller is present). If you partition any drives, you must do this for each partition on each drive, including drives that can hold only one partition.

Example: *You have selected a Maxtor 4380 drive that has a capacity of 584,000 blocks.*

$$\frac{584{,}000}{65{,}535} = 8.91 \text{ (9 logical units)}$$

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 assign logical names to the partitions beginning with DU0. For the previous example, the assignments are made as follows:

```
SET DU0 UNIT=0 PART=0
SET DU1 UNIT=0 PART=1
SET DU2 UNIT=0 PART=2
SET DU3 UNIT=0 PART=3
SET DU4 UNIT=0 PART=4
SET DU5 UNIT=0 PART=5
SET DU6 UNIT=0 PART=6
SET DU7 UNIT=0 PART=7
```

Modify the system start-up command file to include the disk partitioning statements.

3.5.3 RSX-11M Operating Systems (v4.0 and above)

RSX-11M SYSGEN is an interrogative program that allows a complete, running RSX-11M system to be configured for a particular hardware environment. SYSGEN is well documented in the *RSX-11M System Generation and Installation Guide*, and you are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the UD23 may present.

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

3.5.3.1 Installing a Single MSCP Controller

If you have only one UD23, install it at the standard address (772150_8) and use autoconfigure to connect your peripherals. The procedure given in the *RSX-11M System Generation and Configuration Guide* is adequate for this purpose.

3.5.3.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say a DEC MSCP controller and a UD23, you must perform a complete manual initialization. We recommend that the DEC MSCP controller be installed at the standard UNIBUS address. Locating the UD23 at the alternate UNIBUS address does not prevent its being used as the system device. Both MSCP controllers are connected to the operating system by using the following procedure.

1. Invoke SYSGEN.

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

2. To indicate that you want to use autoconfigure, answer **Y** (yes) to the following question:

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

3. To indicate that you do not want to override autoconfigure results, answer **N** (no) to this question:

```
*Do you want to override Autoconfigure results? [Y/N]:
```

Answer the rest of the questions in the SETUP section appropriately, and continue to the next section, TARGET CONFIGURATION. In TARGET CONFIGURATION, the defaults presented for the first group of questions should be accurate for your system because autoconfigure was requested.

4. In response to the question regarding devices, indicate that you have two MSCP-class controllers:

```
*     Devices: DU=2<return>
      Devices: .<return>
```

This entry supersedes 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 asks 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, SYSGEN asks questions on those devices.)

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

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

The standard vector address for MSCP controllers is 154_8. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300_8 and 774_8 can be allocated. See Appendix A for a description of DEC's algorithm for assigning floating vectors.

The standard UNIBUS bus address for MSCP controllers is 772150_8. Emulex recommends that second unit be located in floating UNIBUS address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

The number of DU-type disk drives depends on the configuration that you have selected for the UD23, or on the number of drives that are attached to a DEC MSCP controller.

When you select a configuration for the UD23, you are taking into account the number of physical disk drives that you are attaching to the UD23's ESDI interface. When you select a configuration, you are also specifying a logical arrangement for the UD23 MSCP-class subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each ESDI disk drive when you program the UD23's NOVRAM (see subsections 4.7, 4.8, and 4.9).

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

- RD51
- RD52
- RD53
- RC25
- RA series

The RC25 has both fixed and removable hard media; count an RC25 as two drives.

RSX-11M supports up to eight command and eight response rings; the number of command and response rings that you specify depends on your application. Four command and four response rings are reasonable and adequate for most applications. In most instances, further information is not required to install the UD23.

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

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

For the DEC MSCP controller, indicate the appropriate peripherals.

For the UD23, indicate that you have one RA81 for each logical disk drive.

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

7. Complete the SYSGEN procedure according to DEC documentation.

3.5.4 RSX-11M-PLUS Operating Systems (v2.1 and above)

RSX-11M-PLUS SYSGEN is an interrogative program that allows a complete, running RSX-11M-PLUS system to be configured for a particular hardware environment. SYSGEN is well documented in the *RSX-11M-PLUS System Generation and Installation Guide,* and you are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the UD23 may involve.

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

3.5.4.1 Installing a Single MSCP Controller

If you have only one UD23, install it at the standard address (772150_8) and use autoconfigure to connect your peripherals. The procedure given in the *RSX-11M-PLUS System Generation and Configuration Guide* is adequate for this purpose.

3.5.4.2 Installing Multiple MSCP Controllers

If your initial system configuration includes two MSCP controllers, connect the alternate MSCP controller to the operating system during the initial SYSGEN. We recommend that you use autoconfigure to connect the first controller at the standard address (772150_8). We recommend that the DEC MSCP controller be installed at the standard UNIBUS address; locating the UD23 at the alternate UNIBUS address does not prevent its being used as the system device.

If you are adding the second MSCP controller to the system configuration, use the Add a Device option of SYSGEN or a complete SYSGEN. The following procedure describes the Add a Device process (user input is in **boldface** print:

1. Invoke SYSGEN.

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

2. To indicate that you want to do a subset of the SYSGEN procedure, answer **N** (no) to the following questions:

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

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

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

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

4. Select the Add a Device section of SYSGEN:

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

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

   The questions that SYSGEN asks pertain to 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 0 (zero) for all types of controllers until you are prompted for the number of UDA-type devices.

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

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

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

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

The answer to this question depends on the configuration that you have selected for the UD23 and on the number of drives that are attached to any DEC MSCP controllers.

When you select a configuration for the UD23, you are taking into account the number of physical disk drives that you are attaching to the UD23's ESDI interface. When you select a configuration, you are also specifying a logical arrangement for the UD23 MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each ESDI disk drive when you program the UD23's NOVRAM (see subsections 4.7, 4.8 and 4.9).

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

- RD51
- RD52
- RD53
- RC25
- RA series

The RC25 drive has both fixed and removable hard media; count an RC25 as two drives.

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

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

This question is asked as many times as the number of MSCP drives that you have indicated are on the system. RSX-11M-PLUS does not tolerate gaps in sequence; the MSCP 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. Use A for the primary controller and B for the alternate controller.

8. Enter the vector address for each MSCP controller:

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

The standard vector address for MSCP controllers is 154_8. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300_8 and 774_8 can be allocated. See Appendix A for a description of DEC's algorithm for assigning floating vectors.

9. Enter the CSR address for each MSCP controller:

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

The standard CSR address for MSCP controllers is 772150_8. Emulex recommends that the second unit be located in floating CSR address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

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

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

RSX-11M-PLUS supports up to eight command rings. The value you specify depends on your application. Four command rings are reasonable and adequate for most applications.

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

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

RSX-11M-PLUS supports up to eight response rings. The value you specify depends on your application. Four response rings are reasonable and adequate for most applications.

3.5.5 VMS Operating Systems (v3.2 and above)

VAX/VMS supports MSCP controllers at the standard address, 772150_8, and in floating address space. VMS has a software utility called SYSGEN which can be used to determine the UNIBUS address and interrupt vector address for any I/O devices to be installed on the computer's UNIBUS. A running VAX/VMS computer system is required in order to use this utility.

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

The following procedure tells how to use VMS SYSGEN to determine UNIBUS addresses and interrupt vectors.

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

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

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

2. Obtain a list of devices already installed on the VAX UNIBUS by typing:

   ```
   SYSGEN> SHOW/CONFIGURATION<return>
   ```

```
Name: PUA  Units: 1  Nexus: 0  CSR: 772150   Vector1: 154  Vector2: 000
Name: TTA  Units: 1  Nexus: 0  CSR: 760100*  Vector1: 300* Vector2: 304*
Name: TXA  Units: 1  Nexus: 0  CSR: 760400*  Vector1: 310* Vector2: 000

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

Figure 3-3. Sample SHOW CONFIGURATION

   SYSGEN lists by logical name the devices already installed on the UNIBUS. Make a note of these other devices with floating addresses (greater than 760000$_8$) or floating vectors (greater than 300$_8$) that you plan to re-install with your UD23.

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

   ```
   SYSGEN> CONFIGURE<return>
   DEVICE>
   ```

   Specify the UNIBUS devices to be installed by typing their UNIBUS names at the DEVICE prompt (the device name for MSCP-class controllers under VMS is UDA).

   ```
   DEVICE> UDA,2<return>
   DEVICE> DMF32<return>
   DEVICE> DZ11<return>
   ```

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

In addition to the UD23, you need only specify devices that have floating addresses or vectors. Devices with fixed addresses or vectors do not affect the address or vector assignments of devices with floating addresses and vectors.

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

```
DEVICE> ^Z
```

SYSGEN lists the addresses and vectors of the devices entered in the format shown in Figure 3-4.

```
SYSGEN>  CONFIGURE
DEVICE> DZ11
DEVICE> DMF32
DEVICE> UDA,2
DEVICE> ^Z
Device: UDA     Name: PUA    CSR: 772150     Vector: 154     Support: yes
Device: DZ11    Name: TTA    CSR: 760100*    Vector: 300*    Support: yes
Device: UDA     Name: PUB    CSR: 760354*    Vector: 310     Support: yes
Device: DMF32   Name: COMB   CSR: 760400*    Vector: 314     Support: yes

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

Figure 3-4. CONFIGURE Command Listing

5. Note the CSR addresses listed for the UNIBUS devices in floating address space. Program the listed addresses into non-Emulex devices as instructed by the manufacturer's documentation. For the UD23, program the address given for the UD23 (lowest numerical address) into the board as described in subsection 4.3.1.

6. Complete SYSGEN according to the DEC documentation.

If you want to select a nonstandard address for the UD23, that is, one that differs from the address selected by the CONFIGURE command, you must enter CONNECT statements in the SYCONFIG.COM file that is in the system manager's account, SYS$MANAGER. Use the syntax of the CONNECT statements as described in the DEC documentation on VMS SYSGEN.

NOTE

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

3.5.6 Ultrix-11 Operating Systems (V3.0 and above)

The Ultrix-11 Version 3.0 system supports up to a total of four MSCP disk controllers, **but only one of each type of controller.** Therefore, to add support for two MSCP controllers, the system generation procedure must be told that there is, for example, one UDA50 controller and one RQDX1 controller. The choices are:

Controller name	device name	disk name
UDA50	ra	ra??
KLESI	rc	rc??
RQDX1, RQDX2, or RQDX3	rq	rd??
RUX1	rx	rx??

NOTE

A bug exists in version 3.0 that prevents actually using more than three controllers. When an RQDX1, RQDX2, or RQDX3 is specified, the sysgen program will not allow specifying an RUX1 controller, and vice versa.

3.5.6.1 Sysgen

To add a device to an Ultrix-11 kernel, the sysgen program must be run to create and make a new kernel. Creating a kernel involves the creation of a configuration file and then "making" the kernel from this configuration file.

A dialogue mode is used to enter various system parameters. The question:

```
Disk controller type:

<rh11 rh70 rp11 rk611 rk711 rl11 rx211 rk11
 uda50 kda50 rqdx1 rqdx2 rqdx3 klesi rux1> ?
```

asks for the specification of a disk controller. You must choose a different controller type for each MSCP controller on your system, even if they are all UD23s.

NOTE

The order in which you enter each controller is very important. The order becomes the controller number. The same order must also be used when creating the special files (see below).

For each MSCP controller specified, one of the following statements will be typed:

```
First MSCP controller type:
Second MSCP controller type:
Third MSCP controller type:
```

Depending on the controller name specified previously, the next question will differ. See the appropriate correlation below:

Disk Controller Type	Next Sysgen Question
uda50 or kda50	Drive 0 type <ra60 ra80 ra81> ?
klesi	Drive 0 type <rc25> ?
rqdx1/2/3 or rux1	Drive 0 type <rx50 rd51 rd52 rd53> ?

Note that it doesn't matter which drive type you choose. Just enter one of the supplied names for each drive you have connected to each controller.

The next two questions refer to the controller's CSR and vector addresses:

```
CSR address <172150> ?
Vector address <154> ?
```

The defaults for the CSR and Vector address will always be 172150_8 and 154_8, respectively. Be sure to enter the correct CSR value. Since the MSCP controller accepts a software-defined vector, an unused vector from the floating address space should be used for all nonstandard address controllers. Emulex suggests that you use a decrementing (by 4) vector address starting at 700_8. This will prevent you from using a vector address that is already in use.

3.5.6.2 Special Files

The Ultrix operating system communicates with devices on the system by the use of special files. These files contain pointers into a system table that lists the entry points for a corresponding driver for that device. There must be a special file for each device (and each partition for disks) on the system in order for Ultrix to communicate with that device. Some devices will have two special files associated with a device: one for use with character mode, and the other for block mode. These special files exist in the account "/dev".

The special files for Ultrix-11 are created with the 'msf' program (make special file). If no options are supplied, this program enters a dialogue mode:

```
# /etc/msf
```

The "msf" program will issue the prompt:

```
Command <create exit help remove table>:
```
Use the "c" command to create the special files.

```
Device name (? for help) <rp06,dz11,lp11,etc>:
```

The "msf" program does not understand the notations for different controller types. Instead, it uses the device name and controller number in order to create the special files. For example, the special files for ra60, ra80, and ra81 would be "ra", the special file for an rc25 would be "rc", and the special files for an rd51/2/3 would be "rd". Therefore, you must enter a unique device name for each controller. It is suggested that you use the same device names used previously with the sysgen program.

The next two questions are:

```
MSCP controller number <0 1 2 3>:
Unit number <0 -> 7 or all>:
```

The MSCP controller number assigned to each controller is determined by the order in which you entered the devices to the sysgen program; that is, the number for the first controller is 0.

The unit number for each drive (as it is identified by SW1-2 through SW1-4) must match the drive's specification in the configuration file. In addition, the drive to be booted from must be 0, regardless of whether the controller is at the standard or an alternate address.

For ra, rc, and rd type devices, the next question will be asked:

```
Assume standard disk partitions (? for help) <y or
n> ?
```

If you answer "no", the next question will be asked:

```
Create partitions <0 -> 7 or all>?
```

You should always answer "all".

3.5.6.3 Newfs

The "newfs" program is used to create file systems on specified partitions. The newfs program requires no arguments and immediately enters a dialogue mode. See the *Ultrix-11 System Manager's Guide* for more information on newfs.

3.5.6.4 Volcopy

Once a device is configured into your current kernel, you can copy an existing file system onto a new partition with the 'volcopy' program. The new partition will be created with the identical size parameters of the original file system. See the *Ultrix-11 System Manager's Guide* for more information on volcopy.

3.5.6.5 Copying a Bootstrap

A new bootstrap can be copied onto a new system disk with the "dd" program. The command:

```
# dd if=/mdec/rauboot of=/dev/ra00
```

will copy the bootstrap file onto block zero of ra0.

NOTE

V7M-11 V1.0 and Ultrix-11 V2.0 did not support self-sizing disks and are unusable with the Emulex MSCP controllers.

3.5.7 Ultrix-32m Operating Systems

The Emulex MSCP class disk subsystems emulate the DEC DSA UDA-50/KDA-50/RA81 (MSCP) disk subsystem. They report that they are of controller type "DU" and of device type "RA81". However, when asked for the number of logical blocks, they do not return a size value that matches that of a "real" DEC RA81.

3.5.7.1 The Kernel

Support for MSCP controllers must be included in a monitor when rebuilding the kernel. The configuration file is edited to reflect the number of controllers and the number of drives connected to each controller. The Ultrix-32m system supports two MSCP disk controllers.

Ultrix-32m does not require that MSCP device numbers be assigned to the units in sequential order. However, the MSCP device number for the drive to be booted from **MUST** be 0 regardless of the controller's UNIBUS address. Further, be certain that the MSCP device number of each drive (as it is identified by SW1-2 through SW1-4) matches the drive's specification in the configuration file.

The following example of a configuration file shows two controllers, the first with two drives, the second with one:

```
controller  uda0  at uba0 csr 0172150  vector
                                       udintr
disk        ra0   at uda0 drive 0
disk        ra1   at uda0 drive 1
controller  uda1  at uba0 csr 0160334  vector
                                       udintr
disk        ra2   at uda1 drive 2
```

In this example, the first unit on the second controller must be MSCP device number two regardless of the units on the first controller.

3.5.7.2 Special Files

The Ultrix operating system communicates with devices on the system by the use of special files. These files contain pointers into a system table that lists the entry points for a corresponding driver for that device. There must be a special file for each device (and each partition for disks) on the system in order for Ultrix to communicate with that device. Some devices will have two special files associated with a device: one for use with character mode, and the other for block mode. These special files exist in the account '/dev'.

