

**QD01/D DISK CONTROLLER  
TECHNICAL MANUAL  
(MSCP COMPATIBLE)**



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QD0151003-00 Rev E  
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## EMULEX PRODUCT/MANUAL REVISION HISTORY

PROM A62x<sup>1</sup>, Location U43

PROM A62x	DESCRIPTION	MANUAL P/N
A,B,C,D, E,F,G	QD01/D with optional diagnostics	QD0151001-00, QD0151002-00
H and above	QD01/D with firmware- resident diagnostics	QD0151003-00

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 H controller firmware PROM. Due to the nature of these firmware changes, a QD01/D with a Revision H 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 is appropriate for the revision level of your controller firmware, as noted in the table above. This firmware is easily identified by the label at U43.

### 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.

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<sup>1</sup> 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.

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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 in such a manner for which it was not designed, or by causes external to the product, such as but not limited to, power failure or air conditioning. Emulex's sole obligation hereunder shall be to repair or replace any defective product, and, unless otherwise stated, pay return transportation cost for such replacement.

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## **1.1 Overview**

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The QD01/D Disk Controller, designed and manufactured by Emulex Corporation, is a Mass Storage Control Protocol (MSCP) compatible controller with an ST-506 peripheral interface. This manual is designed to help you install and use your QD01/D Disk Controller. It assumes that you have some knowledge of hardware configuration, LSI-11 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 QD01/D Disk Controller.
- **Section 2 (Controller Specification):** This section contains the specification for the QD01/D 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 NOVDRAM.
- **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 QD01/D's LSI-11 bus 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, LSI-11 bus and ST-506 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 QD01/D Disk Controller in the field.

- **Appendix C (Disk Drive Configuration Parameters):** This appendix contains configuration parameters for supported ST-506 disk drives.

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## 1.2 Subsystem Overview

---

The QD01/D Disk Controller connects high-capacity mass storage peripherals to the LSI-11 bus on computers manufactured by Digital Equipment Corporation (DEC). The QD01/D 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 QD01/D uses the industry standard ST-506 interface as its peripheral interface. The ST-506 interface is used on 5.25-inch Winchester disk drives built by numerous manufacturers.

---

### 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 ST-506 compatible peripherals, the QD01/D provides just such a subsystem. The QD01/D relieves the host CPU of many file maintenance tasks. The QD01/D 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.

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## 1.3 Physical Organization Overview

---

The QD01/D Disk Controller is a modular, microprocessor-based disk controller that connects directly to the host computer's LSI-11 bus backplane. The microprocessor architecture ensures excellent reliability and compactness.

The QD01/D is contained on a single dual-wide printed circuit board assembly (PCBA) that plugs directly into a LSI-11 bus backplane slot.

The QD01/D supports up to two physical or four logical disk drives. Aggregate data storage capacities are limited only by the capacities of the peripherals. Figure 1-1 shows one possible ST-506 configuration.

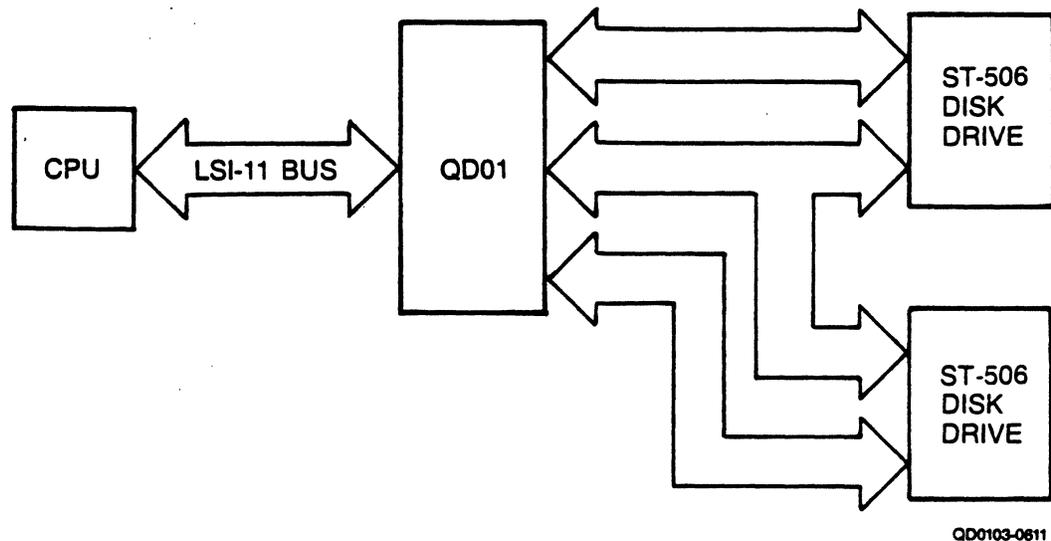


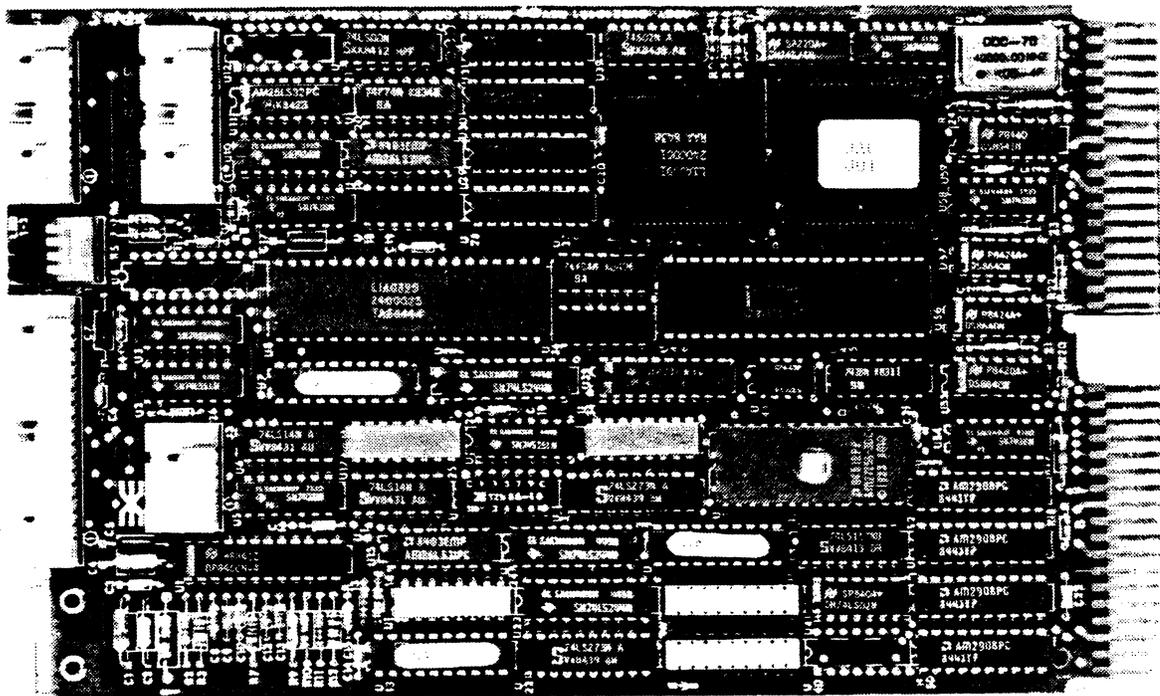
Figure 1-1. QD01/D Subsystem Configuration

## 1.4 Subsystem Models

The QD01/D Disk Controller, with appropriate peripherals, provides a DEC MSCP-compatible mass storage subsystem. The QD01/D is pictured in Figure 1-2. The QD01/D is identified by a top level assembly tag that is glued to the 8031 microprocessor chip on the PWB. The QD01/D top level assembly number is given in Table 1-1 along with the part numbers of the items that are delivered with the QD01/D.

Table 1-1. Basic Contents

Itm	Qty	Description	Part Number
1	1	QD01/D Disk Controller	QD0110202-00
2	1	22-Bit Addressing Kit	QD0113002-00
3	1	QD01/D Technical Manual	QD0151001-00



QD0103-0668

Figure 1-2. QD01/D Disk Controller

Table 1-2 lists the options that can be ordered to tailor your QD01/D to your particular application.

Table 1-2. Subsystem Options

Option	Description
QD0113003	QD01 Cabling Kit MICRO/PDP-11 and MicroVAX I and II Tower. Includes cables, panels, and instructions.
QU0111201-0n <sup>1</sup>	34-line, control interface cable for ST-506 disk drives. Cable length is per customer order.
QU0111201-0n <sup>1</sup>	20-line, data interface cable for ST-506 disk drives. Cable length is per customer order.
QU0111203-0n <sup>1</sup>	34-line, daisy-chain control interface cable for ST-506 disk drives. Cable length is per customer order.
<sup>1</sup> See Table 4-5 for part numbers for specific cable lengths.	

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## 1.5 Features

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The following features enhance the usefulness of the QD01/D Disk Controller.

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### 1.5.1 Microprocessor Design

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The QD01/D 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.

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### 1.5.2 Firmware-Resident Diagnostics

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The QD01/D disk controller firmware incorporates a self-contained set of disk preparation and diagnostic utilities. These utilities are contained in QD01/D Revision H and above firmware. Controllers with this firmware are easily identified by a tag labeled with the top assembly number QD0110201-00E.

These utilities allow the user to communicate directly with the QD01/D via a firmware resident terminal driver that is compatible with either CRT or hardcopy devices connected to an LSI-11 or MicroVAX 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

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An onboard NOVRAM can be programmed for two 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 Self-Test**

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The QD01/D incorporates an internal self-test routine which exercises all parts of the microprocessor, the onboard memory, the LSI-11 bus interface, and the ST-506 interface. Although this test does not completely test all circuitry, successful execution indicates a very high probability that the disk controller is operational. If the QD01/D detects an error during 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).

---

**1.5.5 Error Control**

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

---

**1.5.6 Host-Initiated Bad Block Replacement**

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The QD01/D 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 QD01/D reports even corrected single bit errors as candidates for replacement.

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**1.5.7 Seek Optimization**

---

The QD01/D 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 optimum order saves a great deal of time and makes the entire system more efficient.

---

**1.5.8 Command Buffer**

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The QD01/D 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.

---

### 1.5.9 Adaptive DMA

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During each DMA data transfer burst, the QD01/D monitors the LSI-11 bus 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 QD01/D defaults to 16 words per burst. Because of these adaptive DMA techniques, the QD01/D ensures that CPU functions, including interrupt servicing, are not locked out for excessive periods of time by high-speed disk transfers. The QD01/D firmware design includes a DMA burst delay of either 4 or 8 microseconds to avoid data-late conditions.

In addition, the QD01/D allows you to modify its DMA operations by disabling the adaptive DMA and defaulting to burst transfers of 8 words or less.

---

### 1.5.10 Block-Mode DMA

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The QD01/D supports block-mode DMA for accessing memory. In this mode, the initial address of the data is transmitted, followed by a burst of up to 16 words of data. The memory address is automatically incremented to accommodate this burst. Block mode transfers considerably reduce the overhead associated with DMA operations.

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### 1.5.11 22-Bit Addressing

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The QD01/D supports the 22-bit addressing capability of the extended LSI-11 bus.

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## 1.6 Compatibility

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This subsection describes the compatibility of operating systems and hardware.

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### 1.6.1 Operating Systems

---

The QD01/D implements MSCP. Emulex supports its implementation of MSCP beginning with the indicated version of the following DEC operating systems:

Operating System	Version
Micro/VMS	4.0
RSTS/E	8.0
RSX-11M	4.1
RSX-11M-PLUS	2.1
RT-11	5.1
Ultrix-11	3.0
Ultrix-32	1.1

---

**1.6.2 Hardware**

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The QD01/D Disk Controller complies with DEC LSI-11 bus protocol, and it directly supports 22-bit addressing and block-mode DMA. The QD01/D also supports scatter-write and gather-read operations on the MicroVAX I.

The disk drives supported by the QD01/D are not media compatible with comparable DEC MSCP products; however, this is not a problem due to the fixed nature of most DEC drives.

ST-506 disk drives that are supported by the QD01/D should provide buffered head stepping. Buffered stepping is required to provide adequate performance in DEC operating environments.

## **2.1 Overview**

This section contains the general, environmental, physical, electrical, and port specifications for the QD01/D Disk Controller.

Subsection	Title
1.2	General Specification
1.3	Environmental Specification
1.4	Physical Specification
1.5	Electrical Specification

## **2.2 General Specification**

Table 2-1 contains a general specification for the QD01/D Disk Controller.

