QD35
Disk Controller
Installation and User Manual

QD3550901-00, Rev F
July 1991

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Effective: October 15, 1990

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Section 1
OVERVIEW

1.1 Introduction

The QD35 Disk Controller is an MSCP-compatible controller that interfaces SMD and SMD-E disk drives with DEC's Q-Bus. This manual is designed to help you install and use your QD35 Disk Controller. It assumes that you have some knowledge of hardware configuration, MicroVAX, Q-Bus architecture, and terminology, and interpretations of error messages and device register contents. The contents of the nine sections and two appendices are described below:

- **Section 1 (Overview):** Provides an overview of the models, features, and hardware and software compatibility of the QD35 Disk Controller.
- **Section 2 (Controller Specifications):** Lists the QD35 Disk Controller general, environmental, electrical, and physical specifications.
- **Section 3 (Installation):** Presents the information for physical installation of the controller, including switch and jumper settings and cabling. A Firmware Resident Utilities (FRU) software overview is also provided.
- **Section 4 (Firmware-Resident Utility Software):** Describes the Firmware Resident Utility (FRU) software provided for the QD35. The FRU includes a disk drive and controller options configuration utility for loading configuration parameters into the NOVRAM; the format/verify/replace bad blocks utility; and controller and disk drive diagnostics.
- **Section 5 (Performance Monitor Software):** Describes the Performance Monitor software provided with the QD35. This software provides statistics on the frequency with which the cache memory onboard the QD35 is accessed, allowing you to adjust the cache memory configuration for maximum efficiency.
- **Section 6 (Troubleshooting):** Describes fault isolation procedures that can be used to pinpoint trouble spots.
- **Section 7 (Device Registers and Programming):** Describes the QD35's Q-Bus registers and presents an overview of the Mass Storage Control Protocol (MSCP).
- **Section 8 (QD35 Disk Controller Architecture):** Describes the QD35 Disk Controller Architecture.
- **Section 9 (Interfaces):** Describes the QD35's Q-Bus and SMD interfaces.
- **Appendix A (PROM Removal and Replacement):** Contains instructions for removing and replacing the firmware so that the user can upgrade the QD35 Disk Controller in the field.
- **Appendix B (Disk Drive Configuration):** Contains configuration parameters for supported SMD disk drives.

1.2 Subsystem Overview

The QD35 Disk Controller connects high-capacity, mass storage peripherals to the Q-Bus in MicroVAX computers manufactured by Digital Equipment Corporation (DEC). The QD35 implements DEC's Mass Storage Control Protocol (MSCP) to provide a software-transparent interface for the host MicroVAX computer. To provide traditional Emulex flexibility in peripheral selection, the QD35 uses the industry standard SMD-E interface as its peripheral interface.

1.2.1 Mass Storage Control Protocol (MSCP)

MSCP is a software interface designed to lower the host computer's mass storage overhead by offloading much of the work associated with file management onto an intelligent, mass-storage subsystem. Together with SMD-compatible peripherals, the QD35 provides just such a subsystem. The QD35 relieves the host CPU of many file maintenance tasks. The QD35 Disk Controller performs these MSCP functions: error checking and correction, bad block replacement, seek optimization, command prioritizing and ordering, and data mapping.

Data mapping 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 detailed knowledge of the peripheral's geometry (cylinders, tracks, sectors, for example). 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.

1.3 Physical Organization Overview

The QD35 Disk Controller is a modular, microprocessor-based disk controller that connects directly to the MicroVAX Q-Bus backplane. The microprocessor architecture ensures excellent reliability and compactness.

The QD35 is contained on a quad-wide printed circuit board assembly (PCBA) and attached daughterboard and front panel. The QD35 plugs directly into a MicroVAX or LSI-11 system backplane slot.

The QD35 supports up to four physical or sixteen logical disk drives. Aggregate data storage capacities are limited only by the capacities of the peripherals. Figure 1–1 shows one possible MicroVAX II and one MicroVAX III SMD subsystem configuration. The MicroVAX III subsystem includes a QD35-III Disk Controller and a distribution panel. In a MicroVAX II or LSI-11 system, the QD35 Disk Controller is cabled directly to the SMD disk drives.

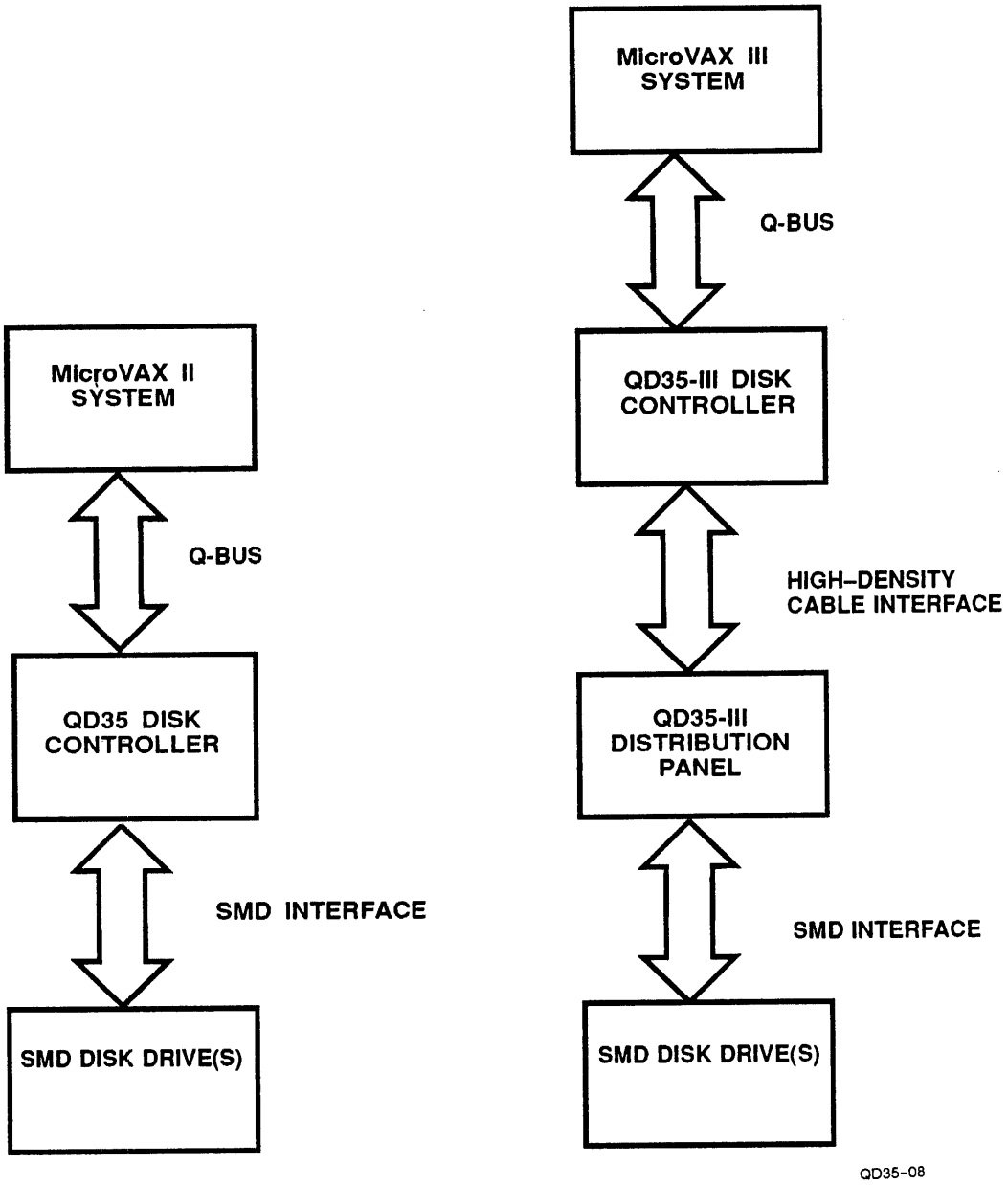


Figure 1–1. QD35 and QD35-III Subsystem Configurations

1.4 QD35 Subsystem Models and Options

The QD35 models described in this manual consist of a disk controller, cabling, and other necessary peripheral accessories for installing the disk controller in a MicroVAX or LSI-11 system. With a maximum of four SMD or SMD-E disk drives, the QD35 models provide a DEC MSCP-compatible mass storage subsystem.

Three types of QD35 Disk Controller are provided: the QD35 designed for compatibility with MicroVAX II and LSI-11 systems; the QD35-III designed for compatibility with MicroVAX 3300/3400, 3500/3600, and 3800/3900 (hereafter referred to as MicroVAX III) systems; and the QD35F-III, a subvariant of the QD35-III. It combines the QD35-III Disk Controller with a special distribution panel designed for use with round-shielded SMD cables that provide extra shielding against radiated interference. The basic QD35-III distribution panel is used with unshielded flat ribbon cables.

Figure 1–2 shows the QD35 and QD35-III Disk Controllers.

The following subsections describe the QD35 and QD35-III Disk Controllers. Standard components for each model are shown in Tables 1–1, 1–2, and 1–3. Table 1–4 describes cables and panels available for the various QD35 models.

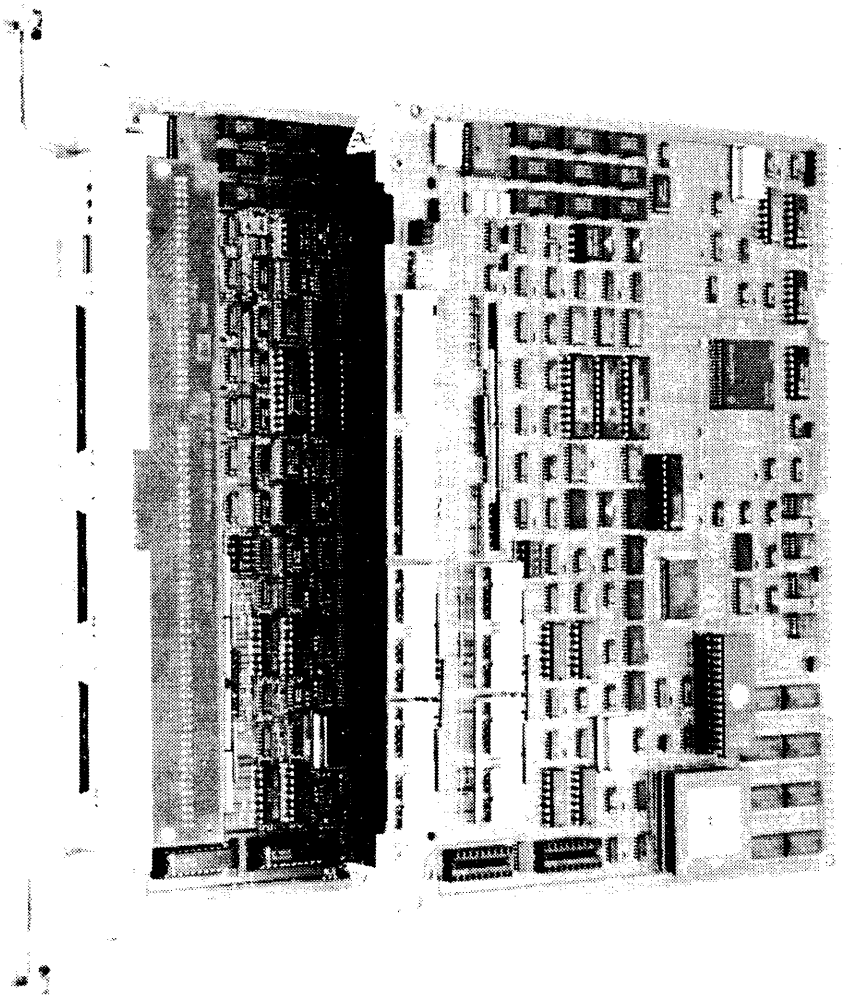


Figure 1–2. QD35 and QD35-III Disk Controllers

1.4.1 QD35

The QD35 consists of a single quad-wide, printed-circuit board module. The QD35 provides five 3M connectors located on the front panel of the board. These connectors interface the disk controller to the attached disk drives with SMD A and B cables. The QD35 is designed for use in MicroVAX II systems that do not require the use of FCC-compliant front handles. Gap-filler panels and cable clamps are provided with the controller, as listed in Table 1–1. Round-shielded SMD A and B cables of different lengths can be ordered, as listed in Table 1–4.

1.4.2 QD35-III and QD35F-III

The QD35-III Disk Controller uses the same quad-wide printed circuit board as the QD35. In place of the 3M drive connectors, the QD35-III uses a daughterboard mounted on top of the main board. The daughterboard contains one 68-pin and two 50-pin, high-density connectors to interface from the controller to a distribution panel. SMD A and B cables then connect from the distribution panel to the disk drives. In addition, both models of the QD35-III are equipped with a special handle designed to maintain FCC compliance for a MicroVAX III system cabinet with a QD35-III installed.

The QD35-III consists of the controller board, a drive cable distribution panel, and gap filler panels, as listed in Table 1–2. The distribution panel supplied with the QD35-III uses flat cables to connect the distribution panel to individual drives. These unshielded cables are generally used only with older disk drives that have a transfer rate of 2.5M bytes/second or less. Table 1–4 lists the descriptions and part numbers of unshielded cables available from Emulex.

The QD35F-III is the same as the QD35-III, except that the distribution panel is specially designed for use with round-shielded cables between the distribution panel and the individual drives. Table 1–3 describes the QD35F-III package.

Emulex recommends the use of shielded cables for all installations, particularly when disk drives are in use that have transfer rates of 3M bytes/second or faster. Table 1–4 lists the descriptions and part numbers for shielded cables available from Emulex.

MicroVAX cables from the controller to the distribution panel, and SMD A and B cables from the distribution panel to the disk drives are available in several different lengths, as listed in Table 1–4. They are ordered as optional accessories. Flat cables for the QD35 and round-shielded cables for the QD35F-III are listed, as well as the rack-mount panel that holds the distribution panel in many subsystem configurations.

NOTE: This manual documents the QD35, QD35-III, and the QD35F-III Disk Controller models. Unless otherwise noted, the references to the QD35 Disk Controller apply to all three controller models.

Table 1–1. QD35 Standard Components

Item	Quantity	Description	Part Number
1	1	QD35 Disk Controller	QD3510206-04
2	1	QD35 Installation and User Guide	QD3550901-00

Table 1–2. QD35-III Standard Components

Item	Quantity	Description	Part Number
1	1	QD35-III Disk Controller	QD3510206-02
2	2	Gap-filler Panels	QT1420102-00
3	1	QD35 Distribution Panel (Panel for flat SMD cables)	QD3510208-02
4	1	QD35 Installation and User Guide	QD3550901-00

Table 1–3. QD35F-Standard Components

Item	Quantity	Description	Part Number
1	1	QD35F-III Disk Controller	QD3510206-02
2	2	Gap-filler Panels	QT1420102-00
3	1	QD35F-III Distribution Panel (panel for shielded SMD cables)	QD3510208-01
4	1	QD35 Installation and User Guide	QD3550901-00

Table 1–4. Cables and Panels

Applies to QD35 Model	Kit/Part Number	Description	Length (Feet)	Qty. Rqd.	Function
All	QT1311201-00	Serial cable to connect an ASCII terminal to an onboard serial port	NA	1	Serial port
QD35[1]	QD3313002-02	Cable clamp and filler panels	NA	1	NA
QD35[1]	PE1111202-01 PE1111202-02 PE1111201-01 PE1111201-02	60-conductor cable, round-shielded 60-conductor cable, round-shielded 26-conductor cable, round-shielded 26-conductor cable, round-shielded	15 25 15 25	1-4 1-4 1-4 1-4	SMD-A SMD-A SMD-B SMD-B
QD35-III & QD35F-III	CU2213002-00	Rack-mount panel	NA	1	NA
QD35-III & QD35F-III	CKQD342-15	High-density cable kit: two-drive support (one 68-pin connector and one 50-pin connector cable).	15	1	µVAX III Interface
QD35-III & QD35F-III	CKQD344-15	High-density cable kit: four-drive support (one 68-pin connector and two 50-pin connector cable).	15	1	µVAX III Interface
QD35-III & QD35F-III	CKQD342-25	High-density cable kit: two-drive support (one 68-pin connector and one 50-pin connector cable).	25	1	µVAX III Interface
QD35-III & QD35F-III	CKQD344-25	High-density cable kit: four-drive support (one 68-pin connector and two 50-pin connector cable).	25	1	µVAX III Interface
QD35-III	SU1111201 SU1111203 SU1111205 SU1111207 SU1111209	60-conductor cable, unshielded 60-conductor cable, unshielded 60-conductor cable, unshielded 60-conductor cable, unshielded 60-conductor cable, unshielded	8 15 25 35 50	1	SMD A SMD A SMD A SMD A SMD A
QD35-III	SU1111202 SU1111204 SU1111206 SU1111208	26-conductor cable, unshielded 26-conductor cable, unshielded 26-conductor cable, unshielded 26-conductor cable, unshielded	8 15 25 35	1-4 1-4 1-4 1-4	SMD B SMD B SMD B SMD B
QD35F-III	SM8011216-01 SM8011216-02	60-conductor cable, unshielded 60-conductor cable, unshielded	3 5	1 1	SMD A SMD A
QD35F-III	SM8011215-01 SM8011215-02	26-conductor cable, unshielded 26-conductor cable, unshielded	3 5	1-4 1-4	SMD B SMD B

[1]QD35 In this table refers to the QD35 disk controller only, for use with MicroVAX-II and LSI-11 systems only.
NOTE: SMD 850 drives require that these round-shielded cables be used inside the drive rack-mount cabinet.

1.5 QD35 Features

Descriptions follow for several of the features that enhance the performance and ease of use of the QD35 Disk Controller.

1.5.1 Microprocessor Design

The QD35 design incorporates a Motorola 68020 microprocessor to perform all controller functions. The microprocessor approach provides a reduced component count, high reliability, easy maintainability, and the microprogramming flexibility that allows MSCP to be implemented without expensive, dedicated hardware.

1.5.2 Onboard Cache Memory

One megabyte of cache memory onboard the QD35 allows for a substantial performance improvement. Frequently-accessed program or data blocks are stored in the cache memory, which has a much faster access time than regular disk storage.

A linked list data structure automatically monitors the use of the blocks of data in the cache memory, leaving the least frequently accessed blocks stored in cache memory as the first blocks to be replaced during disk transfers.

A menu driven configuration utility allows you to select operating parameters for the cache memory. These parameters include the number of blocks that can be transferred to cache memory at one time and which areas of the attached disk drives' memory may be accessed for the cache memory.

A firmware-resident monitor program allows you to monitor the frequency of access to the program modules and data blocks stored in the QD35 cache memory. This allows you to evaluate the disk caching parameters you have set, and to maximize the performance of the QD35.

1.5.3 Firmware-Resident Utility (FRU) Program

The QD35 Disk Controller firmware provides an enhanced, menu-driven configuration utility that handles most of your subsystem configuration requirements, including the following functions:

- Configuring controller options.
- Configuring disk drive parameters for the four disk drives attached to the QD35.
- Formatting and verifying disk drives, and replacing bad blocks on the disk drives.
- Setting parameters for disk caching as part of the disk drive and controller configuration options.

1.5.4 Firmware-Resident Monitor Program

The Firmware-Resident Performance Monitor allows you to oversee the performance of the disk-caching function, in order to maximize the throughput of the QD35. Section 5 of this manual describes the Performance Monitor software in detail.

1.5.5 Firmware-Resident Diagnostic Software

The QD35 Disk Controller firmware incorporates a self-contained set of diagnostic utilities. These utilities allow the user to communicate directly with the QD35 using a firmware resident terminal driver that is compatible with hardcopy devices connected to a MicroVAX console port. These firmware-resident utilities provide several important disk preparation functions, including the ability to:

- Test the disk surface and replace defective blocks.
- Perform reliability testing of the attached disk subsystem.

1.5.6 Self-Test

The QD35 incorporates an internal self-test routine that exercises all parts of the microprocessor, the on-board memory, the buffer controller, and the Host Adapter Controller (HAC). Although this test does not completely test all circuitry, successful execution indicates a very high probability that the disk controller is operational. If the QD35 fails the self-test, it leaves three light-emitting diodes (LEDs) ON and sets an error bit in the Status and Address (SA) register (base address plus two).

1.5.7 Error Control

The QD35, in conjunction with the operating system software, presents error-free media to the host. The disk controller corrects soft errors, performs retry operations, and allows the operating system to dynamically replace blocks with correctable errors before they become uncorrectable. Error checking is implemented with a 48-bit Error Correction and Checking (ECC) algorithm.

1.5.8 Host-Inititated Bad Block Replacement

The QD35 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 QD35 reports even corrected single-bit errors as candidates for replacement.

1.5.9 Media Defect List Management

The firmware resident diagnostics allow the user to enter bad blocks found in the manufacturer's defect list manually, in either bytes from index format or logical block number format.

1.5.10 Seek Optimization

The QD35 is able to pool the various seeks that need to be performed and to 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.

The method of optimization is user-selectable from the firmware-resident configuration utility. You may select one out of four possible seek optimization methods: None, Sawtooth, Elevator, or Nearest.

1.5.11 Command Buffer

The QD35 contains a buffer that is able to store up to 32 MSCP commands. This large buffer allows the subsystem to achieve a higher throughput and to operate at a very efficient level. You may use the FRU utility, as described in subsection 4.6.6 to program the size of the buffer.

1.5.12 Adaptive DMA

During each DMA data transfer burst, the QD35 monitors the Q-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, and you may program the QD35 NOVRAM to monitor DMA requests from as often as every word to as long as every eight words.

In addition, the QD35 firmware design includes a selectable DMA burst delay to avoid data late conditions on other slower devices that may reside on a given system.

Because of these adaptive DMA techniques, the QD35 ensures that CPU functions, including interrupt servicing, are not locked out for excessive periods of time by high-speed disk transfers.

1.5.13 Block-Mode DMA

The QD35 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 addressing.

1.5.14 Twenty-Two Bit Addressing

The QD35 supports the 22-bit addressing capability of the extended Q-Bus.

1.5.15 Rotational Position Sensing (RPS)

This feature increases the performance of the disk subsystem during data transfer when two drives are active. RPS allows the controller to determine which drive is rotationally closest to any of the data transfers in the controller command buffer. By matching a data transfer with the drive rotationally closest to that command, the rotational latency is reduced, causing an increase in the subsystem's throughput.

RPS is a programmable NOVRAM function. The performance gain is achieved only when two drives are used simultaneously. Single drive subsystems should have RPS disabled.

1.5.16 Zero Latency Read

The QD35 attempts to reduce the rotational latency for the current command by fragmenting the data transfer. Requested sectors that are immediately accessible from the disk are transferred first, instead of waiting for the first sector of the request to come under the head.

1.5.17 Sector Read-Ahead Feature

The QD35 attempts to read additional unrequested sectors from disk into cache memory while waiting for the requested sectors to be transferred to host memory. Very often these additional sectors read are requested in the next read command, and can be quickly transferred from cache memory. User definable NOVRAM parameters on the FRU Controller Options Menu allow the user to define the minimum and maximum sector read-ahead count for each command.

1.5.18 Dual Port Support

The QD35 supports single, static, and dynamic dual porting with Revision K and above firmware.

1.6 Compatibility

The following subsections describe the diagnostics, operating system, and hardware compatibility of the QD35.

1.6.1 Diagnostics

The QD35 self-test and embedded diagnostic firmware are all that is required to test the subsystem's integrity. Currently, DEC diagnostics are not supported.

1.6.2 Operating Systems

The QD35 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 and above
VMS	5.0 and above
Ultrix-32m	2.2 and above
RSTS/E	8.0 and above
RSX-11M	4.1 and above
RSX-11M PLUS	2.1 and above
RT-11	5.1 and above
Ultrix-11	3.0 and above

1.6.3 Hardware

The QD35 Disk Controller complies with DEC Q-Bus protocol, and it directly supports 22-bit addressing and block mode DMA. The disk drives supported by the QD35 are not media-compatible with comparable DEC MSCP products.

The QD35 Disk Controller supports hard sectored disk drives that use the SMD interface. The QD35 also supports the extended cylinder addressing functions of the SMD-E interface (subsection 9.3). The QD35 supports disk transfer rates of up to 3.0M bytes per second.

1.6.4 Supported Disk Drives

In general, any disk drives that utilize an SMD or SMD-E interface that complies with the CDC SMD or SMD-E specification should function properly with the QD35. Appendix B lists disk drive configuration parameters for 28 SMD disk drives qualified for use with the QD35 Disk Controller.

Section 2
CONTROLLER SPECIFICATIONS

2.1 Overview

This section includes the following specifications:

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

2.2 General Specifications

Table 2–1 contains the general specifications for the QD35 Disk Controller.

Table 2–1. QD35 General Specifications

Parameter	Description
Function	Provides mass data storage interface to Digital Equipment Corporation (DEC) MicroVAX and LSI-11 computers
Logical CPU Interface	Emulates DEC's Mass Storage Control Protocol (MSCP)
Diagnostics	Embedded diagnostics
Operating Systems Supported	Micro/VMS 4.0 and above VMS 5.0 and above Ultrix–32m 2.2 and above RSTS/E 8.0 and above RSX–11M 4.1 and above RSX–11M PLUS 2.1 and above RT–11 5.1 and above Ultrix–11 3.0 and above
CPU I/O Technique	DMA, including adaptive techniques and block mode
Interface	
CPU Interface	Extended Q–Bus Interface
Available Q–Bus Device Address	17772150_8 17760364_8 17772154_8 17760370_8 17760334_8 17760374_8 17760340_8 17760400_8 17760344_8 17760404_8 17760350_8 17760410_8 17760354_8 17760414_8 17760360_8 17760420_8
Vector Address	Host Programmable
Priority Level	BR4 of BR5 (jumper-selectable)
Bus Loading	1 DC Load, 2.5 AC Loads
Peripheral Interface	SMD–E (Extended) up to 24 MHz; SMD–0
Disk Transfer Rate	Up to 3.0M bytes per second
Number of Physical Drives Supported	4 drives
Drive Sectoring	Hard-Sectored
Maximum Cable Lengths	
A Cable (Daisy-chain)	100 ft (30 m) cumulative
B Cable (radial)	50 ft (15 m) per drive
Firmware Diagnostic Host Console	
MicroVAX	Processor-resident console port

2.3 Environmental Specifications

Table 2–2 contains the environmental specifications for the QD35 Disk Controller.

Table 2–2. QD35 Environmental Specifications

Parameter	Description
Operating Temperature	0 to 45 degrees C, where maximum temperature is reduced 1.8 degrees C per 1000 meters (1 degree F per 1000 feet) altitude
Storage Temperature	-40 to 66 degrees C
Relative Humidity	10 percent to 95 percent, noncondensing
Cooling	6 cubic feet per minute
Heat Dissipation	110 BTU per hour

2.4 Electrical Specifications

Table 2–3 contains the electrical specifications for the QD35 Disk Controller.

Table 2–3. QD35 Electrical Specifications

Parameter	Description
Power	+5 VDC $\pm$ 5 percent, 6.3 amperes (A)

2.5 Physical Specifications

Table 2–4 contains the physical specifications for the QD35 Disk Controller.

Table 2–4. QD35 Physical Specifications

Parameter	Description
Packaging	
QD35	Quad-sized Q-Bus compatible PCBA, form-factor designed for the uVAX II
QD35-III	Quad-sized Q-Bus PCBA with attached daughterboard and front panel; form-factor designed for the uVAX III
Shipping Weight	4 pounds
Connectors	
Q-Bus	Standard DEC PCBA edge connectors
Peripheral Interface: QD35	One 60-pin, four 26-pin 3M-style flat cable connectors
Peripheral Interface: QD35-III	One 68-pin, two 50-pin high-density connectors
Serial Terminal	One 3-pin connector

Section 3
INSTALLATION

3.1 Overview

This section describes the procedures for installing the QD35 Disk Controller, distribution panel, and cabling in your host system. The subsections in this chapter are as follows:

Subsection	Title
3.1	Overview
3.2	Inspection
3.3	QD35 Configuration Reference Sheet
3.4	QD35 Switch Settings
3.5	QD35 Jumper Settings
3.6	SMD Disk Drive Preparation
3.7	Installing the QD35-III in the MicroVAX III
3.8	Installing the QD35 in the MicroVAX II
3.9	Grounding
3.10	Firmware-Resident Utilities (FRU) Overview
3.11	Operation

This section describes the basic steps for installing the QD35 hardware. Installation and cabling for the QD35-III Disk Controller in a MicroVAX III system and for the QD35 Disk Controller in a MicroVAX II (or LSI-11) system are discussed in separate subsystems. You may, however, refer to other sections of this manual and your SMD disk drive manual for additional information.

Loading disk drive configuration parameters into the NOVRAM is accomplished with the Firmware Resident Utility (FRU) program, as described in Section 4. For the SMD disk drive preparation, refer to Appendix B for suggested disk drive configuration parameters and to your disk drive manual for switch setting information. The Installation Checklist outlines the entire installation process.