There is a shell script, called "MAKEDEV" (uppercase important), on the Ultrix-32m system to help build these special files. The format of this command is:

```
% /dev/MAKEDEV device ...
```

This script passes your input to the program "mknod" to create the special files. You should use this command file to create the special files for each disk you wish to connect to the system. An example for two disks is:

```
% /dev/MAKEDEV ra4 ra5
```

This example assumes that you have already added the device into the configuration file, and you chose the logical names ra4 and ra5 for your disks.

3.5.7.3 Autoconfigure

At boot time, Ultrix-32m attempts to autoconfigure the devices included in the booted monitor's configuration file. If the device was not included in the configuration files, it will not be configured into the running system. If the device is not present, Ultrix will skip it.

When Ultrix-32m finds a device at autoconfigure time it prints a message as follows:

```
rqd0 at csr 172150 vec 774, ipl 17
ra0 at rqd0 slave 0
ra1 at rqd0 slave 1
rqd1 at csr 160334 vec 770, ipl 17
ra2 at rqd1 slave 0
```

The CSR addresses were set in the configuration file. The vectors are assigned sequentially in reverse order by the operating system. If the CSR or unit numbers don't match the configuration file, the device will be skipped (and no message will be printed).

3.5.7.4 Disk Partitions

Ultrix allows a user to logically subdivide a disk into sections called "partitions". Disk partitions were created because the first Unix operating systems could access only a limited amount of space on large disks. Disk partitioning lets several Unix file systems reside on the same disk, one file system per partition. This allows the operating system to use the entire disk.

Each disk has a partition table that defines the starting location and size (both in blocks) of each partition on that disk. When a disk is opened by the operating system (for the first time), it writes the partition size table into the super block of partition "a" (the first partition) on the disk.

3.5.7.5 Disk Partition Modifications

Modifications to a disk's partition table is done with the "chpt" command each time a disk is initialized or reinitialized. The "chpt" command allows a system manager to alter a particular partition's location and size characteristic.

The operating system initializes the disk's partition table with that of a real DEC RA81's size table (found in the disk driver) on its very first opening. The system manager should then edit these sizes (with "chpt" command) to match system needs.

3.5.7.6 Default Partition Modifications

It is also possible to modify the default RA81 partition size table, which is stored in the device driver; this would eliminate the need for editing the partition table each time the disk is initialized.

When DEC reorganized the Berkeley 4.2 Unix system to create Ultrix-32(m) they set it up to allow the distribution of the operating system in a binary format. This allowed them to distribute a minimum amount of source code to binary license holders. They separated each of the drivers and system kernel modules into two sections: a code portion and a data portion. The code portion does not require recompilation depending on the selected options at sysgen time; this is supplied in object format (xx**.o**). The data portion requires selection parameters based on sysgen answers; this is supplied in source code format (xx_**data.c**). Making changes to this table will alter the default partition size characteristics for new disks. An example of the changes to the 'uda' driver is included here.

/usr/sys/data/uda_data.c:

```
}, ra81_sizes[8] ={
    15884,    0,          /* A=blk 0 thru 15883 */
    66880,    15884,      /* B=blk 15884 thru 82763 */
    -1,       0,          /* C=blk 0 thru end */
    0,        0,          /* D= not used */
    0,        0,          /* E= not used */
    0,        0,          /* F= not used */
    -1,       82764,      /* G=blk 82764 thru end */
    0,        0,          /* H= not used */
};
```

The -1 above indicates the end of the disk.

3.5.7.7 Newfs

The newfs program speeds up the creating of a file system on a partition. It looks up information, in the file /etc/disktab, on the disk specified by the system manager and creates the file system according to those default values. An example of the changes to the /etc/disktab file have been included here.

```
/etc/disktab:

qd32|UD23|Emulex UD23 Fujitsu Eagle M2351A Winchester:\
        :ty=winchester:ns#47:nt#20:nc#840:\
        :pa#15884:ba#4096:fa#512:\
        :pb#66880:bb#4096:fb#512:\
        :pc#789600:bc#4096:fc#1024:\
        :pg#706836:bg#4096:fg#1024:
```

3.5.7.8 Suggestions/Warnings

There is a maximum of eight partitions per disk. The partitions form logical boundaries on the disk, separating each file system from all others. These logical divisions are useful for disk management because you can put similar types of users, files, directories or projects all on the same file system. Because a file system can never exceed its partition in size, you can use partitions to regulate disk use.

There are certain areas of the disk which, by default, are reserved for the operating system. By mounting the swap space, for example, on its own partition, important data can not be overwritten when data from memory is swapped to the disk. The Ultrix-32m systems use partition "b" for the swap file. If you plan to use your own partition values, be sure to allocate an area on your system disk for a swap file.

For more information on disk partitioning and modifications to the partition sizes, see the *Ultrix-32m System Manager's Guide.*

The program "diskpart" is used to create entries for the disk driver or for the "disktab" file. It creates a template based on the default rules used at Berkeley. The following is a table defining the Berkeley defaults:

Partition	20-60 MB	61-205MB	206-355 MB	356+ MB
a	15884	15884	15884	15884
b	10032	33440	33440	66880
c *	all	all	all	all
d	15884	15884	15884	15884
e	unused	55936	55936	307200
f *	unused	end	end	end
g *	end	end	end	end

* The 'c' partition is, by convention, used to access the entire disk. In normal operation, either the 'g' partition is used, or the 'd', 'e', and 'f' partitions are used. The 'f' and 'g' partitions are variable sized, occupying whatever space remains after allocation of the fixed sized partitions.

NOTE

Ultrix-32m V1.0 did not support self-sizing disks and is unusable with the Emulex MSCP controllers. The "diskpart" program was not included on the Ultrix-32m V1.1 distribution kit.

Section 4
INSTALLATION

4.1 Overview

The procedure for installing the UD23 Disk Controller 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	Disk Controller Setup
4.4	Physical Installation
4.5	ESDI Drive Preparation
4.6	Cabling
4.7	NOVRAM Loading, Disk Formatting, and Testing
4.8	F.R.D. Options
4.9	Drive Configuration Parameters
4.10	Operation

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, PLANNING THE INSTALLATION, before attempting to install this subsystem.**

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

UD23 CONFIGURATION REFERENCE SHEET

GENERAL INFORMATION

- Host computer type ______________________
- Host computer operating system ______________________ Version __________
- Other MSCP Controllers; Type __________, UNIBUS Address __________

DRIVE CONFIGURATION PARAMETERS

- Drive Manufacturer (0) ______________ Model ______________
- Drive Manufacturer (1) ______________ Model ______________
- Drive Manufacturer (2) ______________ Model ______________
- Drive Manufacturer (3) ______________ Model ______________
- NOVRAM Parameters:

DRIVE 0

1	Number Units	______
2	Type Code	______
3	Head Offset	______
4	Sectors/Track	______
5	Heads	______
6	Cylinders	______
7	Spare Sectors	______
8	Alternate Cylinders	______
9	Configuration Bits	______
10	Split Code	______
11	Removable Media	______
12	Gap 0	______
13	Gap 1	______
14	Gap 2	______
15	Cylinder Offset	______
16	Spiral Offset	______

DRIVE 1

1	Number Units	______
2	Type Code	______
3	Head Offset	______
4	Sectors/Track	______
5	Heads	______
6	Cylinders	______
7	Spare Sectors	______
8	Alternate Cylinders	______
9	Configuration Bits	______
10	Split Code	______
11	Removable Media	______
12	Gap 0	______
13	Gap 1	______
14	Gap 2	______
15	Cylinder Offset	______
16	Spiral Offset	______

DRIVE 2

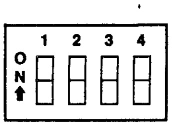
1	Number Units	______
2	Type Code	______
3	Head Offset	______
4	Sectors/Track	______
5	Heads	______
6	Cylinders	______
7	Spare Sectors	______
8	Alternate Cylinders	______
9	Configuration Bits	______
10	Split Code	______
11	Removable Media	______
12	Gap 0	______
13	Gap 1	______
14	Gap 2	______
15	Cylinder Offset	______
16	Spiral Offset	______

DRIVE 3

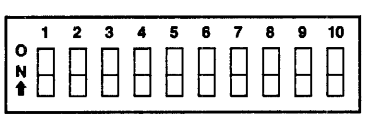
1	Number Units	______
2	Type Code	______
3	Head Offset	______
4	Sectors/Track	______
5	Heads	______
6	Cylinders	______
7	Spare Sectors	______
8	Alternate Cylinders	______
9	Configuration Bits	______
10	Split Code	______
11	Removable Media	______
12	Gap 0	______
13	Gap 1	______
14	Gap 2	______
15	Cylinder Offset	______
16	Spiral Offset	______

UD23 CONFIGURATION

- Firmware revision number ______________
- Top assembly number ______________
- UNIBUS address ______________
- Switch settings (□ = OFF ■ = ON)
- Warranty expiration date ______________
- Serial number ______________
- Interrupt vector address ______________



SW1



SW2

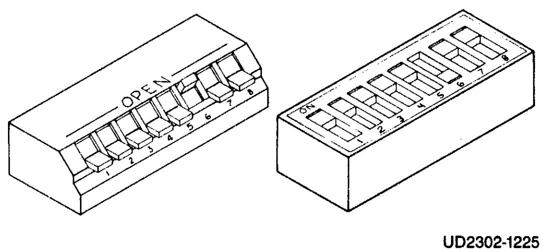
UD2302-1540

Figure 4-1. UD23 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. Each is 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 UD23 Intelligent Disk Controller with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the UD23 does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the UD23 and its associated ESDI peripherals can be installed:

- With both the UD23 Disk Controller and the ESDI disk drives mounted in the same cabinet, and
- With the UD23 mounted in the CPU cabinet and the ESDI drives mounted in a separate cabinet.

To limit radiated interference, DEC completely encloses the components of its computers that generate or could conduct radio-frequency interference (RFI) with a grounded metal shield (earth ground). During installation of the UD23, nothing must be done that would reduce this shield's effectiveness. That is, when the UD23 installation is complete, no gap in the shield that would allow RFI to escape can be allowed.

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

The steps that must be taken to maintain the integrity of the shield and to limit conducted interference are explained fully in subsection 4.6.

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 UD23 subsystem and, using the shipping invoice, verify that all equipment is present. Verify also that model or part numbers (P/N), revision levels, and serial numbers agree with those on the shipping invoice. 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.

Visually inspect the UD23 Disk Controller after unpacking. Check for such items as bent or broken connector pins, damaged components, or any other evidence of physical damage.

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

4.2.1 UD23 Disk Controller Inspection

Visually inspect the UD23 Disk Controller after unpacking. Check for such items as bent or broken connector pins, damaged components, or any other evidence of physical damage.

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

4.3 Disk Controller Setup

Several configuration setups must be made on the UD23 Disk Controller before inserting it into the chassis. These setups are made by option switches SW1 and SW2.

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

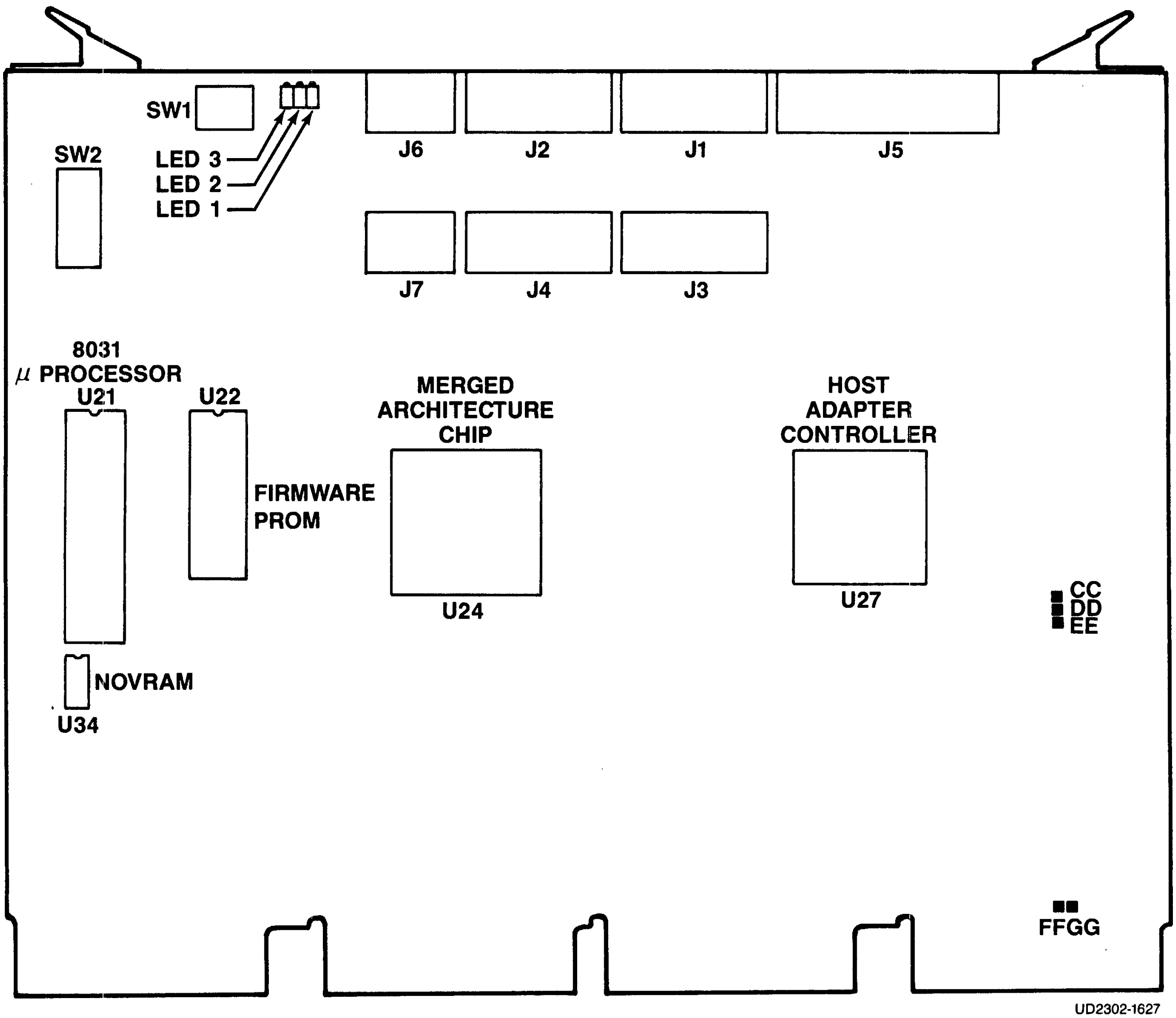


Figure 4-3. UD23 Disk Controller Assembly

NOTE

If you change a switch position on the UD23 or change configuration values in NOVRAM, you must also reset the UD23 so that the host operating system's initialization sequence reads the codes established by the switch settings and/or NOVRAM. To reset the UD23, either toggle switch SW1-1 (ON then OFF), or power-down and power-up the system. **If you toggle SW1-1, be sure the system is offline. Resetting the controller with the system running is likely to crash the system.**

Table 4-1 defines the function and factory configuration of all switches on the UD23 controller. The factory configuration switch settings are representative of most UD23 Disk Controller applications.

Table 4-1. UD23 Switch Definitions and Factory Configuration

Switch	OFF(0)	ON(1)	Fact	Function	Section
SW1-1	Run	Reset/Halt	OFF(0)	Run vs. Reset/Halt	
SW1-2	-	-	OFF(0)	MSCP Device Number	4.3.3.1
SW1-3	-	-	OFF(0)	MSCP Device Number (LSB)	4.3.3.1
SW1-4	-	-	OFF(0)	MSCP Device Number (MSB)	4.3.3.1
SW2-1	Enable	Disable	OFF(0)	Adaptive DMA Mode	4.3.3.3
SW2-2	4 usec	8 usec	OFF(0)	DMA Burst Delay	4.3.3.2
SW2-3			OFF(0)	Reserved	
SW2-4	-	-	OFF(0)	UNIBUS Address	4.3.1
SW2-5	-	-	OFF(0)	UNIBUS Address	4.3.1
SW2-6	-	-	OFF(0)	UNIBUS Address	4.3.1
SW2-7	-	-	OFF(0)	Reserved	
SW2-8	Disable	Enable	OFF(0)	Loop on Self-Test Error	

ON (1) = Closed
OFF (0) = Open
Fact = Factory switch setting

Table 4-2 lists the function and factory configuration of all jumpers on the controller.

Table 4-2. UD23 Jumper Definitions and Factory Configuration

JUMPER	OUT	IN	FACT	COMMENT
CC1 - DD1	Disable Clock	Enable Clock	IN	Must be IN
EE1	Not used	Not used		Ground
FF1 - GG1	Normal Operation	Factory Test	OUT	Must be OUT
FACT	= Factory Setting			

4.3.1 Disk Controller Bus Address

Every UNIBUS I/O device has a block of several registers through which the system can command and monitor that device. The registers are addressed sequentially from a starting address assigned to that controller, in this case an MSCP-class Disk Controller.