Table 2-1. QD01/D General Specifications

Parameter	Description														
<b>FUNCTION</b>	Providing mass data storage to Digital Equipment Corporation (DEC) computers that use the LSI-11 bus														
<b>Logical CPU Interface</b>	Emulates DEC's Mass Storage Control Protocol (MSCP)														
<b>Diagnostics</b>	Embedded diagnostics														
<b>Operating System Compatibility</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 60%;">Micro/VMS</td> <td>V4.0 and above</td> </tr> <tr> <td>RSTE/S</td> <td>V8.0 and above</td> </tr> <tr> <td>RSX-11M</td> <td>V4.1 and above</td> </tr> <tr> <td>RSX-11M PLUS</td> <td>V2.1 and above</td> </tr> <tr> <td>RT-11</td> <td>V5.1 and above</td> </tr> <tr> <td>Ultrix-11</td> <td>V3.0 and above</td> </tr> <tr> <td>Ultrix-32</td> <td>V1.1 and above</td> </tr> </table>	Micro/VMS	V4.0 and above	RSTE/S	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-32	V1.1 and above
Micro/VMS	V4.0 and above														
RSTE/S	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-32	V1.1 and above														
<b>CPU I/O Technique</b>	Direct Memory Access (DMA), including adaptive techniques and block mode; supports scatter-write and gather-read operations on the MicroVAX I														

*(continued on next page)*

Table 2-1. QD01/D General Specifications (continued)

Parameter	Description
<b>INTERFACE</b>	
<b>CPU Interface</b>	Extended LSI-11 bus interface
<b>Device Base Address</b>	
<b>Standard Alternates</b>	17772150 <sub>8</sub> 17772154 <sub>8</sub> 17760334 <sub>8</sub> 17760340 <sub>8</sub> 17760344 <sub>8</sub> 17760350 <sub>8</sub> 17760354 <sub>8</sub> 17760360 <sub>8</sub>
<b>Vector Address</b>	Programmable
<b>Priority Level</b>	BR4
<b>Bus Loading</b>	1 dc load, 2.5 ac loads
<b>Peripheral Interface</b>	Seagate Technology (ST-506)
<b>Number of Physical Disk Drives Supported</b>	2
<b>Interface Cables</b>	34-line control cable (daisy-chain), maximum 20 ft (3 m) 20-line data cables (radial), maximum 20 ft (3 m)
<b>Step Pulse Interval</b>	Programmable, 3msec to 12 usec <sup>1</sup>
<b>Firmware Diagnostic Host Console</b>	
<b>LSI-11</b>	DLV11J or Processor-resident console interface
<b>MicroVAX</b>	Processor-resident console port

<sup>1</sup> For adequate performance under DEC operating systems, Emulex recommends using a disk drive that can buffer step pulses.

## 2.3 Environmental Specification

Table 2-2 contains the environmental specifications for the QD01/D Disk Controller.

Table 2-2. QD01/D Environmental Specifications

Parameter	Description
<b>OPERATING TEMPERATURE</b>	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
<b>RELATIVE HUMIDITY</b>	10% to 90% with a maximum wet bulb of 28°C (82°F) and a minimum dewpoint of 2°C (3.6°F)
<b>COOLING</b>	6 cubic feet per minute
<b>HEAT DISSIPATION</b>	82 BTU per hour

## 2.4 Physical Specification

Table 2-3 contains the physical specifications for the QD01/D Disk Controller.

Table 2-3. QD01/D Physical Specifications

Parameter	Description
<b>PACKAGING</b>	Single, dual-wide, four-layer PCBA
<b>Dimensions</b>	5.186 by 8.70 inches 13.172 by 22.09 centimeters (see Figure 2-1)
<b>Shipping Weight</b>	3 pounds

## 2.5 Electrical Specification

Table 2-4 lists and describes the electrical specification for the QD01/D Disk Controller.

Table 2-4. QD01/D Electrical Specification

Parameter	Description
<b>POWER</b>	5 Vdc $\pm$ 5%, 2.6 amperes (A)

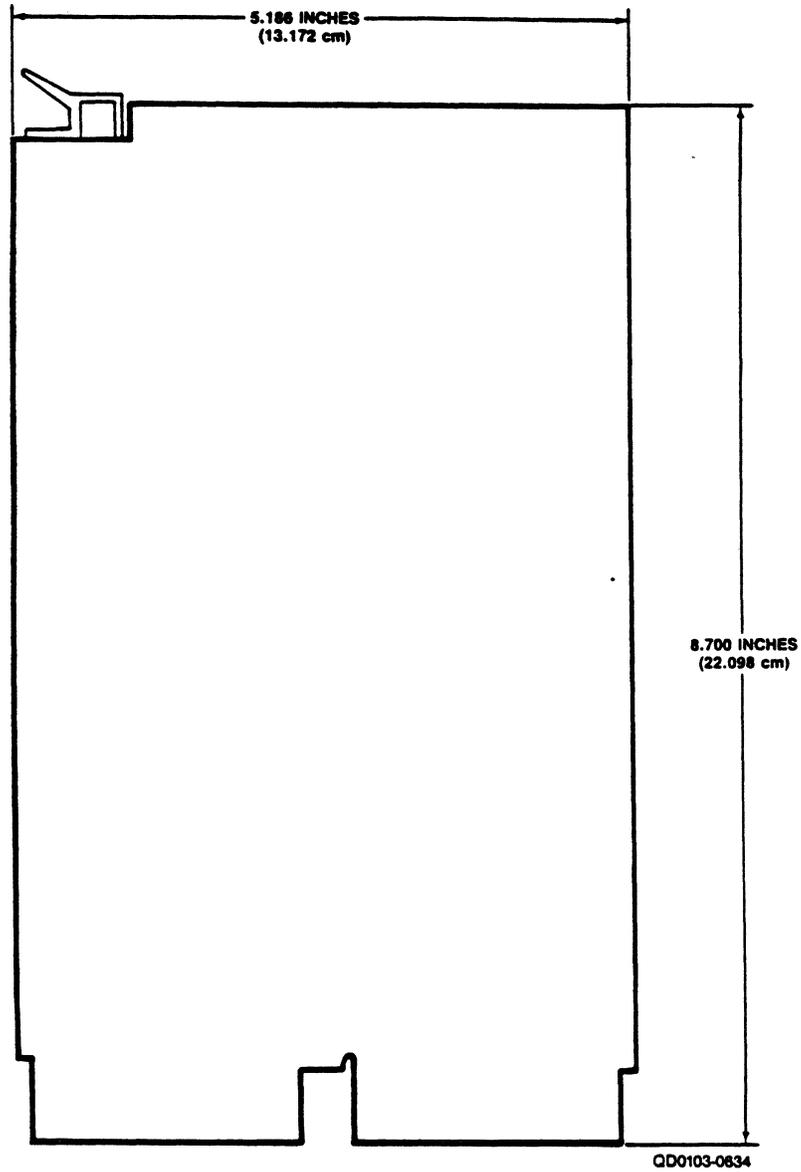


Figure 2-1. QD01/D Disk Controller Dimensions

---

## **3.1 Overview**

---

This section is designed to help you plan the installation of your QD01/D Disk Controller. Taking a few minutes and planning the configuration of your subsystem before beginning its installation should result in a smoother installation with less system down time. This section contains QD01/D application examples and configuration procedures. The subsections are listed in the following table:

Subsection	Title
3.2	MSCP Subsystem Configuration
3.3	A DEC MSCP Subsystem
3.4	The QD01/D 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 a 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 QD01/D 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 QD01/D implements MSCP in mass storage subsystems using ST-506 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 MicroVMS 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 LSI-11 bus device addresses. For example, under RSX-11M-PLUS, if there are three peripherals on the first MSCP controller (at 772150<sub>8</sub>), 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. A 10M byte peripheral such as DEC's RD51 is able to store about 20,000 logical blocks.

## 3.3 A DEC MSCP Subsystem

Figure 3-1 shows the organization of a typical DEC MSCP subsystem for the LSI-11 bus. The MSCP host and controller functions are combined in a single piece of hardware, in this example the DEC RQDX1. The RQDX1 supports RD51, RD52, or RD53 hard disk drives and the RX50 5.25-inch floppy drive. The RQDX1 plugs directly into the LSI-11 bus and is attached to disk drives via a disk-drive-native interface.

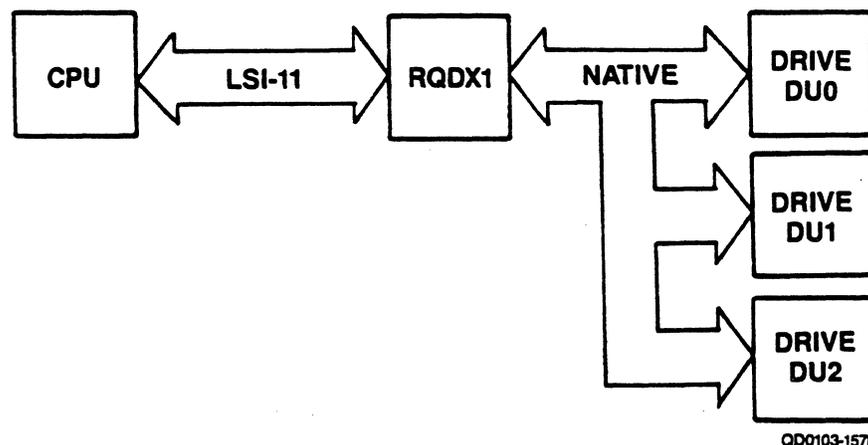


Figure 3-1. DEC MSCP Subsystem Logical and Physical Configuration

### 3.4 The QD01/D Subsystem

Figure 3-2 illustrates a typical QD01/D MSCP subsystem. As with the DEC implementation, the QD01/D is connected directly to the LSI-11 bus. The QD01/D, however, uses the ST-506 peripheral interface to communicate with one or two disk drives.

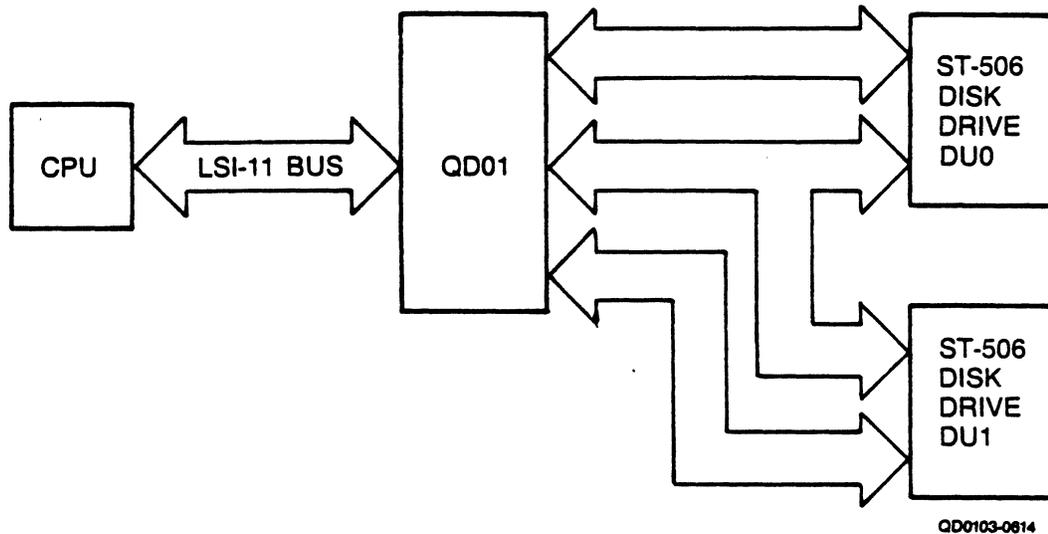


Figure 3-2. QD01/D Subsystem Logical and Physical Configuration

The MSCP subsystem provided by the QD01/D is essentially analogous to the DEC MSCP subsystem. As in the DEC subsystem, the QD01/D MSCP controller connects directly to the LSI-11 bus. As an MSCP controller, the QD01/D receives requests from the host, optimizes the requests, generates ST-506 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 QD01/D also performs all of the functions of the peripheral controller, including serialization and deserialization of data. The QD01/D connects to the peripherals it supports via the ST-506 interface.