INSTALLATION CHECKLIST

- ☐ 1. Inspect the QD35 Disk Controller (subsection 3.2).
- ☐ 2. Fill out the Configuration Reference Sheet (subsection 3.3). This summarizes the configuration information for your QD35 subsystem, including the types of SMD disk drives you plan to install and the QD35 switch and jumper settings. You may wish to fill this out as you read through subsections 3.4 and 3.5, which explain the switch and jumper settings.
- ☐ 3. Set up the switches on the QD35 module (subsection 3.4).
- ☐ 4. Set the jumpers on the QD35 module (subsection 3.5).
- ☐ 5. Prepare the SMD disk drives for installation with the QD35 (subsection 3.6).
- ☐ 6. For MicroVAX-III systems only: Install the QD35-III Disk Controller and cabling in the MicroVAX III system (subsection 3.7).
- ☐ 7. For MicroVAX II and LSI-11 systems only: Install the QD35 Disk Controller and cabling in the MicroVAX II or LSI-11 system (subsection 3.8).
- ☐ 8. Ensure that the grounding is installed properly for your disk controller and controller drives (subsection 3.9).
- ☐ 9. Run the Firmware-Resident Utilities (FRU) and diagnostic tests. Subsection 3.10 provides an overview of the FRU. Section 4 describes the FRU in detail, including descriptions of all configuration parameters.
- ☐ 10. Reset any diagnostic switches, and bring the system online.

If you are not familiar with the subsystem installation procedure, Emulex recommends reading this entire section before beginning. The QD35 is software-transparent to DEC MSCP drivers. Refer to your DEC software documentation for information on the sysgen utility and other procedures for determining the proper Q-Bus address for the QD35 Disk Controller.

3.1.1 Maintaining FCC Class A Compliance (QD35-III)

Emulex has tested the QD35 Intelligent Disk Controller with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the QD35 does not cause compliant computers to exceed Class A limits.

The QD35 Disk Controller subsystem has only one basic hardware configuration. The QD35 PCBA is installed in the host system cabinet, and the distribution panel and disk drives are mounted in a separate rack-mount cabinet. The QD35F-III model distribution panel for the MicroVAX III host system uses a bracket to support the round-shielded cables necessary for the faster, 3.0M byte per second drives.

Conducted interference is generally prevented by installing a filter in the AC line between the computer and the AC outlet. Most currently manufactured power distribution panels contain suitable filters.

Subsection 3.8.4.1 provides additional FCC compliance information that is specific to the QD35.

3.2 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 QD35 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 describes the contents that should be included for each model of the QD35. 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.

3.2.1 QD35 Disk Controller Inspection

Visually inspect the QD35 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.

CAUTION! Be sure to take static-handling precautions when handling the QD35 Disk Controller. Static electricity may damage some of the components on the QD35 Disk Controller if precautions are not taken.

3.3 QD35 Configuration Reference Sheet

This section is limited to switch and jumper setting data and hardware installation instructions. No attempt is made to describe the many subsystem configurations that are possible. When you are installing the subsystem, you should make a record of the subsystem configuration you have chosen and the environment where the QD35 will be located.

Figure 3–1 is a Configuration Reference Sheet that lists the information required and shows where the data can be found. This information will be helpful to an Emulex service representative if your subsystem requires service.

QD35 CONFIGURATION REFERENCE SHEET

GENERAL INFORMATION

- Host computer type _____
- Host computer operating system _____
  Version _____
- Other MSCP Controllers; Type _____ , Q-bus address _____

NOVRAM/DRIVE CONFIGURATION PARAMETERS

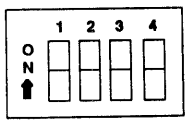
- Drive Manufacturer (0) _____ Model _____
- Drive Manufacturer (1) _____ Model _____
- Drive Manufacturer (2) _____ Model _____
- Drive Manufacturer (3) _____ Model _____

	DRIVE 0	DRIVE 1	DRIVE 2	DRIVE 3
Physical Sectors/Track				
Physical Heads				
Physical Cylinders				
Spare Sectors Per Track				
Spare Cylinders				
Head Select Negates On Cylinder				
Lower Limit (RPS)				
Upper Limit (RPS)				
Removable Media				
Gap 0				
Gap 1				
Gap 2				
Spiral Offset				
Bytes/Sector				

See Appendix B for suggested parameters.

QD35 CONFIGURATION

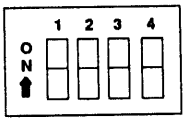
- Firmware revision number _____
- Top Assembly number _____
- Q-bus address _____
- Switch settings (□ = OFF ■ = ON)
- Warranty expiration date _____
- Serial number _____
- Interrupt vector address _____



SW2

"OFF"

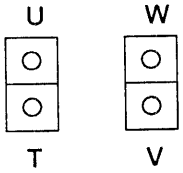
"ON"

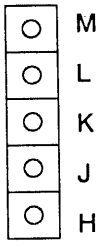


SW1

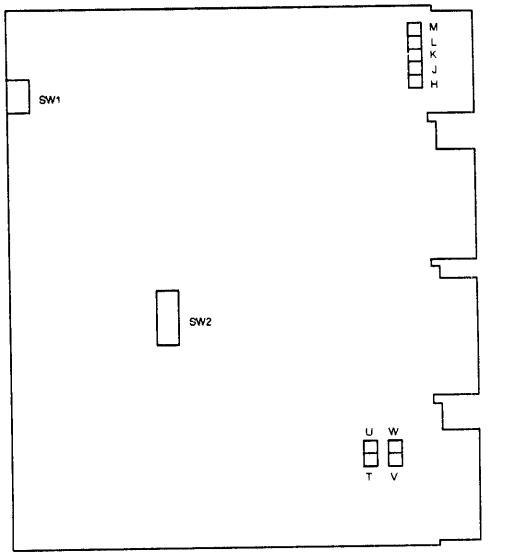
See subsection 3.4 for switch setting information.

- Jumper settings (○○ = OUT ●● = IN)





See subsection 3.5 for jumper setting information.



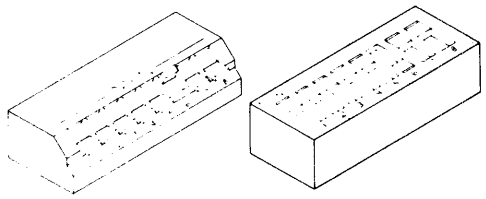
QD35-01

Figure 3–1. QD35 Configuration Reference Sheet

3.4 QD35 Switch Settings

Several configuration setups must be made on the QD35 Disk Controller before inserting it into the chassis. These setups are made by option switches SW1 and SW2. There are also several jumper blocks on the QD35 that should be configured correctly for your system configuration, as described in subsection 3.5. Many additional configuration choices are selected from the Firmware Resident Utility (FRU) program, as described in Section 4 of this manual.

The two DIP switch types used in this product are shown in Figure 3–2. 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

QD35-2147

Figure 3–2. Switch Setting Example

Figure 3–3 shows the QD35-III PCBA layout, including the locations of the configuration switches referenced in the following paragraphs. Figure 3–4 shows the QD35 PCBA layout. The locations of components for the two boards are similar, except for the front panel. The cable and serial port connectors are different, since the QD35-III interfaces to a multiplexing distribution panel, while the QD35 connectors are cabled directly to the SMD disk drives and the serial port.

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.

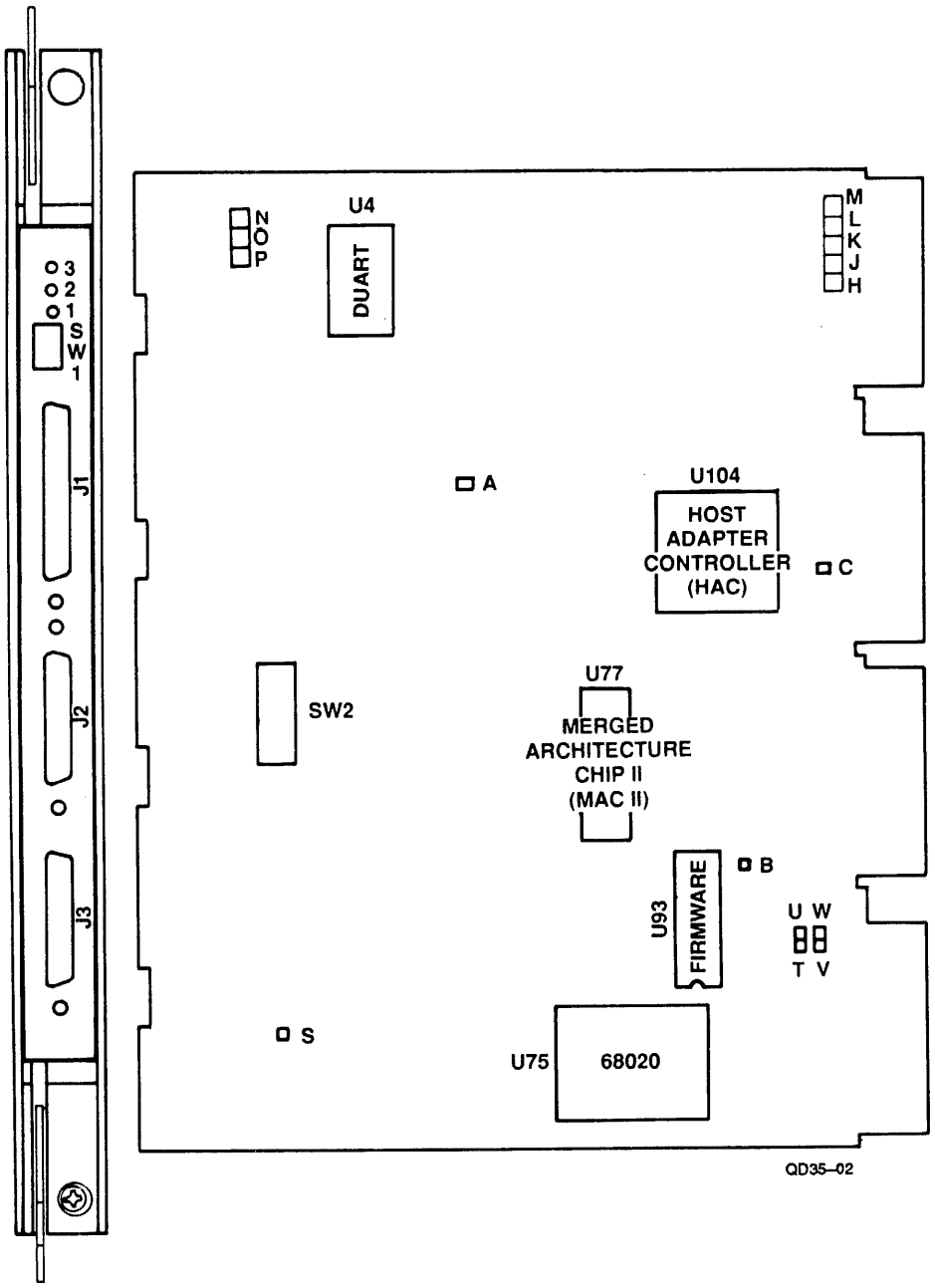


Figure 3–3. QD35-III Disk Controller Assembly

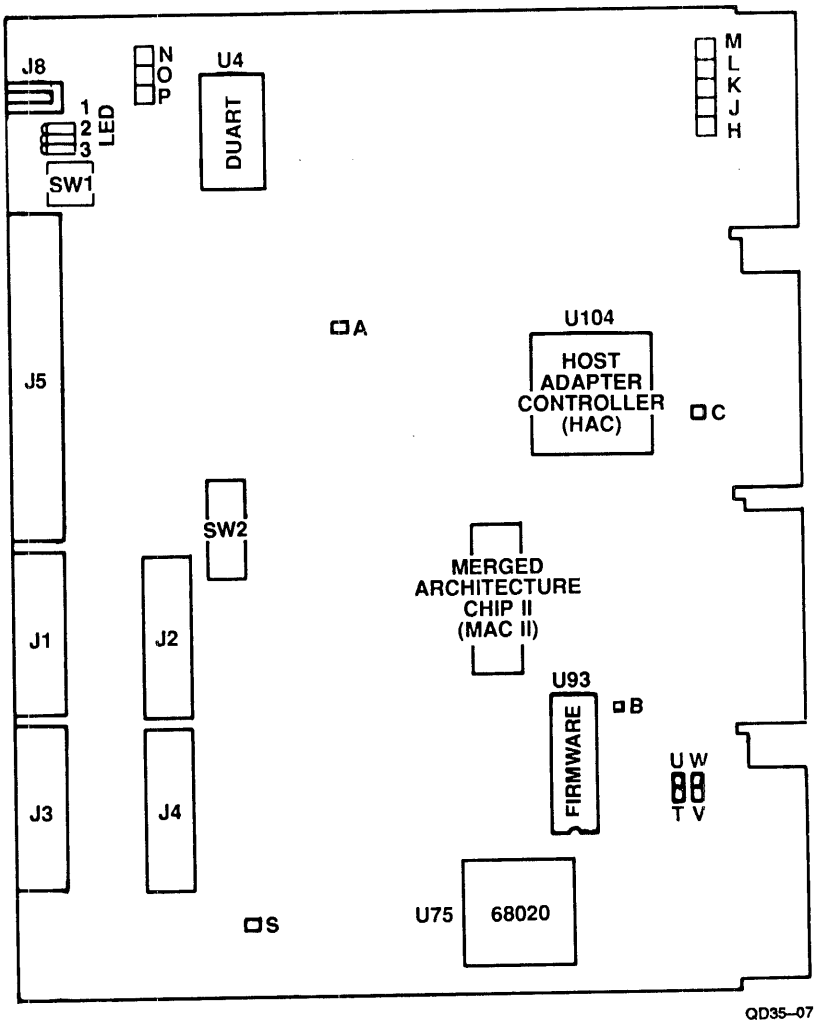


Figure 3–4. QD35 Disk Controller Assembly

Table 3–1 defines the function and factory configuration of Dual Inline Package (DIP) switches SW1 and SW2 on the QD35 controller. SW1 is a four-position piano switch. It is located on the front panel of both the QD35 and the QD35-III, directly below the LED indicators. Because it is on the front panel, SW1 can be reconfigured without removing the PCBA from the system.

SW2 is one of the components on the controller board. Once the board has been installed, changing the SW2 settings requires removing the controller from the system cabinet.

Table 3–1. QD35 Switch Definitions and Factory Configuration

Switch	Function	Factory Setting: OFF (0)	Alternate Setting: ON (1)	Section
SW1-1	Run or Reset/Halt	Run	Reset/Halt	3.4.1
SW1-2	FRU disable/enable	FRU disabled	FRU enabled	3.4.2
SW1-3	FRU console select	Host console	Onboard serial port	3.4.3
SW1-4	Loop on self-test error disable/enable	Loop on error disabled	Loop on error enabled	3.4.4
SW2-1	Host system type	MicroVAX	LSI-11	3.4.5
SW2-2	Not Used	N/A	N/A	N/A
SW2-3	LSI-11 Autoboot disable/enable	Autoboot disabled	Autoboot enabled	3.4.6
SW2-4	Sector pulse source A cable or B cable	B cable	A cable	3.4.7

3.4.1 Run or Reset/Halt (SW1-1)

Switch SW1-1 is a toggle switch that allows you to reset and halt the operation of the QD35. The default setting is in the OFF (0) position. To reset the controller, toggle the switch from OFF to ON (1) and back. Leave the switch in the ON (1) position only if you wish to halt the QD35 operation. Some examples of situations where you might want to reset and/or halt the QD35 follow:

- If you change any of the other switch settings on the QD35 or if you change some of the NOVRAM configuration values using the Firmware Resident Utility program, you must reset the QD35 so that the host operating system's initialization sequence reads the new codes established by either the switch settings or the NOVRAM or both.

  To reset the QD35, either toggle switch SW1-1 (ON then OFF), or power-down and power-up the host system.

- If you receive a hardware error code during diagnostic testing of the QD35, reset the controller in order to rerun this section of the diagnostic test. (See Troubleshooting, Section 6, for further information.)

CAUTION! If you toggle switch SW1-1, be sure that the operating system is not running. Resetting the controller with the operating system running is likely to cause a system crash.

3.4.2 Firmware Resident Utilities (FRU) Disable/Enable (SW1-2)

This switch enables or disables the Firmware Resident Utilities (FRU). The default setting is disabled (OFF), since the utilities are generally used only once when the QD35 is initially being configured.

This switch must be set to ON before the initial system console FRU startup and the serial port FRU startup for MicroVAX and LSI-11 systems, as described in subsection 4.2. After exiting the FRU program, the SW1-2 switch must be set to OFF before the system is brought back online.

The FRU can run from the host console while this switch is OFF only if the alternate system console startup procedure is used, once the device address for the QD35 controller has already been set. Refer to subsection 4.2.1.2 (for the MicroVAX) and to subsection 4.2.2.2 (for the LSI-11) for information on the alternate system console startup.

3.4.3 FRU Console Select (SW1-3)

This switch selects either the host system console or the QD35 serial port for running the QD35 Firmware Resident Utility (FRU) software. The default setting is OFF. This allows you to run the FRU from the host console. To use the serial port (with a terminal attached) for running the FRU, set this switch to ON.

3.4.4 Looping on Self-Test Errors Disable/Enable (SW1-4)

This switch enables looping on self-test errors. The self-test loop option detects intermittent hardware failures that have already passed through the first self-test. The LED indicators on the QD35 front panel will blink when a pass has completed. If an error occurs, the self-test loop option stops and reports an error; the LEDs on the front panel display the error code. A description of the error codes displays on the host operator console.

3.4.5 Host System Type (SW2-1)

This switch must remain OFF (the factory setting) whenever the QD35 is installed in a MicroVAX system. This switch must be set to ON for LSI-11 systems.

3.4.6 LSI-11 Autoboot Disable/Enable (SW2-3)

This switch must remain OFF (the factory setting) whenever the QD35 is installed in a MicroVAX system. Setting this switch to ON enables the Autoboot feature, which is only available in LSI-11 systems. In an LSI-11 system, enabling autoboot allows the LSI-11 to select a logical unit number (LUN) between 0 and 7 of the device to be used to autoboot the system.

3.4.7 Index and Sector Signal Source (SW2-4)

The QD35 can use index and sector signals from either the A or B cables. Switch SW2-4 selects between these two sources. Set the switch as appropriate for your disk drive(s). For multiple drive configurations, all drives must provide the signals on the same cable, either A or B.

NOTE: When there are two or more disk drives attached to the QD35, Emulex recommends configuring drives so that the sector and index signals are on the B cable; otherwise, the rotational position sensing (RPS) algorithm used by the controller can not operate, and the performance enhancement provided by this feature can not be used.

3.5 QD35 Jumper Settings

Table 3–2 shows the configuration choices provided by different jumper settings. Several of the jumpers are used for factory test only and can be ignored.

Each letter shown in the following table indicates a pin on a jumper block on the QD35. Some of the pins are used individually for factory testing (where configuration is shown as N/A). Configure the jumper by placing jumper plugs on adjacent pairs of pins.

The configuration OUT indicates that there is no jumper connecting the two pins. The configuration IN indicates that there is a jumper placed over the two pins. When several jumper pins are adjacent to each other, some of the settings are mutually exclusive. To avoid a conflict, the points are arranged so that they are also mutually exclusive.

Table 3–2. QD35 Jumper Definitions and Factory Configuration

Jumper	Function	Factory Setting	Alternate Setting	Comment
A	Test Point	N/A	N/A	Ground
B	Test Point	N/A	N/A	Ground
C	Test Point	N/A	N/A	Ground
H-J	Factory Test	OUT	IN	For factory test only
K-L	Bus Request Level	OUT-BR4	IN-BR5	Subsection 3.5.1
L-M	Bus Request Level	IN-BR4	OUT-BR5	Subsection 3.5.1
NOP	Not used	N/A	N/A	Not used
S	Scope Ground	N/A	N/A	Ground
T-U	Interrupt Acknowledge	IN	OUT	Subsection 3.5.2
V-W	DMA Grant	IN	OUT	Subsection 3.5.2

3.5.1 Interrupt Priority Level (K-L and L-M)

The QD35 is factory-configured for interrupt request (IRQ) level 4 (BR4). This is the preferred configuration for most DEC Q-Bus systems. In the case of special applications, you may use jumpers to change IRQ5 (BR5). The following table describes the factory and alternate settings for these jumpers.

If you use IRQ5, Emulex strongly recommends that the QD35 be located ahead of all DEC peripheral devices on the bus. The settings are summarized as follows in the following subsections.

3.5.2 Interrupt Acknowledge and DMA Grant (T-U and V-W)

The QD35 Disk Controller is factory-configured to interconnect the Interrupt Acknowledge input and output signals, and the DMA grant input and output signals on the DEC Q-Bus C connector. This configuration is appropriate for the standard "serpentine" system backplanes in which the A, B, C, and D connector slots are all configured to carry Q-Bus signals. A jumper is placed at the jumper block T-U so that the DMA Grant signal is passed from pin N (BDMGO) on the C connector to pin M (BDMGI) on the C connector. A jumper is placed at jumper block V-W so that the Interrupt Acknowledge signal is passed from pin N (BIAKO) on the C connector to pin M (BIAKI) on the C connector.

On some MicroVAX and PDP-11 system backplanes, the C and D connector signals have been redefined so that they do not carry the standard Q-Bus signals. This type of backplane configuration is often referred to as a "CD" backplane. Removing the jumpers from jumper blocks T-U and V-W prevents the QD35 from interfering with the normal operation of the CD connector.

In some combination backplane systems, serpentine and CD slots coexist in the same backplane. In a combination backplane system, leave the jumpers IN if the QD35 is installed in a serpentine slot, and remove the jumpers if the QD35 is installed in a CD-type slot.

The default jumper settings assume that the QD35 will be installed in a serpentine backplane slot. The jumper settings are summarized as follows:

Jumper	Factory Setting (IN)	Alternate Setting (OUT)
T-U	The Interrupt Acknowledge signal is passed through the CD connector (serpentine backplane).	The Interrupt Acknowledge signal is not passed through the CD connector (CD backplane).
V-W	The DMA Grant signal is passed through the CD connector (serpentine backplane).	The DMA Grant signal is not passed through the CD connector (CD backplane).

3.6 SMD Disk Drive Preparation

The disk drive(s) must be configured for the proper number of sectors per track and have an ID plug or address selection switches properly configured.

3.6.1 Drive Placement

Uncrate and install the disk drives according to the manufacturer's instructions. Position and level the disk drives in their final places before beginning the installation of the QD35. This positioning allows the I/O cable routing and length to be judged accurately.

3.6.2 The Local/Remote Switch

The local/remote switch controls whether the disk drive can be powered up from the drive (local) or from the controller (remote). Place the switch in the REMOTE position. After your drives and drive cabling are installed, press the Start switch on the front panel of each of the drives with the CPU powered down. The Start LED will light, but the drive will not spin up and become ready. After your cabling is installed and the the CPU is powered on, the drives spin up sequentially. This sequential power-up prevents the heavy current surge that would be caused if all the drives were powered up at once.

When in the remote mode, the drives spin down when the CPU is powered down or the QD35 Run/Reset switch (SW1-1) is set to ON. You can use the Start switch on each disk drive to spin individual drives up or down while the CPU is powered on.

3.6.3 Sectoring

See Appendix B, Drive Parameters, for the correct sector count settings for the disk drives in use. Consult the appropriate drive manual for additional information.

3.6.4 Drive Numbering

An address of 0, 1, 2, or 3 must be selected for each drive. Assign the drives different numbers. The logical unit number is determined by the address given to the drive. Refer to your drive documentation for information on selecting the drive address.

3.6.5 Termination

The last (or only) drive attached to the QD35 must be terminated; all other drives must remain unterminated.

3.6.6 Tag 4/5 Support

Since disk drive vendors implement or terminate the A-cable signals (Tag 4/5 by the SMD-E) in various ways, Emulex requires that Tag 4/5 be disabled on all drives attached to the QD35. This is especially true when mixing older style SMD and SMD-E disk drives on the same controller.

3.6.7 Port Release Timer

If the controller is set to static dual port, the drive should have the reserve timer enabled. When you choose dynamic dual port on the controller, Emulex recommends disabling the reserve timer.

3.7 Installing the QD35-III in the MicroVAX III

The following subsections describe how to install the QD35 Disk Controller, distribution panel, and cabling in your MicroVAX III system. If you have a MicroVAX II or LSI-11, skip these subsections and continue the installation with subsection 3.8.

3.7.1 System Preparation

To prepare the MicroVAX III system for installing the QD35, use the following procedure:

1. Power down the system. Switch OFF the main power switch.

   CAUTION! When you power off your system, be sure to power off any peripheral attached to the host drive as well. Attempting to install the QD35 without powering off all host system equipment may result in damage to your host system.

2. Open the front cabinet door.

3. Remove a blank cover from the front of the chassis: an empty slot will then be exposed.

3.7.2 Slot Selection

The QD35 may be assigned to any desired slot because it uses the LSI four-level interrupt scheme to perform distributed interrupt arbitration.

There must be no unused Q-Bus slots, however, between the CPU and the QD35.

3.7.3 Placing the QD35-III in the Backplane

Plug the QD35-III into the MicroVAX III backplane with the 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.

The QD35-III PCBA includes a front panel with extractor handles. To install the board, slide the board into the slot with the extractor handles in the open position (aligned with the front panel of the PCBA). See Figure 3–5. When the board is properly positioned in the throat of the board guides, secure the board by pushing the extractor handles toward the center of the front panel.

The front panel of the QD35-III PCBA might be set back further than the panels of the DEC boards in the backplane. Install a gap-filler panel, if needed, on either side of the QD35-III, between a flatboard cover and the QD35 front panel. (Each QD35-III is shipped with two gap-filler panels; refer to Table 1–2 for the panel part number.)

Use a Phillips head screwdriver and push and turn the handle-locking screws a quarterturn to lock the QD35-III PCBA into the chassis.

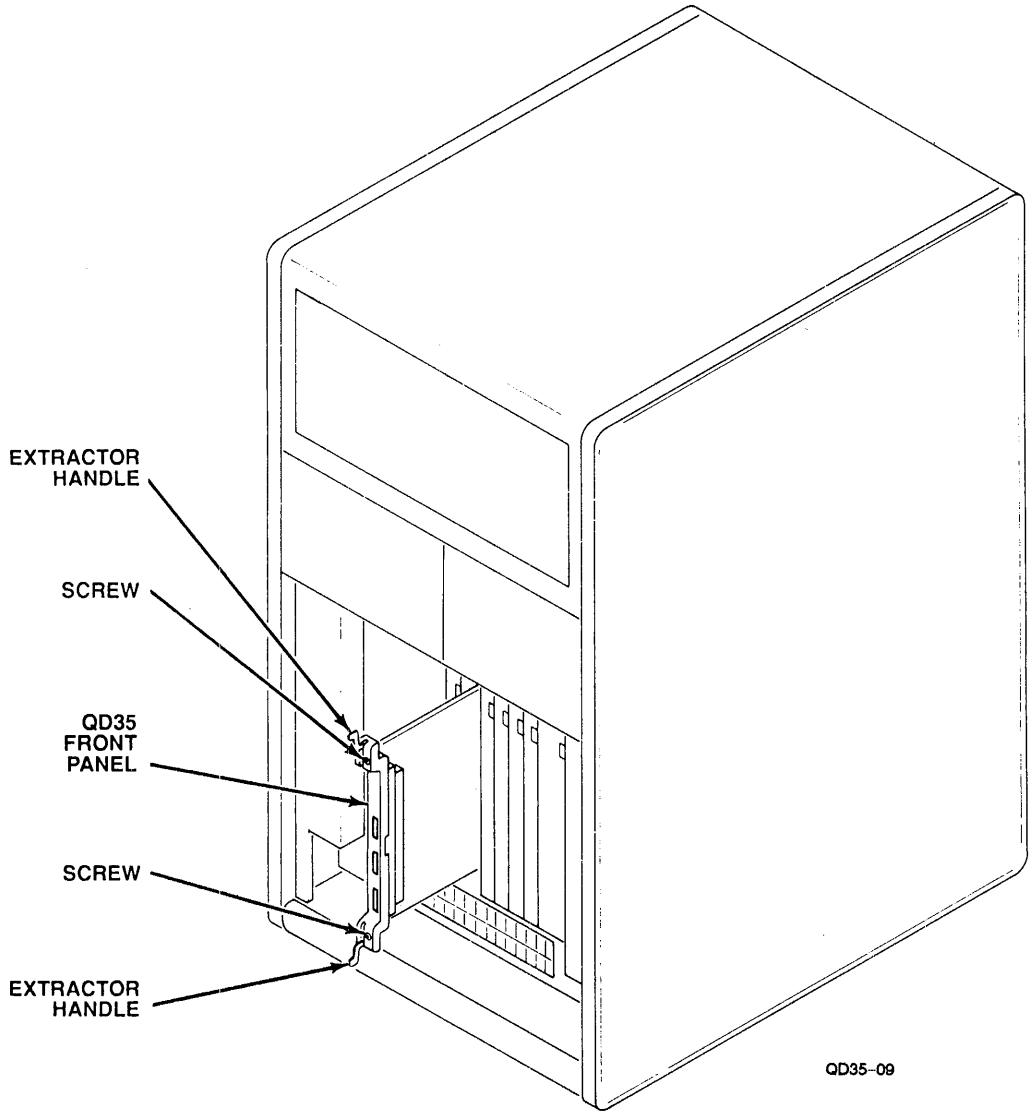


Figure 3–5. Installing the QD35-III PCBA in a MicroVAX III System

3.7.4 Cabling for the MicroVAX III

In a QD35-III (and QD35F-III) subsystem, the QD35-III PCBA is installed in the MicroVAX III system cabinet, and the disk drives are mounted in a separate rack-mount cabinet. A cable distribution panel is installed in the disk drive cabinet to route the cabling from the system cabinet to the disk drive cabinet.