The address for the first of the UD23's two UNIBUS registers is selected by DIP switches SW2-4 through SW2-6. See Table 4-3 for register address switch settings. For more information on determining the UNIBUS address, see Section 3 and Appendix A.

Table 4-3. Controller Address Switch Settings

Bus Address (in octal)	**-- SW2 --** 6	5	4	**Factory**
772150	0	0	0	√
772154	1	0	0	
760334	0	1	0	
760340	1	1	0	
760344	0	0	1	
760350	1	0	1	
760354	0	1	1	
760360	1	1	1	

4.3.2 Interrupt Vector Address

The interrupt vector address for the UD23 is programmed into the device by the operating system during the MSCP initialization sequence. See subsection 3.5 for a discussion of vector addresses.

4.3.3 Options

There are other UD23 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.

4.3.3.1 MSCP Device Number

UD23 switches SW1-2 through SW1-4 specify MSCP device numbers. The functions of these switches are dependent on the option you select for your UD23:

- If the UD23 is installed at an alternate UNIBUS address, these switches identify the MSCP device number of the first drive supported by that alternate UD23. The first drive supported by the UD23 at an alternate address may be drive 0 through 7. See subsection 4.3.3.2.2.

4.3.3.1.1 First Logical Unit Number for an Alternate UD23

If your UD23 is installed at an alternate address, switches SW1-2 through SW1-4 select the MSCP device number of the first drive supported by the UD23. MSCP device numbering schemes may vary by DEC operating system (see subsection 3.4.2.2). Table 4-5 defines the MSCP device numbers selected by switches SW1-2 through SW1-4 if the UD23 is at an alternate address. Check unit offset for alternate control.

Example 4-1: *Your system operates under RSX-11M-PLUS and has two UD23 Disk Controllers. The first UD23 is at the standard base for MSCP controllers, 772150_8, and it is supporting three logical drives, Unit 0, Unit 1, and Unit 2. The second UD23 is at an alternate base address, and it is supporting two logical drives. RSX-11M-PLUS requires that the first drive on the alternate UD23 have an MSCP device number of 3 and that the second drive have an MSCP device number of 4. On the alternate UD23, set switches SW1-2 in the ON position, SW1-3 in the ON position, and SW1-4 in the OFF position to specify an MSCP device number of 3 for the first drive.*

This example would also apply if the first MSCP controller were a DEC MSCP controller with three logical drives.

Table 4-4. MSCP Device Number for the First Drive Supported by a UD23 at an Alternate Address

Starting MSCP Device Number	--- SW1 --- 3 (LSB)	2	4 (MSB)
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

4.3.3.2 DMA Burst Delay

The UD23 firmware design includes a switch-selectable DMA burst delay to avoid data late conditions. Switch SW2-2 selects either a 4-microsecond or 8-microsecond delay between DMA bursts. Even with the UD23 adaptive DMA, some applications may require a longer burst delay to allow other devices adequate time on the bus.

Switch	OFF	ON	Factory
SW2-2	4 usec	8 usec	OFF

4.3.3.3 Adaptive DMA Mode

Depending on the other devices on the bus and their priority, the UD23 may use more or less bus time than optimal for your application. The UD23 allows you to modify its DMA operations by disabling adaptive DMA. If adaptive DMA is disabled, the host processor programs the DMA burst length to a maximum of 8 words per burst, unless overridden by the host processor.

When adaptive DMA is enabled (SW2-1 OFF), the UD23 monitors the UNIBUS for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. If the UD23 is not getting the bus time your application requires, you may want to disable the adaptive DMA. When adaptive DMA is disabled, the UD23 performs a burst transfer of 8 words or less, relinquishes the bus, then performs another DMA burst transfer.

Switch	OFF	ON	Factory
SW2-1	Enable Adaptive DMA	Disable Adaptive DMA	OFF

4.4 Physical Installation

4.4.1 System Preparation

Power down the system and switch OFF the main ac breaker at the rear of the cabinet (the ac power indicator will remain lighted). Slide the CPU out of the cabinet and remove the top cover. Remove the card cage shield to obtain access to the CPU and other modules.

4.4.2 Slot Selection

The UD23 can be inserted into any small peripheral controller (SPC) slot in either the DEC computer chassis or UNIBUS expansion chassis. The closer a module is to the CPU, the higher its interrupt priority. The UD23 can be placed fairly far from the CPU because of its large buffer capacity.

Each CPU slot should contain a module. Card slots that would otherwise remain unoccupied should contain Bus Grant (flip-chip) modules to provide interrupt acknowledge continuity.

NOTE

> The nonprocessor grant (NPG) jumper on the SPC card slot in which the controller is being installed **must be removed** to allow the controller to trap the NPG signal during DMA requests.

4.4.3 NPG Signal Jumper

The NPG jumper on the SPC card slot must be removed to allow the trapping of the NPG signal during DMA requests. Therefore, remove the NPG signal jumper between pins CA1 and CB1 on the backplane so that the NPG signal passes through the UD23 module.

Figure 4-4 shows a DD11-DK nine-slot backplane, with the enlargement depicting the layout of a typical socket as seen from the rear. (The enlargement is valid for each of the sockets on the backplane.) The figure of the backplane includes letters and numbers that are not actually on the backplane; they are included to help identify pin locations. Also, the numbers shown in the enlargement do not appear in the same location on the backplane; rather, they are located in about the center of the backplane.

Jumper locations are defined by a series of numbers and letters that show pin locations by socket, column, and row. To find the NPG signal jumper on the DD11-DK backplane, use the following procedure:

1. Find the appropriate socket (in this case C). The sockets of pins are lettered sequentially, beginning with A and proceeding to F.
2. Find the appropriate card slot. In Figure 4-4, the card slots are numbered 1 through 9 from right to left. The column of pins shown in the socket enlargement corresponds to card slot 7. Note that each card slot is four pins wide, as the enlargement shows.
3. Find the appropriate row of pins. As the enlargement shows, each number is labeled A through V, excluding G, I, O, and Q. Also, each row of pins is offset from the row on either side.
4. Find the appropriate number corresponding to the desired pin. As the enlargement shows, each number differentiates between two pins on the same row that correspond to the same card slot. A number 1 indicates the component side; a number 2 indicates the solder side.

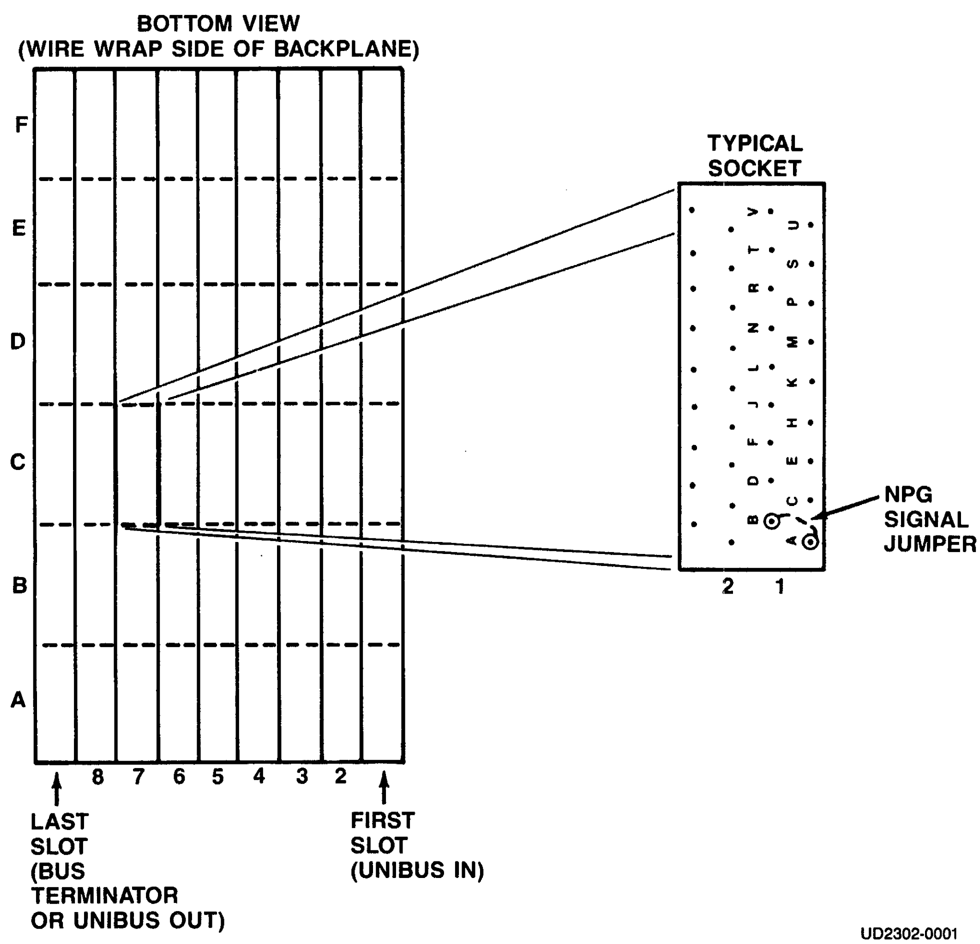


Figure 4-4. NPG Jumper Location

In summary: For the seventh card slot, pin CA1 refers to the fourth socket from the top of the backplane drawing (C), the top pin of the left-hand set (A1). CB1 is one pin to the right and slightly down. An arrow shows the wire between the two pins.

The wire-wrap jumper between CA1-CB1 is the bottom-most wrap on the pair. Once you have located the jumper, cut it. Slipping a small piece of insulation over the end of the pin facilitates later location.

If the UD23 is removed from the backplane, either reconnect the NPG jumper, or insert a dual-width grant continuity module into connectors C and D of the slot vacated by the module. The dual-width grant continuity module (DEC part number G7273) jumpers all grant signals (interrupt grants and nonprocessor grants). It can be ordered from Emulex using part number ZU1110812.

4.4.4 Mounting

The UD23 Disk Controller PWB should be plugged into the PDP-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 board guides before attempting to seat the board by means of the extractor handle.

4.5 ESDI Disk Drive Preparation

The disk drive(s) must have an ID plug or address selection switches properly configured and, if hard-sectored, be configured for the proper number of sectors.

4.5.1 Drive Placement

Uncrate and install the disk drives according to the manufacturer's instructions. Position and level the disk drives in their final places before beginning the installation of the UD23. This positioning allows the I/O cable routing and length to be accurately judged.

4.5.2 Sectoring

The UD23 supports both hard- and soft-sectored drives. The drive parameter tables in Appendix C will recommend either soft or hard sectoring. In general, if a drive is capable of both hard- and soft-sector format, hard-sectoring is preferred as long as the number of hard sectors does not reduce the possible drive capacity. For information on setting the drive's switches, refer to the drive manufacturer's manual.

4.5.3 Drive Numbering

An address from 0 to 3 must be selected for each drive. Be careful that no two drives are assigned the same number. The logical unit number is determined by the address given to the drive.

Drive manufacturers use jumpers, switches, or ID plugs to select addresses. Consult the appropriate drive manual for the exact procedure.

4.5.4 Spindle Motor Spin-Up

Most ESDI drives have a spindle motor control option which allows the drive controller to control the timing of the drive spindle motor spin-up. Emulex recommends that you allow the UD23 controller to start the spindle motor spin-up of the drive(s). If there is more than one drive, the UD23 issues the spin-up commands to each drive sequentially. This will minimize any power surge on multiple drive systems.

4.5.5 Termination

Terminator power is supplied by the drive. The terminated drive must, therefore, have power applied in order for termination to be effective. Otherwise, indeterminate results will occur.

Only the last drive in the string is terminated.

4.6 Cabling

The UD23 Disk Controller interfaces with each ESDI disk drive that it controls via one 34-line control cable and a 20-line data cable. The control cable originates from connector J5 on the UD23 and is daisy-chained to all of the supported drives, terminating on the last drive. Maximum cumulative cable length for the control cable is 10 feet (3 meters). The data cables originate from connectors J1, J2, J3 and J4 on the UD23; each data cable is connected directly from the UD23 to each supported disk drive. Maximum cable length for each data cable is 10 feet (3 meters).

The front panel is interfaced via connectors J6 and J7.

Emulex offers the UD23 Internal Cabling Kit (P/N QD2113001) which allows you to install the UD23 and the ESDI disk drive(s) in the CPU cabinet. Table 4-6 lists the components of this cabling kit; Figure 4-5 shows basic cable installation.

In addition, Emulex offers the UD23 External Cabling Kit (P/N QD0113003) which allows you to install the UD23 in the CPU cabinet and the ESDI disk drives in a separate cabinet; instructions for installing this kit are described in the QD01 Cabling Kit Instruction Sheet (P/N QD0152401).

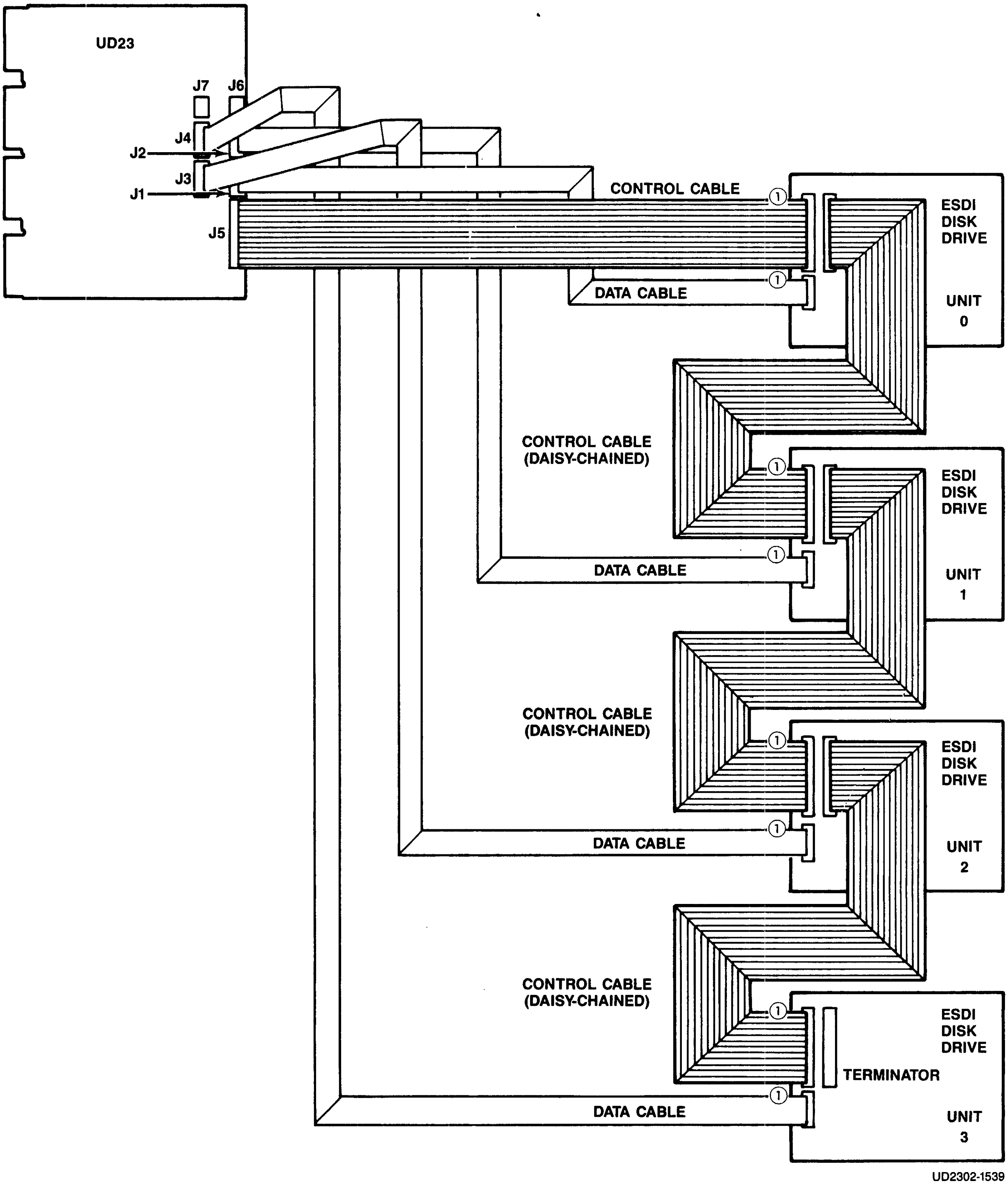
Table 4-5. UD23 Internal Cabling Kit

Qty	Part Number	Length	Cable Description
2	QU0111202-01	3 ft	20-conductor, flat ESDI data interface
1	QU0111201-01	1 ft	34-conductor, flat ESDI control interface daisy-chain
1	QU0111203-01	3 ft	34-conductor, flat ESDI control interface

The Internal Cabling Kit will only support two physical drives. As an alternative to the kit, you can support additional drives by constructing both control and data cables. Table 4-6 lists the components that are required.