---

### 3.4.1 Logical Unit Numbers

---

As noted in section 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-type drives can accept unit identification plugs that define addresses from 0 to 255. Disk drives controlled by the QD01/D do not have this flexibility; the QD01/D can detect only two unique drive addresses at its ST-506 interface: 0 and 1. To prevent a unit-number conflict between the QD01/D's drives and another MSCP controller's drives, the QD01/D 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 supports four disk drives; a QD01/D at an alternate base address supports two disk drives. An offset of 4 is specified for the QD01/D. This causes the QD01/D disk with address 0 to be reported to the operating system as logical unit number (LUN) 4. The QD01/D disk 1 is reported as LUN 5.*

The offset for the logical unit number is specified by using switches SW1-2 through SW1-4 on the QD01/D.

---

### 3.4.2 QD01/D Subsystem Logical Configuration

---

This subsection explains the algorithm used by the QD01/D to map logical MSCP peripherals onto the physical disk drives provided by the QD01/D 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 QD01/D MSCP 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 234,090 blocks, the MSCP controller can divide that capacity into unequal parts: for example, 208,080 blocks and 26,010 blocks. 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 subsections (4.7, 4.8, and 4.9). The field that causes a drive to be divided into multiple logical units is called the Split Code. 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. Alternate cylinders are divided evenly between drives. For example, if the physical drive has 645 cylinders and is split 50/50, the first 322 cylinders are assigned to one drive and the second 322 cylinders are assigned to the other (the odd cylinder is not used).
- 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); consequently, the lower blocks of one logical drive are in the same physical cylinder as the lower blocks of the other logical drive. For example, a Maxtor drive with 15 heads might be divided so that the first logical unit is assigned heads 0 through 6, and the second logical unit is assigned heads 7 through 14. The Starting Head Offset has a value of 7.
- 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 4380 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.

The head splitting technique has a performance advantage over the cylinder method. Typically, most disk accesses are made in the lower cylinders of a disk because many system-oriented files are located there, including the drive's directory. Because the low (and high) cylinders are vertically aligned between the two logical drives when the head splitting technique is used, switching between head-split logical drives requires less head movement than switching between cylinder-split drives.

**3.4.2.2 Device Numbers**

The drives supported by the QD01/D 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 MicroVMS 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

QD01/D Address	Device Description	Drive Unit Number	Device Name
772150	Atasi 3046	0	DU0
	Atasi 3046	1	DU1
760334 (Floating)	Maxtor XT1140 (head split)	0	DU2 DU3
	Maxtor XT1140	1	DU4

**NOTE**

All MSCP peripherals supported by the QD01/D use the same device identifier - RD51.

---

## 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 QD01/D.

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 RT11 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 LSI-11 bus addresses. The following paragraphs address these differences for each supported operating system. This discussion includes information on choosing appropriate LSI-11 bus device addresses and interrupt vectors for the subsystem.

The following operating system discussions give procedures for choosing LSI-11 bus addresses for the first `MSCP` controller and any subsequent controllers in the host configuration. No instructions are provided for programming the chosen address into the QD01/D.

`MSCP`-type controllers contain two registers that are visible to the LSI-11 bus 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 IP register, the CSR address, LSI-11 bus address and the base address all refer to the same register. All of the operating systems described in the following subsections use the standard LSI-11 bus address of  $1772150_8$  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 five 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-11MPLUS	DUA, DUB	DU0, DU1
RT-11	Port0, Port1	DU0, DU1
MicroVMS	PUA, PUB	DUA0, DUA1
Ultrix-11	uda0, uda1	ra0, ra1
Ultrix-32m	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 LSI-11 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 RT11).

---

### 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 LSI-11 bus address, 772150<sub>8</sub>. According to DEC documentation, the second unit should be located in floating address space. For an alternate QD01/D, Emulex suggests specifying a LSI-11 bus address of 760334<sub>8</sub> 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 an LSI-11 bus address of 760334<sub>8</sub> for an alternate QD01/D. 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 online 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 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 LSI-11 bus 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 LSI-11 bus address of 772150<sub>8</sub>. 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 startup 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 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 startup command file when booting:

**Do you want the startup indirect file (Y)? Y**<return>

The startup command file is required to allow additional MSCP controller LSI-11 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 LSI-11 bus 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=7603348       (Floating)
SET DU VECTOR=154          (Default)
SET DU VEC2=300
    
```

The LSI-11 bus for the second device can be any unused address in the I/O page which is supported by QD01/D 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. If the QD01/D is at an alternate LSI-11 bus address (not 772150<sub>8</sub>), then you must specify an MSCP device number by using switches SW1-2 through SW1-4.
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 (up to eight) 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 startup 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 drive that has a capacity of 219,283 blocks.

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

*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 (remember that eight is the maximum).*

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
```

Because this configuration has only one controller, the port is not defined. If you had another controller in this configuration, the controllers would be defined as Port 0 and Port 1.

Modify the system startup 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 QD01/D may present.

SYSGEN supports autoconfigure, and MSCP controllers are detected by autoconfigure. However, autoconfigure detects only the MSCP controller that is located at the standard LSI-11 bus address. Additional MSCP controllers at alternate addresses must be attached to the operating system manually.

#### NOTE

If the QD01/D controls the system disk, you must select 22-bit addressing (SW2-6 ON) even if your system has only 256K bytes of memory.

---

### 3.5.3.1 Installing a Single MSCP Controller

---

If you have only one QD01/D, install it at the standard address (772150<sub>8</sub>) 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 QD01/D, you must perform a complete manual initialization. We recommend that the DEC MSCP controller be installed at the standard LSI-11 bus address. Locating the QD01/D at the alternate LSI-11 bus 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]: N<return>
```

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-TYPE 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, LSI-11 bus 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<sub>8</sub>. The vector for a second unit should be allocated from floating vector address space. Any unused vector between 300<sub>8</sub> and 774<sub>8</sub> can be allocated. See Appendix A for a description of DEC's algorithm for assigning floating vectors.

The standard LSI-11 bus address for MSCP controllers is 772150<sub>8</sub>. Emulex recommends that the second unit be located in floating LSI-11 bus 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 QD01/D, or on the number of drives that are attached to a DEC MSCP controller.

When you select a configuration for the QD01/D, you are taking into account the number of physical disk drives that you are attaching to the QD01/D's ST-506 interface. When you select a configuration, you are also specifying a logical arrangement for the QD01/D MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each ST-506 disk drive when you program the QD01/D's NOVDRAM; see subsections 4.7, 4.8, and 4.9.

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

- RX50
- RD51
- RD52
- RD53
- RC25

The RX50 drive contains two 5.25-inch floppy diskettes; count an RX50 as two drives. 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.

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]RD51 <return>
```

For the RQDX1, indicate that you have an RD51 and two RX50 (in that order).

For the QD01/D, indicate that you have one RD51 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 QD01/D may involve.

SYSGEN supports autoconfigure, and MSCP controllers are detected by autoconfigure. However, autoconfigure detects only the MSCP controller that is located at the standard LSI-11 bus address. Additional MSCP 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 QD01/D, install it at the standard address (772150<sub>8</sub>) 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<sub>8</sub>). We recommend that the DEC MSCP controller be installed at the standard LSI-11 bus address; locating the QD01/D at the alternate LSI-11 bus 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 drives (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 QD01/D and on the number of drives that are attached to any DEC MSCP controllers.

When you select a configuration for the QD01/D, you are taking into account the number of physical disk drives that you are attaching to the QD01/D's ST-506 interface. When you select a configuration, you are also specifying a logical arrangement for the QD01/D MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each ST-506 disk drive when you program the QD01/D's NOVDRAM (see subsections 4.7, 4.8, and 4.9).

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

- RX50
- RD51
- RD52
- RD53
- RC25

The RX50 drive contains two 5.25-inch floppy diskettes; count an RX50 as two drives. 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:11]: 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:60774 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:160000177700 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.

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

\* Enter the number of response rings for DUA  
[D R:1.8. D:4.] 4<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 MicroVMS Operating Systems

---

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

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

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

1. Log in 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 MicroVAX LSI-11 bus 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: 760500*  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 LSI-11 bus. Make a note of these other devices with floating addresses (greater than 760000<sub>8</sub>) or floating vectors (greater than 300<sub>8</sub>) that you plan to reinstall with your QD01/D.

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

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

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

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

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

In addition to the QD01/D, 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> DHV11
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: DHV11    Name: TXA      CSR: 760500*     Vector: 320      Support: yes
```

\*Floating address or vector

Note: All addresses and vectors are expressed in octal notation.

Figure 3-4. CONFIGURE Command Listing

5. Note the CSR addresses listed for the LSI-11 bus devices in floating address space. Program the listed addresses into non-Emulex devices as instructed by the manufacturer's documentation. For the QD01/D, program the address given for the QD01/D (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 QD01/D, 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 MicroVMS 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:

<u>Controller name</u>	<u>device name</u>	<u>disk name</u>
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 QD01/Ds.

#### 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:

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

<u>Disk Controller Type</u>	<u>Next Sysgen Question</u>
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 and 154, 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 (octal). 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, therefore, unusable with the Emulex MSCP controllers.

---

### 3.5.7 Ultrix-32 Operating Systems

---

The Emulex MSCP class disk 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-32 system supports two MSCP disk controllers.

Ultrix-32 does not require that the units be in sequential order. However, the MSCP device number for the drive to be booted from **MUST** be 0 regardless of the controller's LSI-11 bus 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 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-32 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-32 attempts to auto-configure the devices included in the booted monitors 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-32 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 0
rqd1 at csr 160334 vec 770, ipl 17
ra2 at rqd1 slave 0
```

The CSR address 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 Partitlions

---

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 utilize 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 very 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 Partitlon 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 first opening. The system manager should then edit these sizes (with "chpt" command) to match the 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, 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.

Example:

```

/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.

Example:

```

/etc/disktab:

qd21|QD01/D|Emulex QD01/D 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:

```

---

## 4.1 Overview

---

The procedure for installing the QD01/D Disk Controller is described in this section. The subsection titles are listed below to serve as an outline of the procedure.

Subsection	Title
4.2	Inspection
4.3	Disk Controller Setup
4.4	Physical Installation
4.5	ST-506 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, PREPARING 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.

**QD01/D CONFIGURATION REFERENCE SHEET**

**GENERAL INFORMATION**

- Host computer type \_\_\_\_\_
- Host computer operating system \_\_\_\_\_  
Version \_\_\_\_\_
- Other MSCP Controllers; Type \_\_\_\_\_, LSI-11 Bus Address \_\_\_\_\_

**DRIVE CONFIGURATION PARAMETERS**

- Drive Manufacturer (0) \_\_\_\_\_ Model \_\_\_\_\_
- Drive Manufacturer (1) \_\_\_\_\_ Model \_\_\_\_\_
- NOVRAM Parameters:

**DRIVE 0**

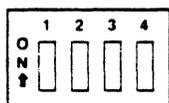
0	Number Units	_____
1	Type Code	_____
2	Head Offset	_____
3	Sectors/Track	_____
4	Heads	_____
5	Cylinders	_____
6	Spare Sectors	_____
7	Alternate Cylinders	_____
10	Reserved	_____
11	Split Code	_____
12	Removable Media	_____
13	Hard/Soft Sector	_____
14	Reduced Write	_____
15	Write Precomp.	_____
16	Step Code	_____
17	Spiral Offset	_____

**DRIVE 1**

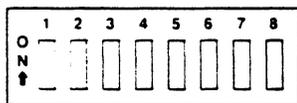
0	Number Units	_____
1	Type Code	_____
2	Head Offset	_____
3	Sectors/Track	_____
4	Heads	_____
5	Cylinders	_____
6	Spare Sectors	_____
7	Alternate Cylinders	_____
10	Reserved	_____
11	Split Code	_____
12	Removable Media	_____
13	Hard/Soft Sector	_____
14	Reduced Write	_____
15	Write Precomp.	_____
16	Step Code	_____
17	Spiral Offset	_____

**QD01/D CONFIGURATION**

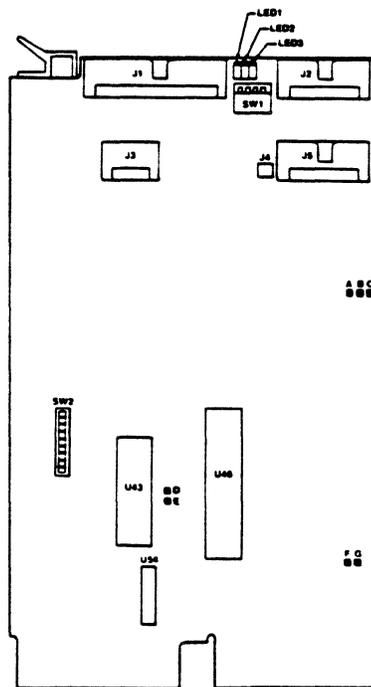
- Firmware revision number \_\_\_\_\_
- Top assembly number \_\_\_\_\_
- LSI-11 Bus address \_\_\_\_\_
- 22-bit addressing IC (AMD 7438) installed (Y or N) \_\_\_\_\_
- Switch settings (□ = OFF ■ = ON)
- Warranty expiration date \_\_\_\_\_
- Serial number \_\_\_\_\_
- Interrupt vector address \_\_\_\_\_



SW1



SW2



Use Pencil

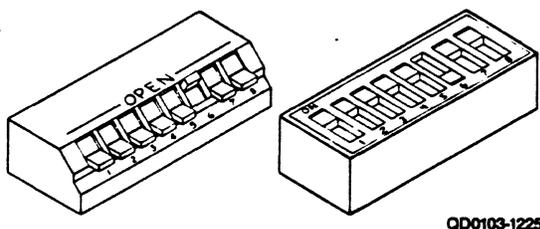
Figure 4-1. QD01/D Configuration Reference Sheet

QD0103-0865

### 4.1.2 DIP Switch Type

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 QD01/D Intelligent Disk Controller with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the QD01/D does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the QD01/D and its associated ST-506 peripherals can be installed:

- With both the QD01/D Disk Controller and the ST-506 disk drives both mounted in the same cabinet, and
- With the QD01/D mounted in the CPU cabinet and the ST-506 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 QD01/D, nothing must be done that would reduce this shield's effectiveness. That is, when the QD01/D 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.

---

## **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 QD01/D subsystem and, using the shipping invoice, verify that all equipment is present. Verify also that model or part numbers (P/N), revision levels, and serial numbers agree with those on the shipping invoice. Subsection 1.4 explains model numbers and details kit contents. These verifications are important to confirm warranty. If evidence of physical damage or identity mismatch is found, notify an Emulex representative immediately. If the equipment must be returned to Emulex, it should be shipped in the original container.

Visually inspect the QD01/D 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 QD01/D 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.

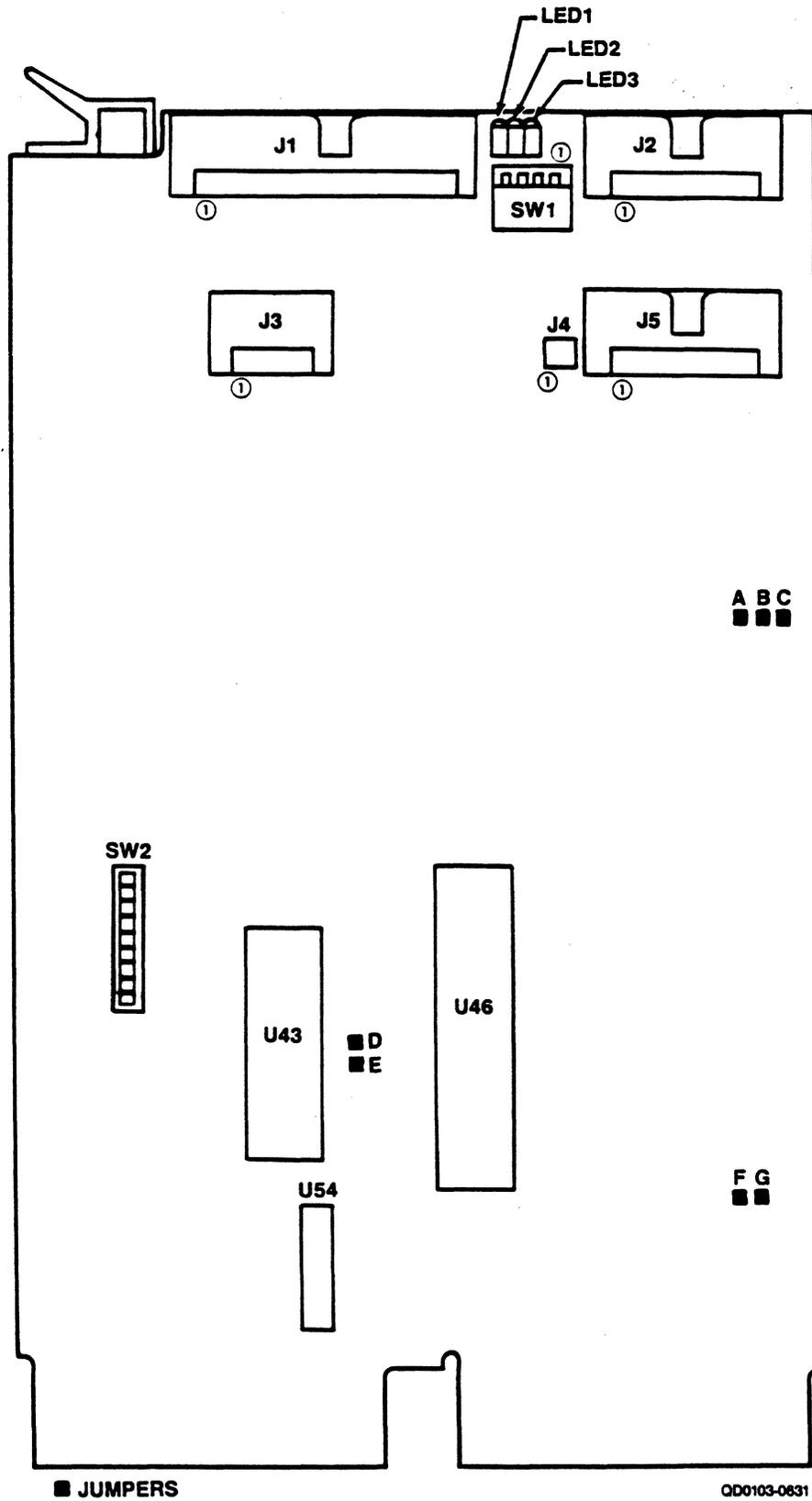


Figure 4-3. QD01/D Disk Controller Assembly

NOTE

If you change a switch position on the QD01/D, or change the configuration values in the NOVRAM, you must also reset the QD01/D so that the host operating system's initialization sequence reads the codes established by the switch settings and/or NOVRAM. To reset the QD01/D, either toggle switch SW1-1 (ON then OFF), or power-down and power-up the the system. **If you toggle SW1-1, be sure the system is offline. Resetting the coupler with the system running is likely to crash the system.**

Table 4-1 defines the function and factory configuration of all switches on the QD01/D controller. The factory configuration switch settings are representative of most QD01/D Disk Controller applications.

Table 4-1. QD01/D Switch Definitions and Factory Configuration

SW	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 (LSB)	4.3.3.2
SW1-3	-	-	OFF(0)	MSCP Device Number	4.3.3.2
SW1-4	-	-	OFF(0)	MSCP Device Number (MSB)	4.3.3.2
SW2-1	Disable	Enable	OFF(0)	Loop on Self-Test Error	
SW2-2	Disable	Enable	OFF(0)	Automatic Bootstrap	4.3.3.1
SW2-3	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-4	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-5	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-6	18-bit	22-bit	OFF(0)	22-Bit Addressing	4.3.3.3
SW2-7	4 usec	8 usec	OFF(0)	DMA Burst Delay	4.3.3.4
SW2-8	Enable	Disable	OFF(0)	Adaptive DMA Mode	4.3.3.5
ON(1) = Closed		FACT = Factory Setting			
OFF(0) = Open					

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

Table 4-2. QD01/D Jumper Definitions and Factory Configuration

Jumper	OUT	IN	FACT	Comment
A-B	Disable Clock	Enable Clock	IN	Must be OUT Rev H and above Rev G and below Must be OUT
C	Not Used	Not Used	OUT	
D-E	16K PROM	32K PROM	IN	
F-G	Normal Operation	Factory Test	OUT	
FACT = Factory Setting				

### 4.3.1 Disk Controller Bus Address

Every LSI-11 bus 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 QD01/D's two LSI-11 bus registers is selected by DIP switches SW2-3 through SW2-5. See Table 4-3 for register address switch settings.

Table 4-3. Controller Address Switch Settings

Bus Address (in octal)	--- SW2 ---			Factory
	3	4	5	
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 QD01/D 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 QD01/D 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 Automatic Bootstrapping

---

The automatic bootstrapping option causes the system to boot automatically from logical unit 0 through 3 on power-up when the QD01/D is at the standard base address. To enable this option, set SW2-2 ON and set switches SW1-2 through SW1-4 as described in Table 4-4. This option should not be enabled with a MicroVAX or in a system that uses an 11/73B CPU module.

Switch	OFF	ON	Factory
SW2-2	Disable	Enable	OFF

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

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

If the bootstrap device is not powered-up or safe (e.g., it failed its self-test), the autoboot routine in the QD01/D halts the CPU after 1 minute. This causes the CPU to enter Console ODT. You can then examine the Status and Address (SA) register (base address plus 2) for an MSCP error code (Table 5-3) and bootstrap the system from another device.

You can bootstrap from a drive supported by a QD01/D installed at an alternate LSI-11 bus address, using any boot process other than autoboot. In this case, be certain that the automatic bootstrap option is disabled (SW2-2 OFF).

### 4.3.3.2 MSCP Device Number

QD01/D switches SW1-2 through SW1-4 specify MSCP device numbers. The functions of these switches are dependent on the options you select for your QD01/D:

- If the QD01/D is installed at the standard LSI-11 bus address, these switches identify the MSCP device number of the drive from which to bootstrap. The QD01/D automatic bootstrap option supports only MSCP units 0 through 3 at the standard address.
- If the QD01/D is installed at an alternate LSI-11 bus address, these switches identify the MSCP device number of the first drive supported by that alternate QD01/D. The first drive supported by the QD01/D at an alternate address may be drive 0 through 7.

### 4.3.3.2.1 Logical Unit to Boot From

If the QD01/D automatic bootstrapping option is enabled (SW2-2 ON) and the QD01/D is at the standard LSI-11 bus address (772150<sub>8</sub>), switches SW1-2 through SW1-4 define the MSCP device number of the drive from which the QD01/D bootstraps. By using these switches, you may select one of four logical units to bootstrap from. Table 4-4 defines the MSCP device numbers selected by switches SW1-2 through SW1-4 if the QD01/D is at a standard address.

Table 4-4. Bootstrap MSCP Device Number

Bootstrap MSCP Device Number	SW1			Factory
	2 (LSB)	3	4 (MSB)	
0	0	0	0	✓
1	1	0	0	
2	0	1	0	
3	1	1	0	

### 4.3.3.2.2 First Logical Unit Number for an Alternate Address

If your QD01/D is installed at an alternate address, switches SW1-2 through SW1-4 select the MSCP device number of the first drive supported by the QD01/D. 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 QD01/D is at an alternate address.

**Example 4-1:**

Your system operates under RSX-11M-PLUS and has two QD01/D Disk Controllers. The first QD01/D is at the standard base address for MSCP controllers (772150<sub>h</sub>) and supports three logical drives: Unit 0, Unit 1, and Unit 2. The second QD01/D is at an alternate base address and supports two logical drives. RSX-11M-PLUS requires that the first drive on the alternate QD01/D have an MSCP device number of 3 and that the second drive have an MSCP device number of 4. On the alternate QD01/D, set switches SW1-2 in the ON position, SW1-3 in the ON position, and SW1-4 in the OFF position to specify a 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 4-5. MSCP Device Number for the First Drive Supported by a QD01/D at an Alternate Address**

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

\*Used to bootstrap a drive from the QD01/D at an alternate LSI-11 bus address.

---

### 4.3.3.3 22-Bit Memory Addressing

---

The 22-bit addressing capability is a standard option for the QD01/D and is supplied with the QD01/D as a kit, part number QD0111302. To enable 22-bit addressing, install the single 7438 IC in socket U49 on the QD01/D PCBA and set SW2-6 ON (1). 22-bit addressing must be enabled with MicroVAX systems.

### CAUTION

Some manufacturers of LSI-11 bus backplanes use the backplane lines now devoted to extended addressing for power distribution. Installing a QD01/D with the extended addressing option in such a system will damage the option IC. Before installing the option, confirm that there is neither positive nor negative potential between lines BC1, BD1, BE1, BF1, and logic ground. A QD01/D without the extended addressing option will not be damaged if power is present on those lines.

---

### 4.3.3.4 DMA Burst Delay

---

The QD01/D firmware design includes a switch-selectable DMA burst delay to avoid data-late conditions. Switch SW2-7 selects either a 4- or 8-microsecond delay between DMA bursts. Even with the QD01/D adaptive DMA, some applications may require a longer burst delay to allow other devices adequate time on the bus.

Switch	OFF	ON	Factory
SW2-7	4 usec	8 usec	OFF

---

### 4.3.3.5 DMA Adaptive Mode

---

Depending on the other devices on the bus and their priority, the QD01/D may use more or less bus time than optimal for your application. The QD01/D 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.

When adaptive DMA is enabled (SW2-8 OFF), the QD01/D monitors the LSI-11 bus for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. If the QD01/D is not getting the bus time your application requires, you may want to disable the adaptive DMA. When adaptive DMA is disabled, the QD01/D performs a burst transfer of 8 words or less, relinquishes the bus, then performs another DMA burst transfer.

Switch	OFF	ON	Factory
SW2-8	Enable Adaptive DMA	Disable Adaptive DMA	OFF

**NOTE**

If you are using the QD01/D with adaptive DMA enabled in a MicroVAX II subsystem, be aware that the CPU module uses DMA requests to gain use of the bus to service device interrupts and may interfere with the QD01/D's bus access. You may consider disabling adaptive DMA for improved throughput.

---

## 4.4 Physical Installation

---

This section provides instruction for system preparation, slot selection, and mounting the QD01/D.

---

### 4.4.1 System Preparation

---

To prepare your CPU to accept the QD01/D, use the following procedures:

- **MICRO/PDP-11 and MicroVAX I and II Preparation:**
  1. Power down the system by switching OFF the main ac breaker.
  2. Remove the rear cover from the chassis so that the patch panel is exposed. The rear cover is held on by snap pads. Grasp the cover at the top and bottom, and pull straight back.
  3. Loosen the captive screws from the patch panel using a standard screwdriver.
  4. Remove the patch panel.
  5. Find the flat-ribbon cable that connects the CPU module to the patch panel. For easier board installation, you may disconnect the CPU flat-ribbon cable from the patch panel.
- **LSI-11 Series Preparation:**
  1. Power down the system by switching OFF the main ac breaker.
  2. Remove the cover from the chassis so that the backplane is exposed.

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

---

### 4.4.2 Slot Selection

---

The QD01/D may be assigned to any desired slot because it uses the LSI four-level interrupt scheme to perform distributed interrupt arbitration.

Be sure to find out whether your backplane is straight or serpentine and choose a slot accordingly. On straight backplanes, the QD01/D must be plugged into connectors A and B, since connectors C and D carry no signals. On a serpentine backplane, the QD01/D can be plugged into either connectors A and B or connectors C and D.

There must be no unused slots, however, between the CPU and the QD01/D. If you have a DEC RQDX1 in your backplane, be sure to install the QD01/D in front of the RQDX1; not all RQDX1 controllers pass grant signals.

---

### 4.4.3 Mounting

---

The QD01/D Disk Controller PWB should be plugged into the LSI-11 backplane with components oriented in the same direction as the CPU and other modules. Always insert and remove the boards with the computer power OFF to avoid possible damage to the circuitry. Be sure that the board is properly positioned in the throat of the board guides before attempting to seat the board by means of the extractor handle.

---

## 4.5 ST-506 Disk Drive Preparation

---

There is only one configuration setup that needs to be made on common ST-506 disk drives: drive unit numbering.

Most ST-506 peripherals must have unit numbers assigned to them during installation. The QD01/D supports drive unit numbers of only 0 and 1. Check the manual supplied with the drive for instructions on how to set the unit drive number.

Select either 0 or 1 for your drives in accordance with the configuration that you have programmed into the NOVRAM.

---

### 4.5.1 Drive Placement

---

Unpack and install the disk drives according to the manufacturer's instructions. Install the disk drives in their final positions before beginning the installation of the QD01/D. This positioning allows the I/O cable routing and length to be accurately judged.

---

### 4.5.2 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 QD01/D Disk Controller controls its two physical disk drives via a standard ST-506 interface. The interface has two parts: a 34-line control segment, which is connected to both drives, and two 20-line data segments, one of which goes to each drive. The physical interface is implemented by using three headers (J1, J2, and J5) that are located on the outside edge of the PWB. J1 is the control segment header; J2 and J5 are the data segment headers. The control cable that begins at J1 is daisy-chained between the two disk drives, and each of the data cables that begin at J2 and J5 goes to one of the drives. Maximum cable length is 20 ft. (6 m).

Table 4-6 lists cables offered by Emulex for the QD01/D. Table 4-7 lists the components that are required to construct both control and data cables. Figure 4-4 shows basic cable installation.

In addition, Emulex offers the QD01/D External Cabling Kit (P/N QD0113003) for installation in a MICRO/PDP or MicroVAX I or II Tower. The QD01 Cabling Kit, which includes cables and panels for separate cabinet installation, is documented in the QD01 Cabling Kit Instruction Sheet (P/N QD0152401).

Table 4-6. QD01/D Internal Cabling Kit (P/N QD0113001)

Qty	Part Number	Cable Length	Cable Description
2	QU0111201-01	3 ft	Control, 34-line
	QU0111201-02	6 ft	
	QU0111201-03	9 ft	
	QU0111201-04	12 ft	
	QU0111201-05	15 ft	
	QU0111201-06	18 ft	
1	QU0111202-01	1 ft	Data, 20-line
	QU0111202-02	6 ft	
	QU0111202-03	9 ft	
	QU0111202-04	12 ft	
	QU0111202-05	15 ft	
	QU0111202-06	18 ft	
1	QU0111203-01	1 ft	Daisy-chain, 34-line
	QU0111203-02	2 ft	
	QU0111203-03	3 ft	
	QU0111203-04	4 ft	

Table 4-7 lists the components that are required to construct both control and data cables.

Table 4-7. Interface and Cable Components

Cnctr Number	Controller Function	Header Type	Cable Components			Drive Cnctr
			Control Cnctr	Cable Type Unshield	Shielded	
J1	Control	3594	3414	3801/34	3517/34	3463
J2/J5	Data	3592	3421	3801/20	3517/20	3461

Cnctr = Connector  
 All component numbers are 3M. Equivalents may be used.

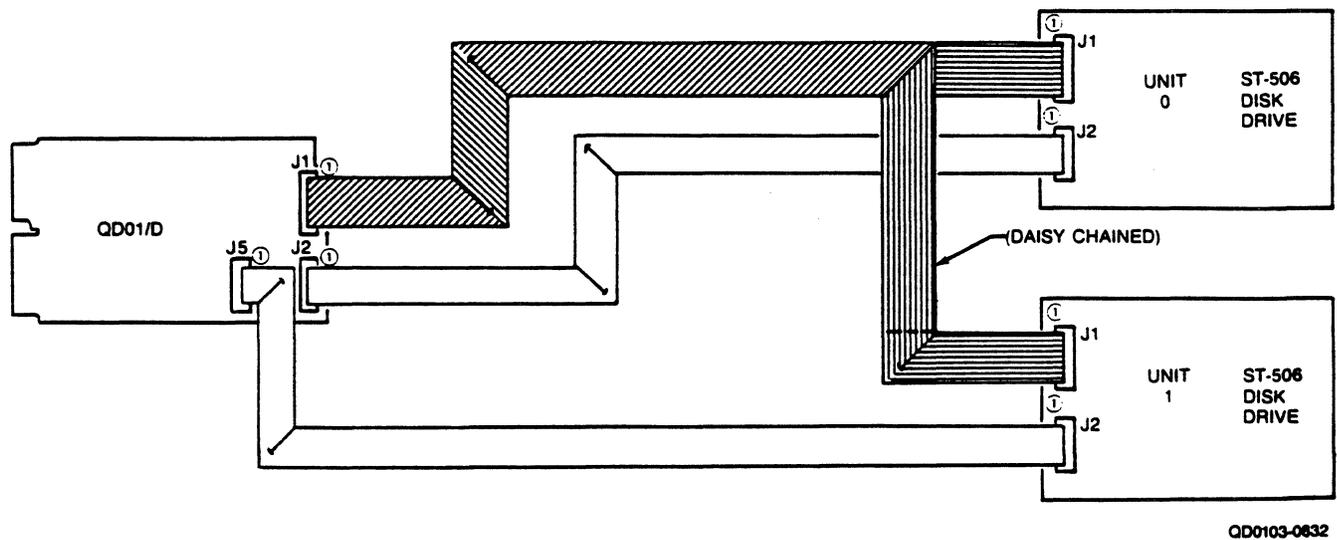


Figure 4-4. Drive Cabling

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.

The routing of the cables that connect the QD01/D and its disk drives can have a major impact on the amount of EMI that is radiated by the subsystem (the combination of the QD01/D and its drives), especially if the QD01/D and the disk drives are installed in separate cabinets.

When the QD01/D and the ST-506 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 ST-506 interface between the QD01/D and the ST-506 peripherals.

#### NOTE

If the cabinet in which the QD01/D and LSI-11 CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsibility to take whatever steps are necessary to correct the interference.

If the ST-506 disk drives are mounted in a separate cabinet from the QD01/D Disk Controller, then the cables that connect the QD01/D to the drives should probably 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 through 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 QD01/D, 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 QD01/D 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 an LSI-11 or MicroVAX 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.

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 no manufacturer's defect list is available, use:

- Option 2, Format and Verify with replacement enabled

If 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 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 MicroVAX I

---

F.R.D. is started by issuing a special command sequence via console ODT. To start F.R.D. on a MicroVAX I, first apply power to the system. Put the system in console mode, then enter the following commands via the host console in response to the >>> prompt:

*2DEC*  
*00EE*

*1468*  
*146A*