Figure 3–6 shows an overview of the cabling for four SMD disk drives in a QD35-III, the maximum subsystem configuration. Brief descriptions follow for installing the three MicroVAX cables, four SMD A and B cables, and the serial port cable. More detailed procedures are provided in the following subsections.

The 68-conductor, MicroVAX A (control) cable connects from the J1 connector on the QD35 PCBA front panel to the 68-pin J1 connector on the front side of the QD35 Distribution Panel. Two 50-conductor, round-shielded B (data) cables connect from high-density connectors J2 and J3 on the QD35 front panel to connectors J2 and J3 on the front side of the QD35 Distribution Panel. J2 is the connector for ports 0 and 1. J3 is the connector for ports 2 and 3. If only two disk drives are in use, then only one MicroVAX cable is needed (from J2 to J2). If three or four SMD disk drives are present in the configuration, then the second MicroVAX cable (from J3 to J3) must also be installed.

NOTE: Because the QD35-III PCBA and the SMD drives are located in separate cabinets, the MicroVAX cables that run between the cabinets must be shielded. The points of cabinet exit and entry must not cause the computer installation to exceed FCC limits for RFI.

An SMD A cable (either ribbon or round-shielded) is attached from the J4 A cable connector on the back of the distribution panel to the A cable connector on the first SMD disk drive (drive 0). Other SMD A cables are then daisy-chained from disk drive 0 to disk drive 1, 2, and 3, and a terminator is placed on the last SMD drive, as shown in Figure 3–6. The maximum A cable length from the QD35 to the last SMD drive is 100 feet.

SMD B cables connect from J5 (port 0), J6 (port 1), J7 (port 2), and J8 (port 3) on the back side of the panel to SMD drives in a radial scheme to SMD disk drives 0, 1, 2, and 3 respectively. The maximum B cable length (cumulative) for each drive is 50 feet.

A serial port cable is installed at connector J9 on the distribution panel on one end; the other end plugs into the serial device.

Figure 3–6 is a block diagram that shows the basic cabling configuration for a QD35-III with four SMD disk drives attached. The following are step-by-step instructions and detailed illustrations for installing the distribution panel, MicroVAX cables, and SMD A and B cables.

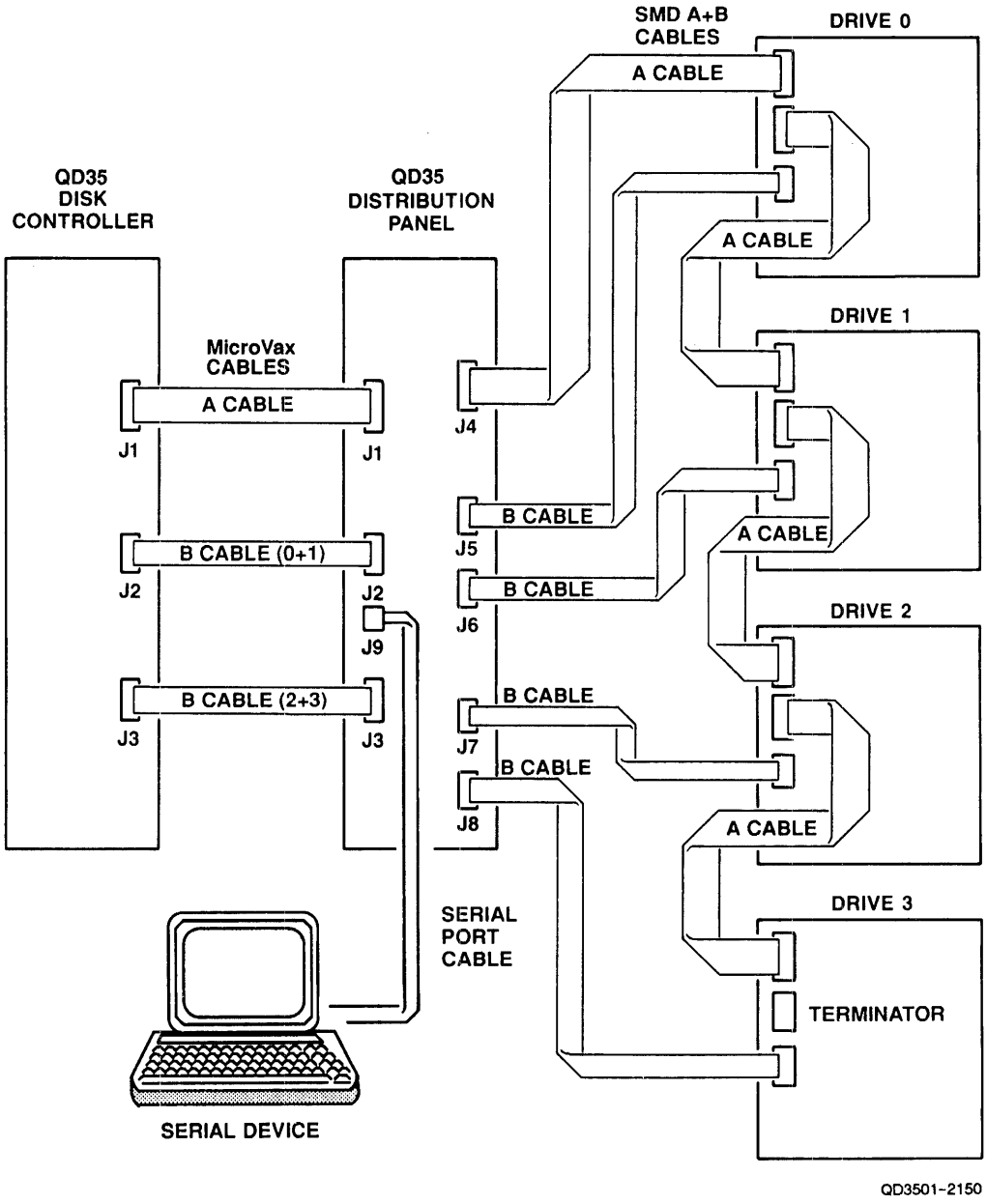


Figure 3–6. QD35-III and QD35F-III Drive Cabling

NOTE: The rack-mount panel, shielded MicroVAX cables, SMD A and B cables, and serial port cable described in the following procedures are available from Emulex (see Table 1–4). The distribution panel is included with the basic QD35-III or QD35F-III package. The QD35-III panel supports unshielded ribbon cables. The QD35F-III panel supports shielded SMD cables.

3.7.4.1 Installing the MicroVAX III Cables and Distribution Panel

The following steps are for installing the MicroVAX III cables and distribution panel:

1. Power-off your system. Ensure that the QD35-III PCBA is installed in the backplane of the MicroVAX III system and that the system power is OFF.
2. Install the QD35-III (or QD35F-III) distribution panel in the rack-mount panel. Place the distribution panel in the open side of the rack-mount panel, and secure it with eight captive screws. The flat-cable distribution panel and the eight screws are shown in Figure 3–7. Tighten the screws until they are finger-tight. Make sure that no gaps are present around the distribution panel.

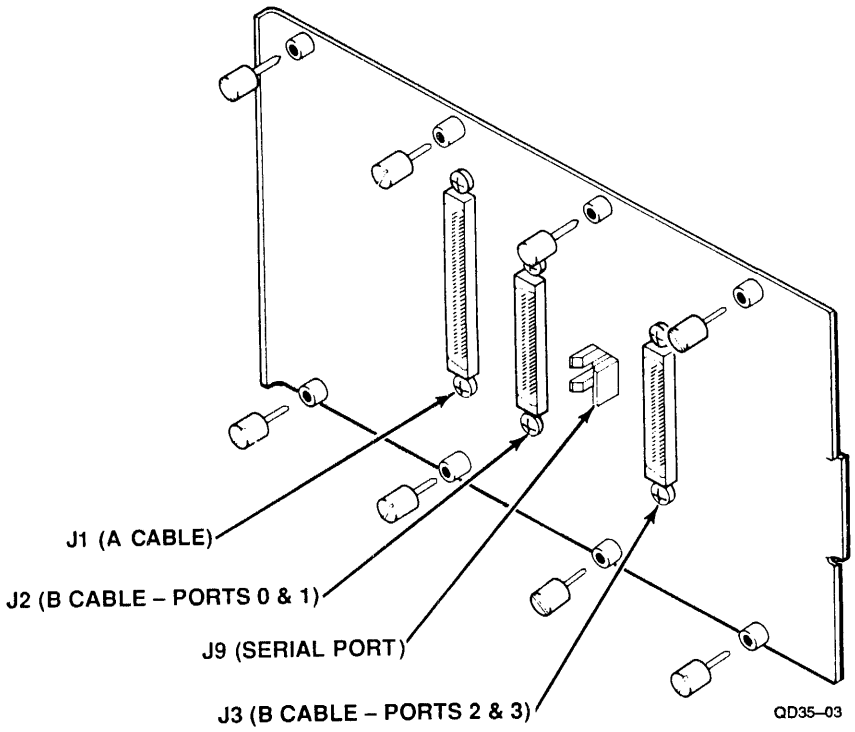


Figure 3–7. QD35-III Distribution Panel (Front View)

3. Install the rack-mount panel in the disk drive cabinet. Mount the rack-mount panel containing the distribution panel in the RETMA rack in the disk drive cabinet. Figure 3–8 shows the rack-mount panel.

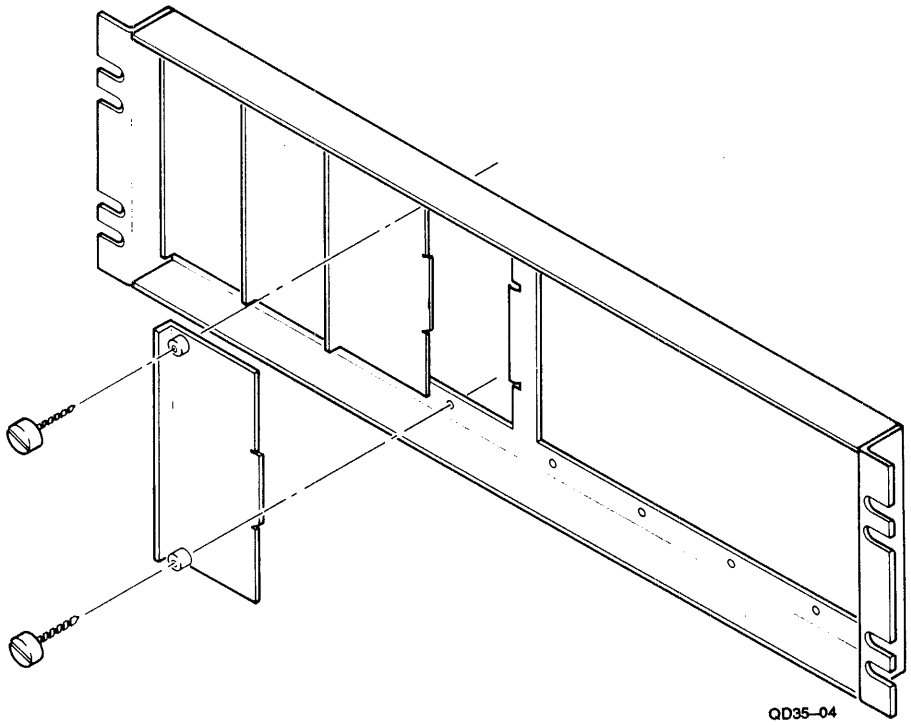


Figure 3–8. Rack-Mount Panel

4. Connect the round-shielded, MicroVAX III cables from the QD35 PCBA front panel to the Distribution Panel: Align the 68-conductor cable header with the top of the high-density connector J1 on the front panel of the QD35-III PCBA. Hold in the latches on each side of the cable header, and press the header firmly into the J1 connector. Connect the other end of the cable in the same manner to the connector labeled "J1-A-CABLE" on the front side of the distribution panel. Figure 3–9 shows the cabling in detail.

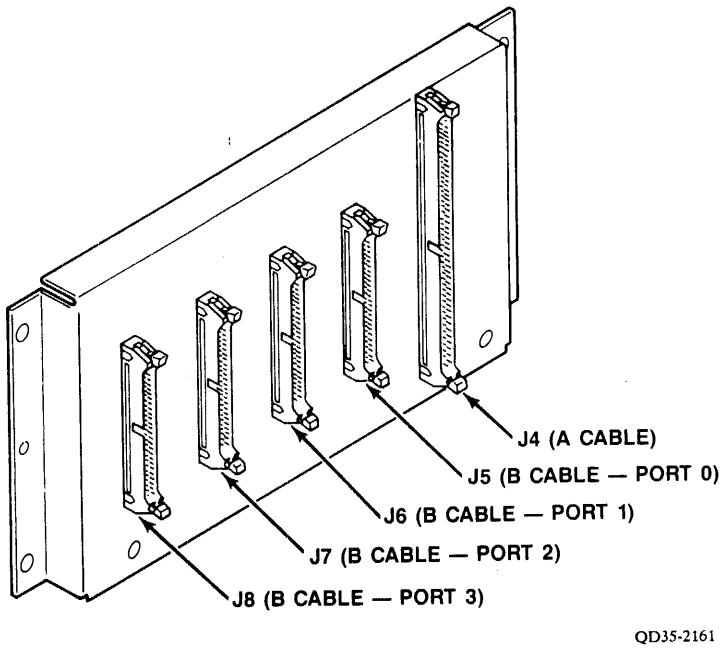


Figure 3–9. QD35-III Ribbon Cable Distribution Panel (Rear View)

Follow the same procedure described above to connect the two 50-pin MicroVAX cables from the QD35-III front panel J2 and J3 connectors to the J2-B-Cable and J3-B-Cable connectors, respectively, on the distribution panel.

3.7.4.2 Installing the Serial Port Cable

The serial port cable plugs into the J9 connector on the front of the QD35-III or QD35F-III distribution panel. The other end of the cable plugs into the serial terminal (a DB25 adapter may be required for the terminal port).

3.7.4.3 Installing the SMD A and B Cables

Steps follow for installing SMD A and B Cables from the distribution panel to the SMD disk drives:

1. Connect the A cable from the J4 connector at the rear of the distribution panel to the first SMD drive. Figure 3–10 shows the rear view of the QD35-III distribution panel used with ribbon cables. Figure 3–11 shows the rear view of the QD35F-III panel used with round-shielded cables.

   For flat-ribbon SMD cables: Connect the cable header to the distribution panel by aligning the molded arrow (triangle) on the cable header with the molded arrow on the J4 A cable connector on the back side of the panel. Press the header into J4, and squeeze the top and bottom connector handles on the panel to secure the SMD cable in the connector.

   For round-shielded SMD cables (the QD35F-III): Secure each cable under the cable holders on the round-cable distribution panel by loosening the Phillips head screws on the panel cable holders and threading the cables under the cable support holders. Figure 3–11 shows a round cable secured in the round-cable panel.

   Once the A cable is secured to the distribution panel, attach the header at the other end of the cable to the first A cable connector on the first SMD disk drive.

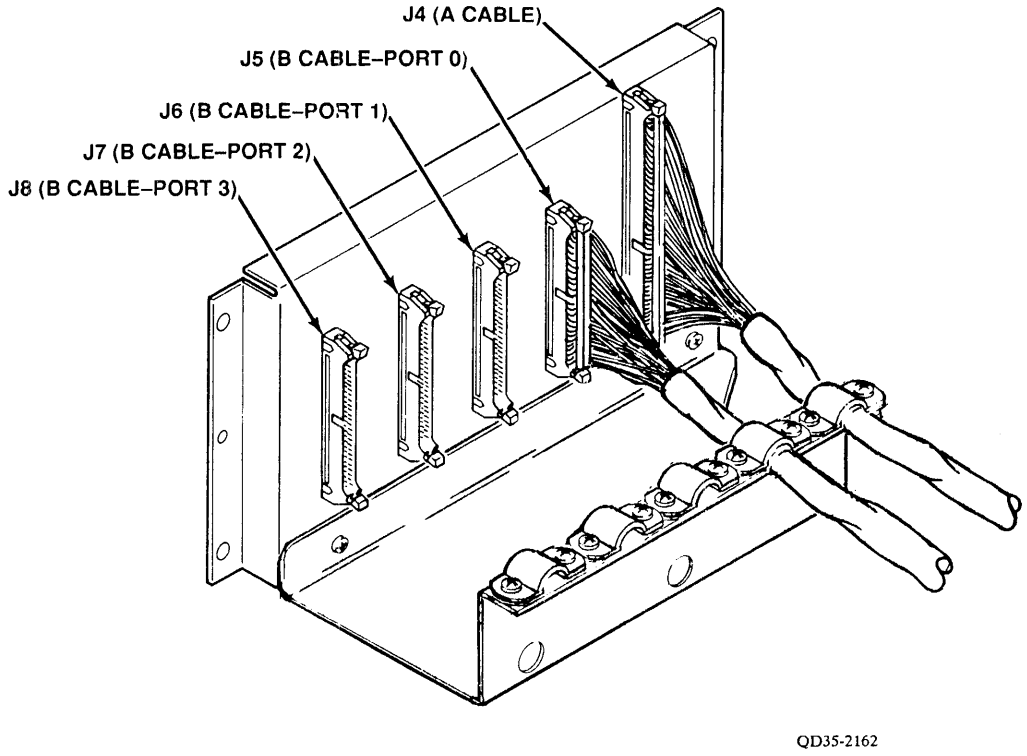


Figure 3–10. QD35F-III Round Cable Distribution Panel (Rear View)

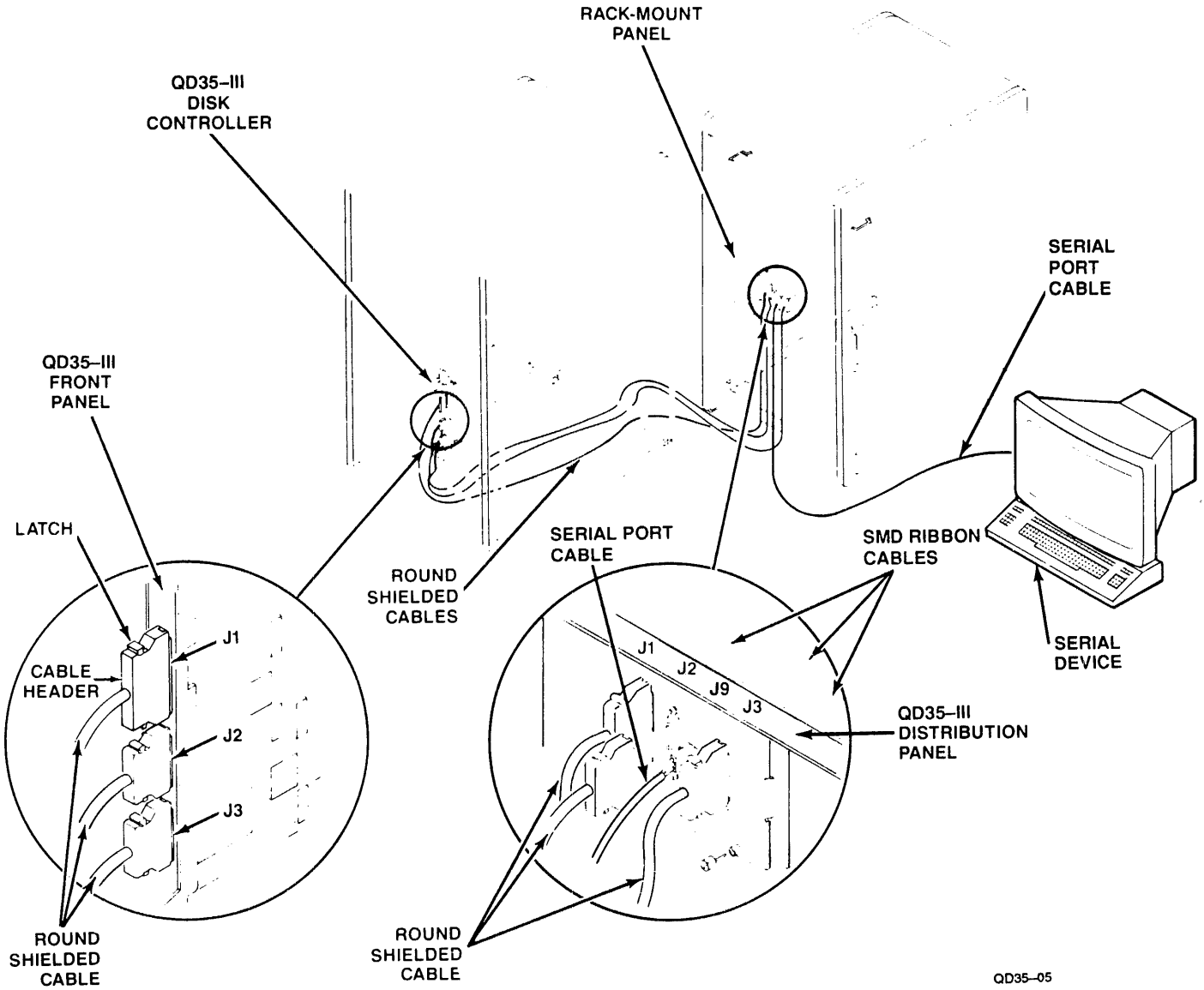


Figure 3–11. QD35-III Subsystem Cabling Detail

2. Daisy-chain the A cable to the remaining SMD disk drives: Select an A cable that is the proper length to reach from the first SMD disk drive to the second SMD disk drive. Run the cable from the second A cable connector on the first SMD drive to the first A cable connector on the second drive. Make sure that the latches on the disk drive connector fully engage the cable header. Repeat this procedure for the third and fourth SMD disk drives. Install the A cable terminator (supplied with the disk drive) on the second A-cable connector of the last SMD drive.

3. Connect the SMD B cables from the distribution panel to the SMD drives in a radial scheme: Align the molded arrow on the cable header of the 26-conductor B cable with pin 1 of connector J5 (port 0) on the back side of the panel. Press the header into J5; attach the header at the other end of the cable to the B cable connector on the first SMD drive. Make sure that the latches on the connector fully engage the cable header.

   To install the three SMD B cables for the second, third, and fourth SMD disk drives, repeat the procedure described for the first drive: for the second disk drive, connect the B cable from the QD35 panel J6 connector to the SMD B cable connector on the second disk drive; for the third disk drive, connect the B cable from the J7 panel connector to the third drive's B cable connector; for the fourth SMD disk drive, connect the B cable from the J8 panel connector to the fourth drive's B cable connector. Figure 3–11 shows an overview of the A and B cabling.

3.8 Installing the QD35 in the MicroVAX II and LSI-11

The following subsections describe the procedures for installing the QD35 Disk Controller and the SMD disk drive cabling in DEC MicroVAX II and LSI-11 systems. If you have a MicroVAX III, skip this subsection and continue the installation with subsection 3.9, Grounding.

3.8.1 System Preparation

To prepare the MicroVAX II system for installing the QD35, take the following steps:

1. Power down the system. Switch OFF the main AC breaker.

   CAUTION! When you power off your system, be sure to power off any peripheral attached to the host drive as well. Attempting to install the QD35 without powering off all host system equipment may result in damage to your host system.

2. Remove the rear cover from the chassis so that the patch panel is exposed.
3. Remove the patch panel. Loosen the captive screws from the patch panel using a standard screwdriver.
4. 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.

To prepare the LSI-11 for installing the QD35, take the following steps:

1. Power down the system. Switch OFF the main AC breaker.

   CAUTION! When you power off your system, be sure to power off any peripheral attached to the host system as well. Attempting to install the QD35 without powering off all host system equipment may result in damage to your host system.

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

3.8.2 Connecting the Subsystem to the Host Using Direct Cabling

The disk controller interfaces with each disk drive using one control cable (A cable) and a data cable (B cable).

The following subsections describe the connections at the host for a variety of DEC cabinets using round-shielded, SMD cables supplied with Emulex subsystems.

3.8.2.1 Cabling on Emulex Subsystem to the QD35 in DEC BA23 or BA123 Cabinets

Direct cabling the disk drives to either cabinet configuration is done in the same manner. You are provided with one clamp assembly to secure the cables. The clamp assembly provides strain relief and grounding.

The clamp assembly requires one "A" size cut-out slot in the rear panel of the BA23 or BA123 enclosure for each two drives supported. To connect the cables perform the following:

1. At the CPU, remove the filler plate in the "A" slot and replace it with the Cable Filler Plate provided.
2. Install the QD35 controller in the CPU backplane and connect the cables to the controller. Select the ground-point of each cable nearest the cable egress point.
3. With an Exacto knife, carefully remove all the shrink tubing from the cable. Do not remove the shrink tubing from more than one grounding point of each cable.
4. Route the cable through the cable filler plate and slide the exposed shield into a notched hole. Place the exposed part of the cable between the grounding clamp bracket and the grounding clamp, and secure the assembly using the Phillips screws provided (see Figure 3–12).

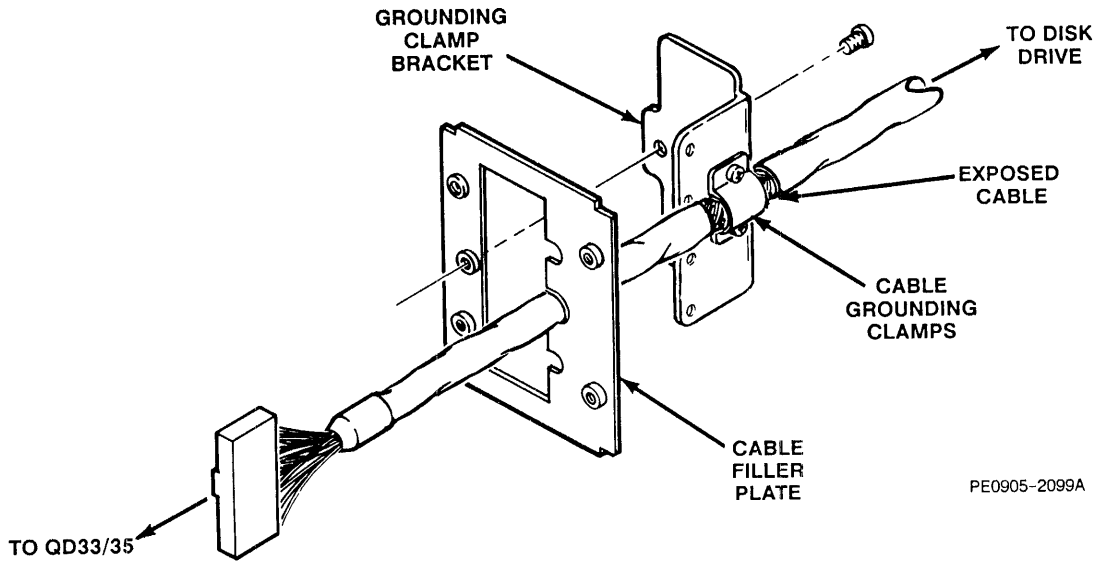


Figure 3–12. Installing the Cable Clamp

3.8.3 Seating the PCBA in the Backplane

Plug the QD35 into the Q-Bus 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. Properly position the board in the throat of the board guides before attempting to seat the board by pressing it into place.

3.8.4 Installing the SMD and Serial Port Cables

The QD35 Disk Controller requires one control cable (A cable) and one data cable (B cable) for each SMD disk drive that it controls. The A cable originates from connector J5 on the QD35 and is daisy-chained to all of the supported drives, terminating on the last drive. Maximum cumulative length for the control cable is 100 feet (30 meters). The B cable originates from connectors J1, J2, J3, and J4 on the QD35. A radial (B) cable is connected directly from the QD35 to each supported disk drive. Maximum cable length for each B cable is 50 feet (15 meters).

There is no distribution panel between the QD35 and the SMD A and B cables, as there is for the QD35-III. Figure 3–13 shows an overview of the SMD A and B cables for the QD35.

In addition to the SMD Cables, you should also install a serial port cable from the J8 connector on the QD35 to the terminal's serial port. A DB25 adapter may be required for the terminal port.