Table 4-6. Disk Drive Interface and Cable Components

		Cable Components				
Connector Number	**Controller Function**	**Header Type**	**Control Connector**	**Cable Type Unshielded**	**Cable Type Shielded**	**Drive Connector**
J5	Control	3594	3414	3801/34	3517/34	3463
J1/J2/J3/J4	Data	3592	3421	3801/20	3517/20	3461
All component numbers are 3M. Equivalents may be used.						



Daisy-chained control cables shown are not available from Emulex.

Figure 4-5. Drive Cabling

The Federal Communications Commission (FCC) has mandated that equipment that uses radio-frequency signals in its operation must limit the amount of electromagnetic interference (EMI) that it radiates. Most manufacturers, including DEC, limit EMI by building continuous metal shields into their equipment cabinets.

When installing the UD23 and its disk drives, you must take care that the shield that DEC has built into its equipment cabinets is not defeated.

The routing of the cables that connect the UD23 and its disk drives can have a major impact on the amount of EMI that is radiated by the subsystem (the combination of the UD23 and its drives), especially if the UD23 and the disk drives are installed in separate cabinets.

As noted in subsection 4.1.3, the UD23 and its ESDI disk drive(s) can be installed in either of two configurations:

- With both the UD23 Disk Controller and the ESDI disk drive(s) that it supports mounted in the same cabinet
- With the UD23 mounted in the CPU cabinet and the ESDI disk drive(s) mounted in a separate cabinet

When the UD23 and the ESDI disk drive are installed in the same cabinet, it is possible that the cabinet itself provides sufficient shielding. In such cases, it is not usually necessary to shield the cable that carries the ESDI interface between the UD23 and the ESDI peripherals.

NOTE

If the cabinet in which the UD23 and UNIBUS CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsibility to take whatever steps are necessary to correct the interference.

If the ESDI disk drives are mounted in a separate cabinet from the UD23 Disk Controller, then the cables that connect the UD23 to the drives should be shielded, because they run outside the shielded cabinet environment.

In addition, you should take special care that the integrity of the shield is maintained where the cables pass though it. Usually, designers use clamps that effectively connect the cable shielding to the cabinet shield.

4.7 NOVRAM Loading, Disk Formatting, and Testing

After physically installing the UD23, several steps are required to prepare the subsystem for operation. They are:

- Loading the drive configuration into the NOVRAM
- Formatting and verifying the media
- Testing the subsystem

The UD23 disk controller firmware incorporates a self-contained set of disk preparation and diagnostic utilities, called firmware-resident diagnostics (F.R.D.). F.R.D. provides several important disk preparation functions, including the ability to configure the controller NOVRAM, format the drive, test the disk surface and replace defective blocks, and perform reliability testing of the attached disk subsystem. These utilities allow you to communicate directly with either CRT or hardcopy devices connected to a UNIBUS console port.

The basic application of F.R.D. is in preparing MSCP disk drives for use in your subsystem. Before data can be stored on a drive, the disk must be formatted and any bad blocks identified. F.R.D. provides options that allow you to perform these functions. You use NOVRAM configuration options to set and review your drive parameter values.

The steps involved in disk preparation are formatting the drive and then verifying that each logical block is good. F.R.D. supports both automatic and manual block replacement operations to allow for replacing defective and pattern-sensitive blocks.

Automatic replacement, or blanket bad block replacement, is a feature of several F.R.D. options. With this feature, you can format a drive, verify, and replace any bad blocks in one step. During this format/verify operation, bad blocks are displayed in logical block number (LBN) format. If replacement is enabled, the blocks are replaced automatically.

Manual bad block replacement is a separate option. This option allows you to identify specific bad blocks to be replaced. In addition, you can identify the blocks in Bytes From Index (BFI) format or in LBN format. Using BFI format eliminates the calculation required for LBN. This is most often useful in replacing blocks identified as bad in the manufacturer's defect list when that list no longer exists on the drive.

BFI replacement must be done before any LBN replacement. Once LBN replacement occurs, the BFI values are no longer valid.

There are several ways you can use F.R.D. options to format and verify your disk. The method you choose depends on whether you:

- have formatted this disk
- want to replace blocks using BFI or LBN information
- want to preserve data on this disk

Each method is described below. The options listed are on the F.R.D. main menu. Use them in the order they are listed. (F.R.D. options are described in section 4.8.)

If this is the initial format of a disk and you want to replace only those defects that F.R.D. finds with the four worst-case data patterns, use:

- Option 2, Format and Verify (with replacement enabled)

If this is the initial format of a disk and you want to replace manufacturer's detected defects from the hardcopy list, use:

- Option 1, Format
- Option 7, Replace Block (using BFI format)
- Option 3, Verify (with replacement enabled)

If this disk is formatted and you want to preserve data and obtain a list of bad blocks, use:

- Option 4, Read Only Test (with replacement disabled)

4.7.1 F.R.D. Conventions

F.R.D. uses the following keyboard conventions:

<CR>	required to terminate operator inputs
<Ctrl C>	aborts the current operation and returns to the main menu

A minimum delay of 10 seconds may occur between the <Ctrl C> and the next display. During some verify operations, the delay may be considerably longer because the abort is delayed until the successful completion of the current command. In this case, a screen message informs you of the delay.

In this section, operator responses to F.R.D. prompts appear in **bold** print. The symbols used in this section are listed below with their meanings:

<CR>	carriage return key
<LF>	line feed key
<Ctrl C>	Ctrl key and the letter C pressed at the same time

4.7.2 Starting F.R.D. on a VAX

F.R.D. is started by issuing a special command sequence via console ODT. The sequence to use is illustrated by the following example; specific commands are contained in the tables noted in parentheses. The example pertains to a VAX 750 with UNIBUS Adapter (UBA) #0 and a UD23 base address of 772150 (octal) or 3F468 (hex).

1. Initialize the VAX by applying power to the system and entering the console I/O mode. To initialize the UNIBUS:

   >>>D/I 37 1<CR> (Table 4-7)

2. Enable the map registers for two pages (must be longword aligned):

   >>>D/L/P F30800 80000000<CR> (Table 4-8)
   >>>D/L/P F30804 80000001<CR>

3. Deposit the UD23 "backdoor enable" code in the SA register:

   >>>D/W/P FFF46A 3003<CR> (Tables 4-9, 4-10)

   The SA register is arrived at by the following:

   UBA Base Address + UD23 Base Address + 2 = UD23 SA Register
   FC0000 + 3F468 + 2 = FFF46A

4. Wait for 100 to appear in the SA Register:

   >>>E/W/P FFF46A 100

5. Deposit UD23 F.R.D. code in the SA register:

   >>>D/W/P FFF46A 44xx<CR> (Table 4-11)

   The value of **xx** is 01 for the VAX 750 UBA #0.

6. Wait for 400 to appear in the SA Register:

   >>>E/W/P FFF46A<CR> 400

   A value other than 400 may indicate one of the following vendor-unique errors:

SA Register	Type of Error
100111	Timeout
100121	Driver upload failure

7. Start the F.R.D.

   S 80<CR>

Table 4-7. VAX Initialization Command Sequences

VAX Model	Initialization Command(s)
VAX 730	**I<CR>**
VAX 750[1]	**D/I 37 1<CR>**
VAX 780,[1] 8600/8650[1]	**UNJAM<CR>**
VAX 8200[1]	**20000000+720 20000[2]<CR>**

[1] Console mode I/O command " I " initializes only the CPU, not the UNIBUS, for some VAX systems.

[2] The format of this sequence is Node Space Address + DWUBA Control and Status Register, followed by the Data in the UPI bit. See Table 4-8.

Table 4-8. VAX and UBA Memory Map Register Addresses

VAX Model	Address	Data	Bit Definition
730	F26800 F26804	80000000 80000001	Validity bit, PFN = 0 Validity bit, PFN = 1
750	F30800 F30804 F32800 F32804	80000000 80000001 80000000 80000001	Validity bit, DDP, PFN = 0 at UBA #0 Validity bit, DDP, PFN = 1 at UBA #0 Validity bit, DDP, PFN = 0 at UBA #1 Validity bit, DDP, PFN = 1 at UBA #1
780 and 8600/8650 on SBIA #0	20006800 20006804 20008800 20008804 2000A800 2000A804 2000C800 2000C804	80000000 80000001 80000000 80000001 80000000 80000001 80000000 80000001	Validity bit, DDP, PFN = 0 at TR #3, UBA #0 Validity bit, DDP, PFN = 1 at TR #3, UBA #0 Validity bit, DDP, PFN = 0 at TR #4, UBA #1 Validity bit, DDP, PFN = 1 at TR #4, UBA #1 Validity bit, DDP, PFN = 0 at TR #5, UBA #2 Validity bit, DDP, PFN = 1 at TR #5, UBA #2 Validity bit, DDP, PFN = 0 at TR #6, UBA #3 Validity bit, DDP, PFN = 1 at TR #6, UBA #3
8600/8650 on SBIA #1	22006800 22006804 22008800 22008804 2200A800 2200A804 2200C800 2200C804	80000000 80000001 80000000 80000001 80000000 80000001 80000000 80000001	Validity bit, DDP, PFN = 0 at TR #3, UBA #0 Validity bit, DDP, PFN = 1 at TR #3, UBA #0 Validity bit, DDP, PFN = 0 at TR #4, UBA #1 Validity bit, DDP, PFN = 1 at TR #4, UBA #1 Validity bit, DDP, PFN = 0 at TR #5, UBA #2 Validity bit, DDP, PFN = 1 at TR #5, UBA #2 Validity bit, DDP, PFN = 0 at TR #6, UBA #3 Validity bit, DDP, PFN = 1 at TR #6, UBA #3

(continued on next page)

NOTE

TR levels and UBAs listed for the VAX 780/8600/8650 are standard but may vary depending on your configuration.

Table 4-8. VAX and UBA Memory Map Register Addresses (continued)

VAX Model 8200

Data to be deposited in selected Node and Map Register:

Map Addr. Offset	Data	Bit Definition
800	80000000	Validity, DDP, PFN = 0
804	80000001	Validity, DDP, PFN = 1

Node #	Bus #0	Bus #1	Bus #2	Bus #3
0	20000000	22000000	24000000	26000000
1	20002000	22002000	24002000	26002000
2	20004000	22004000	24004000	26004000
3	20006000	22006000	24006000	26006000
4	20008000	22008000	24008000	26008000
5	2000A000	2200A000	2400A000	2600A000
6	2000C000	2200C000	2400C000	2600C000
7	2000E000	2200E000	2400E000	2600E000
8	20010000	22010000	24010000	26010000
9	20012000	22012000	24012000	26012000
10	20014000	22014000	24014000	26014000
11	20016000	22016000	24016000	26016000
12	20018000	22018000	24018000	26018000
13	2001A000	2201A000	2401A000	2601A000
14	2001C000	2201C000	2401C000	2601C000
15	2001E000	2201E000	2401E000	2601E000

Table 4-9. VAX and UBA I/O Base Addresses

VAX Model 730 I/O Address
UBA Base Address

FC0000	

VAX Model 750 I/O Address
UBA Base Address

FC0000	UBA	#0
F80000	UBA	#1

VAX Models 780 and 8600/8650 on SBIA #0 I/O Address
UBA Address

20100000	TR #3	UBA	#0
20140000	TR #4	UBA	#1
20180000	TR #5	UBA	#2
201C0000	TR #6	UBA	#3

VAX Models 8600/8650 I/O Address on SBIA #1
UBA Base Address

22100000	TR #3	UBA	#0
22140000	TR #4	UBA	#1
22180000	TR #5	UBA	#2
221C0000	TR #6	UBA	#3

VAX Model 8200 I/O Address Window Space Assignments
(Window space offset values are 0 through 3FFFF)

Node #	Bus #0	Bus #1	Bus #2	Bus #3
0	20400000	22400000	24400000	26400000
1	20440000	22440000	24440000	26440000
2	20480000	22480000	24480000	26480000
3	204C0000	224C0000	244C0000	264C0000
4	20500000	22500000	24500000	26500000
5	20540000	22540000	24540000	26540000
6	20580000	22580000	24580000	26580000
7	205C0000	225C0000	245C0000	265C0000
8	20600000	22600000	24600000	26600000
9	20640000	22640000	24640000	26640000
10	20680000	22680000	24680000	26680000
11	206C0000	226C0000	246C0000	266C0000
12	20700000	22700000	24700000	26700000
13	20740000	22740000	24740000	26740000
14	20780000	22780000	24780000	26780000
15	207C0000	227C0000	247C0000	267C0000

Table 4-10. UD23 Base Address Offsets (IP Register)

Octal	Hex
772150	3F468
772154	3F46C
760334	3E0DC
760340	3E0E0
760344	3E0E4
760350	3E0E8
760354	3E0EC
760360	3E0F0

Table 4-11. Available F.R.D. Upload Codes

(44xx) xx value	VAX and UBA Number
01	730 and 750 UBA #0
02	750 UBA #1
03	780 UBA #0 and 8600/8650 UBA #0 on SBIA #0
04	780 UBA #1 and 8600/8650 UBA #1 on SBIA #0
05	780 UBA #2 and 8600/8650 UBA #2 on SBIA #0
06	780 UBA #3 and 8600/8650 UBA #3 on SBIA #0
07	8600/8650 UBA #0 on SBIA #1
08	8600/8650 UBA #1 on SBIA #1
09	8600/8650 UBA #2 on SBIA #1
0A	8600/8650 UBA #3 on SBIA #1
10	8200 Node #0 VAXBI Bus #0
11	8200 Node #1 VAXBI Bus #0
12	8200 Node #2 VAXBI Bus #0
13	8200 Node #3 VAXBI Bus #0
14	8200 Node #4 VAXBI Bus #0
15	8200 Node #5 VAXBI Bus #0
16	8200 Node #6 VAXBI Bus #0
17	8200 Node #7 VAXBI Bus #0
18	8200 Node #8 VAXBI Bus #0
19	8200 Node #9 VAXBI Bus #0
1A	8200 Node #10 VAXBI Bus #0
1B	8200 Node #11 VAXBI Bus #0
1C	8200 Node #12 VAXBI Bus #0
1D	8200 Node #13 VAXBI Bus #0
1E	8200 Node #14 VAXBI Bus #0
1F	8200 Node #15 VAXBI Bus #0

(continued on next page)

Table 4-11. Available F.R.D. Upload Codes (continued)

(44xx) xx value	VAX and UBA Number
20	8200 Node #0 VAXBI Bus #1
21	8200 Node #1 VAXBI Bus #1
22	8200 Node #2 VAXBI Bus #1
23	8200 Node #3 VAXBI Bus #1
24	8200 Node #4 VAXBI Bus #1
25	8200 Node #5 VAXBI Bus #1
26	8200 Node #6 VAXBI Bus #1
27	8200 Node #7 VAXBI Bus #1
28	8200 Node #8 VAXBI Bus #1
29	8200 Node #9 VAXBI Bus #1
2A	8200 Node #10 VAXBI Bus #1
2B	8200 Node #11 VAXBI Bus #1
2C	8200 Node #12 VAXBI Bus #1
2D	8200 Node #13 VAXBI Bus #1
2E	8200 Node #14 VAXBI Bus #1
2F	8200 Node #15 VAXBI Bus #1
30	8200 Node #0 VAXBI Bus #2
31	8200 Node #1 VAXBI Bus #2
32	8200 Node #2 VAXBI Bus #2
33	8200 Node #3 VAXBI Bus #2
34	8200 Node #4 VAXBI Bus #2
35	8200 Node #5 VAXBI Bus #2
36	8200 Node #6 VAXBI Bus #2
37	8200 Node #7 VAXBI Bus #2
38	8200 Node #8 VAXBI Bus #2
39	8200 Node #9 VAXBI Bus #2
3A	8200 Node #10 VAXBI Bus #2
3B	8200 Node #11 VAXBI Bus #2
3C	8200 Node #12 VAXBI Bus #2
3D	8200 Node #13 VAXBI Bus #2
3E	8200 Node #14 VAXBI Bus #2
3F	8200 Node #15 VAXBI Bus #2
40	8200 Node #0 VAXBI Bus #3
41	8200 Node #1 VAXBI Bus #3
42	8200 Node #2 VAXBI Bus #3
43	8200 Node #3 VAXBI Bus #3
44	8200 Node #4 VAXBI Bus #3
45	8200 Node #5 VAXBI Bus #3
46	8200 Node #6 VAXBI Bus #3
47	8200 Node #7 VAXBI Bus #3
48	8200 Node #8 VAXBI Bus #3
49	8200 Node #9 VAXBI Bus #3
4A	8200 Node #10 VAXBI Bus #3
4B	8200 Node #11 VAXBI Bus #3
4C	8200 Node #12 VAXBI Bus #3
4D	8200 Node #13 VAXBI Bus #3
4E	8200 Node #14 VAXBI Bus #3
4F	8200 Node #15 VAXBI Bus #3

4.7.3 Starting F.R.D. on a PDP-11 System

To start F.R.D. on a PDP-11 system, first halt the processor. Then enter the following commands in response to the ODT prompt:

```
>>>D 177xxxxx 1<CR>
>>>D 177yyyyy 30003<CR>
>>>D 177yyyyy 42000<CR>
>>>E 177yyyyy<CR>
>>> 177yyyyy 2000
>>>S  200<CR>
```

NOTE: XXXX and YYYY are offsets dependent on the address of the UD23 controller. See Table 4-12 for the available values.