```

>>>D/P/W 2000XXXX 1<CR>            !INIT CONTROLLER
>>>E/P/W 2000YYYY<CR> 900 OR B00    !STEP ONE FROM QD01/D
>>>D/P/W 2000YYYY 3003<CR>        !ENABLE SPECIAL MODE
>>>E/P/W 2000YYYY<CR> 0100        !ACK SPECIAL MODE
>>>D/P/W 2000YYYY 4401<CR>        !UPLOAD DRIVER
>>>E/P/W 2000YYYY<CR> 0400        !UPLOAD DONE
>>>S        80<CR>                !START DRIVER

```

NOTE: XXXX and YYYY are offsets dependent on the address of the QD01/D controller. See Table 4-8 for the available values.

### 4.7.3 Starting F.R.D. on a MicroVAX II

F.R.D. is started by issuing a special command sequence via console ODT. To start F.R.D. on a MicroVAX II, first apply power to the system. Put the system in console mode, then enter the following commands via the host console in response to the >>> prompt:

```

>>>I                                !BUS INIT
>>>D/P/W 20001F40 20<CR>           !ENABLE MEMORY
>>>D/P/L 20088000 80000000<CR>     !SETUP MAP 0
>>>D/P/L 20088004 80000001<CR>     !SETUP MAP 1
>>>D/P/W 2000XXXX 1<CR>            !INIT CONTROLLER
>>>E/P/W 2000YYYY<CR> 900 OR B00   !STEP ONE FROM QD01/D
>>>D/P/W 2000YYYY 3003<CR>         !ENABLE SPECIAL MODE
>>>E/P/W 2000YYYY<CR> 0100         !ACK SPECIAL MODE
>>>D/P/W 2000YYYY 4401<CR>         !UPLOAD DRIVER
>>>E/P/W 2000YYYY<CR> 0400         !UPLOAD DONE
>>>S 80<CR>                        !START DRIVER

```

NOTE: XXXX and YYYY are offsets dependent on the address of the QD01/D controller. See Table 4-8 for the available values.

Table 4-8. MicroVAX Offsets

CONTROLLER BUS ADDRESS	XXXX	YYYY
772150	1468	146A
772154	146C	146E
760334	00DC	00DE
760340	00E0	00E2
760344	00E4	00E6
760350	00E8	00EA
760354	00EC	00EE
760360	00F0	00F2

#### 4.7.4 Starting F.R.D. on an LSI-11 System

To start F.R.D. on an LSI-11 system, first halt the processor. Then enter the following commands in response to the ODT prompt (@):