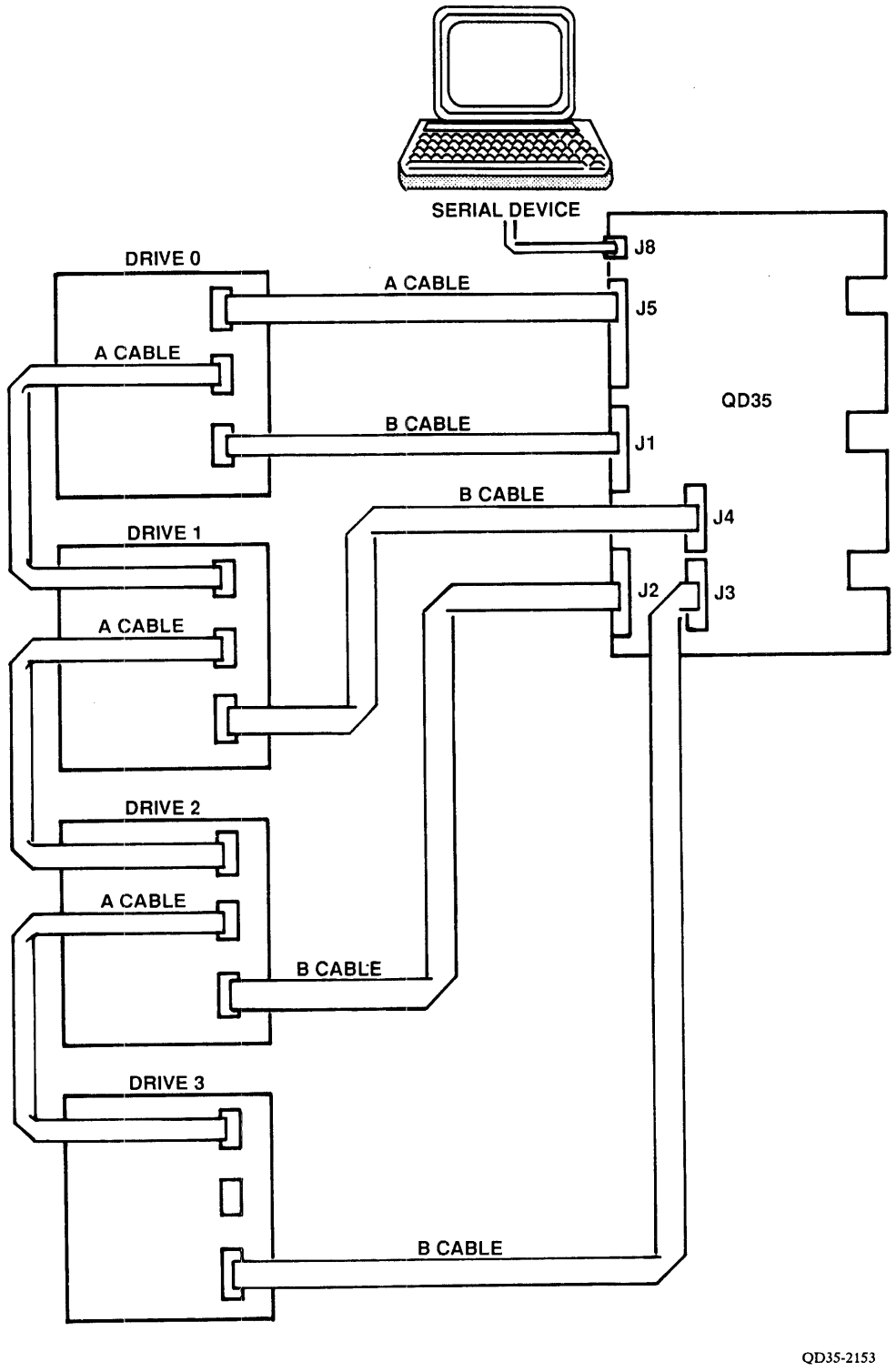


Figure 3–13. QD35 Subsystem Cabling Overview

3.8.4.1 FCC Compliance Considerations in QD35 Cabling

The QD35 is certified to comply with FCC standards for a class A computing device. Emulex obtained this certification using a controlled configuration based on subsystem solutions provided by Emulex Corporation. If your QD35 is purchased as part of an Emulex subsystem, then all the parts needed to make an FCC-compliant installation are included.

Some cable clamps and FCC type shielded cables of different lengths that may be used for installing the QD35 are listed in Table 1–4. However, please note that if you purchase the QD35 Disk Controller from Emulex and you plan to obtain the cables, disk drives, and system cabinets from other sources, it is your responsibility, as an integrator to guarantee that the resulting subsystem remains FCC-compliant.

Table 1–4 lists the hardware and cables that provide you with FCC class A compliance when installing the QD35 in a DEC BA23 or BA123 chassis. When these components are used to connect the QD35 to an IMPRMIS (CDC) SABRE series drive using the standard cable clamps provided on the SABRE drive, the entire SABRE drive subsystem will be FCC-compliant.

3.8.4.2 Installing the SMD A Cables

Take the following steps to install SMD A cables:

1. Connect the first A cable header to the J5 connector on the QD35. Choose the A cable that is the appropriate length to reach from the QD35 to the first SMD disk drive. Take either cable header (they are identical), and find the molded-in arrow that identifies pin 1 of the connector. Find the molded on connector J5 located on the QD35. Align the arrow on the cable header with the connector arrow, and press the header into the connector.

2. Connect the other end of the A cable to the first SMD disk drive's A cable connector. Find the molded-in arrow on the cable header at the other end of the A cable. Find the arrow on the disk drive's A cable connector. Most SMD drives have two A cable interfaces to allow daisy-chaining; use either one. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the locking tabs on the connector are fully flush with the sides of the cable header.

3. Connect the first SMD disk drive to the second drive using a second A cable. Select a second A cable that is the proper length to reach from the first SMD disk drive to the second SMD disk drive. Run the cable from the second A cable connector on the first SMD drive to the first A cable connector on the second drive. Follow step 2 for instructions on installing the cable in the disk drive connectors. Repeat this procedure for drives 3 and 4.

4. Install the A cable terminator (supplied with the drive) on the second A-cable connector of the last drive.

3.8.4.3 Installing the SMD B Cables

Take the following steps to install SMD B cables:

1. Connect the cable header to the QD35. The headers on both ends of the B cable are identical, so you can use either cable header to connect to the QD35. Select a cable header, then find the molded in arrow that identifies pin 1 of the connector.

2. Find the molded arrow on connector J1 located on the QD35. Align the arrow on the cable header with the connector arrow, then press the header into the connector.

3. Connect the other cable header to the disk drive. Find the arrow on the first disk drive's B cable connector. If the drive is a dual port model, make sure that you connect the B cable to the same port where the A cable is already installed.

   Align the arrow on the cable header with the connector arrow, and press the header into the connector. Make sure that the locking tabs on the connector are fully flush with the sides of the cable header.

4. Repeat steps 1 and 2 for each of the other drives, using connectors J2, J3, and J4 on the QD35.

3.9 Grounding

Proper grounding is extremely important for proper operation of the disk subsystem.

If you are using flat-ribbon SMD A and B cables, then there must be a good connection between each drive in the subsystem and the CPU logic ground. The recommended grounding method is to connect each drive to a common point on the CPU chassis using a half-inch or larger braided ground strap, preferably insulated, or an AWG number 10 (or heavier) wire. Another option, though a less desirable one, is to daisy-chain a ground wire between the drives, then connect the wire to the CPU.

If you are using round shielded SMD A and B cables, the separate ground braid connection is not required as long as the round cable outer shield is connected to chassis ground at each end.

For most applications, connect the drive chassis and logic grounds (AC and DC grounds) together. In environments with noise problems, however, it might work better to separate these two grounds. Whatever drive grounding method is used, all drives in the subsystem must be configured the same way. Consult the disk drive manual for specific instructions on connecting the chassis and logic grounds.

Because each subsystem is unique, it is difficult to predict which method will work best for each. Be aware that some experimentation may be required.

NOTE: Failure to observe proper signal grounding methods generally results in marginal operation with random error conditions.

3.10 Resident Utility (FRU) Installation Overview

After physically installing the QD35, 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 QD35 Firmware Resident Utility (FRU) provides configuration and disk formatting functions, including the ability to load the drive configuration into the NOVRAM, format the drive, test the disk surface, replace defective blocks, and perform diagnostic testing of the QD35 controller and attached disk drives. The FRU can be run from the MicroVAX operator console or from a terminal attached to the serial port on the QD35. The following subsections briefly describe how to start and run the FRU to install a default software configuration. Section 4 describes the FRU in detail.

3.10.1 Starting the FRU

The steps for starting the FRU are slightly different for a MicroVAX system versus an LSI-11 system. Descriptions for each system follow.

3.10.1.1 Initial MicroVAX Startup

The following method for starting the FRU on a MicroVAX system is the best for a first time installation because it allows you to set the controller address so that it does not conflict with other controllers already in your system. Two other methods are described in subsection 4.2.

NOTE: This method can also be used if you are unsure of the address for which your controller is set.

1. Apply power to the system, put the system in console mode, and enter the following commands using the host console in response to the >>> prompt:

```
>>> I <CR>                          !BUS INIT
>>> D/P/W 20001F40 20 <CR>          !ENABLE MEMORY
>>> D/P/L 20088000 80000000 <CR>    !SET UP MAP 0
>>> D/P/L 20088004 80000001 <CR>    !SET UP MAP 1
```

2. Set the QD35 switch SW1-2 to ON, and switch SW1-3 to OFF.

3. Toggle the QD35 switch SW1-1 from OFF to ON and then back to OFF. This initiates the uploading of the MicroVAX driver for the FRU.

4. At the >>> prompt, enter the following:

```
>>> S 80
```

For a GPX workstation, enter the following:

```
>>> S 82
```

When the start procedure is complete, the FRU identifies itself by displaying the firmware revision number and the controller address on the MicroVAX system console, as shown in Figure 3–14.

NOTE: When you are finished running the FRU, you must reset the QD35 switch SW1-2 to the OFF position before booting up the system.

3.10.1.2 Initial LSI-11 Startup

The following method for starting the FRU on an LSI-11 system is the best for a first time installation because it allows you to set the controller address so that it does not conflict with other controllers already in your system. Two other methods are described in subsection 4.2. Take the following steps:

1. Make sure that the QD35 switch SW2-1 is set to ON, indicating that the host is an LSI-11 system.
2. Halt the processor.
3. Set the QD35 switch SW1-2 to ON, and set switch SW1-3 to OFF.
4. Toggle the QD35 switch SW1-1 from OFF to ON, then back to OFF.
5. Using the ODT, enter the following data at the @ prompts:

```
@ OG
@ R7/ZZZZZZ 200 <CR>
@ P <CR>
```

When you type R7, the current contents of register R7 displays (represented by zzzzzz). Entering 200 places the value 200 in the R7 register. When this startup procedure is completed, the FRU Startup Screen displays, as shown in Figure 3–14.

NOTE: When you are finished running the FRU, you must reset the QD35 switches SW1-2 and SW1-3 to the OFF position before booting up the system.

3.10.1.3 FRU Startup Screen

After completing one of the above startup procedures, you are presented with an FRU startup screen that displays as shown in Figure 3–14.

NOTE: If you are using a GPX workstation, do not use VT100 mode. At the prompt `VT100-compatible terminal?` type `N`.

```
QD35 Firmware-Resident Utilities

Copyright 1989 Emulex Corporation

All Rights reserved
Controller firmware revision: X

Reading NOVRAM

Current controller address:  172150

VT100-compatible terminal? [Y/N, def=Y]

Hardcopy terminal? [Y/N, def=N]
```

Figure 3–14. QD35 FRU Startup Screen

3.10.2 FRU Main Menu

During FRU startup, the current configuration parameters are read from the NOVRAM, and the current controller address displays. You are then prompted to enter the type of terminal you have. The options you enter at the prompts on this display determine the format in which the FRU displays. Generally, they should reflect the characteristics of the terminal at which you are monitoring the utility display.

Once you have responded to the two prompts, the FRU Main Menu displays. Figure 3–15 shows the QD35 FRU Main Menu.

```
QD35 Firmware Resident Utilities

Main Menu

1 - Configuration Utility
2 - Format/Verify Utility
3 - Replace Block Utility
4 - Controller Diagnostic
5 - Disk Drive Diagnostic
8 - Display Error Log

Enter option:
```

Figure 3–15. FRU Main Menu

The Configuration utility allows you to configure your disk drives and your QD35 Disk Controller. It also allows you to edit and create logical partitions and to set disk drive parameters for the NOVRAM. To quickly install a default configuration for the QD35 Disk Controller and one of the supported disk drives, select Option 1, and the configuration utility will display.

The Format and Verify utility and the Replace Block utility allow you to prepare the SMD disk drives connected to the QD35. The controller diagnostic and disk drive diagnostic provide extensive diagnostic testing of the QD35 Disk Controller and its attached drives. The error log contains all of the error messages that occur during the diagnostic tests.

3.10.3 Configuration Utility Menu

Figure 3–16 shows the QD35 Configuration Utility Menu.

```
          QD35  Firmware Resident Utilities

                    CONFIGURATION MENU

                    1 - Set Controller Options
                    2 - Configure Drive 0
                    3 - Configure Drive 1
                    4 - Configure Drive 2
                    5 - Configure Drive 3
                    6 - Display Configured Devices
                    9 - Return to Main Menu

Enter option [def=9]
```

Figure 3–16. Configuration Utility Main Menu

NOTE: You must select Option 9 to return to the Main Menu in order to write any configuration changes to the NOVRAM.

3.10.3.1 Controller Options Menu

The Controller Options Menu, which is accessed from the Configuration Utility Main Menu, shows the default values for the controller (see Figure 3–17). Descriptions for each field on the Controller Options Menu follow, along with guidelines for selecting values for those parameters.

```
                QD35 Firmware Resident Utilities

                      CONTROLLER OPTIONS

Controller Address: [172150]        Autoboot unit number: [0]
Adaptive DMA: [Enabled]  DMA burst length: [16]  DMA burst delay: [2]
Command queue size: [16]
Seek opt. algorithm: [Elevator]  Seek optimization fairness count: [16]
Disk caching: [Enabled]  Maximum transfer size to cache (blocks): [32]
Minimum number of blocks to read-ahead: [4]  Max. no. of blocks: [16]
Zero latency read: [Enabled]        Autotune: [Disabled]
Performance Monitor: [Disabled]  Baud rate: [19200]  Int (5 sec): [1]

  Use up/down arrow keys or <Return> to move cursor  <Ctrl-C> to exit

            Enter octal value between 160000 and 177776
```

Figure 3–17. Controller Options Menu

To select the default configuration shown in the controller options menu, enter <Ctrl-C>. If you cannot use the default controller address shown, 172150, then be sure to enter a different parameter value before you exit from this menu by entering <Ctrl-C>. For further explanations of the parameters on this menu, refer to subsection 4.6. After you have entered <Ctrl-C>, the Configuration Utility Menu displays. Select Option 2 at the Configuration Utility Menu to configure the first SMD disk drive.

NOTE: The parameters you have selected will not be written to NOVRAM until you return to the Main Menu.

3.10.3.2 Configuring the Disk Drives

Selecting Configure Drive 0, 1, 2, or 3 on the Configuration Utility Menu (Figure 3–16) transfers you to the Disk Drive Configuration Menu; which along with its associated submenus, allows you to specify the configuration data for each SMD disk drive attached to the QD35 Disk Controller. There may be as many as four drives attached.

Except for the drive number, the menus you are presented with for each of the four drives are the same. The examples that follow specify drive 0, but examples

for drive 1, 2, or 3 would be the same. Once you have selected a drive number, the Disk Drive Configuration Menu displays, as shown in Figure 3–18.

```
QD35 Firmware Resident Utilities

        CONFIGURE DRIVE 0

        1 - Select Disk Drive Type
        2 - Examine/Modify Drive Parameters
        3 - Examine/Modify Logical Partitions
        4 - Delete Drive From Configuration
        9 - Return to Configuration Menu

Enter option [def=9]:
```

Figure 3–18. Disk Drive Configuration Menu

Before selecting drive parameters, you must specify what type of SMD disk drive you have. Option 1 on the Disk Drive Configuration Menu allows you to select the type of drive that you will be attaching to the QD35 controller for the selected drive number (0, 1, 2, or 3). A list of the types of disk drive that are supported for the QD35 is supplied; you are prompted to select one. The Select Drive Type menu is shown in Figure 4–8. Once the correct disk drive is selected, all the parameters recommended by Emulex for that drive are automatically selected, but not automatically displayed.

Next, the FRU displays the Examine/Modify Logical Partition Menu. You may either set logical partitions now or exit this menu and return to the Disk Drive Configuration Menu to view or modify the disk drive parameters. To return to the Disk Drive Configuration Menu, enter <Ctrl-C>. Subsection 4.7.2 describes the disk drive parameters in more detail.

NOTE: To save the disk drive configuration parameters you have selected to NOVRAM, you must return to the Configuration Menu by entering <Ctrl-C>, then return to the Main Menu by selecting Option 9 on the Configuration Utility Menu.

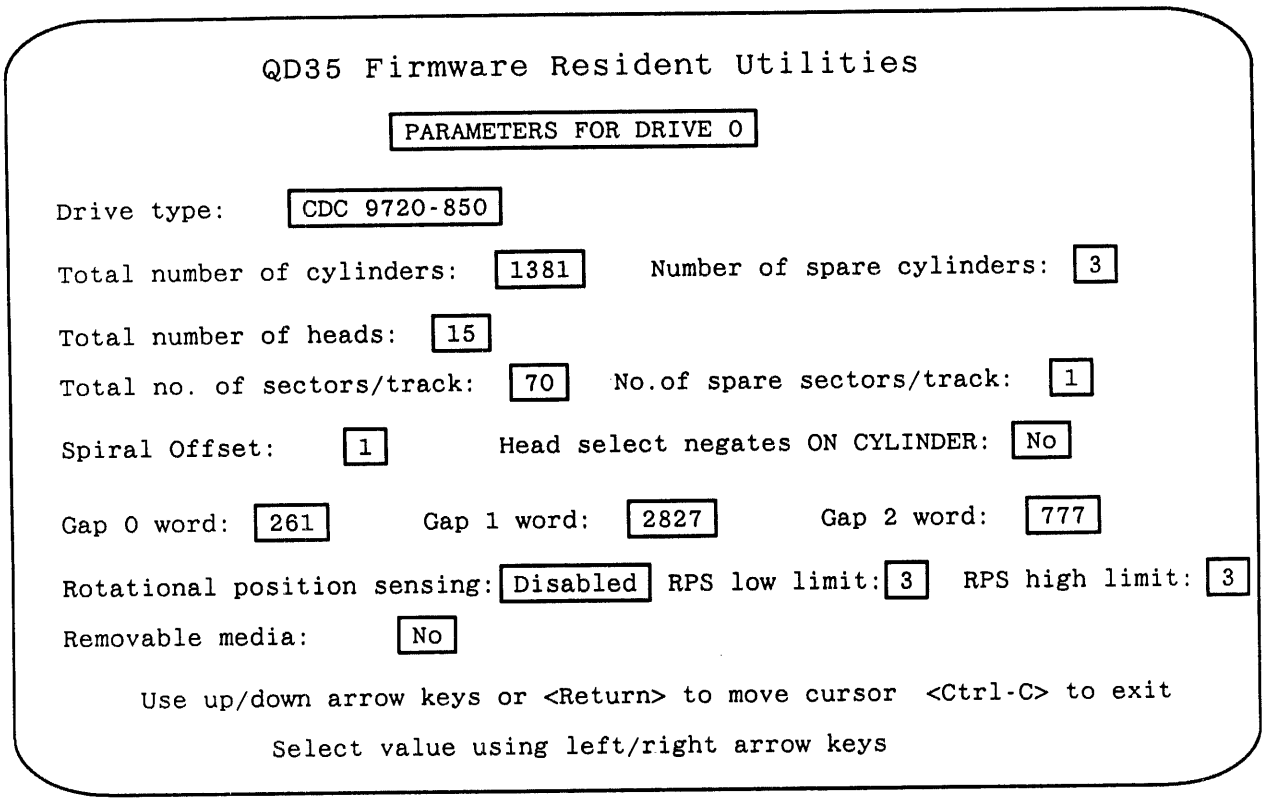


Figure 3–19. Disk Drive Parameters Menu

The default disk partitions selected are shown in Figure 4–10. If you wish to modify them, then select the Examine/Modify Logical Partitions Menu, as described in subsection 4.7.3. Once you have configured all the disk drives in your QD35 subsystem, enter <Ctrl-C> to return from the Disk Drive Configuration Menu to the Configuration Utility Menu.

3.10.4 Saving Your Controller and Disk Drive Configuration to NOVRAM

To save the QD35 Disk Controller and disk drive parameter values you have selected to the NOVRAM onboard the QD35, Select Option 9 on the Configuration Utility Menu, "Return to Main Menu". This displays your disk drive configuration and prompts you to confirm that this configuration should be written to NOVRAM. Figure 3–20 shows the display configured devices confirmation screen.

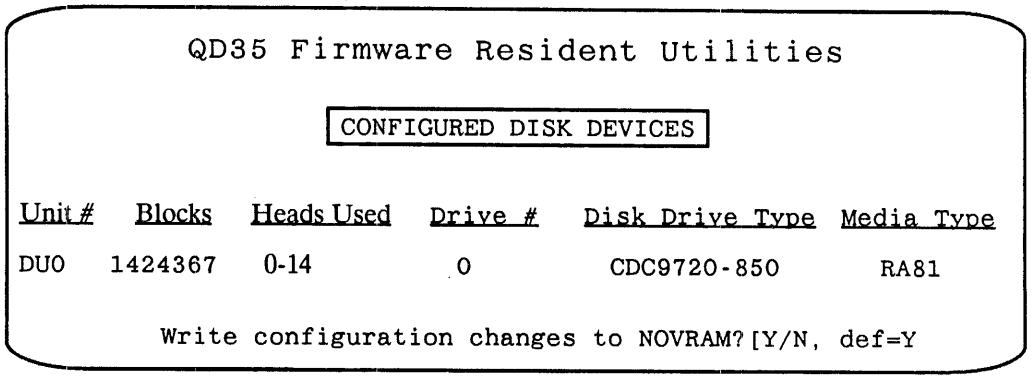


Figure 3–20. Display Configured Devices

This display shows any errors in the disk drive configuration. Duplicate unit numbers and non-contiguous unit numbers will be flagged as errors at this time and must be corrected before returning to the Main Menu. Enter <Y> to write the displayed disk drive configuration values to NOVRAM. The prompt "Writing NOVRAM" will display, followed by the FRU Main Menu.

3.10.5 QD35 Controller Diagnostics

Option 4 on the FRU Main Menu directs you to the Controller Diagnostic Menu, shown in Figure 3–21. The diagnostics should be run before you place the QD35 Disk Controller online. You may also save time by checking for controller problems before formatting and verifying your disk drives. Figure 3–22 shows the status window that is displayed while the controller diagnostics are executing.

```
CONTROLLER DIAGNOSTIC MENU

1--Execute All Tests
2--HAC Chip Test
3--MAC Chip Test
4--Cache Memory Test
5--Scratch Memory Test
6--Q-BUS DMA Test
8--Display Error Log
9--Return to Main Menu

Enter option [def=9]:
```

Figure 3–21. Controller Diagnostic Menu

After you select one of the diagnostic tests from the menu, you are prompted for the number of times to repeat the test (pass count) and whether or not to stop the test if an error is encountered. The format for the display is similar for all of the tests. If errors are encountered, they are stored in the Error Log, rather than displayed in the status window. The status window indicates which test is running, a pass count, and provides a count of the total number of errors encountered.

Figure 3–22 shows the name and status of the diagnostic test.

```
QD35 Firmware Resident Utilities

EXECUTING CONTROLLER DIAGNOSTICS

Executing HAC Chip Test

Pass count:  1                Error Count:  0
                              <Ctrl-C> to exit
```

Figure 3–22. Controller Diagnostic Status Messages

NOTE: Failure to enter the required console commands when starting up the FRU will result in diagnostic test errors. See subsection 4.2 for information on starting up the FRU.

3.10.6 Format/Verify/Replace Block Menu

The Format/Verify and the Replace Block utilities, Options 2 and 3 on the main menu, allow you to prepare the SMD disk drives attached to the QD35 controller for operation. Figure 3–23 shows the Format/Verify/Replace Block Menu.

```
QD35 Firmware Resident Utilities

FORMAT/VERIFY/REPLACE BLOCK MENU

1-Build Procedure List
2-Execute Procedure List
8-Display Error Log
9-Return to Main Menu

Enter option [def=9]:
```

Figure 3–23. Format/Verify/Replace Block Menu

For a detailed description of the Format and Verify function, refer to subsection 4.8. The procedure is briefly outlined here.

1. Build a procedure list that allows you to specify which disk drives you wish to select for the Format/Verify/Replace bad block procedure (menu item 1).
2. After building the procedure list, execute that procedure list to actually start the format, verify, and replace bad block operations (menu item 2).
3. As a last step, you should display the error log to check for any errors that occurred during the format, verify, and replace bad block procedures (menu item 8).

Figure 3–24 shows an example of the prompts and responses that are needed to build a procedure list. As you will notice, after each procedure is defined and ready to add to the procedure list, you are prompted for a new list item, until you specify <Ctrl-C> indicating that your procedure list is complete.

```
(A)dd item, (D)elete item, or (S)how devices?
[A/D/S]:A<CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: F <CR>
Enter logical unit number [0-255]: 2 <CR>
Enter drive serial number [0-65535] 12345 <CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: V <CR>
Enter logical unit number [0-255]: 2 <CR>
Nondestructive read-only verify? [Y/N, def=N]: N <CR>
Enter number of verify passes [1-255, def=1]: 6 <CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: R <CR>
(B)ytes from index or (L)ogical block number? [B/L]: L
<CR>
Enter logical unit number [0-255]: 2 <CR>
Enter logical block number to replace: 654321 <CR>
```

Figure 3–24. Build Procedure List Example

Press <Ctrl-C> or <CR> to return to the Procedure List window. After building a procedure list with the entries shown in Figure 3–24, the resulting procedure list displays, as shown in Figure 3–25.

```
FORMAT/VERIFY/REPLACE BLOCK PROCEDURE LIST

   1.  Format DU2  SN=12345

   2.  Verify DU2  Passes=6

                                  <Ctrl-C> to exit

(A)dd item, (D)elete item, (S)how devices? [A/D/S]:
```

Figure 3–25. Executing Block Procedure List

Select Option 2 to execute the procedure list previously built through Option 1. The procedure list displays, along with a warning message. The warning message states that execution of the procedure list may result in lost data on a disk drive. You will be prompted to continue. Review all of the entries in the procedure list very carefully before entering Y to continue. If there is a mistake in the displayed procedure list, type N in order to edit the procedure list before continuing.

The status messages reported as the Procedure List executes are shown in Figure 3–26.

```
EXECUTING PROCEDURE LIST

: 1.  Format DU2  SN=12345
@ 2.  Verify DU2  Passes=6

                                  <Ctrl-C> to exit
@=In Progress  :=No Errors  *=Soft Errors #=Fatal Error
          Pass: 3          Cylinder: 932
```

Figure 3–26. Procedure List Status Messages

If any errors occur during the Format/Verify/Replace Block operations, they are stored in an error log. To review the list of errors, select Option 8 on the Format/Verify/Replace Block menu, Display Error Log.

3.10.7 Disk Drive Diagnostics

If you select Option 5 on the FRU Main Menu, the Disk Drive Diagnostic Menu displays, as shown in 3–27.

```
QD35 Firmware Resident Utilities

DRIVE DIAGNOSTIC MENU

1-Execute All Nondestructive Tests
2-Index and Sector Pulse Test
3-Seek Tests
4-Diagnostic Cylinder Test
5-Random Read Test
7-Random Write/Read Test (DESTRUCTIVE)
8-Display Error Log
9-Return to Main Menu
Enter option [def=9]:
```

Figure 3–27. Disk Drive Diagnostic Menu

Once you have selected a test from the menu, the list of configured disk devices displays, and you are prompted to enter the unit number to test. As with the controller diagnostic, you are prompted for a pass count and for whether to stop on error or continue. The disk drive diagnostic status window is similar to the controller diagnostic window; it displays the name of the test currently running, the current pass count, and the error count.

3.10.8 Exiting From the FRU

Once you have configured your disk controller and disk drives, and you have run the controller and disk drive diagnostics, you are ready to exit the FRU. You must reset SW1-2 and SW1-3 to OFF before bringing your system online.

3.11 Operation

There are no operational instructions. The QD35 is ready for MSCP initialization as soon as its drives have been formatted and tested.

3.11.1 Indicators

There are three light emitting diodes (LEDs) on the QD35 front panel. These LEDs are used both for diagnostics and for normal operation.

If switch SW1-4 is OFF, then the QD35 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 68020 microprocessor chip and the Merged Architecture Controller (MAC) chip. When the QD35 successfully completes the preliminary test, LED3 illuminates to indicate that the QD35 is waiting for the MSCP initialization sequence.

During the MSCP initialization sequence, initiated by host software control, the QD35 executes a self-test that exercises the MAC chip, the Host Adapter Controller (HAC) chip and its associated circuitry, the onboard RAM, and the control memory PROM. If the QD35 passes this sequence of its self-test successfully, all the LED indicators on the QD35 front panel are OFF.