Table 4-12. PDP-11 Offsets

CONTROLLER BUS ADDRESS	XXXX	YYYY
772150	72150	72152
772154	72154	72156
760334	60334	60336
760340	60340	60342
760344	60344	60346
760350	60350	60352
760354	60354	60356
760360	60360	60362

When the appropriate start procedure is completed, F.R.D. identifies itself by displaying the controller type and firmware revision. Then, it displays the menu options. See subsection 4.8 for more information on F.R.D. options.

4.7.4 Terminating F.R.D.

To terminate F.R.D., choose one of the following:

- Press the BREAK key
- Reinitialize the system, or
- Halt the CPU.

You can restart the diagnostics from a halted condition if you have not changed the memory contents. On a PDP-11 system, enter 200G at the ODT prompt. On a VAX system, enter S 80.

4.8 F.R.D. Options

F.R.D. is an interactive, menu-driven utility. This section describes the function of each option on the F.R.D. main menu. The menu appears as follows:

Program Option Menu

1 - Self-test loop
2 - Format
3 - Verify
4 - Format and verify
5 - Data reliability test
6 - Format, verify, and data reliability test
7 - Read only test
8 - List known units
9 - Replace block
10 - Print RCT
11 - Display Novram
12 - Edit / Load Novram

Enter option number:

The main menu and each submenu prompt for required input. When you enter a valid selection, the next menu displays or F.R.D. performs the selected option. If you make an invalid entry, F.R.D. rejects it, displays an error message, and reprompts.

Based on the nature of the MSCP emulation being performed, some operations may produce an observable delay when performed on previously unformatted drives. This delay is approximately 30 seconds.

When an option is finished, F.R.D. displays the prompt "Hit any key to continue" and waits for you to do so before returning to the main menu.

4.8.1 Option 1 - Self-test Loop

The Self-test Loop option detects intermittent hardware failures that have already passed through the first self-test. The LED indicators on the QD24 front panel will blink when a pass has compeleted. If an error occurs, the self-test loop option stops and reports an error; the LEDs on the front panel display the error code. A description of the error codes is displayed on the host console device. This option may be aborted by <Ctrl C>

4.8.2 Option 2 - Format

The Format option is used to initially format a drive. The operation writes sector headers; initializes the drive's replacement caching tables (RCT), and replaces any defects listed in the MDL. It is used to format a virgin drive, a drive that has been determined to contain unusable data, or a drive with a format that is improper to use with a particular controller.

If a type 2 drive is being formatted (configuration parameters are read from the drive), F.R.D. prompts for spiral offset.

After formatting, the drive contains a valid RCT with a serial number you specified. During format, F.R.D. attempts to read and use the MDL. F.R.D. displays a message if the MDL cannot be read. If portions of the MDL are bad, F.R.D. uses whatever good information can be extracted.

It is possible that either type 1 or type 2 drives might have so many multiple sector/track defects that the default number of spare cylinders allocated for replacement usage is not large enough. If the number of defects in the MDL exceeds the replacement area allocated, you will be alerted by a message stating that the present value doesn't allow formatting with MDL and how many spare cylinders are required to accomodate the MDL. This number of spare cylinders includes two additional cylinders for future bad spots. If this occurs, you have two choices:

Drive Type Code 2. Continue to format without MDL, running two passes of verify and 10 passes of reliability to remove pattern sensitive bad blocks.

Drive Type Code 1. Change to type code 1 and change the number of spare cylinders as required by the message from F.R.D; restart the format.

You will be notified if a drive has been formatted without the MDL; this will occur if a drive's MDL cannot be read and/or if there is an insufficient number of spare cylinders. You have the option to let the formatting continue or to abort using <Ctrl C).

4.8.3 Option 3 - Verify

The Verify option Write/Read exercises all user-available blocks. F.R.D. uses four worst-case data patterns to find and replace pattern-sensitive blocks not found in the drive defect list. It asks for the logical unit number (LUN) of the drive to be verified. After you enter the LUN, F.R.D. prompts for the number of write/read passes.

Verify operations are performed on 120 logical blocks at a time. Logical blocks are referenced by logical block number (LBN).

During Verify operations, F.R.D. disables all controller error recovery capabilities so that a sector is replaced for any repeatable single bit error. Each data pattern is run until error-free for a single pass, ensuring that replacement blocks are also verified.

When a block is encountered that cannot be accessed because of header or data field errors, the Logical Block Number in error displays. Because the failing pattern may not be the first pattern, it is possible that replacement blocks may not be tested with all patterns. For this reason, Emulex recommends running at least two Verify passes over all 4 data patterns.

The Verify option has many features which allow you to enable full error description. When Error Description is enabled, it reports the type of error that occurs on the bad blocks. If a drive is producing an excessive number of bad blocks, this feature helps determine the kinds of errors responsible.

The Verify option also offers a bad block replacement feature which, when enabled, replaces any bad blocks using the appropriate technique.

At the end of all testing or when you enter a <Ctrl C>, F.R.D. reports the number of bad blocks detected by the Verify operation. There will be no message if the Verify option does not detect any errors.

4.8.4 Option 4 - Format and Verify

This option formats a drive, then tests the surface to replace pattern-sensitive and defective sectors. It performs both of the operations that are available separately with options 2 (Format) and 3 (Verify). This option also offers a bad block replacement feature which, when enabled, replaces any bad blocks found during the verify operation.

4.8.5 Option 5 - Data Reliability Test

This option allows you to thoroughly test your subsystem. The reliability test uses Write, Write/Check, and Read functions to test the controller-to-drive portion of the subsystem. In addition, an independent DMA operation between the host memory and the controller tests the host/controller interface.

The test defaults to two reserved diagnostic cylinders so that user data will be protected; a test of the full pack is your option. To run the reliability test indefinitely, select 0 (zero) passes.

If the test encounters errors, F.R.D. displays text error messages. These messages are primarily for use by Emulex technical support personnel.

4.8.6 Option 6 - Format, Verify, and Data Reliability Test

This option combines options 2 (Format), 3 (Verify), and 5 (Data Reliability Test). This option automates the initialization and testing of drives, since you can select multiple drives and activate the data reliability test without having to wait for the format and verify options to complete. The format and verify portions of this option run in the order of the drives selected. Drives with hard faults are dropped and the sequence moves to the next drive in the list. The reliability portion of this option runs simultaneously on all selected drives.

4.8.7 Option 7 - Read Only Test

This option causes all the user-available blocks on the selected drive to be Read-only, not Write/Read, during the Verify pass. When a block is encountered that cannot be accessed because of header or data field errors, the utility displays the Logical Block Number.

The Read Only Test option also offers a bad block replacement feature, which, when enabled, replaces any bad blocks. Because F.R.D. runs with ECC disabled and does not cache any read data, no corrected data is available to put in the replacement block. This means that even though the defective block is replaced and no forced error flag is set in the replacement sector, the data is nonvalid.

CAUTION

This may cause problems if the replaced blocks contain executable program files. For this reason, you should back up sensitive data before running this option with the replacement feature enabled.

This option is usually used after the drive is formatted. However, if you plan to manually replace the bad blocks identified in the manufacturer's defect list, be certain to do so before using Option 7 with replace enabled.

4.8.8 Option 8 - List Known Units

This option causes the program to list all the drives that are configured in the NOVRAM. Only those units that can be selected by the controller are listed as available.

A user size (in 512-byte blocks) and a media type I.D. are listed with all drives found by this option. The user size does not include RCT area, diagnostic cylinders, designated or hidden spare tracks or blocks, etc.

In addition, this option displays the attached drive's physical geometry. This display includes all areas of the disk. If the device size in logical blocks is calculated from this data, the number will be larger than the displayed user size. The difference is the number of LBNs used for RCT, diagnostic cylinders, spares, etc.

4.8.9 Option 9 - Replace Block

This option allows you to replace a specific bad block or group of blocks without using the blanket replacement feature found in the Verify and Read Only options. You choose to identify either logical blocks (entered in decimal MSCP Logical Block Number format) or Bytes From Index (as listed in the manufacturer's defect list), then enter the block to be replaced. If you specify LBN, then you will be prompted to enter the block to be replaced. If you specify BFI, you will be prompted for the number of bytes from index, then to enter the length in bits.

BFI replacement eliminates the calculation required to translate BFI to LBN format. F.R.D. requires the cylinder, track, and bytes from index of the defect for each BFI entry. When you initiate replacement, F.R.D. prompts for the number of bytes from index. As soon as you enter this value, you are prompted to enter the length in bits, then F.R.D. begins replacing blocks.

LBN replacement allows you to replace blocks identified as bad during the format operation, when they are identified in LBN format by older versions of DEC operating systems which do not support host-initiated replacement.

If you are using both types of replacement, BFI replacement must be complete before LBN replacement is begun. Further, BFI replacement must be complete before the blanket bad block replacement feature of other options is enabled.

Emulex recommends that you run the Verify option after the replacement option is complete. The Verify option runs test patterns that may detect any pattern-sensitive blocks.

4.8.10 Option 10 - Print RCT

This option allows you to display the selected drive's Replacement Caching Table. The entries listed will show the pack serial number, the displayed RCT copy (multiple copies are saved), and if the sector was primary, secondary, or nonusable with the associated logical block number. The number of remaining spare tracks (used for track replacements) is also shown. Zero remaining replacement tracks will force the system to software writelock the drive upon the next replace command.

4.8.11 Option 11 - Display NOVRAM

This option displays the current contents of the NOVRAM for your drives. The information displayed depends on the type code entered in the NOVRAM. For type 1 drives, this option displays the current NOVRAM parameter values. For type 2 drives, this option lists the drive as type 2 with parameters read from the drive.

4.8.12 Option 12 - Edit/Load NOVRAM

This option allows you to enter the drive configuration parameters into the controller. If a drive type code of 1 is specified, F.R.D. prompts you for the required drive parameters. If a drive type code of 2 is specified, the controller obtains configuration parameters from the drive.

4.9 Drive Configuration Parameters

When you edit or load NOVRAM configuration parameters, you are asked to enter the values required for your configuration. This section describes each parameter and states the range of valid entries for each. The required values for each drive supported by Emulex are listed in Appendix C.

You begin loading NOVRAM parameter values by selecting Option 9 from the F.R.D. main menu. F.R.D. then displays each parameter, one at a time. The parameter displays with a range of valid entries and a default value. Enter the appropriate value (in decimal) or simply press the return key to accept the default value (the last value entered). The next parameter then displays.

4.9.1 Type Code

This parameter indicates the type of disk drive. Valid values are 1 and 2. If you enter 1, the controller expects to find drive configuration information contained in the NOVRAM. F.R.D. then displays each parameter for you to enter the values.

If you enter 2, the controller obtains the drive configuration information from the drive. In this case, the only other NOVRAM parameter value you enter for this drive is the spiral offset, which is entered when you initiate a verify option. Default values are used for the number of spare sectors per track (1) and the number of alternate cylinders (2).

NOTE

A compatibility issue may exist if you define a drive as Type 1, then later redefine it as Type 2, even if the NOVRAM values you entered match those read from the drive.

If a drive is in hard sector mode, the controller is configured for Type 2 drives, and you want to switch the drive to Type 1, then the drive must first be powered down. This allows it to switch from Type 2 commanded Bytes per Sector to the number of bytes per sector determined by the drive sector switches or jumpers. This problem may be eliminated by setting the drive jumpers or switches to match the number of sectors determined by the Type 2 calculations.

4.9.2 Number of Units of this Type

This parameter specifies the quantity of attached physical disk drives that use the NOVRAM parameters that follow. Valid values are 1 and 2. If you enter 1, the utility uses a separate set of parameter values for each drive. In this case, it prompts for parameter values for the second drive. If you enter 2, the same parameter values are used for both drives.

4.9.3 Starting Head Offset

This parameter specifies the physical drive head that is to be used as the first head of the second logical drive. This field has meaning only if a Split Code 2 or 3 is specified. The valid range is from 0 through 63. If a Split Code 0 or 1 is selected, this value must be 0.

4.9.4 Number of Sectors per Track

This parameter specifies the total number of physical sectors per track, including spares. The valid range is from 1 through 255.

4.9.5 Number of Heads

This parameter specifies the number of data heads per physical drive. The valid range is from 1 through 63.

4.9.6 Number of Cylinders

This parameter specifies the total number of physical cylinders per drive, including spares. The valid range is from 1 through 4,095.

4.9.7 Number of Spare Sectors per Track

This parameter specifies the number of spare sectors reserved per track. Emulex recommends a value of 1; larger values will unnecessarily reduce the capacity of the drive. The default value of 1 is used if you select a type code of 2.

4.9.8 Number of Alternate Cylinders

This parameter specifies the number of spare cylinders per physical drive. The valid range is from 2 through 15. At least two cylinders must be specified as alternates. (If spare sectors are specified, the sector replacement algorithm needs one track for working space.)

If Split Code 1 is used, you must specify twice the normal number of alternate cylinders because they are divided evenly between the two logical drives. A minimum of 2 alternate cylinders must be specified if block replacement is to function with a cylinder split.

4.9.9 Configuration Bits

These parameters define additional configuration characteristics of the drive. This parameter has a 4-bit field with a valid range from 0 through 15.

If you selected type code 2 for this drive, the configuration information is read from the drive and you will not need this information.

If you selected type code 1 for this drive and your subsystem includes a drive that Emulex supports, refer to Appendix C, Table C-1, for the decimal values to enter for these parameters. If your drive is not supported by Emulex, refer to the drive manufacturer's manual for drive requirements, then enter the appropriate values as discussed subsequently.

Configuration Bits:

Bit 0: This bit is 0 if the drive is hard-sectored and 1 if the drive is soft-sectored.

Bit 1: This bit specifies whether or not the drive can perform early or late data strobe operations. The valid range for this bit is 0 or 1. If the bit is 0, the drive cannot perform early or late data strobe operations. If the bit is 1, the drive is capable of performing early or late data strobe operations.

Bit 2: This bit specifies whether or not the drive is capable of head offset operations. The valid range for this bit is 0 or 1. If this bit is 0, the drive cannot perform head offset operations. If the bit is 1, the drive is capable of performing head offset operations.

Bit 3: This bit specifies whether or not the drive negates the Command Complete signal during a head select operation. The valid range is 0 or 1. If the bit is 0, the Command Complete signal remains on during a head select. If the bit is 1, the Command Complete signal is negated during a head select.

Table 4-13. Configuration Bit Values in Decimal

Command Complete	Head Offset	Data Strobe	Sector	Decimal Value
OFF	NO	NO	HARD	0
OFF	NO	NO	SOFT	1
OFF	NO	YES	HARD	2
OFF	NO	YES	SOFT	3
OFF	YES	NO	HARD	4
OFF	YES	NO	SOFT	5
OFF	YES	YES	HARD	6
OFF	YES	YES	SOFT	7
ON	NO	NO	HARD	8
ON	NO	NO	SOFT	9
ON	NO	YES	HARD	10
ON	NO	YES	SOFT	11
ON	YES	NO	HARD	12
ON	YES	NO	SOFT	13
ON	YES	YES	HARD	14
ON	YES	YES	SOFT	15

4.9.10 Split Code

This parameter allows the drive(s) defined by this parameter block to be split into two logical disk units (two each, if more than one drive is defined by this block). The split codes are:

Code 0: No split.

Code 1: The cylinders are divided between the two logical drives. A starting cylinder offset value specifies the first cylinder of the second logical drive.