```
@ 177xxxxx/ 000000 1 <LF>
@ 177yyyyy/ 4400 or 5400 30003 <CR>
@/000400 42000 <CR>
@ 177yyyyy/ 2000 <CR>
@ 200G
```

!TEST FOR 2000

NOTE: XXXX and YYYY are offsets dependent on the address of the QD01/D controller. See Table 4-9 for the available values.

Table 4-9. LSI-11 Offsets

CONTROLLER BUS ADDRESS	XXXX	YYYY
772150	72150	72152
772154	72154	72156
760334	60334	60336
760340	60340	60342
760344	60344	60366
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.

#### 4.7.5 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 an LSI-11 system, enter 200G at the ODT prompt. On a MicroVAX 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 - Format
- 2 - Format and verify
- 3 - Verify
- 4 - Read only test
- 5 - Data reliability test
- 6 - List known units
- 7 - Replace block
- 8 - Display Novram
- 9 - 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 "Strike any key when ready" and waits for you to do so before returning to the main menu.

---

### 4.8.1 Option 1 - Format

---

The Format option is used to initially format a drive. The operation writes sector headers, initializes the drive's RCT tables, and replaces any defects listed in the manufacturer's defect list. 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.

---

### 4.8.2 Option 2 - Format and Verify

---

This option formats a drive, then tests the surface to replace pattern-sensitive defective sectors not found by the manufacturer. It performs both of the operations that are available separately with options 1 (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.

---

### 4.8.3 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 contained 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 also offers a bad block replacement feature, which, when enabled, replaces any bad blocks using the appropriate technique.

Use this option if you plan to manually replace the bad blocks identified in the manufacturer's defect list.

---

#### 4.8.4 Option 4 - 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 5 with replace enabled.

---

#### 4.8.5 Option 5 - Data Reliability Test

---

This option allows you to thoroughly test your subsystem before use. 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.

A test of the full pack is your option; the test prompts you to access the user area of the disk. The test otherwise defaults to two reserved diagnostic cylinders so that user data will be protected. 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 - 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.

---

#### **4.8.7 Option 7 - 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.

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 per track. As soon as you enter this value, 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. That runs test patterns that may detect any pattern-sensitive blocks.

---

#### **4.8.8 Option 8 - 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.

---

#### **4.8.9 Option 9 - 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.

---

## 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 where the controller looks for drive configuration information. The valid value is 1. When 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.

---

### 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 3 is specified. The valid range is from 0 through 63. If a Split Code 0, 1, or 2 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 0 through 15. At least one cylinder must be specified as an alternate. (If spare sectors are specified, the sector replacement algorithm needs one track for working space.) Emulex recommends a value of two; this is the default value if you select a type code of 2.

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

---

This parameter defines some additional configuration parameters 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 for the value to enter for this parameter. If your drive is not supported by Emulex, refer to the drive manufacturer's manual for drive requirements, then enter the appropriate values as defined below:

- 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 this bit is 0, the drive cannot perform early or late data strobe operations. If this 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 this 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 for this bit is 0 or 1. If this bit is 0, the Command Complete signal remains on during a head select. If this bit is 1, the Command Complete signal is negated during a head select.

The decimal value for this parameter is calculated from these binary bits. Table 4-10 shows the decimal value for each drive configuration. If your drive is not listed in Appendix C, find your drive configuration in the table. Then follow that row over to the decimal value.

Table 4-10. 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 relative sizes of the logical drives are defined as follows:

Code	Drive 0	Drive 1
0	8/8	0
1	4/8	4/8
2	7/8	1/8
3	Head Offset Dependent	

- Code 0:** No split.
- Code 1:** The cylinders are split evenly between the two logical drives. If there is an odd number of cylinders, the odd cylinder is not used.
- Code 2:** The total number of cylinders are divided by eight. The first drive contains seven-eighths of the total, and the second contains one-eighth. When the number of cylinders is not evenly divisible by eight, the odd cylinders (remainder of the division) are assigned to the larger logical unit.
- Code 3:** The drive's data heads are divided between the two logical drives. See Starting Head Offset, Section 4.9.3.

Use of the split option disables seek-ordering and overlapped seek processing in the MSCP Controller, which reduces performance, particularly when both logical of a split physical drive are active. Therefore, we do not recommend using this option unless necessary to allow for convenient file backup and restoration.

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 Removable Media

---

This parameter indicates whether the disk media is fixed or removable. If you are defining one logical/physical 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

---

#### 4.9.12 Reduced Write Current Cylinder

---

For type 1 drives, this parameter specifies the physical cylinder at which the write current to the data heads is reduced. Some disk drives require that the write current to the heads be reduced above a certain cylinder to reduce the strength of the flux transition. This reduction prevents adjacent flux transitions in the higher cylinders (where they are closer together) from displacing one another to such an extent as to force data bits out of their data clock windows.

Consult the drive manufacturer's technical manual for the proper cylinder. The valid range is from 0 through 4096. If no reduction is required, specify the total number of physical cylinders.

---

#### **4.9.13 Write Precompensation Cylinder**

---

For type 1 drives, this parameter specifies the physical cylinder at which the timing of write data transmitted to the disk drive must be advanced or retarded (with reference to the disk data clock). This timing shift compensates for timing shifts that are caused by adjacent flux transitions in the higher cylinders (where they are closer together). Shifting the write data with respect to the data clock ensures that, when the data is read back, the data will fall within the clock window, despite the tendency of one transition to affect the apparent position of the adjacent transition. This shifting is called precompensation.

Consult the drive manufacturer's technical manual for the proper cylinder. The valid range is from 0 through 4096. If no precompensation is required, specify the total number of physical cylinders.

Write data is precompensated by 12 nanoseconds (both early and late).

---

#### **4.9.14 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.

---

#### **4.9.15 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 QD01/D 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 QD01/D PWB. These LEDs are used for both diagnostics and for normal operations.

If switch SW2-1 is OFF, the QD01/D 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 QD01/D successfully completes the preliminary test, LED3 illuminates indicating that the QD01/D is waiting for the MSCP initialization sequence.

During the MSCP initialization sequence, initiated by host software control, the QD01/D executes a self-test that exercises the buffer controller chip, the Host Adapter Controller (HAC) chip and its associated circuitry, the on-board RAM, and the control memory PROM. If the QD01/D passes this sequence of its self-test successfully, all the LED indicators on the edge of the QD01/D 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 QD01/D fails to pass its power-up self-tests, you can select a special diagnostic mode (switch SW2-1 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 LSI-11 bus activity and ST-506 disk drive activity respectively.





---

## **5.1 Overview**

---

This section describes the several diagnostic features with which the QD01/D Disk Controller is equipped, and outlines fault isolation procedures that use these diagnostic features.

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

---

## **5.2 Service**

---