If a fatal error is detected either during self-test or while the system is running, all three of the LED indicators are ON (Illuminated). If the QD35 fails to pass its power-up self-tests, select a special diagnostic mode (switch SW1-4 ON) that causes the LEDs to display an error code. See subsection 6.4 for descriptions of self-test error codes.

During normal operation, LED1, LED2, and LED3 flicker occasionally. These LEDs are used to indicate Q-Bus activity and SMD drive activity, as follows:

LED1	Flickers to indicate that the host has a command to get.
LED2	Flickers to indicate that a drive has commands in its command queue.
LED3	Flickers during firmware format operations and self-test.

Section 4
FIRMWARE-RESIDENT UTILITY SOFTWARE

4.1 Overview

This section describes the Firmware-Resident Utility (FRU) software. The following subsections are included:

Subsection	Title
4.1	Overview
4.2	Starting the FRU
4.3	FRU Startup Screen
4.4	FRU Main Menu
4.5	Configuration Utility Main Menu
4.6	Set Controller Options Menu
4.7	Configuration Disk Drive Menus
4.8	Format/Verify/Replace Block Menu
4.9	QD35 Diagnostic Menus
4.10	Disk Drive Diagnostics Menu

A brief introduction to running the FRU with default parameters is provided in subsection 3.10. This section provides a detailed presentation of the FRU menus. Definitions for many of the parameter fields on the configuration menus are presented. Step-by-step instructions are provided for the following tasks:

- Setting QD35 disk controller options (subsection 4.6), disk drive configuration parameters (subsection 4.7), and loading those values to the NOVRAM. Suggestions are provided for choosing configuration parameters that will provide the best performance for the QD35. Default disk drive parameters recommended by Emulex are provided for supported disk drives.
- Formatting and verifying disk drives attached to the QD35 Disk Controller and replacing bad blocks on the disk drives attached to the QD35 (subsection 4.8).
- Running diagnostic tests for the QD35 Disk Controller and monitoring the errors reported during the tests (subsection 4.9).
- Running diagnostic tests on the disk drives attached to the QD35 Disk Controller and monitoring the errors reported during the tests (subsection 4.10).

All of the tasks listed above are provided by a series of menus. Figure 4–1 shows an overview of the FRU utility menu structure.

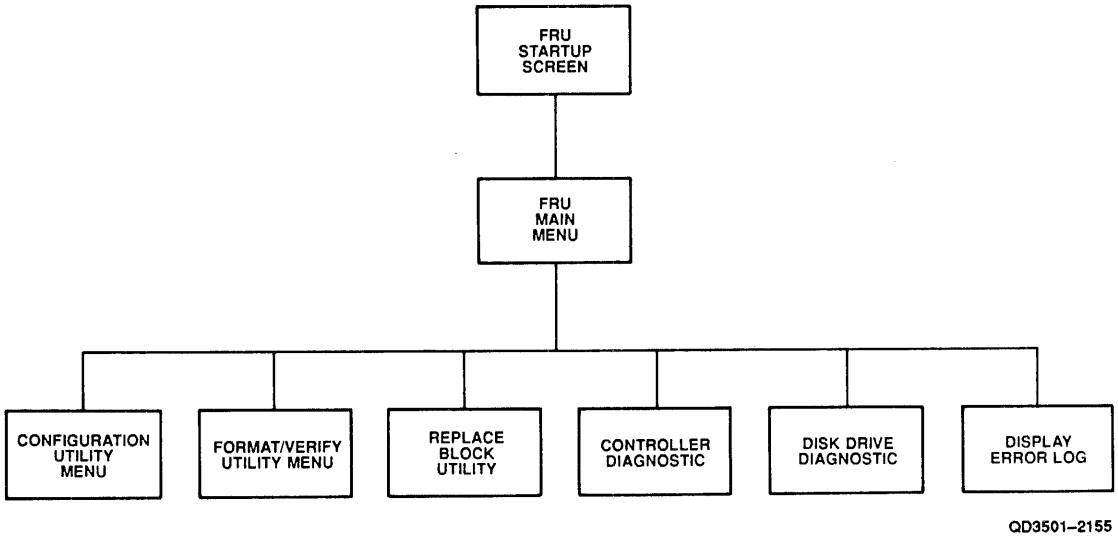


Figure 4–1. FRU Menu Structure

4.2 Starting the FRU

The QD35 Firmware-Resident Utilities (FRU) can be executed from the host console or from the QD35 onboard serial port with an attached local terminal. These two methods are described in the following subsections. Emulex recommends that a VT100 or compatible terminal be used for running the FRU. However, a dumb CRT or hardcopy terminal can be used. The terminal must be set for 9600 baud while you are running the FRU. When running the FRU, the host system must be in shutdown or offline mode.

Several different procedures can be used for starting the FRU, depending on what type of host system you have, whether you are using a serial terminal attached to the QD35 serial port, and whether your base I/O address for the QD35 is already set (you have already run the FRU once and set your controller options parameters). The following subsections describe three startup procedures for MicroVAX systems and another set of procedures for LSI-11 host systems.

4.2.1 MicroVAX FRU Startup Procedures

Descriptions of several startup procedures follow. The first is the initial system console startup used before the controller Q-Bus address is specified. The second is an alternate startup method used after the Q-Bus address is specified. A third method allows you to run the FRU at a serial terminal attached to the QD35 serial port.

4.2.1.1 Initial System Console Startup

You should always use the Console Startup procedure or the onboard serial port procedure (subsection 4.2.1.3) the first time you start up the FRU. This allows you to set the controller address so that it does not conflict with other controllers already installed in your MicroVAX system. The following steps are required for starting the FRU from the system console:

NOTE: This method can also be used if you are unsure of your controller's address.

1. Apply power to the system, put the system in console mode, and enter the following commands using the host console in response to the > > > prompts shown in the screen below:

```
>>> I <CR>                                !BUS INIT
>>> D/P/W 20001F40 20 <CR>                !ENABLE MEMORY
>>> D/P/L 20088000 80000000 <CR>          !SET UP MAP 0
>>> D/P/L 20088004 80000001 <CR>          !SET UP MAP 1
```

2. Set the QD35 switch SW1-2 to ON, and set switch SW1-3 to OFF.
3. Toggle the QD35 switch SW1-1 from OFF to ON and then back to OFF. This initiates the uploading of the MicroVAX driver for the FRU.
4. At the >>> prompt, enter the following:

```
>>>S 80
```

   For a GPX workstation, enter the following:

```
>>> S 82
```

When the start procedure is complete, the FRU identifies itself by displaying the firmware revision number and the controller address on the MicroVAX system console, (see subsection 4.3).

NOTE: When you are finished running the FRU, you must reset the QD35 switch SW1-2 to the OFF position before booting up the system.

4.2.1.2 Alternate System Console Startup

If the QD35 has already been installed in the system cabinet, and it is difficult to change the switch settings on the board, an alternate method of starting the FRU on the MicroVAX system console can be used. This procedure allows for the QD35 switches SW1-2 and SW1-3 to be left in the normal OFF position.

To use this procedure, you must know the Q-Bus address for the controller which is not generally used for the initial FRU startup because it may conflict with addresses for other Q-Bus controllers in your MicroVAX system.

1. Apply power to the system, and put the system in console mode.
2. Enter the following commands using the host console in response to the >>> prompt.

   NOTE: In the following commands, XXXX and YYYY are offsets dependent on the address of the QD35 Disk Controller. See Table 4–1 for the available values.

```
>>> I <CR>                              !BUS INIT
>>> D/P/W 20001F40 20 <CR>              !ENABLE MEMORY
>>> D/P/L 20088000 80000000 <CR>        !SET UP MAP 0
>>> D/P/L 20088004 80000001 <CR>        !SET UP MAP 1
>>> D/P/W 2000XXXX 1 <CR>               !INIT CONTROLLER
>>> D/P/W 2000YYYY 3003 <CR>            !ENABLE SPECIAL MODE
>>> D/P/W 20000YYYY 4401 <CR>           !STEP ONE FROM QD35
>>> S 80 <CR>                           !START DRIVER
```

NOTE: For a GPX workstation, enter >>> S 82 instead of >>> S 80.

Table 4–1. MicroVAX Offsets

QD35 CONTROLLER	XXXX	YYYY
172150_8	1468	146A
172154_8	146C	146E
160334_8	00DC	00DE
160340_8	00E0	00E2
160344_8	00E4	00E6
160350_8	00E8	00EA
160354_8	00EC	00EE
160360_8	00F0	00F2
160364_8	00F4	00F6
160370_8	00F8	00FA
160374_8	00FC	00FE
160400_8	0100	0102
160404_8	0104	0106
160410_8	0108	010A
160414_8	010C	010E
160420_8	0110	0112

When the start procedure is complete, the FRU startup screen will display at your station, (see subsection 4.3).

4.2.1.3 Serial Port Startup

This method allows you to set the controller address so that it does not conflict with other controllers already installed in your MicroVAX system. The following steps are required for starting the FRU from a terminal connected to the QD35 onboard serial port:

1. Apply power to the system, put the system in console mode, and enter the following commands using the host console in response to the >>> prompt. Note that the following commands must be sent. If they are not entered, then some of the controller diagnostic tests will fail.

```
>>> I <CR>                              !BUS INIT
>>> D/P/W 20001F40 20 <CR>              !ENABLE MEMORY
>>> D/P/L 20088000 80000000 <CR>        !SET UP MAP 0
>>> D/P/L 20088004 80000001 <CR>        !SET UP MAP 1
```

2. Attach a serial terminal to the serial port connector J9 on the QD35 distribution panel. Set the baud rate for the terminal for 9600 baud, 8 data bits, 1 stop bit, and no parity.
3. Set the QD35 switches SW1-2 and SW1-3 to ON.
4. Toggle the QD35 switch SW1-1 from OFF to ON and then back to OFF.

NOTE: When you are finished running the FRU, reset switches SW1-2 and SW1-3 to OFF before bringing the QD35-III online. Once the QD35 address is saved to the NOVRAM, you can then use the alternate method, which does not require changing the SW1 switch settings.

When the start procedure is complete, the FRU identifies itself by displaying the firmware revision number and the controller address on the serial terminal (see subsection 4.3).

4.2.2 LSI-11 FRU Startup Procedures

Descriptions of three methods for starting the FRU on an LSI-11 system are described in the following subsections. The initialization startup should be used to set the QD35 device Q-Bus address the first time that you run the FRU. The alternate host console startup can be used after the Q-Bus address is set, without having to change any switch settings on the QD35. The serial port startup can be used initially or as an alternate.

4.2.2.1 Initial System Console Startup

System Console Startup allows you to set the controller address so that it does not conflict with other controllers already installed in your LSI-11 system. The following steps are required for starting the FRU from the system console:

1. Make sure that the QD35 switch SW2-1 is set to ON, indicating that the host is an LSI-11 system.
2. Halt the processor.
3. Set the QD35 switch SW1-2 to ON, and set switch SW1-3 to OFF.
4. Toggle the QD35 switch SW1-1 from OFF to ON, then back OFF.
5. Using the ODT, enter the following data at the @ prompts:

```
@ 0G  <CR>

@ R7/ZZZZZZ 200 <CR>

@ P <CR>
```

Typing R7/ displays the current contents of register R7 (represented by zzzzzz). Entering 200 places the value 200 in the R7 register. When this startup procedure is completed, the FRU Startup Screen displays (see subsection 4.3).

NOTE: When you finish running the FRU, you must reset the QD35 switch SW1-2 to the OFF position before booting up the system.

4.2.2.2 Alternate System Console Startup

When the QD35 has already been installed in the system cabinet, and it is difficult to change the switch settings on the board, an alternate method of starting the FRU on the LSI-11 system console can be used. This procedure allows the QD35 switches SW1-2 and SW1-3 to be left in the normal OFF position. (However, switch SW2-1 must be in the ON position to indicate that the host system is an LSI-11.)

NOTE: Do not use the alternate system console startup method for your initial FRU startup, because address conflicts with other Q-Bus controllers in your host system might result.

```
@  177XXXXX/000000 1 <LF>
@  177YYYYY/005400 30003 <CR>
@  /000400  42000  <CR>
@  R7/ZZZZZZ 200  <CR>
@  P <CR>
```

NOTE: XXXXX and YYYYY are offsets that depend on the address of the QD35 Disk Controller. See Table 4–2 for appropriate values. The contents of register R7 is ZZZZZZ before the value 200 is loaded into the register.

Table 4–2. LSI-11 Offsets for MSCP Emulation

QD35 Controller Bus Address	XXXXX	YYYYY
172150_8	72150	72152
172154_8	72154	72156
160334_8	60334	60336
160340_8	60340	60342
160344_8	60344	60346
160350_8	60350	60352
160354_8	60354	60356
160360_8	60360	60362
160364_8	60364	60366
160370_8	60370	60372
160374_8	60374	60376
160400_8	60400	60402
160404_8	60404	60406
160410_8	60410	60412
160414_8	60414	60416
160420_8	60420	60422

4.2.2.3 Serial Port Startup

The serial port startup method allows you to run the FRU at a serial terminal. This method allows you to set the controller address so that it does not conflict with other controllers in your LSI-11 system.

1. Attach a serial terminal to the serial port connector J8 on the QD35 PCBA. Set the terminal for 9600 baud, 8 data bits, 1 stop bit, and no parity.
2. Apply power to the system, and put the system in console mode.
3. Set the QD35 switches SW1-2 and SW1-3 to ON.
4. Toggle the QD35 switch SW1-1 from OFF to ON to OFF.

When this startup procedure is completed, the FRU Startup screen displays (see subsection 4.3).

NOTE: When you are finished running the FRU, reset switches SW1-2 and SW1-3 to the OFF position before booting up the system.

4.3 FRU Startup Screen

After completing one of the above startup procedures, the FRU startup screen displays as shown in Figure 4–2.

NOTE: Do not use VT100 mode on a GPX workstation. At the `VT100-compatible terminal?` prompt, input is very slow when running the FRU on a GPX workstation, you must type slowly when entering multiple character strings.

```
QD35 Firmware-Resident Utilities

Copyright 1989 Emulex Corporation

All Rights reserved
Controller firmware revision: X

Reading NOVRAM

Current controller address:  172150

VT100-compatible terminal? [Y/N, def=Y]

Hardcopy terminal? [Y/N, def=N]
```

Figure 4–2. QD35 FRU Startup Screen

During FRU startup, the current configuration parameters are read from the NOVRAM, and the current controller address displays. You are then prompted to enter the type of terminal you have. The options you enter at the prompts on this display determine the format in which the Firmware Resident Utilities display. Generally, they should reflect the characteristics of the terminal at which you are monitoring the utility display.

Once you have responded to the two prompts, the Firmware Resident Utilities Main Menu displays.

4.4 FRU Main Menu

Figure 4–3 shows the QD35 FRU Main Menu.

```
QD35 Firmware-Resident Utilities

Main Menu

1 - Configuration Utility
2 - Format/Verify Utility
3 - Replace Block Utility
4 - Controller Diagnostic
5 - Disk Drive Diagnostic
8 - Display Error Log

Enter option:
```

Figure 4–3. FRU Main Menu

LED1The configuration utility includes several configuration functions, as shown in Figure 4–4. It allows you to configure your disk drives and your QD35 Disk Controller. It also allows you to edit and create logical partitions and to set disk drive parameters for the NOVRAM.

The Format/Verify utility and the Replace Block utility allow you to prepare the SMD disk drives connected to the QD35 for operation. The controller diagnostic and disk drive diagnostic provide extensive diagnostic testing of the QD35 Disk Controller and its attached drives. The error log contains all of the error messages that occur during the diagnostic tests.

Figure 4–4 shows the configuration utility menu structure. The following subsections show and describe all of the parameter fields included in each submenu of the Configuration Utility Main Menu.

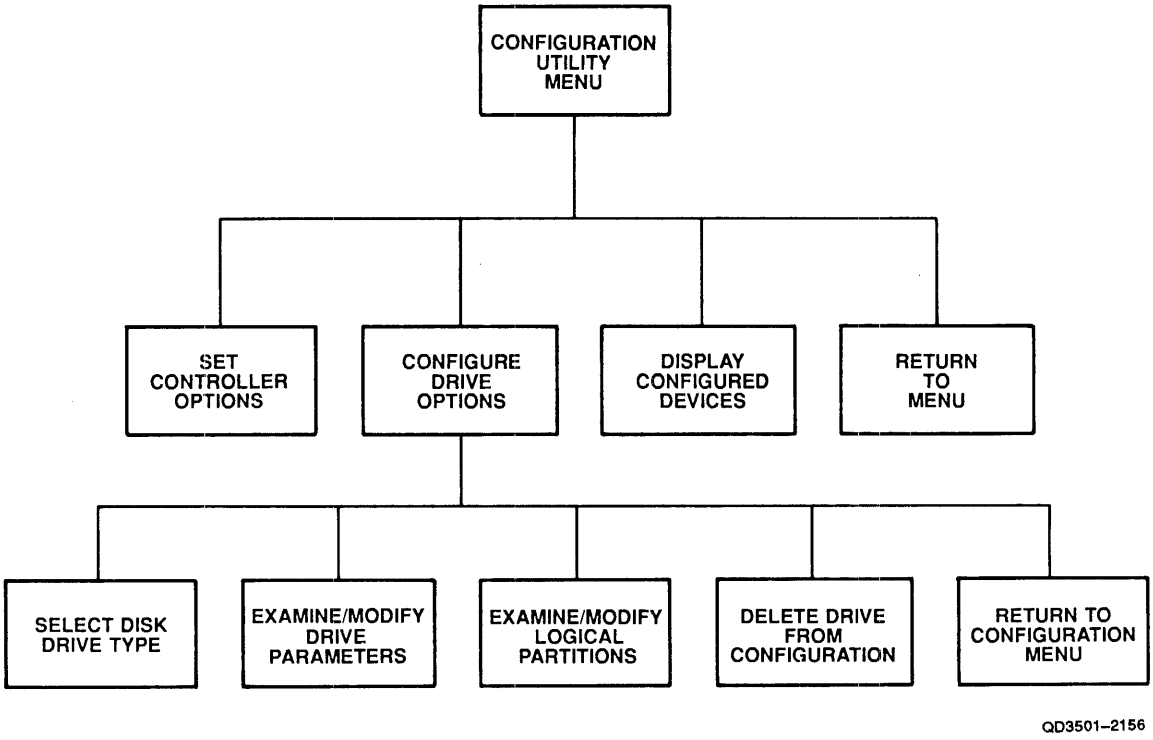


Figure 4–4. FRU Configuration Utility Menu Structure

4.5 Configuration Utility Main Menu

Figure 4–5 shows the QD35 Configuration Utility Main Menu.

```
          QD35  Firmware-Resident Utilities

                  CONFIGURATION MENU

                1 - Set Controller Options
                2 - Configure Drive 0
                3 - Configure Drive 1
                4 - Configure Drive 2
                5 - Configure Drive 3
                6 - Display Configured Devices
                9 - Return to Main Menu

Enter option [def=9]
```

Figure 4–5. Configuration Utility Main Menu

NOTE: You must select Option 9 to return to the Main Menu in order to write any configuration changes to the NOVRAM.

4.6 Set Controller Options Menu

Figure 4–6 shows the Set Controller Options Menu which is accessed by selecting Option 1 on the Configuration Utility Main Menu. The controller options menu is shown with the default values. Descriptions for each field on the controller options menu follow, along with guidelines for selecting values for those parameters.

A highlighted prompt displays at the bottom of the menu for the currently selected parameter. In Figure 4–6, the prompt shown is `Enter octal value between 0 and 177776`, for the controller address parameter. The prompt either indicates the range of values that you may specify for the selected parameter, or tells you to toggle between the acceptable values using the left and right arrow keys.

Entering `<Ctrl-C>` returns you to the Configuration Menu.

```
                QD35 Firmware-Resident Utilities
                      [CONTROLLER OPTIONS]

Controller Address: [172150]      Autoboot unit number: [0]
Adaptive DMA: [Enabled]  DMA burst length: [16]  DMA burst delay: [2]
Command queue size: [16]
Seek opt. algorithm: [Elevator]  Seek optimization fairness count: [16]
Disk caching: [Enabled]  Maximum transfer size to cache (blocks): [32]
Minimum number of blocks to read-ahead: [4]  Max. no. of blocks: [16]
Zero latency read: [Enabled]      Autotune: [Disabled]
Performance Monitor: [Disabled]  Baud rate: [19200]  Int (5 sec): [1]

  Use up/down arrow keys or <Return> to move cursor  <Ctrl-C> to exit

            Enter octal value between 0 and 177776
```

Figure 4–6. Controller Options Menu

The following subsections describe each of the parameters on the Controller Options Menu, including the default value for the parameter and the prompt shown on the display for that parameter.

4.6.1 Controller Address

Every Q-Bus device has a block of several registers through which the host 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. This parameter determines which Q-Bus device address in the host system address space is assigned to the QD35 Disk Controller.

For information on determining the proper Q-Bus address to select, refer to your DEC operating system and host system documentation. The following is a list of the base I/O addresses that you may enter:

172150_8	160344_8	160364_8	160404_8
172154_8	160350_8	160370_8	160410_8
160334_8	160354_8	160374_8	160414_8
160340_8	160360_8	160400_8	160420_8

Prompt: `Enter octal value between 0 and 177776`

Default value: `172150`

4.6.2 Autoboot Unit Number (LSI-11 Only)

If the autoboot option is enabled, this option selects a logical unit number (LUN) between 0 and 7 for the device to be used to autoboot the system. The autoboot feature is available only if all of the following conditions are true:

1. The QD35 is installed in an LSI-11 system (not a MicroVAX system).
2. The QD35 automatic bootstrapping option is enabled (switch SW2-3 ON).
3. The QD35 is at the standard LSI-11 bus address.

Refer to subsection 3.4.6 for more information on the Autoboot feature.

Prompt: `Enter decimal value between 0 and 7`

Default value: `0`

4.6.3 Adaptive DMA Enable/Disable

Adaptive DMA allows prompt access to the Q-Bus for devices other than the QD35 and prevents them from being locked out of DMA activity during long disk data transfers. If adaptive DMA is enabled, the QD35 monitors the Q-Bus. When it detects a Bus Grant Acknowledge (BSACK) signal, indicating that another device on the bus is requesting bus mastership, the QD35 terminates DMA during the current DMA burst (after one or two additional word-length DMA cycles) and then waits for the length of time specified in the burst delay field.

This parameter can be set to disable adaptive DMA. If adaptive DMA is disabled, the QD35 does not monitor the Q-Bus and other devices may access the Q-Bus only between DMA bursts. This might be desirable in a system where there is a lot of interactive terminal activity. In these cases, the CPU may request the bus to service interrupt requests that prevent the QD35 from performing efficient DMA activity.

When adaptive DMA is enabled, other DMA devices may prevent the QD35 from accessing the bus. The DMA burst length and burst delay should be set differently for adaptive DMA enabled versus disabled, as described in the following subsections.

Prompt: `Select value using left/right arrow keys`

Default: `Enabled`

4.6.4 DMA Burst Length

The DMA burst length determines how much data is transferred at one time while the QD35 has control of the Q-Bus. A different burst length is appropriate depending on whether adaptive DMA is enabled or disabled.

With adaptive DMA enabled, control of the Q-Bus can be transferred to other devices in the middle of a DMA burst, so the burst length may be relatively short. The default burst length of 16 words is appropriate when adaptive DMA is enabled.

If adaptive DMA is disabled, other devices may contend for the Q-Bus only during burst delays, rather than during a DMA burst. In this situation, a shorter burst length such as eight words should be specified so that DMA burst delays will occur more frequently. In addition, you may wish to increase the burst delay time (described in the following subsection).

Prompt: `Enter decimal value between 1 and 16`

Default value: `16`

NOTE: The burst length can be changed with this menu selection per MSCP port requirements. That is, the defaults are in effect until the operating system gives the QD35 another value.

4.6.5 DMA Burst Delay

The QD35 firmware design includes a programmable delay period between DMA bursts to allow adequate time for other devices to access the bus. A different burst delay time is appropriate depending on whether adaptive DMA is enabled or disabled.

With adaptive DMA enabled, the DMA burst delay time can be relatively short, since other devices may access the bus during the DMA transfers. However, a longer burst delay than the default (2 microseconds) might be needed to allow other devices adequate time on the bus. You may specify a value for the burst delay between 2 and 32 microseconds.

NOTE: A minimum delay of four microseconds may be required on LSI-11 systems for proper operation.

If adaptive DMA is disabled you should increase the burst delay to allow a longer time interval during which other devices can access the bus. The recommended value is two microseconds for the MicroVAX and four microseconds for the LSI-11.

Prompt: `Enter decimal value between 2 and 32`

Default value: `2 microseconds`

4.6.6 Command Queue Size

A buffer on the QD35 can store up to 32 MSCP commands. This option field allows you to select how many MSCP commands will be queued in the MSCP command buffer at one time. The QD35 Performance Monitor Command Queue Statistics display may be used to help in determining how to set the QD35 configuration parameter specifying the command queue size (described in subsection 5.5). The seek optimization algorithms can operate more effectively if there are plenty of command buffers for bringing in new commands from the host. On the other hand, too many unused command buffers will waste buffer space that could be used for data transfers.

Prompt: `Enter decimal value between 2 and 32`

Default value: `16 commands`

NOTE: When running the Ultrix operating system, setting this parameter too high may result in a system crash. The total outstanding command queuing for the system should not exceed 24.

4.6.7 Seek Optimization Algorithm

One of the following four algorithms may be selected for seek optimization: Elevator, Nearest, Sawtooth, or None. Elevator, the default setting, and the other choices are described below:

- The Elevator seek algorithm (default setting) processes commands as the head moves in one direction until there are no more commands for that direction. The positioner then reverses travel direction and continues processing commands.
- The Nearest algorithm processes the command that requests the next nearest location regardless of travel direction.
- The Sawtooth algorithm moves the head from outer to inner tracks until there are no longer any requests in that direction. The process then starts over beginning with the outer-most cylinder.
- None – If you choose not to select an algorithm, the drive commands are processed in the order received.

Prompt: `Select value using the left/right arrow keys`

4.6.8 Seek Optimization Fairness Count

This parameter is used by the seek optimization algorithms to prevent a command from waiting too long to be executed. The fairness count specifies the maximum number of new commands that can be placed before a pending command. The default setting is 16.

Prompt: `Enter decimal value between 8 and 32`

Default value: `16 commands`

4.6.9 Disk Caching Enable/Disable

This parameter, which enhances QD35's performance, enables or disables use of the one megabyte of cache memory onboard the QD35.

NOTE: Several other parameters on different FRU menus affect the performance of the disk caching function. Disk caching can be enabled for particular partitions on each disk drive attached to the QD35 (see subsection 4.7.3).

In addition, a maximum transfer size to and from the cache memory and a maximum number of blocks to read ahead into the cache memory can also be set, as described below.

Prompt: `Select value using left/right arrow keys`

Default value: `Enabled`

4.6.10 Maximum Transfer Size to Cache (Blocks)

This parameter selects the maximum number of 512-byte blocks that can be transferred in one command to the megabyte of cache memory on the QD35 controller. The acceptable range of values is from 1 to 64 blocks (512 bytes through 32K bytes). This parameter prevents a few large transfers from flushing out many frequently accessed blocks in the QD35 cache memory. The default transfer size is 32 blocks. The Performance Monitor disk caching statistics display (described in subsection 5.3) provides information to help determine whether the default parameter value should be modified to improve performance on your system.

Prompt: `Enter decimal value between 1 and 64`

Default value: `32 (512-byte blocks)`

4.6.11 Minimum Number of Blocks to Read-ahead

This parameter specifies the minimum number of additional unrequested sectors that are read into cache memory on each read command. The additional sectors are read, since in many cases the operating system will request them on the next read command.

Prompt: `Enter decimal value between 1 and 64`

Default value: `4 (512-byte blocks)`

4.6.12 Maximum Number of Blocks to Read-ahead

This parameter specifies the maximum number of additional unrequested sectors that are read into cache memory for each read command. The additional sectors are read ahead since in many cases they will be requested next by the operating system. The QD35 will keep reading additional sectors until one of the two following conditions are met:

- The QD35 has read in the maximum number set by this parameter
- The QD35 has finished transferring the requested number of blocks from cache memory back into host memory, is ready to complete the read command, and has read the minimum number of read-ahead blocks into the cache memory.

Prompt: `Enter a decimal value between 0 and 64`

Default value: `16 (512-byte blocks)`

4.6.13 Zero Latency Read Enable/Disable

With the zero latency read feature enabled, the QD35 attempts to minimize the disk rotational latency on read commands by fragmenting the data transfer. Requested sectors that are immediately accessible from the disk are transferred first, instead of waiting for the first sector of the request to come under the head. This option should be enabled for the best performance on the QD35.

Prompt: `Select value using left/right arrow keys`

Default value: `Enabled`

4.6.14 Autotune Enable/Disable

This parameter enables or disables the QD35 Autotune feature. When Autotune is enabled, the QD35 monitors the current I/O work load on the QD35 and makes adjustments to several of the caching and read-ahead parameters, in order to optimize controller performance.