Code 2: The drive's data heads are divided between the two logical drives. A starting head offset value specifies the first head of the second logical drive. If you select a head split code on a drive with both fixed and removable media, the removable media may be configured as logical unit number (LUN) 0 and the fixed media as LUN 1.

Code 3: Identical to Code 2 except the logical assignments for the physical drives are reversed. Reverse head split codes also divide the drive by data heads, but assign the lower numbered heads to drive 1 and the higher numbered heads to drive 0.

Use of the split option disables seek-ordering and overlapped seek processing in the MSCP Controller, which reduces performance, particularly when both logicals of a split physical drive are active.

If drive type 2 is selected, no splits are available. For more information on split codes, see subsection 3.4.2.1.

4.9.11 Cylinder Offset

This parameter specifies the physical cylinder that is to be used as the first cylinder of the second logical drive. This field has meaning only if a Split Code 1 is specified. If a Split Code 0, 2, or 3 is selected, this parameter must be 0.

4.9.12 Starting Head Offset

This parameter specifies the physical drive head that is to be used as the first head of the second logical drive. This field has meaning only if a Split Code 2 or 3 is specified. The valid range is from 1 through 63. If a Split Code 0 or 1 is selected, this value must be 0.

4.9.13 Removable Media

This parameter indicates whether the disk media is fixed or removable. If you are defining one physical/logical drive, this parameter uses a 1-bit field with valid values of 0 and 1, where 0 indicates fixed media and 1 indicates removable media.

If you are defining a drive with a logical split, this parameter uses a 2-bit field with a valid range from 0 through 3:

Definition	Decimal Value
LUN 0 and LUN 1 are both fixed.	0
LUN 0 is removable, LUN 1 is fixed.	1
LUN 0 is fixed, LUN 1 is removable.	2
LUN 0 and LUN 1 are both removable.	3

4.9.14 Media ID Type

This parameter identifies a media type of RA81 or RA82 and is intended for systems that run the Digital Standard Mumps (DSM) operating system. When utilizing disk drives that have a capacity greater than the DEC RA81 (456 megabytes formatted capacity), it is necessary to specify the DEC RA82 (622 megabytes formatted capacity) media type. Specifying the RA82 media type allows the use of disk drives with capacities greater than 456 megabytes and less than or equal to 622 megabytes.

0 = RA81 MEDIA ID
1 = RA82 MEDIA ID

4.9.15 Gap 0, 1, and 2 Parameters

These parameters specify the recording format for each sector on the drive. The recording format allows gaps, as, for example, between header and data fields. These gaps are based on a formula intended to allow the drive time for read/write transitions while maximizing data capacity.

Enter the appropriate value for the type code 1 drive. The values Emulex recommends for certified drives are contained in Appendix C, Disk Drive Configuration Parameters. These values are factory parameters and are to be used with Emulex certified drives. If any of these factory parameters are altered, the UD23 may not support the disk drive.

If you specified type code 2 for this drive, F.R.D. calculates these values based on information provided by the drive.

4.9.16 Spiral Offset

This parameter specifies the number of sectors by which sector 0 of a track is offset from sector 0 of the previous track. Offsetting sector 0 from one track to the next is a technique that is used to reduce latency when performing write or read operations that cross a track boundary. When the drive is formatted, sector 0 of a track is offset a certain number of sectors from the position of sector 0 on the previous track. When this is done, spiral write and read operations are more efficient because the drive has time to seek from track to track before encountering sector 0.

The valid range is from 0 through 31.

4.10 Operation

There are no operational instructions. The UD23 is ready for MSCP initialization as soon as its drives are formatted and tested.

4.10.1 Indicators

There are three light emitting diodes (LEDs) on the UD23 PWB. These LEDs are used for both diagnostics and for normal operations.

If switch SW1-1 is OFF, the UD23 executes a preliminary test at the following times:

- On power-up
- After a reset condition
- After a bus initialization
- After a write operation to the Initialization and Polling (IP) register (base address)

The self-test routine consists of two test sequences: preliminary and self-test. The preliminary test sequence exercises the 8031 microprocessor chip and the Disk Formatter chip. When the UD23 successfully completes the preliminary test, LED3 illuminates indicating that the UD23 is waiting for the MSCP initialization sequence.

During the MSCP initialization sequence, initiated by host software control, the UD23 executes a self-test that exercises the buffer controller chip, the Host Adapter Controller (HAC) chip and its associated circuitry, the onboard RAM, and the control memory PROM. If the UD23 passes this sequence of its self-test successfully, all the LED indicators on the edge of the UD23 are OFF.

If a fatal error is detected either during self-test or while the system is running, all three of the edge-mounted LED indicators are ON (illuminated). If the UD23 fails to pass its power-up self-tests, you can select a special diagnostic mode (switch SW2-8 ON) which causes the LED indicators to display an error code. See Self-Test Error Reporting, in Section 5, TROUBLESHOOTING. During normal operation, LED1 and LED2 flicker occasionally. These LEDs are used to indicate UNIBUS activity and ESDI disk drive activity, respectively.

Section 5
TROUBLESHOOTING

5.1 Overview

This section describes the several diagnostic features with which the UD23 Disk Controller is equipped, and outlines fault isolation procedures that use these diagnostic features.

Subsection	Title
5.1	Overview
5.2	Service
5.3	Fault Isolation Procedure
5.4	Power-Up Self-Diagnostics
5.5	Fatal Error Codes

5.2 Service

Your Emulex UD23 Disk Controller was designed to give years of trouble-free service, and it was thoroughly tested before leaving the factory.

Should one of the fault isolation procedures indicate that the UD23 is not working properly, the product must be returned to the factory or to 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 Outside California (800) 854-7112
FAX: (714) 966-1299 TLX: 183627

After 5 p.m. Pacific Time, call (800) 638-7243. When answered, you will be prompted to key in 37115, followed by a # symbol, then a message.

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

To help you efficiently, Emulex or its representative requires certain information about the product and the environment in which it is installed. During installation, a record of the switch setting should have 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 component **postage paid** to the address given you by the Emulex representative. The sender must also insure the package.

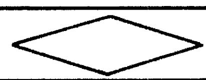
5.3 Fault Isolation Procedure

This fault isolation procedure is provided in flow chart format. The procedure is based on the self-diagnostics incorporated into the UD23. The procedure is designed to be used if the product's self-diagnostic fails or if many errors are flagged by the subsystem during normal operation. If neither of these events happens, 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 5.2 for instructions on how to do so.

Table 5-1. Flow Chart Symbol Definitions

Symbol	Description
	**Start point, ending point.**
	**Decision, go ahead according with YES or NO.**
	**Connector, go to same-numbered symbol on another sheet.**
	**Process.**

UD2302-0106

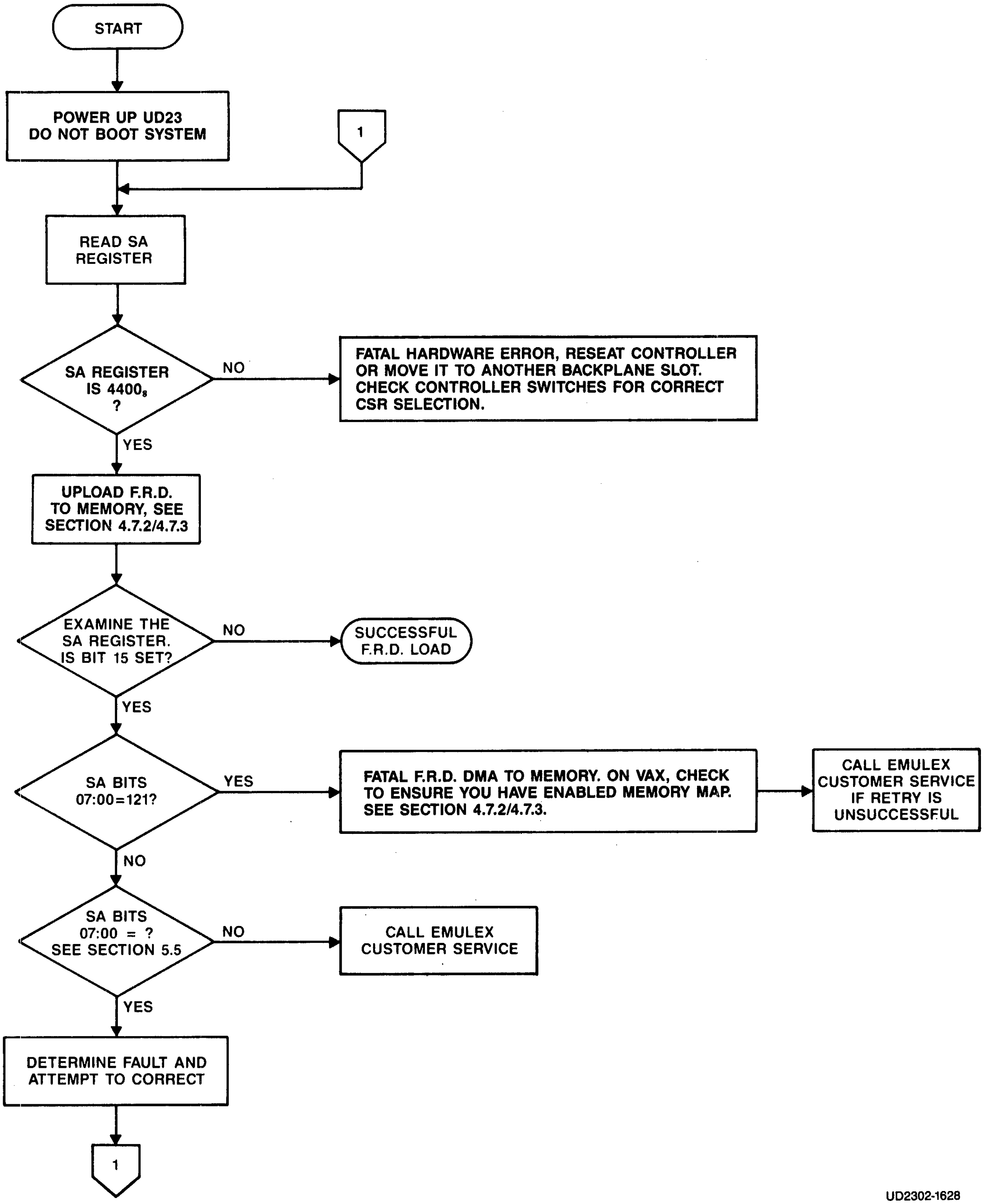


Figure 5-1. Fault Isolation Chart

5.4 Power-Up Self-Diagnostic

The UD23 executes an extensive self-diagnostic to ensure that the disk controller is in good working order. The self-diagnostic is divided into several parts. Table 5-2 indicates the order in which the tests are performed.

The first two tests are executed immediately after power-up, a reset, a bus INIT, or a write to the IP register (base address). The other tests are executed as the controller interacts with the MSCP initialization routine. If the UD23 fails any of the tests, it posts an MSCP fatal error code in the low-byte of the SA register (base address plus 2) and turns on three LEDs which are located on the outside edge of the PWB. The MSCP fatal error codes used by the UD23 are listed in Table 5-3.

To help determine the location of the problem, the operator can select a special diagnostic mode that causes the LEDs to display an error code. To enable this diagnostic mode, place the CPU halt switch in the ON position and set UD23 switch SW3-1 ON (1). After setting SW2-1 ON, the host computer must be powered down or UD23 switch SW1-1 must be toggled (turned ON and then OFF) to cause the UD23 to again perform its self-test.

Upon encountering an error, the host microprocessor halts and the LEDs display an error code. The error codes are listed and described in Table 5-2.

If the UD23 completes the diagnostic mode without errors, all three LEDs are OFF. Set switch SW2-1 in the OFF position and reset the UD23 controller before using.

Table 5-2. LED Error Codes

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

5.5 Fatal Error Codes

If the UD23 encounters a fatal error anytime during operation, all three LEDs are illuminated and an error code is posted in the low byte of the SA register (base address plus 2). Table 5-3 lists the MSCP fatal error codes used by the UD23.

Table 5-3. MSCP Fatal Error Codes used by the UD23

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the UD23 attempted to read data from a message packet.
2	2	Possible parity or timeout error when the UD23 attempted to write data to a message packet.
4	4	UD23 diagnostic self-test indicated a controller RAM error.
5	5	UD23 diagnostic self-test indicated a firmware checksum error.
6	6	Possible parity or timeout error when the UD23 attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the UD23 attempted to write an envelope address to a command ring.
11	9	Host did not communicate with UD23 within the time frame established while bringing the controller online.
12	A	Operating system sent more commands to the UD23 than the controller can accept.
13	B	Controller unable to perform DMA transfer operation correctly.
14	C	UD23 diagnostic self-test indicated controller fatal error.
16	E	The MSCP connection identifier is invalid.
23	13	An error occurred during the MSCP initialization sequence.

Additional fatal error messages may appear. These error codes are listed in Table 5-4.

Table 5-4. Fatal Error Codes

Octal Code	Hex Code	Description
004	04	RAM error
005	05	Firmware checksum error
014	0C	Fatal error during self-test
111	49	Autoboot timeout
121	51	F.R.D. load to memory failed

Section 6
DEVICE REGISTERS AND PROGRAMMING

6.1 Overview

This section contains an overview of the UD23 device registers that are accessible to the UNIBUS and that are used to monitor and control the UD23 Disk Controller. The registers are functionally compatible with DEC implementations of MSCP controllers.

The following table outlines the contents of this section.

Subsection	Title
6.1	Overview
6.2	Overview of MSCP Subsystem
6.3	Programming
6.4	Registers
6.5	Bootstrap Command

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 a microprocessor and is referred to as an MSCP controller. The MSCP controller has all of the responsibilities outlined above.

The host computer runs corresponding software processes which take calls from the operating system, convert them into MSCP commands, and cause the resulting command to be transferred to the MSCP controller.

In summary, an MSCP subsystem is characterized by an 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 UD23 Disk Controller posts is beyond the scope of this manual.

6.3.1 Command Support

No currently available MSCP Controller supports the entire range of MSCP commands. The following subsections describe the extent of MSCP command support by the UD23.

6.3.1.1 Minimal Disk Subset

The UD23 Disk Controller supports the entire minimal disk subset of MSCP commands.

6.3.1.2 Diagnostic and Utility Protocol (DUP)

The UD23 Disk Controller does not support any of the DUP commands or maintenance read/write commands. Therefore, the UD23 is not compatible with DEC diagnostics that use the MSCP DUP commands.

6.4 Registers

During normal operation, the UD23 Disk Controller is controlled and monitored using the command and status packets that are exchanged by the Class Driver (host) and the MSCP Controller. The UD23 has two 16-bit registers in the PDP-11 Bus I/O page that are used primarily to initialize the subsystem. During normal operation, the registers are used only to initiate polling or to reset the subsystem. These registers are always read as words. The register pair begins on a longword boundary. Table 6-1 lists the octal and hexadecimal values for the Initialization and Polling (IP) register (base address) and the Status and Address (SA) register (base address plus 2) supported by the UD23.

The IP register (base address) has two functions as detailed below:

- When written with any value, it causes a hard initialization of the MSCP Controller.
- When read while the port is operating, it causes the controller to initiate polling.

The SA register (base address plus 2) has four functions as listed below:

- When read by the host during initialization, it communicates data and error information relating to the initialization process.
- When written by the host during initialization, it communicates certain host-specific parameters to the port.
- When read by the host during normal operation, it communicates status information including port and controller-detected fatal errors.
- When zeroed by the host during either initialization or normal operation, it signals the port that the host has successfully completed a bus adapter purge in response to a port-initiated purge request.

Table 6-1. UD23 IP and SA Registers

UD23 Address		VAX-11/730 VAX-11/750 Hex Address With Offset	------------- VAX-11/780 ------------- Hex Address with Offset			
Octal	Hex		UBA #0	UBA #1	UBA #2	UBA #3
772150	F468	FFF468	2013F468	2017F468	201BF468	201FF468
772152	F46A	FFF46A	2013F46A	2017F46A	201BF46A	201FF46A
772154	F46C	FFF46C	2013F46C	2017F46C	201BF46C	201FF46C
772156	F46E	FFF46E	2013F46E	2017F46E	201BF46E	201FF46E
760334	E0DC	FFE0DC	2013E0DC	2017E0DC	201BE0DC	201FE0DC
760336	E0DE	FFE0DE	2013E0DE	2017E0DE	201BE0DE	201FE0DE
760340	E0E0	FFE0E0	2013E0E0	2017E0E0	201BE0E0	201FE0E0
760342	E0E2	FFE0E2	2013E0E2	2017E0E2	201BE0E2	201FE0E2
760344	E0E4	FFE0E4	2013E0E4	2017E0E4	201BE0E4	201FE0E4
760346	E0E6	FFE0E6	2013E0E6	2017E0E6	201BE0E6	201FE0E6
760350	E0E8	FFE0E8	2013E0E8	2017E0E8	201BE0E8	201FE0E8
760352	E0EA	FFE0EA	2013E0EA	2017E0EA	201BE0EA	201FE0EA
760354	E0EC	FFE0EC	2013E0EC	2017E0EC	201BE0EC	201FE0EC
760356	E0EE	FFE0EE	2013E0EE	2017EOEE	201BEOEE	201FEOEE
760360	E0F0	FFE0F0	2013E0F0	2017E0F0	201BE0F0	201FE0F0
760362	E0F2	FFE0F2	2013E0F2	2017E0F2	201BE0F2	201FE0F2

For more information on the VAX 8600/8650/8200 addresses, refer to Table 4-9 on page 4-23.