Your Emulex QD01/D 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 QD01/D 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 TWX 910-595-2521  
Outside California: (800) 852-7112

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.

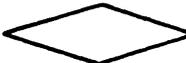
After you have contacted Emulex and received an RMA, package the component (preferably using the original packing material) and send the component **postage paid** to the address given you by the Emulex representative. The sender must also insure the package.

### 5.3 Fault Isolation Procedure

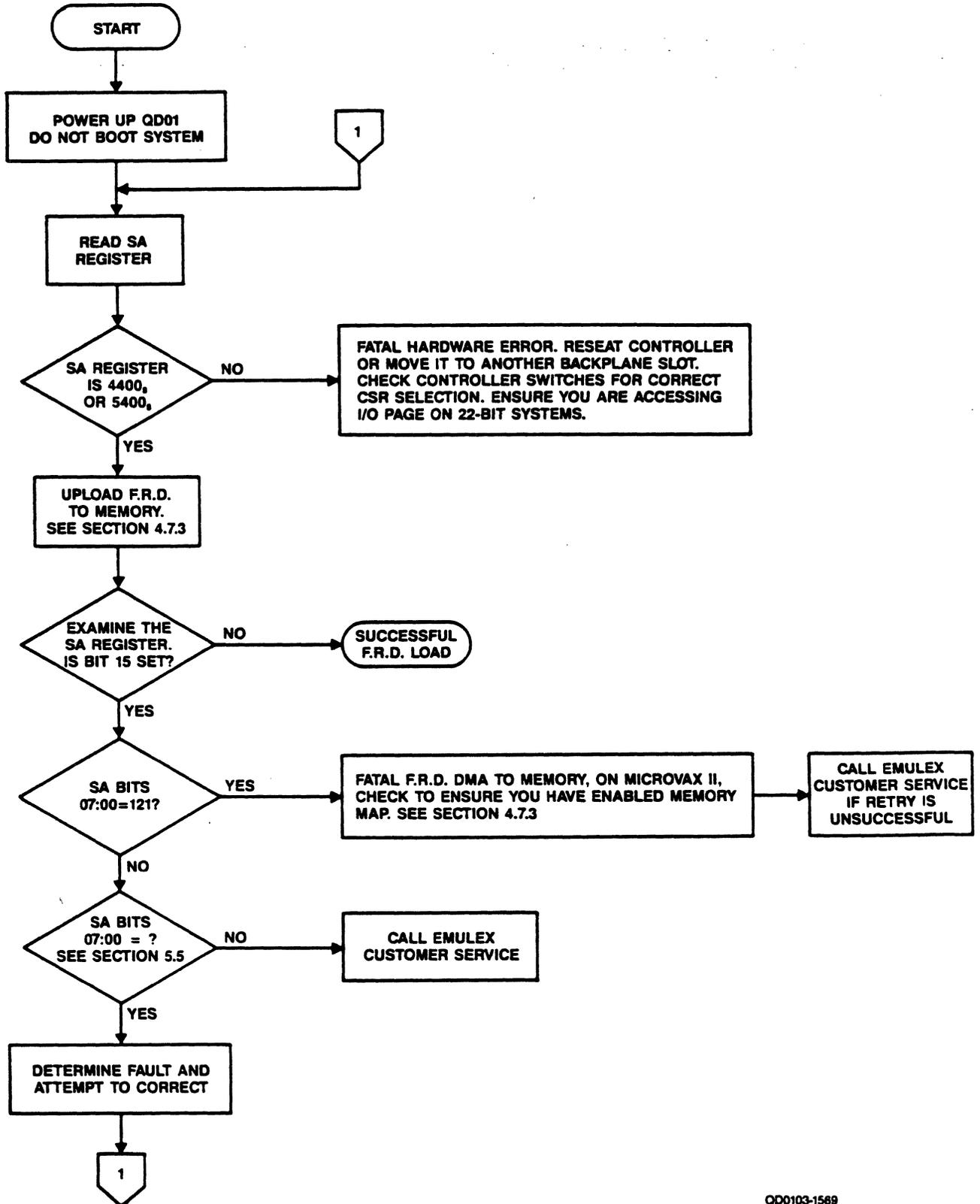
This fault isolation procedure is provided in flow chart format. The procedure is based on the self-diagnostics incorporated into the QD01/D. The procedure is designed to be used if the product's self-diagnostic fails or if many errors are flagged by the subsystem during normal operation. If neither 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.

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.

QD0103-0108



QD0103-1589

Figure 5-1. Fault Isolation Chart

## 5.4 Power-Up Self-Diagnostic

QD01/D 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 lists the tests in the order in which they 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 QD01/D 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 QD01/D are listed in Table 5-3. Note that some fatal errors may not allow access to the SA register from the console.

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 QD01/D switch SW2-1 ON (1). After setting SW2-1 ON, the host computer must be powered down or QD01/D switch SW1-1 must be toggled (turned ON and then OFF) to cause the QD01/D 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 QD01/D completes the diagnostic mode without errors, all three LEDs are OFF. Set switch SW2-1 in the OFF position and reset the QD01/D controller before using.

Table 5-2. LED Error Codes

LED			Error Description
3	2	1	
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 QD01/D detects 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 QD01/D.

Table 5-3. MSCP Fatal Error Codes Used by the QD01/D

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the QD01/D attempted to read data from a message packet.
2	2	Possible parity or timeout error when the QD01/D attempted to write data to a message packet.
4	4	QD01/D diagnostic self-test indicated a controller RAM error.
5	5	QD01/D diagnostic self-test indicated a firmware checksum error.
6	6	Possible parity or timeout error when the QD01/D attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the QD01/D attempted to write an envelope address to a command ring.
11	9	Host did not communicate with QD01/D within the time frame established while bringing the controller online.
12	A	Operating system sent more commands to the QD01/D than the controller can accept.
13	B	Controller unable to perform DMA transfer operation correctly.
14	C	QD01/D 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**

<b>Octal Code</b>	<b>Hex Code</b>	<b>Description</b>
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

---

## **6.1 Overview**

---

This section contains an overview of the QD01/D device registers that are accessible to the LSI-11 bus and that are used to monitor and control the QD01/D Disk Controller. The registers are functionally compatible with DEC implementations of MSCP controllers.

The following table outlines the contents of this section.

Subsection	Title
6.2	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.

For more information about MSCP subsystems, see subsections 3.2, 3.3, and 3.4.

---

## **6.3 Programming**

---

A complete description of MSCP commands and the corresponding status responses which the QD01/D Disk Controller posts is beyond the scope of this manual.

---

### **6.3.1 MSCP 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 QD01/D.

---

#### **6.3.1.1 Minimal Disk Subset**

---

The QD01/D Disk Controller supports the entire minimal disk subset of MSCP commands.

---

#### **6.3.1.2 Diagnostic and Utility Protocol (DUP)**

---

The QD01/D Disk Controller does not support any of the DUP commands or maintenance read/write commands. Therefore, the QD01/D is not compatible with DEC diagnostics that use the MSCP DUP commands.

---

## 6.4 Registers

---

During normal operation, the QD01/D 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 QD01/D has two 16-bit registers in the LSI-11 Bus I/O page that are used primarily to initialize the subsystem. During normal operation, the registers are used only to initiate polling or to reset the subsystem. These registers are always read as words. The register pair begins on a longword boundary. 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 QD01/D.

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. QD01/D IP and SA Registers

Register	Octal	Hexadecimal
IP	772150	20001468
SA	772152	2000146A
IP	772154	2000146C
SA	772156	2000146E
IP	760334	200000DC
SA	760336	200000DE
IP	760340	200000E0
SA	760342	200000E2
IP	760344	200000E4
SA	760346	200000E6
IP	760350	200000E8
SA	760352	200000EA
IP	760354	200000EC
SA	760356	200000EE
IP	760360	200000F0
SA	760362	200000F2

---

## 6.5 Bootstrap Command

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To allow the system to be easily bootstrapped from peripherals attached to the QD01/D 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 MicroVAX or on systems using an 11/73B CPU module.

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 QD01/D PWB, but on some other module in the system.) The Bootstrap Command causes the QD01/D to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the QD01/D:

1. Initialize the QD01/D by writing any value into the IP register (base address). The QD01/D performs self-test and begins the initialization dialog.

Register	Octal
IP: Write	000001

2. The QD01/D 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. If 22-bit addressing is enabled, bit 9 will be set.

Register	Octal	Addressing
SA: Read	0044000	18-Bit
	005400	22-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. At the console emulator prompt, enter P to begin:

@P



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## **7.1 Overview**

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This section contains a description of the QD01/D Disk Controller's architecture.

---

## **7.2 QD01/D Disk Controller Architecture**

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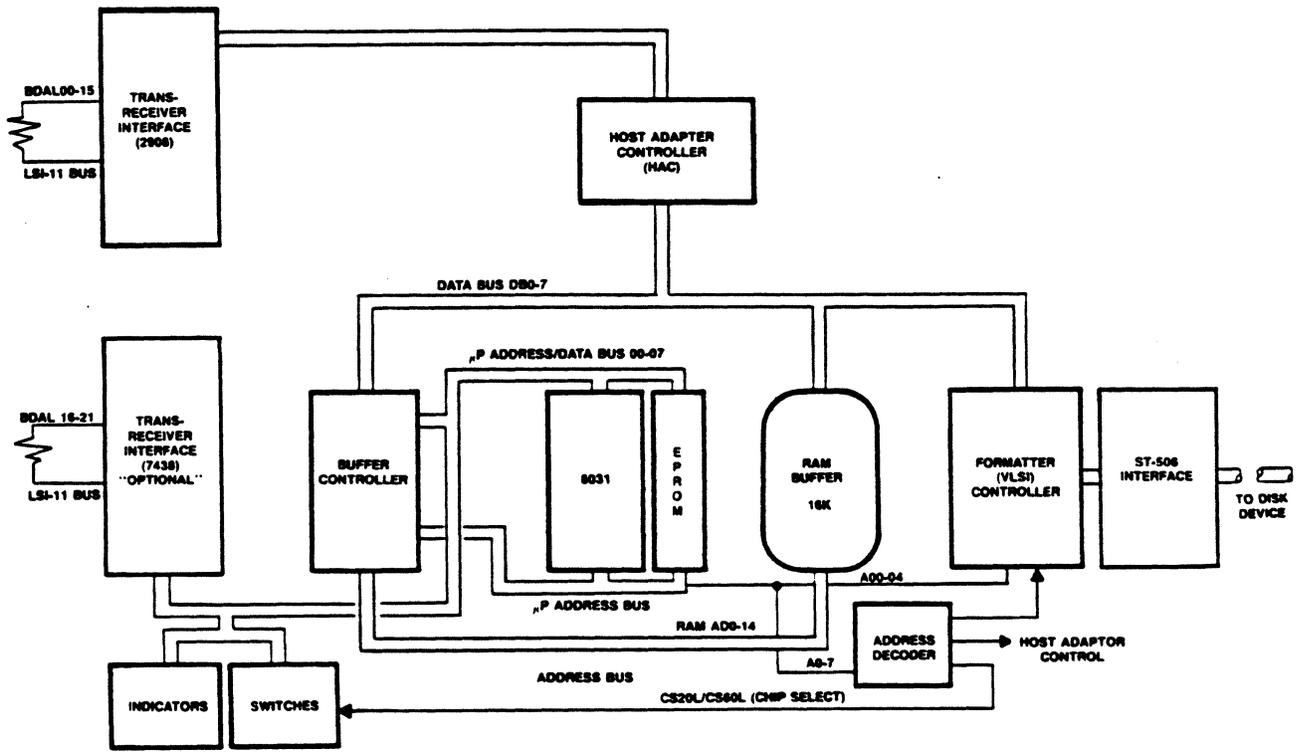
The QD01/D is a microprocessor-based emulating disk controller that is contained on a single dual-wide PCBA. The QD01/D's major functional blocks are shown in Figure 7-1. The disk controller is organized around the eight-bit 8031 microprocessor. The board has an eight-bit internal data bus with 16-bit addressing capability. The Host Adapter Controller, the Formatter Controller, and the Buffer Controller are addressed as memory (memory-mapped I/O).

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

The QD01/D uses a 27256 erasable programmable read-only memory (EPROM), which contains the control program, and 16K bytes of random access memory (RAM), which is used for data buffering and working storage.

The LSI-11 bus interface contains 22 lines. Sixteen of the lines are multiplexed for both address and data; six are used for only address. The Host Adapter Controller is used for programmed I/O, CPU interrupts, and DMA data transfers. The microprocessor responds to all programmed I/O and carries out the I/O functions required for the addressed disk controller register. The Host Adapter Controller has automatic LSI-11 bus address generation capability that, in conjunction with a byte counter, allows the interface to conduct LSI-11 bus DMA transfers without direct microprocessor intervention after the interface is set up for a transfer. This automatic DMA capability is used with the QD01/D Buffer Controller to transfer large blocks of data directly between host memory and the QD01/D's RAM.

The Buffer Controller is implemented on a single chip. This multi-channel DMA is responsible for moving large blocks of data between the 16K RAM buffer and the ST-506 interface, and between the LSI-11 bus interface and the 16K RAM buffer. After being set up for an operation by the microprocessor, either interface requests DMA service from the Buffer Controller 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.



QD0103-1579

Figure 7-1. QD01/D Block Diagram

---

## 8.1 Overview

---

This section describes the interfaces that the QD01/D Disk Controller incorporates. It includes information on the QD01/D implementation of ST-506 interface electrical and mechanical requirements. Excluding this overview, the section is divided into the following subsections.

Subsection	Title
8.2	QD01/D LSI-11 Bus Interface
8.3	QD01/D ST-506 Drive Interface

---

## 8.2 LSI-11 Bus Interface

---

The LSI-11 bus between the CPU and the QD01/D Disk Controller contains 42 bidirectional signal lines and two unidirectional signal lines on connectors A and B, and two unidirectional signal lines on connector C. LSI-11 bus interface pin assignments are listed and described in Table 8-1. These signal lines provide the means by which the CPU and the QD01/D Disk Controller communicate with each other.