Once every minute, the QD35 calculates the average transfer size for all Read commands processed in the past minute. Based on this value, adjustments are then made to the following parameters: maximum transfer size to cache and minimum and maximum number of blocks to read-ahead.

Prompt: `Select value using left/right arrow keys`

Default value: `Enabled`

4.6.15 Performance Monitor Enable/Disable

This parameter field enables or disables the QD35 Performance Monitor. The Performance Monitor includes four displays that allow you to monitor the following four types of statistics:

- Read/Write statistics
- Caching statistics
- Seek statistics
- Command queueing statistics

Section 5 of this manual describes the Performance Monitor in detail. The value is toggled between Enabled and Disabled.

4.6.16 Baud Rate

This parameter field selects a baud rate for running the Performance Monitor only. This parameter is not used for running the FRU, which must run at 9600 baud. It is recommended that the performance monitor run at 19200 baud to reduce the overhead and performance impact in updating the displays. The baud value for this option is toggled between 9600 and 19200.

Prompt: `Select value using left/right arrow keys`

Default value: `19200 baud`

4.6.17 Interval (5 Second Units)

This option field selects an interval that updates the performance monitor statistics display in units of 5 seconds. With a value of one, the display updates every 5 seconds. Increasing this parameter reduces the overhead in running the performance monitor.

Prompt: `Enter decimal value between 1 and 60`

Default value: `1 (5 seconds)`

4.7 Configuration Disk Drive Menus, Drives 0-3

Selecting Drive 0, 1 2, or 3 on the Configuration Utility Menu (Figure 4–5) transfers you to the Configuration Disk Drive Menu (Figure 4–7), which allows you to configure the four SMD disk drives attached to the QD35 Disk Controller.

The menus for each of the four drives are the same, except for the drive number. The examples that follow specify drive 0, but are the same for drives 1, 2, or 3.

```
QD35 Firmware-Resident Utilities

        CONFIGURE DRIVE 0

        1 - Select Disk Drive Type
        2 - Examine/Modify Drive Parameters
        3 - Examine/Modify Logical Partitions
        4 - Delete Drive From Configuration
        9 - Return to Configuration Menu

Enter option [def=9]:
```

Figure 4–7. Configuration Disk Drive Menu

Entering <Return> brings you back to the Configuration Utility Main Menu.

4.7.1 Select Disk Drive Type

This option displays the Select Disk Drive Type Menu, shown in Figure 4–8. A list of disk drives supported for the QD35 is supplied, and you are prompted to select a drive type number. If your drive is not on the list, then select item 1, Unknown Type. Figure 4–8 shows the Select Drive Type Menu.

```
                    QD35 Firmware-Resident Utilities

                        SELECT TYPE FOR DRIVE 0


1--Unknown type          11--CDC 9720-1230        21--Fujitsu M2361A

2--CDC LMD 9457          12--CDC 9771 XMD         22--Fujitsu M2381K

3--CDC 9710-80           13--CDC 9772 XMD         23--Fujitsu M2382K

4--CDC 9725-340          14--CDC 9772-13 XMD      24--NEC 2352

5--CDC 9715-515          15--CDC 315              25--NEC 2362

6-- 9720-368             16--Fujitsu M2298        26--NEC 2363

7--CDC 9720-500          17--Fujitsu M2321        27--Telecom 2312-50

8--CDC 9720-736          18--Fujitsu M2322        28--Toshiba MK-186FB

9--CDC 97120-750         19--Fujitsu M22333       29--Toshiba MK-286FC

10--CDC 9720-850         20--Fujitsu M2351

                                                  <Ctrl-C> to exit

  Enter drive type number:
```

Figure 4–8. Select Drive Type Menu

After you select a disk drive type (Figure 4–8), that you will be installing as the selected drive (0, 1, 2, or 3), the Examine/Modify Logical Partitions Menu displays. This menu is used for defining the desired partitions (logical devices) on the selected disk drive.

4.7.2 Examine/Modify Drive Parameters

Figure 4–9 shows the Examine/Modify Drive Parameters Menu, with the default parameter values for a CDC 9720-850 disk drive. Once the correct disk drive is selected, all the parameters recommended by Emulex for that drive are automatically displayed. You should not change the values for the parameters that are displayed for that disk drive. Appendix B summarizes all of the recommended parameters for supported disk drives shown on this menu.

NOTE: To save these disk drive configuration parameters you have selected to NOVRAM, you must return to the Main Menu by entering <Ctrl-C>.

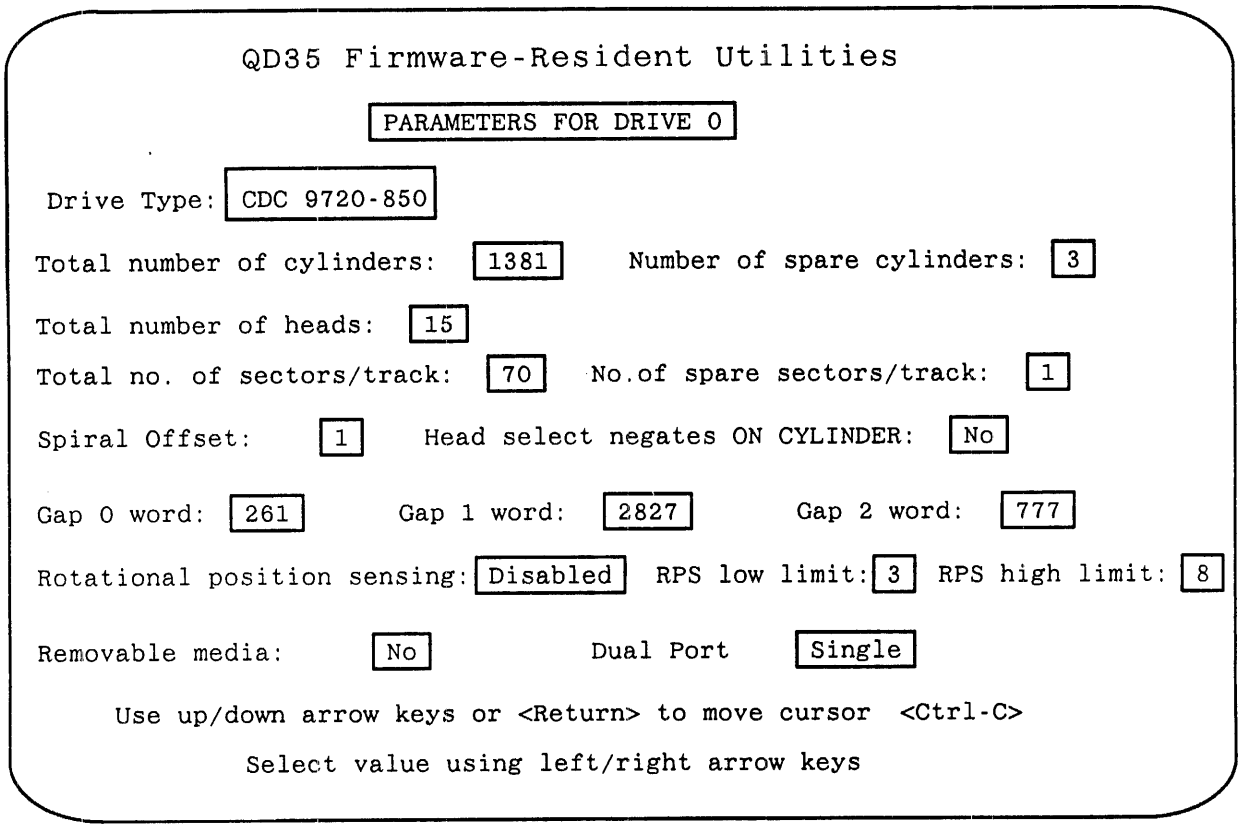


Figure 4–9. Examine/Modify Drive Parameters Menu

If you are using a drive that is not included on the Select Drive Menu, then you should select `Unknown Type` for the drive type. You will also have to calculate and enter the parameter values for that drive. The prompt at the bottom of the display indicates the range of values for the currently selected parameter field. The prompt, `Select value using left/right arrow keys`, is for the drive type field.

Descriptions for each disk drive parameter field are provided to help you select parameters for an Unknown Drive type:

- **Drive Type:** The drive type shown is the one chosen from the numbered list provided by Option 1, Select Disk Drive Type. If the type does not match the drive type you have selected, use the left and right arrow keys to toggle to all of the other supported drives. Changing the drive type from this menu does not change the other parameters on this menu. Use the Select Drive Type Menu to reset all of the parameters for a different drive type.

  Prompt: `Select value using left/right arrow keys`

- **Total number of cylinders:** This field specifies the total number of physical cylinders per drive, including spares. The valid range is from 4 through 4096

  Prompt: `Enter decimal value between 4 and 4096`

- **Number of spare cylinders:** This field specifies the number of spare cylinders per physical drive. The valid range is from 1 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.

  Prompt: `Enter decimal value between 1 and 15`

- **Total number of heads:** This parameter specifies the total number of data heads per physical drive. The valid range is from 1 through 64.

  Prompt: `Enter decimal value between 1 and 64`

- **Total number of sectors/track:** This parameter specifies the total number of physical sectors per track, including spares. The valid range is from 2 through 255.

  Prompt: `Enter decimal value between 2 and 255`

- **Number of spare sectors/track:** This parameter specifies the number of spare sectors reserved per track. This number plus the number of logical sectors per track equals the total number of physical sectors per track. The valid range is 0 or 1. If 0 is specified, no spare sectors are reserved. Emulex recommends a value of 1; larger values unnecessarily reduce the capacity of the drive.

  Prompt: `Enter decimal value of 0 or 1`

- **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 switch heads from track to track before encountering sector 0. The default value is based on format compatibility with the QD32, QD33 and QD34 controllers. If this is not a compatibility issue, then a value of 0 (zero) allows maximum performance. If your drive uses an embedded servo, use a minimum value of 1. The valid range is from 0 through 31.

  Prompt: `Enter decimal value between 0 and 31`

- **Head select negates ON CYLINDER:** This option specifies whether or not the disk drive negates the ON CYLINDER signal during a head select operation. Refer to Appendix B or your disk drive documentation when setting this option.

  Prompt: `Select value using left/right arrow keys`

- **Gap 0, 1, and 2 words:** The Gap 0, 1, and 2 parameters specify the recording format for each sector on the drive. The recording format allows gaps, for example, between header and data fields. These gaps are based on a formula intended to allow the drive time for read/write transitions while maximizing data capacity.

The values Emulex recommends for qualified drives contained in Appendix B, are factory configuration values for the specified drives and are the parameters used to qualify those drives for use with the QD35. If any of these factory parameters is altered, the QD35 might not support the disk drive. The following prompt is provided for all three gap words:

Prompt: `Enter a decimal value between 0 and 9999`

- **Rotational Position Sensing:** Rotational Position Sensing (RPS) increases the performance of the disk subsystem during data transfer when two drives are active. RPS allows the controller to determine which drive is rotational closest to any of the data transfers in the controller command buffer. By matching data transfers with the drive rotational closest to that command, the rotational latency is reduced; as a result, subsystem throughput increases.

  The High and Low Limit parameters on the menu, when defined, determine when the drive will perform RPS. Recommended values are given in the Drive Configuration Parameter Value table in Appendix B. If you need to calculate the decimal value for each drive, a minimum value of 1 and a maximum value of 15 is obtainable. These values correspond directly to the number of sectors ahead on the disk that make up the RPS window.

  If RPS is enabled, the controller looks at the drive's current sector number after an initial seek is completed for that drive and calculates how far away the target sector is. If the sector is not found in the RPS window, the next drive that is executing a seek undergoes the same process.

  The recommended lower RPS limit ensures adequate time for proper controller response. Lowering this value decreases performance by causing extra disk revolutions; since the disk is still spinning between the time the seek command is issued and the time the seek is begun. The optimal high limit for RPS depends heavily on system factors, such as drive types and operating system usage. Though the recommended value is the optimal one for most applications, it is possible that small adjustments could increase system performance.

  For example, if you have a two-drive system consisting of Drive 0 with a 2.4M byte/second drive and Drive 1 with a 1.2M byte/second drive, you would expect to see about twice as many I/O operations completed on Drive 0 as on Drive 1. By setting the Drive 0 RPS value to a low upper limit, and by setting the Drive 1 RPS value to a high upper limit, the number of completed I/O operations will even out significantly. On a heavily loaded system, this will result in more efficient overall subsystem performance.

If only one drive is used with the QD35, RPS should be disabled. You should also disable RPS if you are unfamiliar with the geometry of each of your drives.

Rotational Position Sensing is enabled or disabled with the right and left arrow keys used as a toggle switch.

Prompt: `Select values using left/right arrow keys`

NOTE: Index and Sector signals must be on the B cable for RPS to function. See subsection 3.4.7 for information on setting switch SW2-4 to specify the B cable for Index and Sector signals.

- **RPS low limit:** Recommended values are given in the drive configuration parameter table in Appendix B. If you need to calculate the decimal value for each drive, a minimum value of 1 and a maximum value of 14 is obtainable. These values correspond directly to the number of sectors ahead on the disk that make up the RPS window.

  Prompt: `Enter decimal value between 1 and 14`

- **RPS high limit:** The drive configuration parameter table in Appendix B lists the recommended values for supported drives on the Select Disk Drive Type Menu. If you have a drive that is not listed, you can select a value in the range from 2 to a maximum of 15. These values correspond directly to the number of sectors ahead on the disk that make up the RPS window.

  Prompt: `Enter a decimal value between 2 and 15`

- **Removable media:** This parameter indicates whether the disk media is fixed or removable.

  Prompt: `Select value using left/right arrow keys`

- **Single and dual port options:** If your firmware (Revision K and above) and system configuration support dual porting with MSCP controllers, the dynamic dual port mode, static dual port mode, and single port mode (the default) are displayed. The single and dual port applications are described below.

  NOTE: Since the drive's port is controlled by physical addressing, logical splitting of any dual-ported drive is not supported.

  - Single port mode is the default setting; multiple port access is not supported under any condition. Single port mode should be selected on drives that do not support dual port or drives that do not require multiple-access paths.
  - Dynamic dual port mode is used for systems that must share the drive between two different controllers. The drive is available to both controllers and will seize and release the port for each drive command. The only limitation is that of read/write access from two different systems. Only **one** system may have read/write abilities, the other **must** be mounted read only (nowrite), unless you provide special software to overcome these limitations.
  - Static dual port mode is typically used for Local Area Vax Cluster (LAVC) systems that require failover protection. This mode allows a controller to seize one port when the drive is mounted and lock out the other port (until the drive is dismounted). The drive appears offline to the controller that has not reserved the port, forcing all drives accesses through a single controller. The MSCP server then decides to use either a local access path or Ethernet for communication. Should failover occur in a LAVC system that has reserved the drive, the port is released and made available to the other controller. The VMS software is then able to select the drive and mount it.

    If no commands are processed within 500 msec in systems that require failover, the controller releases the drive. To properly support failover, the drive must have reserve timer ENABLED.

    In LAVC systems failover operations are fully software dependent, and many versions of VMS show problems with failover. Contact Digital Software Support to confirm the correct VMS version that supports this function. Follow the prompt to select one of the port options.

    Prompt: `Select value using left/right arrow keys`

4.7.3 Examine/Modify Logical Partitions

Figure 4–10 shows the Examine/Modify Logical Partitions Menu. A maximum of four partitions may be defined for each drive.

CAUTION! The QD35 can support a maximum of 16 logical drives. All logical drives configured in the NOVRAM are reported as available to the operating system. Some operating systems place a limit on the number of logical drives that can be supported on a single controller and may crash or fail to complete the sysgen process if the limit is exceeded. Do not configure the NOVRAM with more logical drives than your operating system can support for one controller. Refer to your operating system documentation to determine that maximum number of logical drives supported for the QD35.

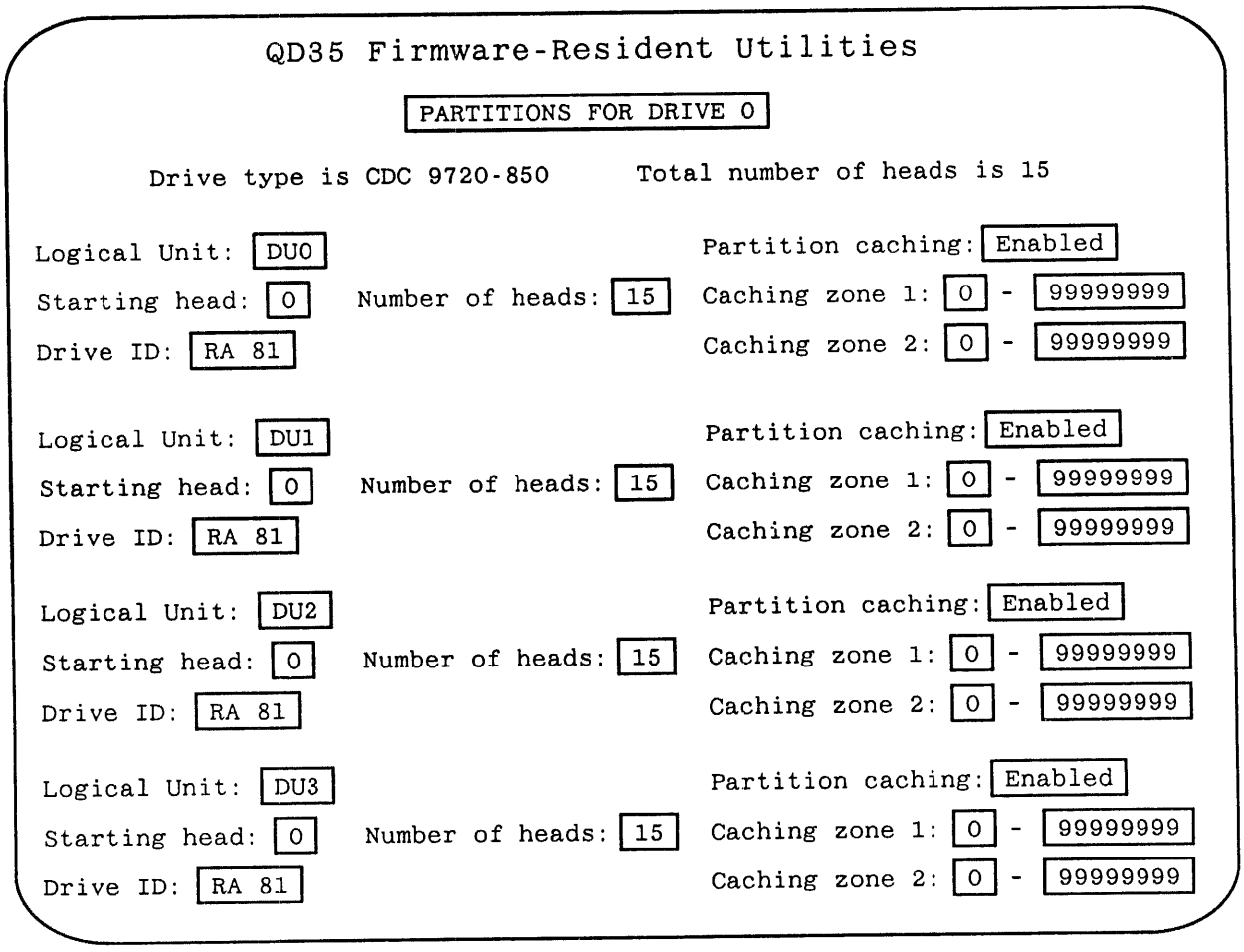


Figure 4–10. Examine/Modify Logical Partitions Menu

Descriptions follow for each of the fields on the Examine/Modify Logical Partitions menu, along with the prompts displayed at the bottom of the display screen for that menu. The drive type and total number of heads fields apply to the entire disk drive. The remaining fields repeat for each partition on the specified disk drive.

- **Drive Type:** This field displays the type of drive chosen from the Select Drive Type Menu (Figure 4–8).
- **Total number of heads:** This field displays the total number of heads on the selected drive. The drive can be partitioned into a maximum of four logical devices by dividing the drive's data heads among the logical devices.

Descriptions of the fields that repeat for each disk partition follow:

- **Logical Unit:** Each disk partition is identified by a unique logical unit number. Note that all defined partitions on all drives must have unique logical unit numbers and the unit numbers must all be contiguous. After defining the partitions on all connected drives, you should select Option 6 from the Configuration Utility Main Menu to verify that the unit numbers are set correctly.
- **Starting head:** This parameter specifies the starting or first head number to assign to this partition. All heads assigned to this partition will be sequenced, starting with this head number.
- **Number of heads:** This parameter specifies how many data heads are to be used for this partition. If you are not partitioning the drive, then set this parameter to the total drive head count for the first partition and set it to 0 for the other three partitions.
- **Drive ID:** The drive ID indicates the type of disk drive for the partition. There are two subfields within this field, one for the three-letter mnemonic for the drive and the other a three-digit identifier.

  Prompt (ID letters): `Enter character string, A through Z`

  Prompt (ID number): `Enter decimal value between 0 and 127`

- **Partition caching:** This option field either enables or disables disk caching for the specified disk partition. Individual logical devices can be disabled from using cache memory. By default, caching is enabled on all partitions.

  Prompt: `Select value using left/right arrow keys`

- **Caching zone 1: and Cashing zone 2:** The numbers you enter in the caching zone fields indicate the starting and ending logical block numbers (LBN) within the specified partition from which transfers may be placed in the cache memory onboard the QD35. The two caching zones may not overlap. Each number must be in a range between 0 and 99999999. Caching is enabled for the entire partition by default.

  Prompt: `Enter decimal value between 0 and 99999999`

4.7.4 Delete Drive from Configuration

When Delete Drive From Configuration from the Disk Drive Configuration Menu is selected, the FRU displays this warning for the currently selected drive.

```
WARNING - All data on disk drive will be lost
Do you wish to continue? [Y/N]
```

If you enter Y, the drive will no longer be configured by the QD35, and the data can not be accessed.

4.7.5 Saving Disk Drive Configuration Changes to NOVRAM

To save disk drive configuration changes to NOVRAM, you must be in the FRU Main Menu and select Option 9, Display Configured Devices. A prompt then appears asking you if you want to save the device configuration to the NOVRAM (see Figure 4–11). If you enter "Y", any changes made to the disk drive configuration is written to NOVRAM. Return to the FRU Main Menu, following this path:

Disk Drive Configuration Menu ➧ Configuration Utility Main Menu ➧ FRU Main Menu.

4.7.6 Display Configured Devices

The Configuration Utility Main Menu, Option 6, Display Configured Devices, or Option 9, Return to Main Menu, display the screen below (see Figure 4–11).

```
                QD35 Firmware-Resident Utilities

                    CONFIGURED DISK DEVICES

Unit #   Blocks     Heads Used   Drive #   Disk Drive Type     Media Type
DUO      1424367    0-14         0         CDC 9720-850        RA81

          Write configuration changes to NOVRAM [Y/N, def=Y]
```

Figure 4–11. Display Configured Devices

This display shows any errors in the disk drive configuration. Enter <CR> to return to the Configuration Utility Main Menu.

4.7.7 Return to Main Menu

Selecting Option 9, Return to Main Menu, takes you back to the Main Menu. Before returning, the currently configured devices display as shown in Figure 4–11, and you will be prompted to write the current configuration data to the NOVRAM on the QD35 controller. Duplicate unit numbers and non-contiguous unit numbers will be flagged as errors at this time and must be corrected before returning to the Main Menu.

4.8 Format/Verify/Replace Block Mode

The Format/Verify/Replace Block utility, Option 2 and 3 on the QD35 Firmware-Resident Utilities Main Menu, allows you to prepare the SMD disk drives that you have attached to the QD35 controller for operation. Figure 4–12 shows the Format/Verify/Replace Block Menu.

```
QD35 Firmware-Resident Utilities

FORMAT/VERIFY/REPLACE BLOCK MENU

1-Build Procedure List
2-Execute Procedure List
8-Display Error Log
9-Return to Main Menu

Enter option [def=9]:
```

Figure 4–12. Format/Verify/Replace Block Menu

NOTE: The drive format, surface verification, and manual block replacements must be performed while either the controller is idle on the other port or the drive has only one port enabled.

The Format option is used to initially format a disk drive. The operation writes sector headers and initializes the disk drive's RCT tables. It is used to format a new disk drive, a drive that has been determined to contain unusable data, or a drive with a format that is improper to use with the QD35 controller. After formatting, the disk drive contains a valid RCT with a serial number you have specified.

The Verify option does write/read operations on all user-available blocks on the disk. The FRU uses the four worst-case data patterns to find and replace pattern-sensitive defective blocks. Verify operations are performed on one cylinder at a time. During Verify operations, the FRU disables all controller error recovery capabilities so that a sector is replaced for any repeatable single bit error. When a block is replaced, all four patterns are rerun on the same cylinder to ensure that replacement blocks are also verified.

The Replace Block option is used to manually reassign a known defective block on the disk. This option is normally not used when installing a disk drive on the QD35, since bad blocks are automatically found and replaced with the Verify option. The block to be replaced can be specified in one of two formats: the logical block number (LBN) or bytes from index.

In order to format and verify a disk drive and to replace any bad blocks on the disk drive, take the following steps:

1. Build a procedure list that allows you to specify which disk drives you wish to select for the Format/Verify/Replace bad block procedure (menu item 1).
2. After building the procedure list, execute that procedure list to actually start the format, verify, and replace bad block operations (menu item 2).
3. As a last step, you should display the error log to check for any errors that occurred during the format, verify, and replace bad block procedures (menu item 8).

4.8.1 Building a Procedure List

Select Option 1 to build a procedure list. Figure 4–13 shows the screen display when you select the Build Procedure List option.

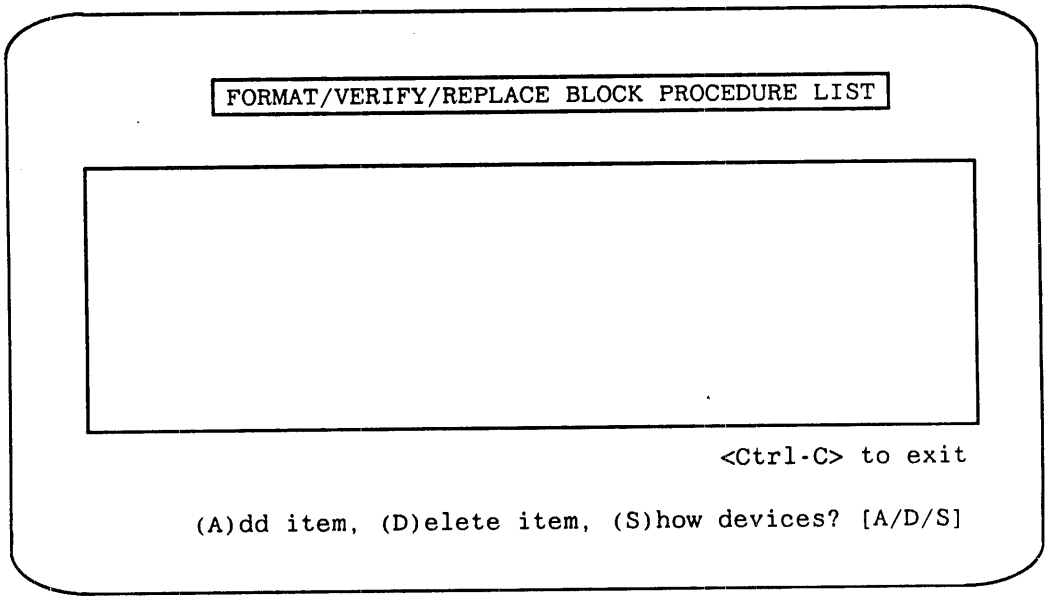


Figure 4–13. Format/Verify/Replace Block Procedure List

To start building a procedure list, select the (A)dd option. A list of prompts then displays, asking you to select one or more utility: format, verify, or replace bad blocks. This is followed by another prompt asking you to identify which disk drive the utility will affect.

The Delete option edits out an entry from the procedure list that you are building. The Show Drives option allows you to refer to the currently configured disk devices as shown in Figure 4–13 when you are building the procedure list.

Figure 4–14 shows an example of the prompts and responses that are needed to build a procedure list. As you will notice, after each procedure is defined and ready to add to the procedure list, you are prompted for a new list item, until you specify <Ctrl-C> to indicate that your procedure list is complete.

```
(A)dd item, (D)elete item, or (S)how devices? [A/D/S]:
A<CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: F<CR>
Enter logical unit number [0-255]: 2<CR>
Enter drive serial number [0-65535] 12345<CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: V<CR>
Enter logical unit number [0-255]: 2<CR>
Nondestructive read-only verify? [Y/N, def=N]: N<CR>
Enter number of verify passes [1-255, def=1]: 6<CR>

(F)ormat, (V)erify, or (R)eplace block? [F/V/R]: R<CR>
(B)ytes from index or (L)ogical block number? [B/L]: L<CR>
Enter logical unit number [0-255]: 2<CR>
Enter logical block number to replace: 654321<CR>
```

Figure 4–14. Build Procedure List Example

Enter <CR> to exit from the procedure list prompts and return to the procedure list window. After building a procedure list with the entries shown in Figure 4–14, the resulting procedure list would display, as shown in Figure 4–15.