6.5 Bootstrap Command

To allow the system to be easily bootstrapped from peripherals attached to the UD23 Disk Controller, Emulex has incorporated a Bootstrap Command into the controller. This feature is not part of the standard MSCP command set nor is it supported on the VAX.

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 UD23 PWB, but on some other module in the system.) The Bootstrap Command causes the UD23 to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the UD23:

1. Initialize the UD23 by writing any value into the IP register (base address). The UD23 performs self-test and begins the initialization dialog.

Register	Octal
IP: Write	000001

2. The UD23 indicates that initialization step 1 has begun by setting bit 11 in the SA register (base address plus 2). The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set.

Register	Octal	Addressing
SA: Read	004400	18-Bit

3. When the controller indicates that step 1 of the initialization dialog is begun, load the SA register (base address plus 2) with the "special initialization code:"

Register	Octal
SA: Write	030003

4. The controller acknowledges the initialization code with 00400.

Register	Octal
SA: Read	000400

5. Load the SA register (base address plus 2) with $04000n_8$ or $400n_{16}$, where n is the MSCP logical unit number of the unit to bootstrap from. In this example, the unit is 0.

Register	Octal
SA: Write	040000

6. Load R0 with the unit number. Load R1 with the UD23 base address, then enter 0G to begin:

   0G

7.1 Overview

This section contains a description of the UD23 Disk Controller's architecture.

7.2 UD23 Disk Controller Architecture

The UD23 is a microprocessor-based emulating disk controller that is contained on a single quad-wide PCBA. The UD23's major functional blocks are shown in Figure 7-1. The disk controller is organized around the eight-bit 8031 microprocessor. The board has an eight-bit internal data bus with 16-bit addressing capability. The Host Adapter Controller and the Merged Architecture Chip (which includes disk formatter and buffer controller functionalities) 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 Host Adapter Controller and the Merged Architecture Chip for the large data transfers that are their specialties.

The UD23 uses a 27256 erasable programmable read-only memory (EPROM), which contains the control program, and 64K bytes of random access memory (RAM), which is used for data buffering and working storage.

The UNIBUS interface consists of a 16-bit bidirectional set of data lines and an 18-bit set of address lines. The Host Adapter 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 UNIBUS address generation capability that, in conjunction with a byte counter, allows the Interface to conduct UNIBUS nonprocessor request (NPR) transfers without direct microprocessor intervention. This auto NPR capability is used with the UD23 Merged Architecture Chip to transfer large blocks of data directly between host memory and the UD23's RAM.

The Merged Architecture Chip is a single chip. This multi-channel DMA is responsible for moving large blocks of data between the 64K RAM buffer and the ESDI interface, and between the UNIBUS interface and the 64K RAM buffer. After being set up for an operation by the microprocessor, either interface requests DMA service from the Merged Architecture Chip by driving an individual request signal active. The transfer then proceeds without direct intervention by the microprocessor. This allows high-speed data transfers to occur while the microprocessor is focused on other processes.

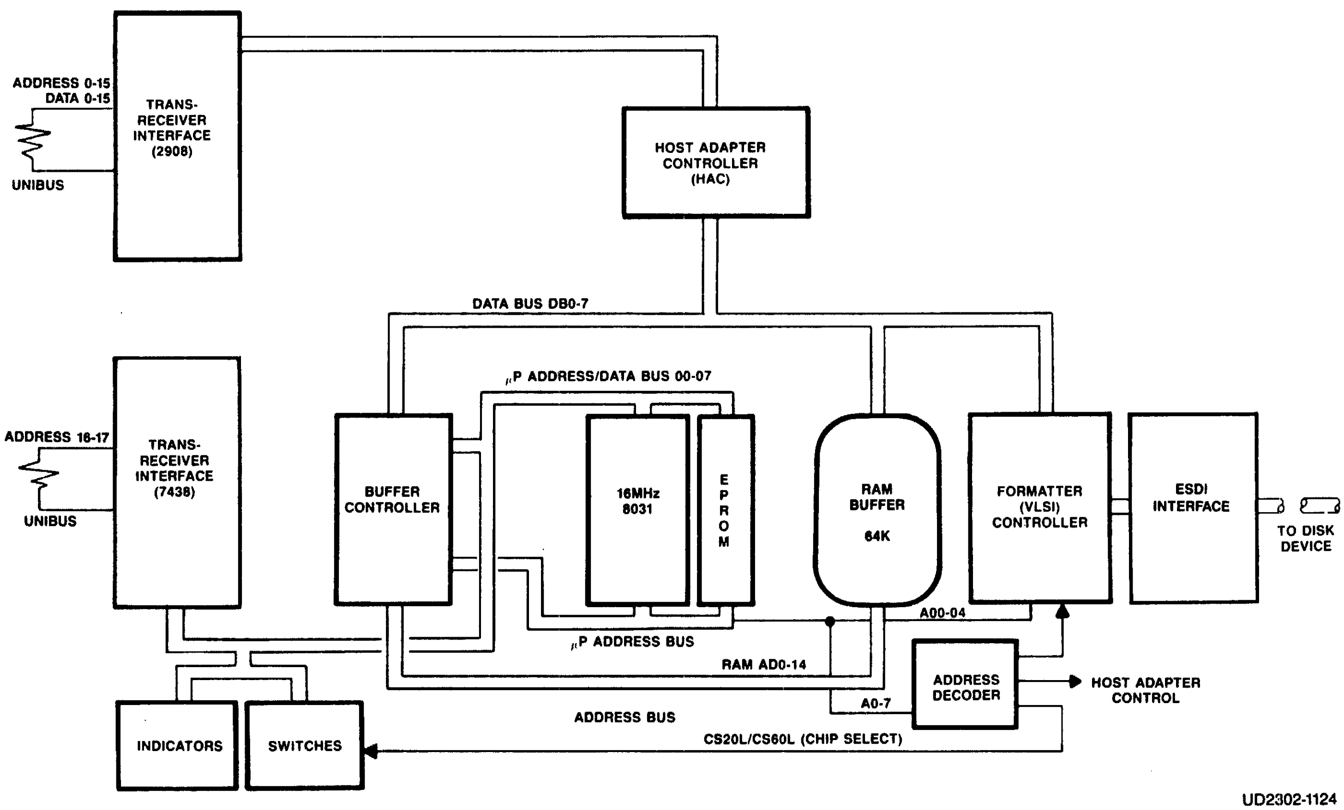


Figure 7-1. UD23 Block Diagram

Section 8
INTERFACES

8.1 Overview

This section describes the interfaces that the UD23 Disk Controller incorporates. It includes information on the UD23 implementation of ESDI interface electrical and mechanical requirements. Including this overview, the section is divided into the following subsections.

Subsection	Title
8.1	Overview
8.2	UD23 UNIBUS Interface
8.3	UD23 ESDI Drive Interface

8.2 UNIBUS Interface

The UNIBUS between the CPU and the UD23 Disk Controller contains 18 address lines and 16 bidirectional data lines, plus control signals for data and interrupt vector address transfer and for becoming bus master. UNIBUS interface pin assignments are listed and described in Table 8-1. These signal lines provide the means by which the CPU and the UD23 Disk Controller communicate with each other.

Table 8-1. UNIBUS Interface Pin Assignments

Connector C			Connector D		
Component Side 1	**Pin**	**Solder Side 2**	**Component Side 1**	**Pin**	**Solder Side 2**
NPGIN H	A	+5V		A	+5V
NPG H	B			B	
PA L	C	GND		C	GND
	D	D15 H		D	
	E	D14 H		E	
BRN TST H	F	D13 H		F	BR5 L
D11 H	H	D12 H		H	
	J	D10 H		J	
	K	D09 H		K	BG7 H
	L	D08 H	INIT L	L	BG7 H
	M	D07 H		M	BG6 H
DCLO L	N	D04 H		N	BG6 H
	P	D05 H		P	BG5IN H
	R	D01 H		R	BG5 H
PB L	S	D00 H		S	BG4 H
GND	T	D03 H	GND	T	BG4 H
	U	D02 H		U	
ACLO L	V	D06 H		V	

Connector E			Connector F		
Component Side 1	**Pin**	**Solder Side 2**	**Component Side 1**	**Pin**	**Solder Side 2**
	A	+5V		A	+5V
	B			B	
UA12 H	C	GND		C	GND
A17 L	D	UA15 H	BBSY L	D	
MSYN L	E	A16 L		E	
UA02 H	F	C1 L		F	
UA01 H	H	UA00 H		H	
SSYN L	J	C0 L	NPR L	J	
UA14 H	K	UA13 H		K	
UA11 H	L			L	
	M		INTR L	M	
	N	UA08 H		N	
UA10 H	P	UA07 H		P	
UA09 H	R			R	
	S			S	
GND	T		GND	T	SACK L
UA06 H	U	UA04 H		U	
UA05 H	V	UA03 H		V	

8.2.1 Interrupt Priority Level

The UD23 is hard-wired to issue level 5 interrupt requests and to monitor level 6.

8.2.2 Register Address

The UD23 Disk Controller has two registers visible to the UNIBUS. Their addresses are determined by DIP switches SW2-4 through SW2-6. See Section 4 for detailed address and switch setting information.

8.2.3 NPR Operations

All NPR data transfer operations are performed under microprocessor control. When doing a Read or Write From Memory operation, a check is made for memory parity or nonexistent memory (NXM) errors. If an error is detected, an MSCP status error is returned.

8.3 UD23 ESDI Disk Drive Interface

This subsection provides information on the UD23 implementation of the Enhanced Small Device Interface (ESDI) interface. The UD23 controller's disk interface conforms to the ESDI Specification and supports the serial mode for magnetic disk drives. The UD23 can use the drive's defect list.

The UD23 Controller interfaces with disk drives via a 34-pin control cable and a 20-pin data cable (for each disk drive). A 34-pin male connector at reference designator J5 on the UD23 Controller plugs directly into the ESDI disk drive control cable. The UD23 Controller contains four 20-pin male connectors, one each at reference designators J1, J2, J3 and J4.

The UD23 Controller can integrate up to a maximum of four physical (eight logical) disk drives. Any of the 20-pin connectors (reference designator J1, J2, J3 or J4) can plug directly into the data cable for the first disk drive. If another disk drive is configured, an unused 20-pin connector is plugged into the data cable for that disk drive.

The pin/signal assignments for control signal interface between the UD23 Controller and an ESDI disk drive are shown in Figure 8-1.

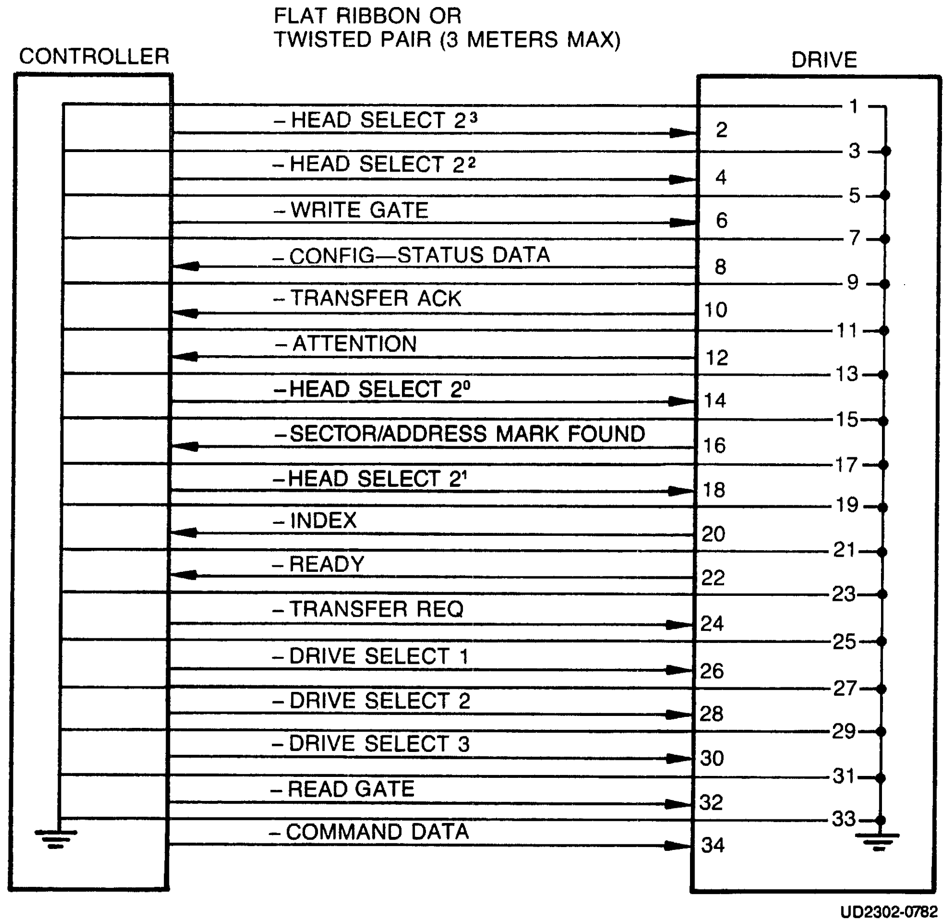


Figure 8-1. Control Pin/Signal Assignments at ESDI Disk Drive Interface (Connector J1)

The pin/signal assignments for data signal interface between the UD23 Controller and an ESDI disk drive are shown in Figure 8-2. As indicated in Figure 8-2, lines 2, 5, 9, and 20 are not connected at the UD23 data interface. Lines 5 and 9 are reserved for step mode implementation (according to the ESDI specification) and are not used with the UD23 serial mode implementation. The UD23 does not use lines 2 and 20 to report the sector and index positions from each drive, but uses the sector and index lines on the control cable for the selected drive (see Figure 8-1).

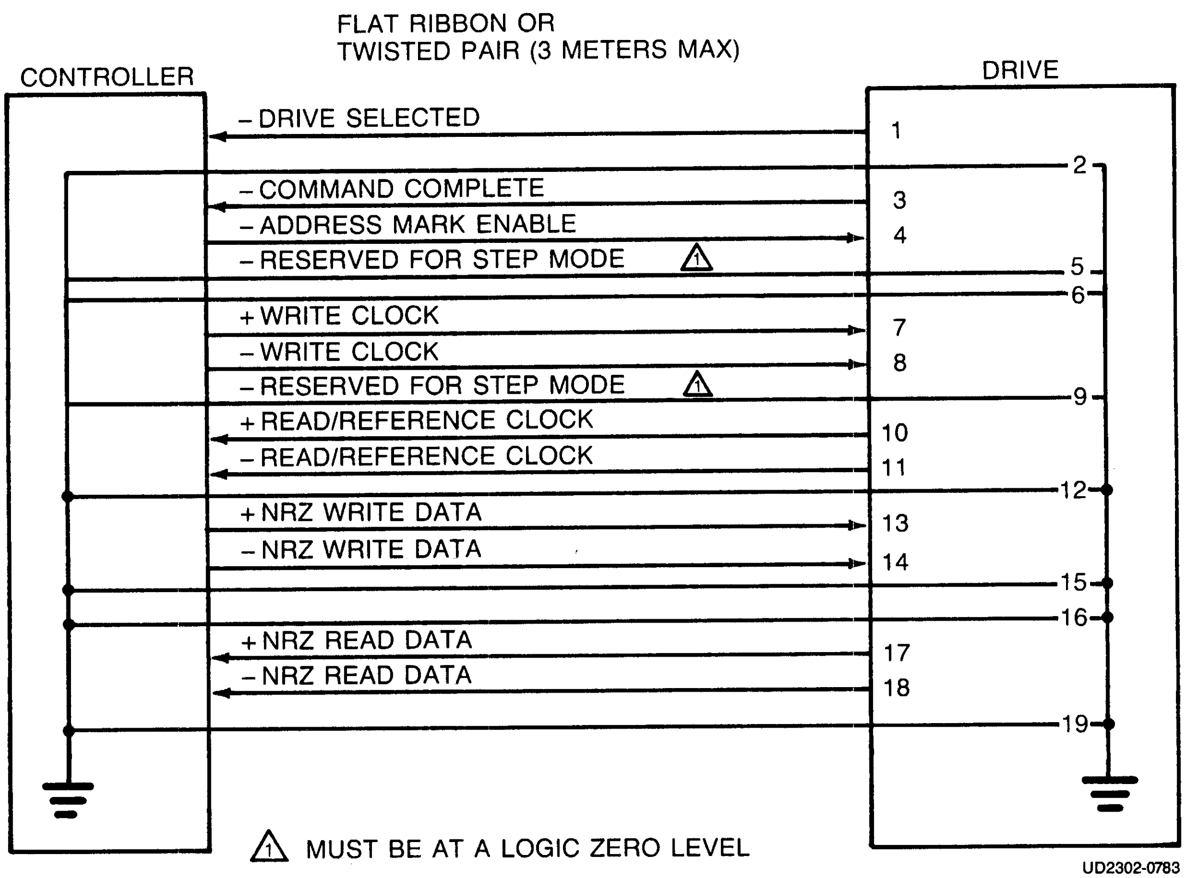


Figure 8-2. Data Pin/Signal Assignments at ESDI Disk Drive Interface (Connector J2 or J3)

8.4 Front Panel Interface

The UD23 provides two interfaces that allows one remote control and status panel to be connected to the controller, one per each two drives. The interface allows write protect switches for each ESDI drive to be connected, and it provides drivers for ready and write-protected status LEDs.