The LSI-11 bus interface is used for programmed I/O, CPU interrupts, and DMA data transfer operations. Addresses, data, and control information are sent along these signal lines, some of which contain time-multiplexed information. The LSI-11 bus interface lines are grouped in the following categories:

- **Twenty-two Data/Address Lines <BDAL00:BDAL21>** The four Data/Address lines which carry the most significant bits (MSB) are lines BDAL21:BDAL18. They are used for addressing only and do not carry data. Lines BDAL17 and BDAL16 reflect the parity status of the 16-bit data word during a Write or Read Data Transfer operation via the LSI-11 bus cycle.
- **Six Data Transfer Control Lines** BBS7, BDIN, BDOUT, BRPLY, BSYNC, and BWTBT.
- **Six Direct Memory Access (DMA) Control Lines** BDMR, BSACK, BDMGI, and BDMGO (the last two are on both connectors A and C).
- **Seven Interrupt Control Lines** BEVNT, BIAKI, BIAKO, BIRQ4, BIRQ5, BIRQ6, and BIRQ7.
- **Five System Control Lines** BDCOK, BHALT, BINIT, BPOK, and BREF.

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

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

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### 8.2.1 Interrupt Priority Level

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The QD01/D is hard-wired to issue level 4 interrupt requests and monitor level 5. The level 4 request is necessary to allow compatibility with either an LSI-11 or LSI-11/2 CPU.

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### 8.2.2 Register Address

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The QD01/D Disk Controller has two registers visible to the LSI-11 bus. Their addresses are determined by DIP switches SW2-3 through SW2-5. See Section 4 for detailed address and switch setting information.

---

### 8.2.3 DMA Operations

---

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

---

### 8.2.4 Scatter/Gather

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The QD01/D Disk Controller supports the MicroVAX I I/O technique of scatter-write operations and gather-read operations.

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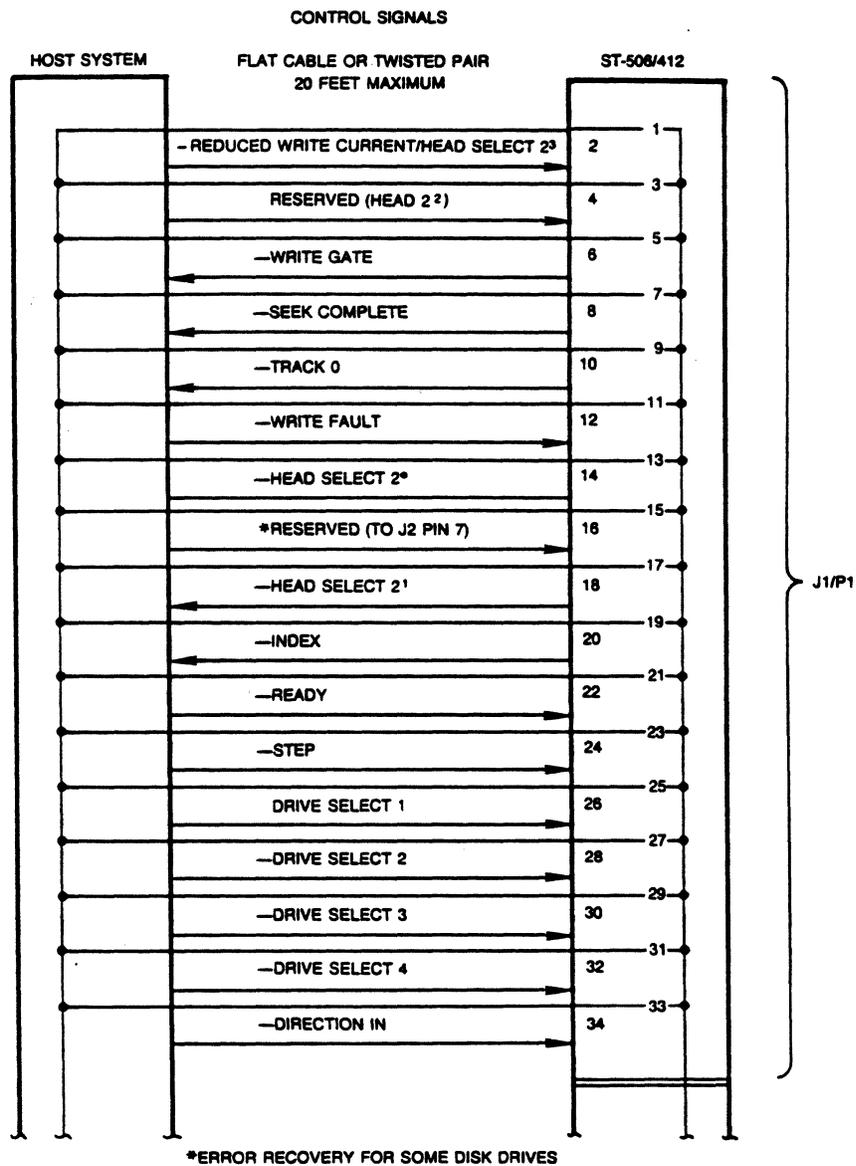
## 8.3 QD01/D ST-506 Disk Drive Interface

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The QD01/D Controller interfaces with each disk drive via a 34-pin control cable and a 20-pin data cable (for each disk drive). A 34-pin male connector at reference designator J1 on the QD01/D Controller plugs directly into the ST-506 disk drive control cable. The QD01/D Controller contains two 20-pin male connectors, one at reference designator J2 and one at reference designator J5.

The QD01/D Controller can control a maximum of two disk drives. Either 20-pin connector (reference designator J2 or J5) can plug directly into the data cable for the first disk drive. If a second disk drive is configured, the unused 20-pin connector is plugged into the data cable for that disk drive.

The pin/signal assignments for control signal interface between the QD01/D Controller and an ST-506 disk drive are shown in Figure 8-1. Figure 8-2 shows the pin/signal assignments for data signal interface between the QD01/D controller and an ST-506 disk drive.



QD0103-0620

Figure 8-1. Control Pin/Signal Assignments at ST-506 Disk Drive Interface (Connector J1)

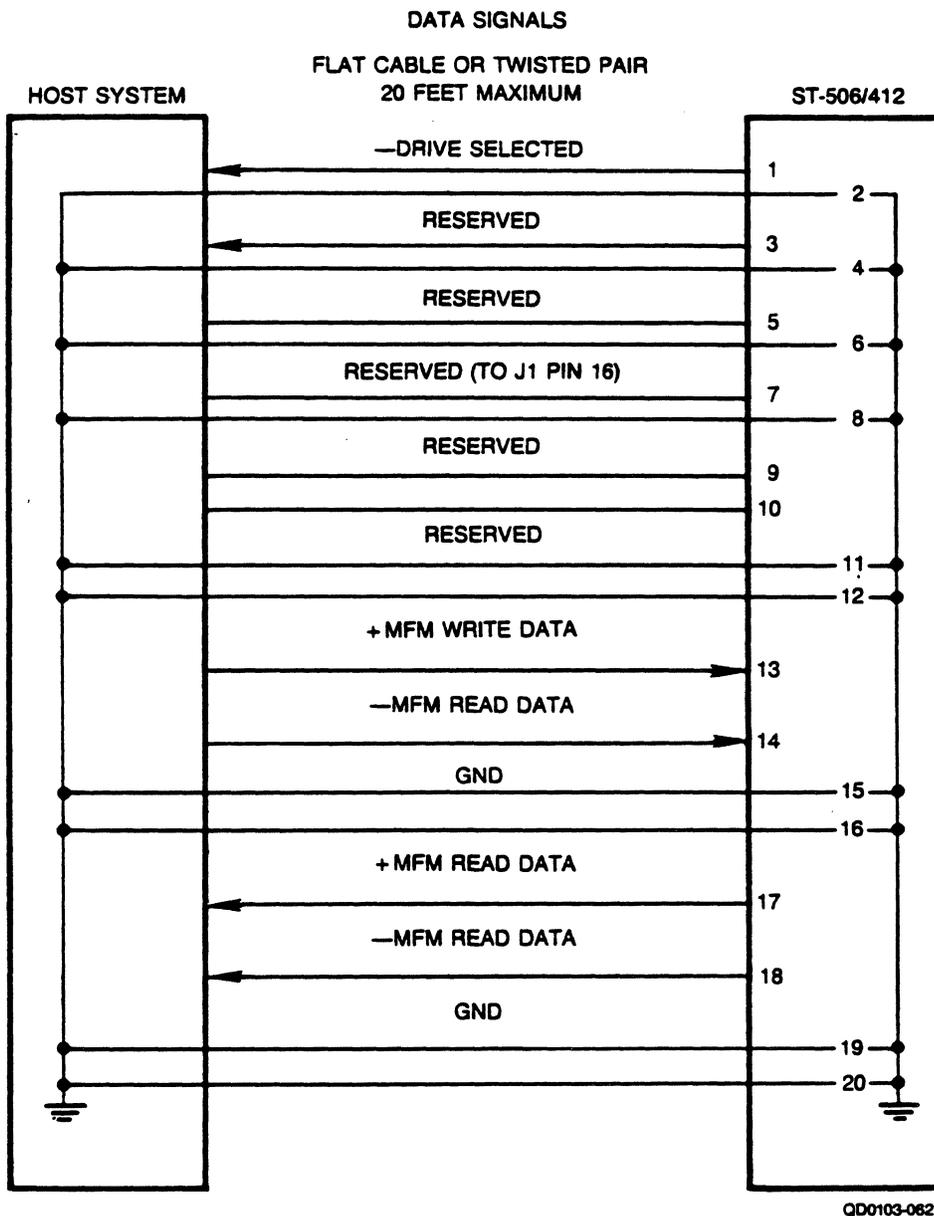


Figure 8-2. Data Pin/Signal Assignments at ST-506 Disk Drive Interface (Connector J2 or J5)

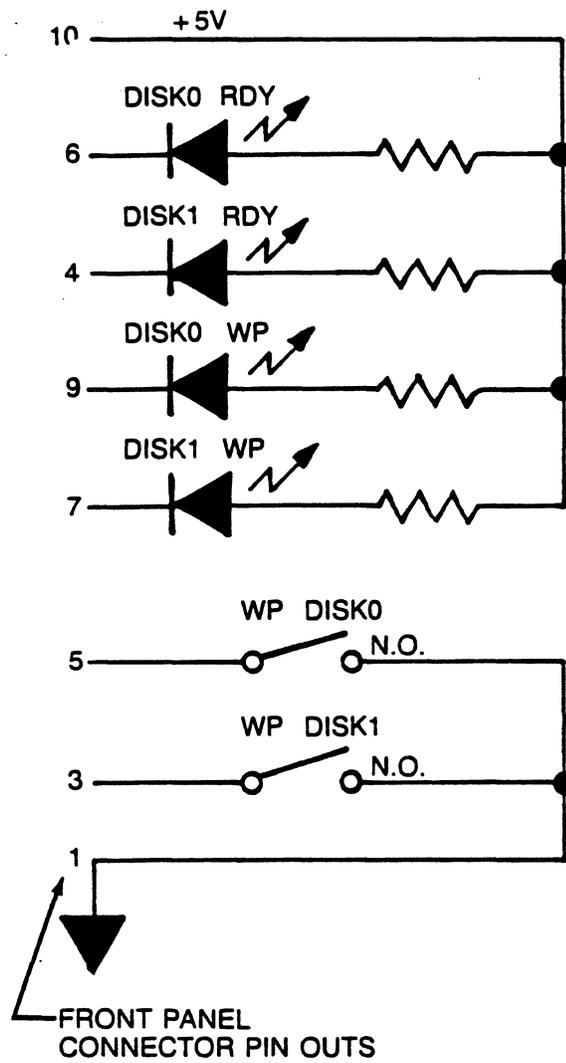
## 8.4 Front Panel Interface

The QD01/D provides an interface that allows a remote control and status panel to be connected to the controller. The interface allows write protect switches for each ST-506 drive to be connected, and it provides drivers for ready and write-protected status LEDs.

The interface is implemented by using a four-wall, right-angle header (3M part number 3591-5002) designated J3. The header has 10 pins. The function of each pin is described in Table 8-2. Figure 8-3 shows the pin-outs and a sample user interface.

Table 8-2. 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	Not connected	
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.



QD0103-0622

Figure 8-3. Status and Control Interface



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## **A.1 Overview**

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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.

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## **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 <sup>2</sup>	4	10
3	DQ11	4	10	18	RX211 <sup>2</sup>	4	10
4	DU11,DUV11	4	10	18	RXV11 <sup>2</sup>	4	10
5	DUP11	4	10	18	RXV21 <sup>2</sup>	4	10
6	LK11A	4	10	19	DR11-W	4	10
7	DMC11	4	10	20	DR11-B <sup>3</sup>	4	10
7	DMR11	4	10	21	DMP11	4	10
8	DZ11 <sup>1</sup>	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 <sup>2</sup>	4	10
9	KMC11	4	10	26	UDA50 <sup>2</sup>	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 <sup>2</sup>	4	10	31	KMV11	8	20
14	RLV11 <sup>2</sup>	4	10	32	DHV11	8	20
15	LPA11-K <sup>2</sup>	8	20	33	DMZ32	16	40
16	KW11-C	4	10	34	CP132	16	40

<sup>1</sup> DZ11-E and DZ11-F are treated as two DZ11s.

<sup>2</sup> The first device of this type has a fixed address. Any extra devices have a floating address.

<sup>3</sup> 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<sub>8</sub> and proceeding upwards)

Rank	Device	Number of Vectors	Octal Modulus
1	DC11	2	10
1	TU58	2	10
2	KL11 <sup>1</sup>	2	10
2	DL11-A <sup>1</sup>	2	10
2	DL11-B <sup>1</sup>	2	10
2	DLV11-J <sup>1</sup>	8	40
2	DLV11,DLV11-F <sup>1</sup>	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
30	VMV21	2	10
31	VMV31	2	10
32	VTV01	2	10
33	DWR70	2	10
34	RL11/RLV11 <sup>2</sup>	1	4
35	TS11 <sup>2</sup> , TU80 <sup>2</sup>	1	4

(continued on next page)

Table A-2. Priority Ranking for Floating Vector Addresses (starting at 300<sub>8</sub> and proceeding upwards) (continued)

Rank	Device	Number of Vectors	Octal Modulus
36	LPA11-K	2	10
37	IP11/IP300 <sup>2</sup>	1	4
38	KW11-C	2	10
39	RX11 <sup>2</sup>	1	4
39	RX211 <sup>2</sup>	1	4
39	RXV11 <sup>2</sup>	1	4
39	RXV21 <sup>2</sup>	1	4
40	DR11-W	1	4
41	DR11-B <sup>2</sup>	1	4
42	DMP11	2	10
43	DPV11	2	10
44	ML11 <sup>3</sup>	1	4
45	ISB11	2	10
46	DMV11	2	10
47	DEUNA <sup>2</sup>	1	4
48	UDA50 <sup>2</sup>	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

<sup>1</sup> A KL11 or DL11 used as a console, has a fixed vector.

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

<sup>3</sup> 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

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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	760500

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 (QD01/D)	772150 <sup>1</sup>
-->	UDA50 (QD01/D)	760354
		Gap 760360
	DMF32	Gap 760400
	KMS11	Gap 760420
	VS100	Gap 760440
	TU81	Gap 761450
	KMV11	Gap 761460
-->	DHV11	761500
-->	DHV11	761520
		Gap 761530
	DMZ32	Gap 761540
	CP132	Gap 761600

<sup>1</sup>Fixed address

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## Appendix B PROM Removal and Replacement

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### B.1 Overview

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This appendix provides instructions for replacing the QD01/D's firmware PROM.

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### B.2 Exchanging PROMs

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The QD01/D firmware PROM is located in the socket at U43. Pry the existing PROM from its socket using an IC puller or an equivalent tool.

The QD01/D PROM is identified by the part numbers on top of the PROMs. Place the QD01/D PROM in socket U43. 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
A62	U43

#### NOTE

Firmware Revision Level H and above requires that jumpers D-E be set IN. See Table 4-2 for QD01/D Jumper Definitions and Factory Configuration.

---

**C.1 Overview**

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This appendix contains the configuration parameters for common ST-506 disk drives, presented in Table C-1. Refer to the drive manufacturer's manual for specific instructions on setting the drive for the required options.

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**C.2 Parameter Values**

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The drive configuration parameters listed in this table are for use with the NOVRAM loading, editing, and displaying options of QD01/D'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 QD01/D. 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 for QD01

PARAMETER	DRIVE NAME									
	ATASI 3046	FUJITSU M2243AS	FUJITSU M2242	MAXTOR XT1140	MICROPOLIS 13250	RODIME 204E	QUANTUM 540	SEAGATE <del>4096</del> 4096	MINSERVE 3085	
Type Code	1	1	1	1	1	1	1			
Number of Units of this Type	1	1	1	1	1	1	1			
Starting Head Offset	-	-	-	-	-	-	-			
Number of Sectors per Track	17	17	17	17	17	17	17			
Number of Heads	7	11	7	15	8	8	8	9	7	
Number of Cylinders	645	754	754	918	1024	640	512	1024	1169	
Number of Spare Sectors per Track	1	1	1	1	1	1	1	1		
Number of Alternate Cylinders	4	4	4	4	4	4	4	4		
Hard/Soft Sector Flag	0	0	0	0	0	0	0	0		
Split Code	0	0	0	0	0	0	0	0		
Removable Media Flag	0	0	0	0	0	0	0	0		
Reduced Write Current Cylinder	320	754	754	918	1024	640	512	0		
Write Precompensation Cylinder	320	754	754	918	1024	0	256	0		
Step Pulse Code	1	1	1	1	1	1	1	1		