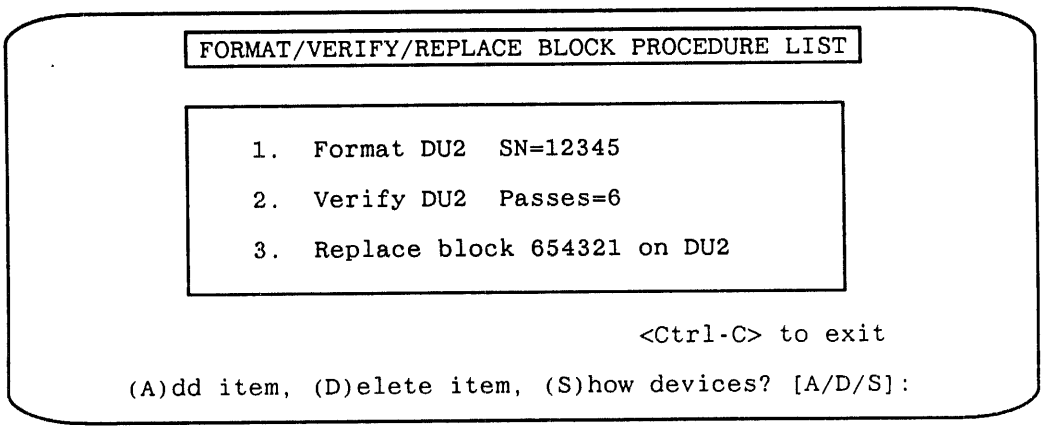


Figure 4–15. Executing Block Procedure List

4.8.2 Executing a Procedure List

Select Option 2 to execute the procedure list previously built through Option 1. The procedure list will display, along with a warning message. The warning message states that execution of the procedure list may result in lost data on a disk drive. You will be prompted to continue. Review all of the entries in the procedure list very carefully before entering Y to continue. If there is a mistake in the displayed procedure list, type N in order to edit the procedure list before continuing.

The status messages reported as the Procedure List executes are shown in Figure 4-16.

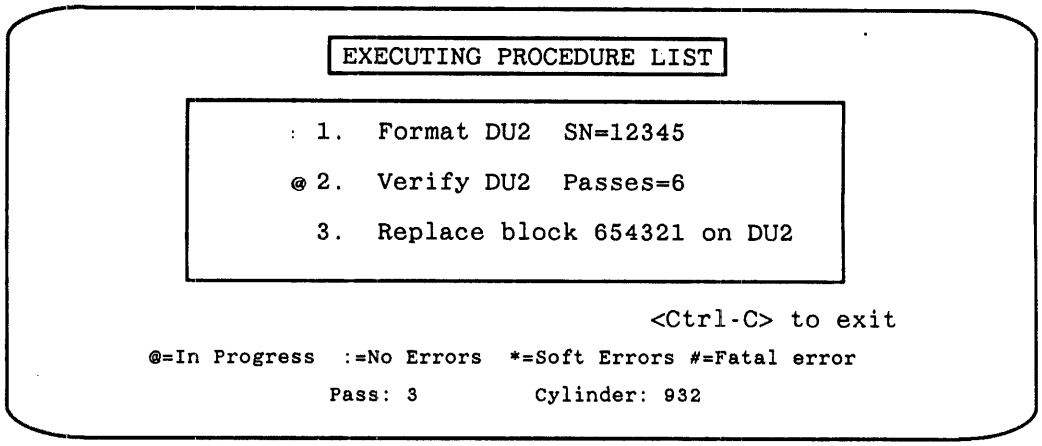


Figure 4–16. Procedure List Status Messages

If any errors occur during the Format/Verify/Replace Block operations, they are stored in an error log rather than being displayed during the Format operation. To review the list of errors, select Display Error Log (Option 8) on the Format/Verify/Replace Block menu.

4.9 QD35 Diagnostic Menus

Option 4 on the FRU Main Menu directs you to the Controller Diagnostic Menu. The diagnostics should be run before you place the QD35 Disk Controller online. Separate tests apply to different chips and functions provided by the QD35, as described below.

In addition to the extensive diagnostic tests described here, there is also a power-up self-test that is automatically performed whenever the QD35 is reset or online. The power-up self-test is described in subsection 6.4. Figure 4–17 shows the controller diagnostics menu.

```
QD35 Firmware-Resident Utilities

CONTROLLER DIAGNOSTIC MENU

  1--Execute All Tests
  2--HAC Chip Test
  3--MAC Chip Test
  4--Cache Memory Test
  5--Scratch Memory Test
  6--Q-BUS DMA Test
  8--Display Error Log
  9--Return to Main Menu

Enter option [def=9]:
```

Figure 4–17. Controller Diagnostic Menu

After you select one of the diagnostic tests from the menu, you are prompted for the number of times to repeat the test (pass count) and whether or not to stop the test if an error is encountered. The format for the display is similar for all of the tests. If errors are encountered, they are stored in the Error Log, rather than displayed in the status window. The status window indicates which test is running, a pass count, and provides a count of the total number of errors encountered. Figure 4–18 shows the resulting status window.

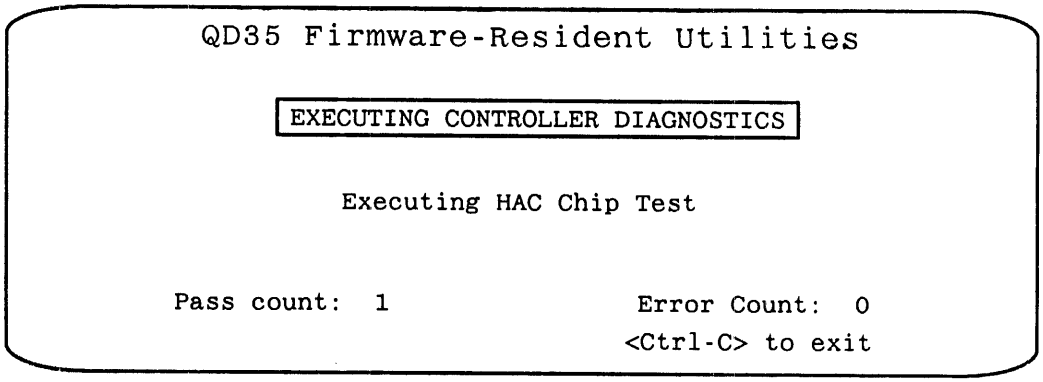


Figure 4–18. Controller Diagnostic Status Messages

4.9.1 Controller Diagnostic Test Descriptions

The HAC chip test verifies that the Host Adapter Controller (HAC) chip on the QD35 is operating correctly. This test uses several different data patterns to test the operation of the HAC chip registers.

The MAC chip test verifies that the Merged Architecture Chip (MAC) on the QD35 is operating correctly. The MAC chip combines the functionality of the disk formatter chip and the buffer controller chip. This test uses several different data patterns to test the operation of the MAC chip registers.

The Cache Memory test exercises the entire one megabyte of cache buffer memory on the QD35. Four different data patterns are written and verified across all of the scratch memory.

The Scratch Memory test exercises the 256K bytes of static RAM on the QD35 controller. Four different data patterns are written and verified across all of the scratch memory.

The Q-Bus DMA test verifies that data can be transferred correctly by means of Direct Memory Access (DMA) between the QD35 buffer memory and the host's system memory. The test starts by setting up a 512-byte data pattern in the QD35 buffer memory. The QD35 buffer controller and the HAC chip are then programmed to send the 512 bytes from the QD35 buffer memory to the host memory by means of DMA. This same data is then transferred from host system memory back to the QD35 buffer memory. The data that has been sent back form the host system memory is then compared to the original data pattern. This test will fail if the host system memory was not initialized properly. See subsection 4.2 for information on FRU startup procedures.

NOTE: Failure to enter the required console commands when starting up the FRU will result in diagnostic test errors. See subsection 4.2 for information on starting up the FRU.

4.10 Disk Drive Diagnostic Menu

If you select Option 5 on the FRU Main Menu, the Disk Drive Diagnostic Menu displays, as shown in Figure 4–19.

```
QD35 Firmware-Resident Utilities

        DRIVE DIAGNOSTIC MENU

    1-Execute All Nondestructive Tests
    2-Index and Sector Pulse Test
    3-Seek Tests
    4-Diagnostic Cylinder Test
    5-Random Read Test
    7-Random Write/Read Test (DESTRUCTIVE)
    8-Display Error Log
    9-Return to Main Menu

Enter option [def=9]:
```

Figure 4–19. Disk Drive Diagnostic Menu

NOTE: To ensure that dual porting is functioning, the Random Read/Write portion of the FRU supports multiple Emulex controllers on the shared disk and allows multiple read/write accesses to test the drive.

Once you have selected a test from the menu, the list of configured disk devices displays, and you will be prompted to enter the unit number to test. As with the controller diagnostic, you will be prompted for a pass count and asked whether or not to stop on error or continue. The disk drive diagnostic status window is similar to the controller diagnostic window; it displays the name of the test currently running, the current pass count, and the error count.

4.10.1 Disk Drive Diagnostic Tests

Descriptions follow for each of the disk drive diagnostic tests:

The Index and Sector Pulse Test verifies that the QD35 is receiving index pulses and sector pulses from the disk drive. If this test fails, check to see that the disk drive is properly cabled to the QD35. This test requires that the index and sector signals are on the B cable. An error will be reported if the signals are only on the A cable.

The Seek Tests include three different tests: a seek timing test, an incremental seek test, and a random seek test. The seek timing test starts by positioning the heads on cylinder 0. The test then verifies that the heads can be moved to the highest cylinder number on the drive within a reasonable amount of time. The

incremental seek test starts at cylinder 0 and does one cylinder seek sequentially across the entire disk. The random seek test does 100 random seeks over the entire disk.

The Diagnostic Cylinder Test operates on the two designated diagnostic cylinders at the end of the disk. These two cylinders are not part of the user area on the disk. The test starts by reformatting the diagnostic cylinders. A data pattern is then written across the two cylinders and then a write check pass is made to verify the data was written correctly and can be read correctly. The write and write check passes are repeated 16 times with a different data pattern each time.

The Random Read Test performs 1000 random read operations across the entire disk. For each read operation, the starting block number and the number of blocks to read are randomly computed. This test will optionally replace any bad blocks encountered during the test.

The Random Write/Read Test performs 1000 random write/read operations across the entire disk drive. For each operation, the starting block number and the number of blocks to transfer are randomly computed. A data pattern is first written to the disk and then a write check command is issued to verify that the data was correctly written and can be read correctly. Sixteen different data patterns are used in rotation, one per write/read operation. This is a destructive test; data in the user area will be destroyed. This test will optionally replace any bad blocks encountered during the test.

Figure 4–20 shows the resulting disk drive diagnostic status window.

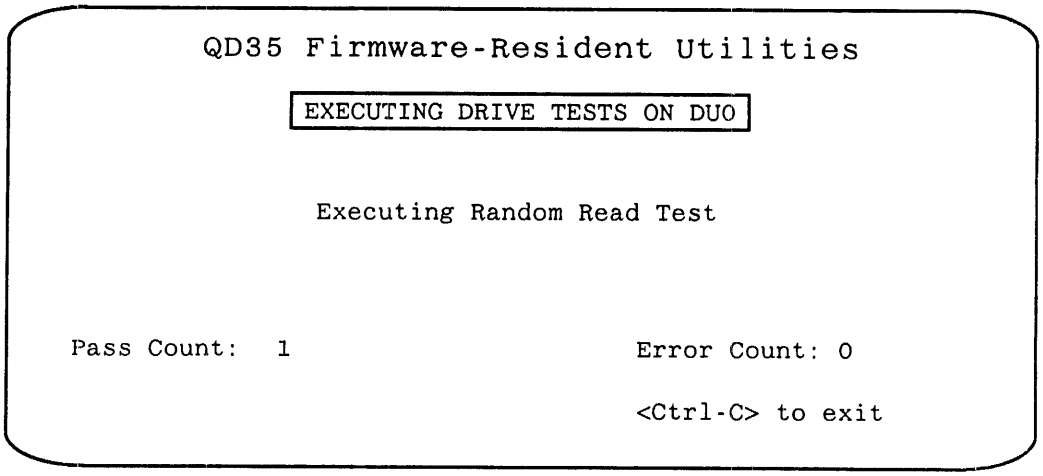


Figure 4–20. Disk Drive Diagnostic Status Messages

Section 5
PERFORMANCE MONITOR SOFTWARE

5.1 Overview

This section describes the firmware-resident Performance Monitor software provided with the QD35 Disk Controller. The Performance Monitor uses the onboard serial port to display performance statistics for several disk controller functions. The statistics are provided in order to help you to adjust the QD35 Disk Controller configuration parameters for the best controller performance, particularly with regard to the disk caching feature. Brief descriptions follow for each of the Performance Monitor displays:

- **Read/Write Statistics:** This display shows the number of read and write commands being issued through the QD35 Disk Controller. It also shows the number of blocks being read and written, and the average transfer size in blocks for read and write operations.
- **Disk Caching Statistics:** This display provides statistics on how frequently the QD35 accesses the cache memory, to help you to improve disk caching performance. The command cache hit rate is the percentage of read commands that have at least one block read from cache memory. The block cache hit rate is the percentage of blocks that are read from cache memory for all Read commands.
- **Command Seek Statistics:** This display provides statistics on the percentage of read and write commands that require a cylinder seek operation on the disk. The average number of cylinders per seek also displays. These statistics measure the non-caching disk accesses from the QD35. The better the disk-caching performance, the lower the number of cylinder seeks should be.
- **Command Queue Statistics:** This display provides statistics on the QD35's internal command buffer utilization. The display includes the number of new commands currently in the unsorted command queue, the number of commands that have been sorted and are waiting in a device queue for execution, and the number of end messages for completed commands that are waiting to be sent back to the host.
- **Parameter Tuning:** This display shows the current values for the QD35, disk caching parameters, read-ahead parameters, and seek optimization parameters. Adjustments to these current working parameters can be made through this display.

The monitor display is updated at user-programmable intervals, providing cumulative and recent statistics for each of the functions listed above. The monitor can display the data for all disk drives attached to the QD35, or it allows you to specify a particular device. Keyboard commands select the desired screen and the device to monitor, and allow you to adjust the time interval for updating the screen.

5.1.1 Running the Monitor Program

The QD35 Performance Monitor is disabled by default and must be enabled by means of the FRU Controller Options Menu. The operating system must be online in order to run the Performance Monitor software. Once the operating system is online, take the following steps:

1. Attach a VT100 with the advanced video option or compatible terminal to the serial port.
2. Make sure that the baud rate for the terminal is the same as the baud rate set on the QD35 controller options menu. There are only two choices for the baud rate, 9600 or 19200. A baud rate of 19200 is recommended because the QD35 performance will be reduced if the controller is set for a baud rate of 9600.
3. As soon as the terminal is attached to the QD35 serial port, information displays at the terminal. A legend at the bottom of each of the four monitor displays describes how to switch between monitor tests, how to disable the monitor display, and how to set the frequency at which the monitor display will be refreshed. If attaching a terminal after your system is online, press the <Return> key to refresh the display.

Figure 5–1 shows the Monitor Program legend.

NOTE: Whenever the terminal display updates, the QD35 Disk Controller performance decreases. For this reason, the display should be disabled by pressing <Ctrl-C> whenever the display is not in use. The Monitor Program will still accumulate statistics even when the display is toggled OFF.

```
<Space Bar> Rotate to next screen        <Ctrl-C> Turn screen off

>< Select next/previous disk device      <Return> Turn screen on

+/- Increment/decrement time interval     <Ctrl-Z> Reset stats to zero
```

Figure 5–1. Performance Monitor Legend

Descriptions follow for each of the operator controls in the legend.

- **< Space-Bar > Rotate to next screen:** Pressing the <Space Bar> moves you back and forth between the six monitor screens. The order in which the monitor screens are first presented is as follows:
  1. Read/Write statistics
  2. Caching statistics
  3. Seek statistics
  4. Command queue statistics
  5. Parameter Tuning, all disk drives
  6. Parameter Tuning, one disk drive
- **< Ctrl-C > Turn screen off:** Pressing <Ctrl-C> disables the monitor display. However, the Performance Monitor is running in the background, and the quantities for total statistics continue to accumulate and will display when the monitor is re-enabled by entering <Return>.
- **> < Select next/previous disk device:** This selection field allows you to select which disk device you plan to monitor for statistics. Typing > increments the unit number of the disk device being monitored from DU0 to DU1, DU2, DU3, or All. The disk device being monitored is indicated at the top of the screen, directly under the type of statistics.
- **< Return > Turn screen on:** Typing <Return> enables the monitor display if it has previously been disabled with <Ctrl-C>.
- **+/- Increment/decrement interval time:** Typing + or − increases or decreases the interval at which the monitor statistics are updated. By increasing the interval at which the statistics display is updated. By increasing the interval at which the statistics display is updated, the amount of processing overhead caused by the screen update is reduced, and the performance capability of the QD35 Disk Controller increases.
- **< Ctrl-Z > Reset statistics to zero:** Pressing <Ctrl-Z> resets the cumulative statistics for the Performance Monitor to zero.

Additional operator control keys not shown in the legend are also provided, as follows:

R Switch to the Read/Write Statistics display.

C Switch to the Caching Statistics display.

S Switch to the Seek Statistics display.

Q Switch to the Command Queue Statistics display.

P Switch to the Parameter Tuning display.

5.2 Read/Write Statistics

Figure 5–2 shows the Read/Write statistics display.

```
                    QD35 Performance Monitor

                    READ/WRITE STATISTICS

                          Disk device: All    Interval: 5 secs

                                                CUR        TOT

Number of Commands              Read            43         23881
                                Write           44         23882

Number of Blocks                Read            1671       810399
                                Write           1626       822437

Number of Commands              Read            32         34
                                Write           32         34

<Space Bar> Rotate to next screen       <Ctrl-C>  Turn screen off
>< Select next/previous disk device     <Return>  Turn screen on
+/- Increment/decrement interval time    <Ctrl-Z> Reset stats to zero
```

Figure 5–2. Read/Write Statistics Display

This display shows the number of Read and Write commands issued through the QD35 Disk Controller. It also shows the number of blocks that are read and written, and the average transfer size in blocks for each Read and Write operation. Knowing the average transfer size on your system can be useful in adjusting the QD35 controller option that specifies the maximum transfer size to cache (subsection 4.6.10). This maximum transfer size parameter should generally be set to a value larger than the average Read command transfer size. The Read command average transfer size is also useful in determining how to set the read-ahead parameters.

The TOT (total) values are the statistics accumulated since the QD35 was booted or since the monitor program was reset. The CUR (current) values are statistics for the most recent time interval shown in the upper right-hand corner of the screen. The "interval" is set on the Controller Options Menu. The default value is five seconds.

5.3 Disk-Caching Statistics

Figure 5-3 shows the Disk-Caching Statistics display.

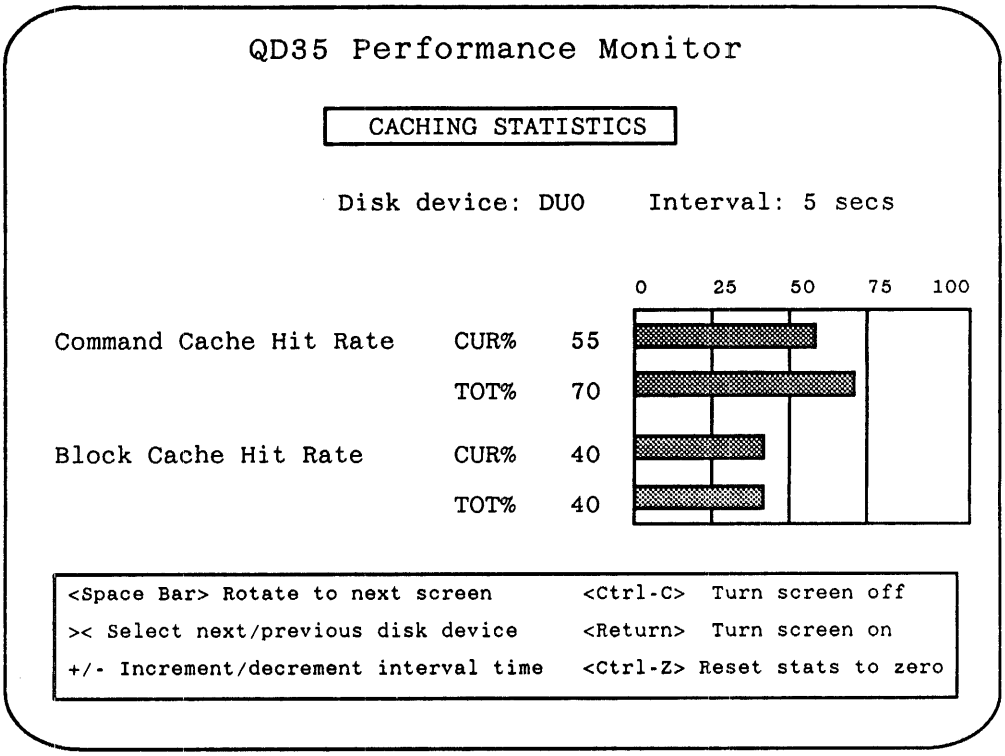


Figure 5-3. Disk-Caching Statistics Display

This display provides statistics on what percentage of commands access at least one block of memory from the cache memory, and what actual percentage of blocks accessed are from the cache memory. The command cache hit rate is the percentage of Read commands that have at least one block read from cache memory. The block cache hit rate is the percentage of blocks that are read from cache memory for all read commands. The percentages are calculated for both the latest time interval and for the total time since the statistics were last reset.

High percentages for the command and block cache hit rates indicate good use of the QD35 disk-caching feature. To increase these percentages, several of the QD35 configuration parameters can be adjusted. These configuration parameters include the following:

- **Maximum transfer size:** This parameter prevents a few large transfers from flushing out numerous frequently used blocks from cache memory. Refer to subsection 4.6.10 for information on this parameter.

- **Partitions enabled for disk-caching:** Disk caching can be disabled on individual logical disk devices, or it can be limited to particular partitions and Logical Block Numbers (LBNs) within each device. Refer to subsection 4.7.3 for more information.
- **Maximum/minimum number of blocks to read-ahead:** Increasing the minimum number of blocks to read ahead to the cache memory might increase disk caching performance. Refer to subsection 4.6.11 and subsection 4.6.12 for more information.

The TOT (total) percentages are the statistics accumulated since the QD35 was booted, or since the Monitor program was reset. The CUR (current) percentages are statistics for the most recent time interval shown in the upper right-hand corner of the screen. The "interval" is set on the Controller Options menu. The default value is five seconds.

5.4 Command Seek Statistics

Figure 5–4 shows the Command Seek Statistics display.

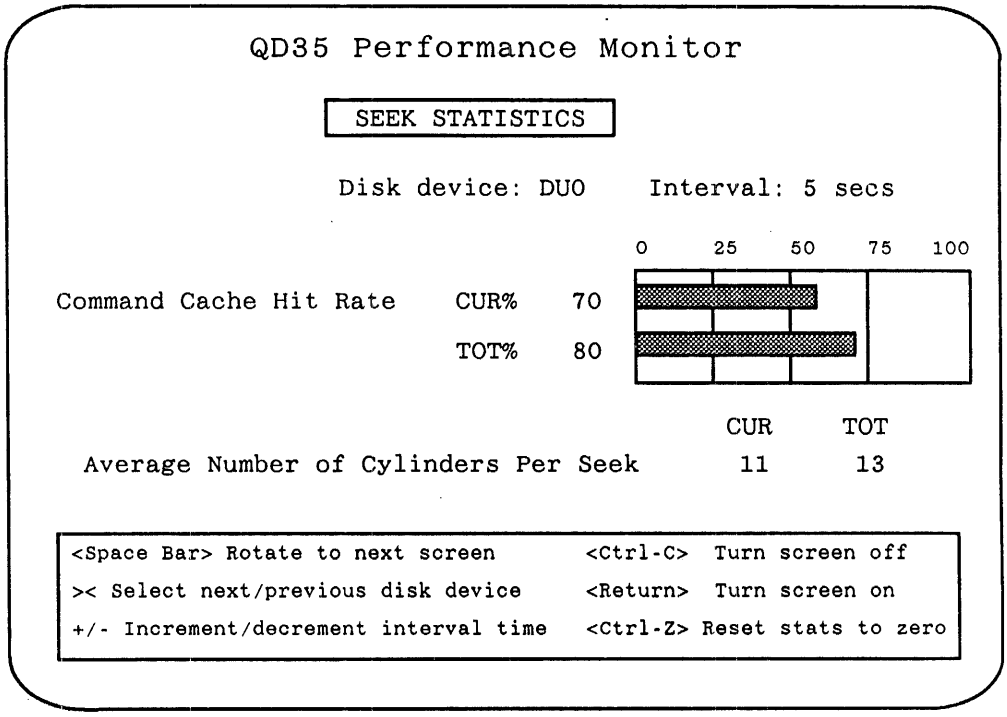


Figure 5–4. Seek Statistics Display

The Seek Statistics display provides statistics on the percentage of read and write commands that require a cylinder seek operation on the disk. The average number of cylinders per seek is also displayed.

The TOT (total) percentages are the statistics accumulated since the QD35 was booted, or since the Monitor Program was reset. The CUR (current) percentages are statistics for the most recent time interval shown in the upper right-hand corner of the screen. The "interval" is set on the Controller Options Menu. The default value is five seconds.

The Seek statistics help you to determine which one of the selectable seek optimization algorithms is best for your system. The seek statistics may also be useful in monitoring disk fragmentation. An increasing percentage of commands requiring a seek and an increasing average number of cylinders per seek might indicate that it is time to clean up or reorganize the data on the disk.

The Seek statistics are related to the caching statistics in that a higher cache hit rate should produce a lower percentage of commands requiring a seek. However, keep in mind that the seek statistics are for both read and write commands, while the caching statistics deal only with read commands. Therefore, you could have a cache hit rate of 90 percent and still have 50 percent of your commands requiring a seek operation.

5.5 Command Queue Statistics

Figure 5-5 shows the command queue statistics display.

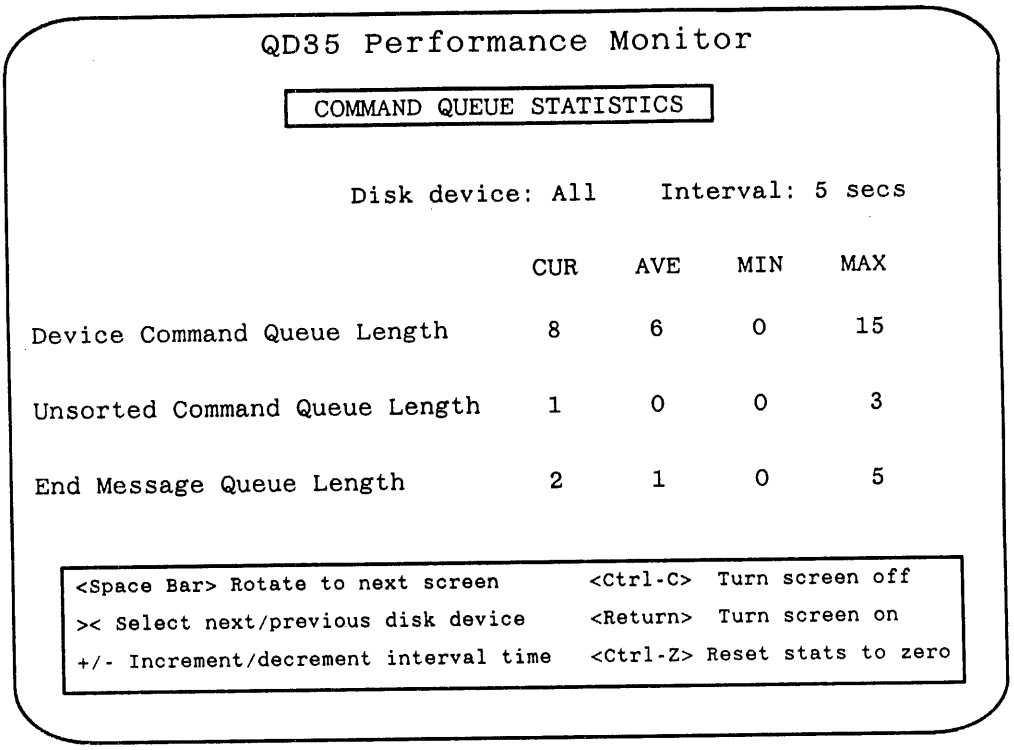


Figure 5-5. Command Queue Statistics Display

The command queue statistics display provides statistics on the QD35's internal command buffer use, including current, average, minimum and maximum values for the following command queue parameters:

- **Device Command Queue Length–** The number of commands that have been sorted and are waiting in a device queue for execution.
- **Unsorted Command Queue Length–** The number of new commands currently in the unsorted command queue.
- **End Message Queue Length–** The number of end messages for completed commands that are waiting to be sent back to the host.