Each interface is implemented by using a four-wall, right-angle header (3M part number 3591-5002) designated J6 and J7. The header has 10 pins. The function of each pin is described in Tables 8-2 and 8-3. Figure 8-3 shows the pin-outs and a sample user interface.

Table 8-2. First Control and Status Interface Pin Function Description

Pin	Function	Description
1	Ground	Controller Logic Ground
2	Not Connected	
3	Disk 1 Write Protect Input	Ground this line to write protect disk 1
4	Disk 1 Ready Status	This line sinks 24 mA when disk 1 is ready
5	Disk 0 Write Protect Input	Ground this line to write protect disk 0
6	Disk 0 Ready Status	This line sinks 24 mA when disk 0 is ready
7	Disk 1 Write Protect Status	This line sinks 24 mA when disk 1 is write protected
8	Spare	
9	Disk 0 Write Protect Status	This line sinks 24 mA when disk 0 is write protected
10	+5 VDC	This line provides 5 VDC. This line is not current protected.

Table 8-3. Second Control and Status Interface Pin Function Description

Pin	Function	Description
1	Ground	Controller Logic Ground
2	Not Connected	
3	Disk 3 Write Protect Input	Ground this line to write protect disk 3
4	Disk 3 Ready Status	This line sinks 24 mA when disk 3 is ready
5	Disk 2 Write Protect Input	Ground this line to write protect disk 2
6	Disk 2 Ready Status	This line sinks 24 mA when disk 2 is ready
7	Disk 3 Write Protect Status	This line sinks 24 mA when disk 3 is write protected
8	Spare	
9	Disk 2 Write Protect Status	This line sinks 24 mA when disk 2 is write protected
10	+5 VDC	This line provides 5 VDC. This line is not current protected.

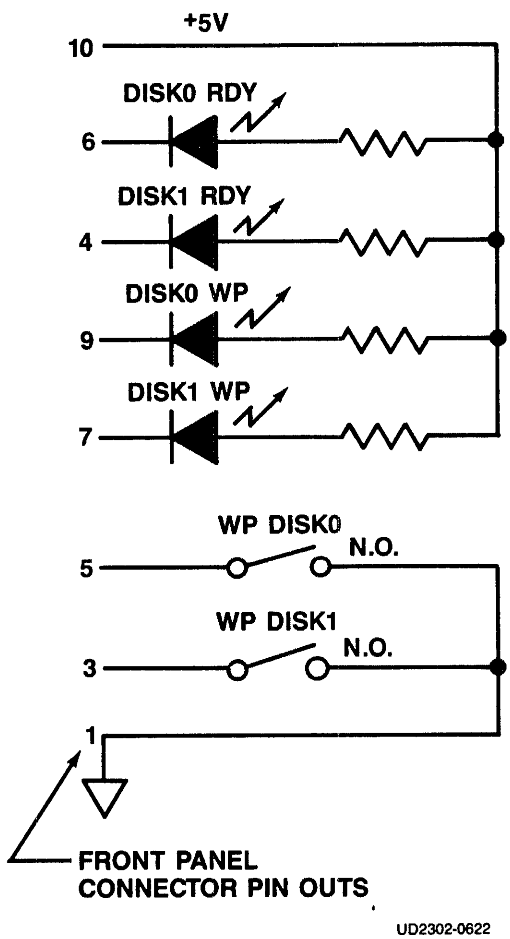


Figure 8-3. Sample Status and Control Interface

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 employs. 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	Number of Registers	Octal Modulus	Rank	Device	Number of Registers	Octal Modulus
1	DJ11	4	10	17	Reserved	4	10
2	DH11	8	20	18	RX11[2]	4	10
3	DQ11	4	10	18	RX211[2]	4	10
4	DU11, DUV11	4	10	18	RXV11[2]	4	10
5	DUP11	4	10	18	RXV21[2]	4	10
6	LK11A	4	10	19	DR11-W	4	10
7	DMC11	4	10	20	DR11-B[3]	4	10
7	DMR11	4	10	21	DMP11	4	10
8	DZ11[1]	4	10	22	DPV11	4	10
8	DZV11	4	10	23	ISB11	4	10
8	DZS11	4	10	24	DMV11	8	20
8	DZ32	4	10	25	DEUNA[2]	4	10
9	KMC11	4	10	**26**	**UDA50[2]**	**2**	**4**
10	LPP11	4	10	27	DMF32	16	40
11	VMV21	4	10	28	KMS11	6	20
12	VMV31	8	20	29	VS100	8	20
13	DWR70	4	10	30	TU81	2	4
14	RL11[2]	4	10	31	KMV11	8	20
14	RLV11[2]	4	10	32	DHV11	8	20
15	LPA11-K[2]	8	20	33	DMZ32	16	40
16	KW11-C	4	10	34	CP132	16	40

[1]DZ11-E and DZ11-F are treated as two DZ11s.

[2]The first device of this type has a fixed address. Any extra devices have a floating address.

[3]The first two devices of this type have a fixed address. Any extra devices have a floating address.

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

(continued on next page)

Table A-2. Priority Ranking for Floating Vectors Addresses (starting at 300_8 and proceeding upwards) (continued)

Rank	Device	Number of Vectors	Octal Modulus
30	VMV21	2	10
31	VMV31	2	10
32	VTV01	2	10
33	DWR70	2	10
34	RL11/RLV11[2]	1	4
35	TS11[2], TU80[2]	1	4
36	LPA11-K	2	10
37	IP11/IP300[2]	1	4
38	KW11-C	2	10
39	RX11[2]	1	4
39	RX211[2]	1	4
39	RXV11[2]	1	4
39	RXV21[2]	1	4
40	DR11-W	1	4
41	DR11-B[2]	1	4
42	DMP11	2	10
43	DPV11	2	10
44	ML11[3]	1	4
45	ISB11	2	10
46	DMV11	2	10
47	DEUNA[2]	1	4
48	**UDA50[2]**	**1**	**4**
49	DMF32	8	40
50	KMS11	3	20
51	PCL11-B	2	10
52	VS100	1	4
53	Reserved	1	4
54	KMV11	2	10
55	Reserved	2	10
56	IEX	2	10
57	DHV11	2	10
58	DMZ32	6	20
59	CP132	6	20

1 A KL11 or DL11 used as a console, has a fixed vector.

2 The first device of this type has a fixed vector. Any extra devices have a floating vector.

3 ML11 is a Massbus device which can connect to a UNIBUS via a bus adapter.

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 UDA50	154	772150
1 DZ11	300	760100
1 UDA50	310	760354
2 DHV11	320,330	760500, 760520

Table A-4. Floating CSR Address Assignment Example

Installed	Device		Octal Address
	DJ11	Gap	760010
	DH11	Gap	760020
	DQ11	Gap	760030
	DU11	Gap	760040
	DUP11	Gap	760050
	LK11A	Gap	760060
	DMC11	Gap	760070
---->	DZ11		760100
		Gap	760110
	KMC11	Gap	760120
	LPP11	Gap	760130
	VMV21	Gap	760140
	VMV31	Gap	760150
	DWR70	Gap	760170
	RL11	Gap	760200
	LPA11-K	Gap	760220
	KW11-C	Gap	760230
	Reserved	Gap	760240
	RX11	Gap	760250
	DR11-W	Gap	760260
	DR11-B	Gap	760270
	DMP11	Gap	760300
	DPV11	Gap	760310
	ISB11	Gap	760320
	DMV11	Gap	760340
	DEUNA	Gap	760350
---->	**UDA50 (UD23)**		**772150**[1]
---->	**UDA50 (UD23)**		**760354**
		Gap	760360
	DMF32	Gap	760400
	KMS11	Gap	760420
	VS100	Gap	761440
	TU81	Gap	761450
	KMV11	Gap	761460
---->	DHV11		761500
---->	DHV11		761520
		Gap	761530
	DMZ32	Gap	761540
	CP132	Gap	761600

[1]Fixed address

Appendix B
PROM REMOVAL AND REPLACEMENT

B.1 Overview

This appendix provides instructions for replacing the UD23's firmware PROM.

B.2 Exchanging PROMs

The UD23 firmware PROM is located in the socket at U22. Remove the existing PROM from its socket using an IC puller or an equivalent tool.

The UD23 PROM is identified by the part numbers on top of the PROMs. Place the UD23 PROM in U22. Make certain that the PROM is firmly seated and that no pins are bent or misaligned. (If the two rows of PROM pins are too far apart to fit in the socket, grasp the PROM at its ends using your thumb and forefinger and bend one of the pin rows inward by pressing it against a table top or other flat surface.)

PROM Number	PCBA Location
G86	U22

C.1 Parameter Values

The drive configuration parameters listed in this table are for use with the NOVRAM loading, editing, and displaying options of UD23's firmware-resident diagnostics. They relate to the physical geometry of the disk drives; options such as logical splits are left to you.

The configuration table lists each parameter as it is displayed by the diagnostic, as well as each drive certified for use with the UD23. Parameter values in this table are based on one spare sector per track with no logical splits. Values are listed and entered in decimal.

To use the table, locate the name of your drive along the top of the table. Then read down the column beneath the drive name for the parameter values.

If you are looking for a specific parameter value, find the parameter you need in the "parameter" column. Then find your drive in the "drive name" row. The parameter value is listed at the point where the row and the column intersect.

Table C-1. DRIVE CONFIGURATION PARAMETER VALUES

PARAMETER	DRIVE NAME								
	CDC Wren III[1]	FUJITSU M2246E[2]	HITACHI DK512-17[2]	MAXTOR EXT-4175[1]	MAXTOR EXT-4380[2]/ XT-4380E[2]	MAXTOR XT-8760E[2]	MICROPOLIS 1350[1]	MICROPOLIS 1558[2]	SIEMENS 1300[1]
Type Code	1	1	1	1	1	1[3]	1	1	1
Number of Units of this Type	1	1	1	1	1	1	1	1	1
Starting Head Offset*	–	–	–	–	–	–	–	–	–
Number of Sectors per Track	36	35	35	34	34	52	35	35	35
Number of Heads	9	10	10	7	15	15	8	15	12
Number of Cylinders	969	823	823	1224	1224	1632	1024	1224	
Number of Spare Sectors per Track	1	1	1	1	1	1	1	1	1
Number of Alternate Cylinders	2	2	2	2	2	2	2	2	2
Configuration Bits	6	5	12/13	13	13	4	14	14	8
Split Code	0	0	0	0	0	0	0	0	0
Removable Media Flag	1	0	0	0	0	0	0	0	0
Gap 0 Parameter	2318	3093	2317/2314	3086	3086	4374	2316	2316	3344
Gap 1 Parameter	2827	3084	2827	6682	6682	6168	2827	2827	4112
Gap 2 Parameter	521	3337	521/5384	3095	3095	534	521	521	526
Cylinder Offset*	–	–	–	–	–	–	–	–	–
Spiral Offset	0	0	0	1	1	0	1	1	11

* User-defined value
1 Hard-Sectored Format Only
2 Soft-Sectored Format Only
3 Type Code 2 may also be used for maximum capacity with a programmable sector size jumper enabled on the drive.

C.2 Recommended Drive Options

The drive options listed in Table C-2 describe the drive configuration required by the UD23. This table lists the necessary options, but makes no effort to instruct you on how to set the drive for the options. For that information, refer to the drive manufacturer's manual.

To use the table, locate the name of your drive under the drive name column of the table. Then read across the row for the required options.

The CDC Wren III requires special switch settings. If your Wren III was not purchased from Emulex, you may need to change its switch settings. Instructions for doing so follow Figure C-1.

When using a type code of 2, drives must be able to have sector size programmable via ESDI command. Some drives require this option to be enabled via jumpers or switches on the drive; check the drive manufacturer's manual for more information.

Table C-2. Drive Option Settings

Drive Name	Sector Setting	Bytes/ Sector	Drive Spin-Up Control	ESDI Interface	Drive Output Signals
CDC Wren II	Hard		UD23		
Fujitsu M2246E	Soft		UD23	Serial	Enabled
Hitachi DK512-17	Soft	584/			
Maxtor EXT-4175	Hard		UD23		
Maxtor EXT-4380	Soft		UD23		
Maxtor XT-4380E	Hard				
Maxtor XT-8760E	Hard		UD23		
Micropolis 1350	Hard	595	UD23		
Micropolis 1558	Hard				
Siemens 1300	Hard				

C.2.1 Setting the Switches on the CDC Wren III

The CDC Wren III is shipped from Emulex with the switches set as indicated, so that there are 36 sectors per track (hard-sectored) and the UD23 controls drive spin-up. If your Wren III was not purchased from Emulex, you may need to change the switch settings (see Figure C-1).

Table C-3. CDC Wren III Switch Settings
Hard-Sectored Format

SW1-	Position	Description
1	ON	Spindle control
2	OFF	36 sectors
3	ON	
4	OFF	

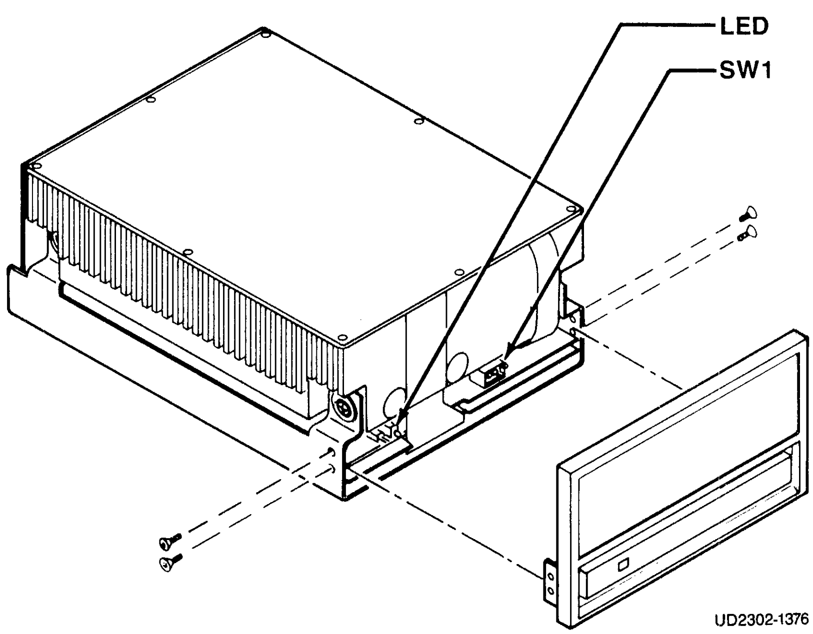


Figure C-1. Setting the Switches on the Wren III

To change the switch settings for WREN III drives not purchased from Emulex, the front cover plate must first be removed. Use a TORX (six-splined) TX-10 screwdriver (or a small, flat-bladed one) to remove the two screws from each side of the drive. Remove the cover plate and set the switches (see Figure C-1).

In some versions of this drive, the LED is attached to the front cover and there is a separate inner plate. Remove both plates after loosening the screws.

After setting the switches, replace the plate(s) and the screws. If your version has the LED on the cover plate, take care that the LED wires are properly aligned with the two top openings.

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