Unlike the other statistics displays, these statistics are reset each time the display is brought up and are only accumulated while the terminal screen is on. This display may be used to help in determining how to set the QD35 configuration parameter specifying the command queue size. The seek optimization algorithms can operate more effectively if there are plenty of command buffers for bringing in new commands from the host. On the other hand, too many unused command buffers will waste buffer space that could be used for data transfers.

5.6 Parameter Tuning

Figures 5–6 and 5–7 show the parameter tuning displays

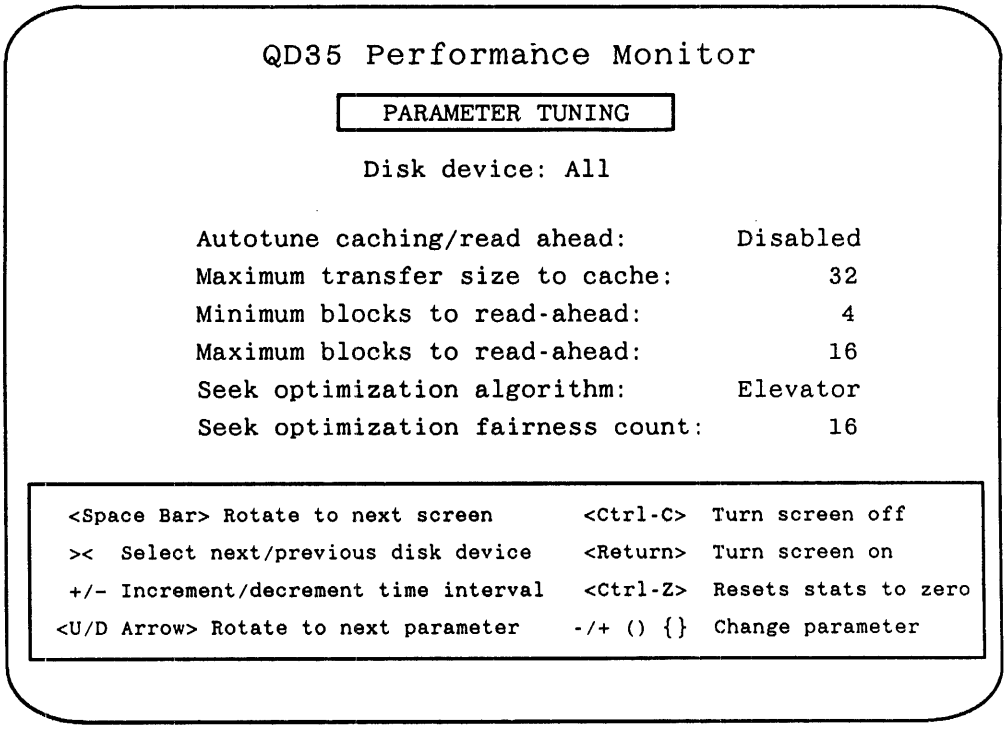


Figure 5–6. Parameter Tuning, All Devices

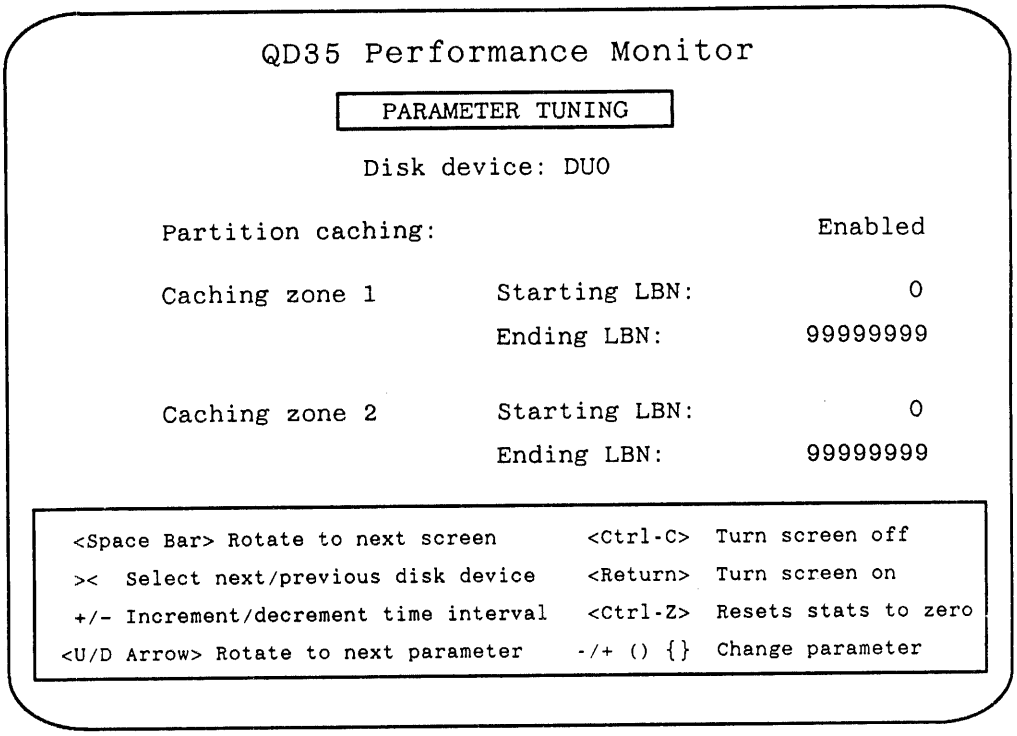


Figure 5–7. Parameter Tuning, One Device

The parameter tuning display shows and allows you to modify the current values for several of the QD35 tunable caching and read-ahead parameters. There are two different parameter tuning displays, one with parameters that apply to all devices (Figure 5-6), and one with parameters for the currently selected individual device (Figure 5-7). Refer to Section 4 of this manual for descriptions of the controller options that affect disk caching.

NOTE: Only the current working parameters may be modified from the two Parameter Tuning displays. The parameter values saved in NOVRAM are not changed, and they will be restored when the controller is reinitialized. To make the changes permanent, you must shut down the system and bring up the FRU to update the parameters saved in NOVRAM.

The bottom line of the legend on the parameter display shows the keys used to modify the parameters. Some additional explanations for four of the parameters follow:

< U/D Arrow >	Up arrow/Down arrow. Typing the Up arrow moves the cursor to the previous parameter. Typing the Down arrow moves the cursor to the next parameter.
-/+	Typing - decrements the parameter value by one. Typing + increments the parameter value by one.
(/)	Typing (decrements the parameter value by 100. Typing) increments the parameter value by 100.
{ /}	Typing { decrements the parameter value by 10000. Typing } increments the parameter value by 10000.

If the Autotune feature is enabled, then the parameter values display updated automatic adjustments made by the QD35.

Section 6
TROUBLESHOOTING

6.1 Overview

This section describes the several diagnostic features with which the QD35 Disk Controller is equipped, and outlines fault isolation procedures that use these diagnostic features.

Subsection	Title
6.1	Overview
6.2	Service
6.3	Fault Isolation Procedure
6.4	Power-up Self-diagnostic
6.5	Fatal Error Codes

6.2 Service

Your Emulex QD35 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 QD35 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 obtain 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 Customer Service
3545 Harbor Blvd
Costa Mesa, CA 92626
(714) 662-5600
FAX: (714) 966-1299
Outside California: (800) 854-7112

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 settings should have been made on the Configuration Reference Sheet. This sheet is contained in the Hardware Installation section, Figure 3-1.

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 to you by the Emulex representative. The sender must also insure the package.

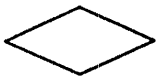
6.3 Fault Isolation Procedure

This fault isolation procedure is provided in flowchart format. The procedure is based on the self-diagnostics incorporated into the QD35. 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.)

Table 6–1 defines the flow chart symbols that are used in the Fault Isolation Chart (Figure 6–1).

If the fault isolation procedure indicates that a component needs to be returned to Emulex, see subsection 6.2 for instructions.

Table 6–1. Flow Chart Symbol Definitions

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

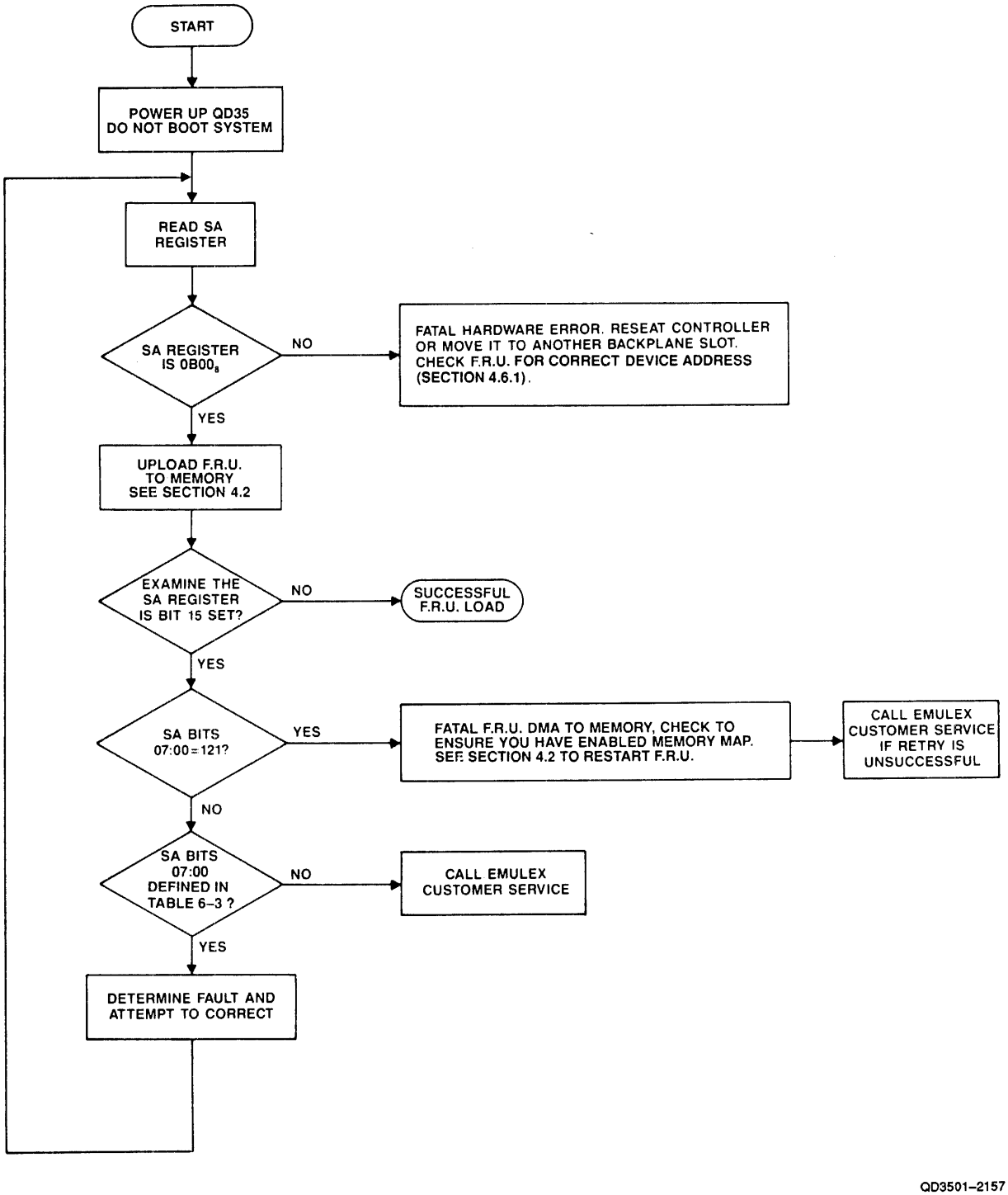


Figure 6–1. Fault Isolation Chart

6.4 Power-Up Self-Diagnostic

The QD35 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 6–2 indicates the order in which the tests are performed.

The first two tests execute immediately after power-up, a reset, a bus INIT, or a write to the IP register (base address). The other tests execute as the controller interacts with the MSCP initialization routine. If the QD35 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 that are located on the front panel of the QD35 PCBA. The MSCP fatal error codes used by the QD35 are listed in Table 6–2.

To help to determine the location of the problem, the operator may 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 the QD35 switch SW1-4 to ON. After setting SW1-4 to ON, the host computer must be powered down or the SW1-1 switch must be toggled ON then OFF, causing the QD35 to repeat its self-test.

Upon finding an error, the host microprocessor halts, and the LEDs display an error code. The error codes are listed and described in Table 6–2. If the QD35 completes the diagnostic mode without errors, all three LEDs should be OFF. Before starting to operate the QD35, set switch SW1-4 in the OFF position, and reset the QD35 controller.

Table 6–2. LED Error Codes

LED Position 3	2	1	Description
0	0	0	Self-diagnostic complete without errors
0	0	1	CPU Chip test failed
0	1	0	Formatter Chip test failed
0	1	1	Buffer controller or external memory test failed
1	0	0	Controller idle, waiting for initialization
1	0	1	HAC test failed
1	1	0	Emulation PROM Checksum Test failed
1	1	1	Refer to Table 6–3, MSCP Fatal Error Codes

6.5 Fatal Error Codes

If the QD35 encounters a fatal error anytime during operation, all three LEDs are illuminated, and an error code is posted in the low-byte of the SA register (base address plus 2). Table 6–3 lists the MSCP fatal error codes used by the QD35.

Table 6–3. MSCP Fatal Error Codes

Octal Code	Hex Code	Description
000	00	No information in message packet.
001	01	Possible parity or timeout error when the QD35 attempted to read data from a message packet.
002	02	Possible parity or timeout error when the QD35 attempted to write data to a message packet.
004	04	QD35 diagnostic self-test indicates a controller RAM error.
005	05	QD35 diagnostic self-test indicates a firmware checksum error.
006	06	Possible parity or timeout error when the QD35 attempted to read an envelope address from a command ring.
007	07	Possible parity or timeout error when the QD35 attempted to write an envelope address from a command ring.
011	09	Host did not communicate with the QD35 within the timeshare established while bringing the controller online.
012	0A	Operating system sent more commands to the QD35 than the controller can accept.
013	0B	Controller unable to perform DMA transfer operation correctly.
014	0C	QD35 diagnostic self-test indicates controller fatal error.
016	0E	The MSCP connection identifier is invalid.
023	13	An error occurred during the MSCP initialization sequence.
111	49	Autoboot timeout.
121	51	FRU load to memory failed.

Section 7
DEVICE REGISTERS AND PROGRAMMING

7.1 Overview

This section contains an overview of the QD35 device registers that are accessible to the Q-Bus and that are used to monitor and control the QD35 Disk Controller. The registers are functionally compatible with DEC implementations of MSCP controllers.

The following table outlines the contents of this section.

Subsection	Title
7.1	Overview
7.2	The Mass Storage Control Protocol (MSCP)
7.3	Programming
7.4	Registers

7.2 The Mass Storage Control Protocol (MSCP)

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 (DEC). 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 (that is, cylinder, track, sector). This scheme gives the MSCP subsystem the responsibility for converting the MSCP logical block numbers into physical addresses that the peripheral devices 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 accomplished efficiently.

There are several advantages to this type of architecture. First, it provides the host with "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 that 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.

7.3 Programming

A complete description of MSCP commands and the corresponding status responses posted by the QD35 Disk Controller is beyond the scope of this manual.

7.3.1 Command Support

No currently available MSCP Controller supports the entire range of MSCP commands. The following subsections describe the extent of MSCP command support by the QD35.

7.3.1.1 Minimal Disk Subset

The QD35 Disk Controller supports the entire minimal disk subset of MSCP commands.

7.3.1.2 Diagnostic and Utility Protocol (DUP)

The QD35 Disk Controller does not support any of the DUP commands or the maintenance Read/Write commands. Therefore, the QD35 is not compatible with DEC diagnostics that use the MSCP DUP commands.

7.4 Registers

During normal operation, the QD35 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 QD35 has two 16-bit registers in the Q-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 7–1 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 QD35.

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

- Writing the register with any value causes a hard initialization of the MSCP controller.
- Reading the register while the port is operating causes the controller to initiate polling.

The SA register (base address plus two) has four functions, as detailed 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, the register signals the port that the host has successfully completed a bus adapter purge in response to a port-initiated purge request.

Table 7–1. QD35 IP and SA Registers

Register	LSI-11 (octal)	Micro VAX (hex)
IP SA	772150 772152	20001468 2000146A
IP SA	772154 772156	2000146C 2000146E
IP SA	760334 760336	200000DC 200000DE
IP SA	760340 760342	200000E0 200000E2
IP SA	760344 760346	200000E4 200000E6
IP SA	760350 760352	200000E8 200000EA
IP SA	760354 760356	200000EC 200000EE
IP SA	760360 760362	200000F0 200000F2

Section 8
QD35 DISK CONTROLLER ARCHITECTURE

8.1 QD35 Architecture Overview

The QD35 is a microprocessor-based emulating disk controller that is contained on a quad-wide PCBA, attached daughter-board, and front panel. The QD35's major functional blocks are shown in Figure 8–1. The disk controller is organized around the 32-bit 68020 microprocessor. The Host Adapter Controller (HAC) and the Merged Architecture Chip (MAC), including disk formatter and buffer controller functions are addressed as memory (memory-mapped I/O).

The 68020'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 checking the cache table for blocks of disk data that might already reside in the RAM buffer and setting up disk devices that are not currently in the RAM buffer. Another job of the microprocessor involves setting up the HAC and the MAC's buffer controller logic for the large data transfers, which are their specialties.

The QD35 uses an erasable programmable read-only memory (EPROM) that contains the control program, 256K bytes of random access memory (RAM) to hold the cache tables and working storage, and 1M byte of RAM that is used for data buffering.

The QD35 provides a serial terminal port that allows the user to execute the Firmware-Resident Utilities (FRU), described in Section 4 for tasks including loading disk drive configuration parameter values to the NOVRAM, and formatting and verifying the attached disk devices. The terminal port can also display disk caching statistics provided by the Performance Monitor software, as described in Section 5.

The Q-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 that are required for the addressed disk controller register. The HAC has automatic Q-Bus address generation capability that, in conjunction with a byte counter, allows the interface to conduct Q-Bus DMA transfers without direct microprocessor intervention after the interface is set up for a transfer. This automatic DMA capability is used with the MAC's buffer controller logic to transfer large blocks of data directly between host memory and the QD35's data buffer.

This multi-channel DMA is responsible for moving large blocks of data between the 1M byte data buffer and the SMD interface, as well as between the Q-Bus interface and the 1M byte data buffer. After being set up for an operation by the microprocessor, either interface requests DMA service from the buffer controller logic by driving an individual request signal active. The transfer then proceeds without direct intervention by the microprocessor. This allows high-speed data transfer to occur while the microprocessor is focused on other processes.

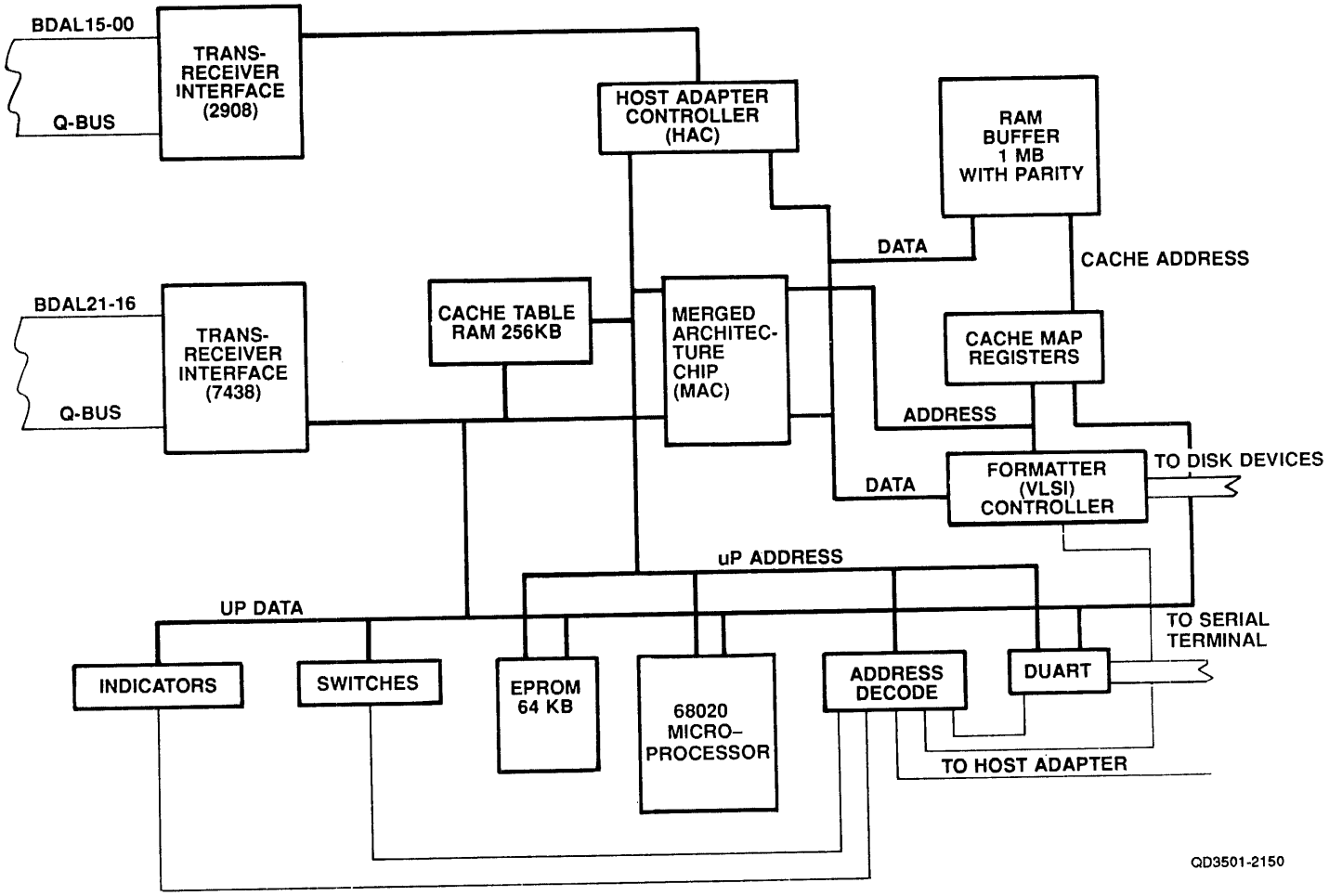


Figure 8–1. QD35 Controller Block Diagram

Section 9
INTERFACES

9.1 Overview

This section describes the interfaces that the QD35 Disk Controller incorporates. It includes information on the QD35 implementation of the SMD interface electrical and mechanical requirements. The following subsections are included:

Subsection	Title
9.1	Overview
9.2	QD35 Q-Bus Interface
9.3	QD35 SMD-E Disk Drive Interface

9.2 Q-Bus Interface

The Q-Bus between the CPU and the QD35 Disk Controller contains 42 bidirectional signal lines, two unidirectional signal lines on connectors A and B, and two unidirectional signal lines on connector C. Table 9–1 lists and describes Q-Bus interface pin assignments. These signal lines provide the means for communication between the CPU and the QD35 Disk Controller.

The Q-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 Q-Bus interface lines are grouped in the following categories:

- **Twenty-two Data/Address Lines** – <BDAL00:BDAL21>. The four Data/Address lines that carry the most significant bits (MSB) are lines BDAL21:BDAl18. They are used for addressing only, not data. Lines BDAL17 and BDAL16 reflect the parity status of the 16-bit data word during a Write or Read Data Transfer operation using the Q-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 9–1. Bus Interface Pin Assignments

Connector A Signal		
Component Side	Pin	Solder Side
BIRQ5	A	+5 V
BIRQ6	B	
BDAL16	C	0V (GND)
BDAL17	D	
	E	BDOUT
	F	BRPLY
	H	BDIN
0V (GND)	J	BSYNC
	K	BWTBT
	L	BIRQ4
0V (GND)	M	BIAKI
BDMR	N	BIAKO
BHALT	P	BBS7
BREF	R	BDMGI
	S	BDMGO
0V (GND)	T	BINIT
	U	BDAL00
	V	BDAL01

Connector B Signal		
Component Side	Pin	Solder Side
BDCOK	A	+5 V
BPOK	B	
BDAL18	C	0V (GND)
BDAL19	D	
BDAL20	E	BDAL02
BDAL21	F	BDAL03
	H	BDAL04
0V (GND)	J	BDAL05
	K	BDAL06
	L	BDAL07
0V (GND)	M	BDAL08
BSACK	N	BDAL09
BIRQ7	P	BDAL10
BEVNT	R	BDAL11
	S	BDAL12
0V (GND)	T	BDAL13
	U	BDAL14
	V	BDAL15

Connector C Signal		
Component Side	Pin	Solder Side
0V (GND)	A	+5 V
	B	0V (GND)
	C	BDOUT
	D	BRPLY
	E	BDIN
	F	BSYNC
	H	BWTBT
	J	BIRQ4
	K	BIAKI
	L	BIAKO
	M	BBS7
	N	BDMGI
	P	BDMGO
	R	BINIT
	S	BDAL00
	T	BDAL01

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

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

9.2.1 Interrupt Priority Level

The QD35 is set by Jumpers K, L, and M to issue level 4 interrupt requests and to monitor level 5 by default. A jumper-selectable option allows level 5 interrupt requests and monitors level 6. Refer to subsection 3.5.1 for information on the interrupt request jumper settings.

9.2.2 Register Address

The QD35 Disk Controller has two registers visible to the Q-Bus. Their addresses are determined by the Q-Bus device address selected on the FRU Controller Options Menu. See subsection 4.6 for further information.

9.2.3 DMA Operations

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

9.3 QD35 SMD-E Disk Drive Interface

The QD35 Disk Controller interfaces with each SMD disk drive through a control cable and a data cable. The QD35 subsystem cabling configuration includes round-shielded cables that connect to a distribution panel and either round or flat SMD cables that connect to the drives. For a more complete description of subsystem cabling, refer to subsections 3.7 (QD35-III) and 3.8 (QD35).

The QD35 Disk Controller can control a maximum of four disk drives. The drive ports are labeled on the back of the QD35 distribution panel.

This subsection provides information on the QD35 implementation of the SMD interface electrical and mechanical requirements.

The QD35 Disk Controller's disk interface conforms to the SMD-E Interface Specification for 15 MHz and 24 MHz Devices (CDC Document No., 64712402). The controller has been tested with most drives using the SMD-E interface, and it is compatible with the electrical and timing characteristics of disk drives up to 24 MHz.

All communications between the QD35 Disk Controller and the SMD disk drives pass through the SMD-E interface. This communication includes all commands, status, control signals, and read/write data transmitted and received by the controller.

9.3.1 I/O Cables

All the signal lines between the controller and the drive are contained in two I/O cables. They are referred to as the A and B cables. Subsection 9.3.1.1 lists lines used in each cable.

9.3.1.1 A Cable

On the QD35-III, the A cable originates from the QD35 PCBA and connects to the drives through the distribution panel (subsection 3.7.4.3). On the QD35, the A cable originates directly from connector J5 on the PCBA (subsection 3.8.4.2). For both types of QD35 PCBA, the A cable is daisy-chained to all disk drives and terminated at the last drive. The purpose of the signals in this cable, along with their function when the control tag (Tag 3) is asserted, are listed in Table 9–2.

The A Cable that connects from the distribution panel to the drive(s) should have an impedance of 100 ohms. The cumulative length of the A cables should not be greater than 100 feet.

Table 9–2. SMD-E A Cable Interface Connections

A CABLE Pins, Lo, Hi	Signal	Tag 3 Function	From/To Drive
22, 52	Unit Select Tag		To
23, 53	Unit Select bit 0		To
24, 54	Unit Select bit 1		To
26, 56	Unit Select bit 2		To
27, 57	Unit Select bit 3	/Tag 5[1]	To
1, 31	Tag 1		To
2, 32	Tag 2		To
3, 33	Tag 3		To
4, 34	Bit 0	Write Gate	To
5, 35	Bit 1	Read Gate	To
6, 36	Bit 2	Servo Offset Plus	To
7, 37	Bit 3	Servo Offset Minus	To
8, 38	Bit 4	Fault Clear	To
9, 39	Bit 5	AM Enable	To
10, 40	Bit 6	Return to Zero	To
11, 41	Bit 7	Data Strobe Early	To
12, 42	Bit 8	Data Strobe Late	To
13, 43	Bit 9	Release	To
14, 44	Open Cable Detect		To
15, 45	Fault		From
16, 46	Seek Error		From
17. 47	On Cylinder		From
18, 48	Index		From
19, 49	Unit Ready		From
21, 51	Busy (dual port)		From
25, 55	Sector		From
28, 58	Write Protected		From
29	Power Sequence Pick		To
30, 60	Tag 4[1]		To
59	Power Sequence Hold		To

[1]Tag 4, Tag 5, and Tag 6 are part of the SMD-E extended functions. Tag 6 is the logical AND of Tag 4 and Tag 5. These lines are terminated, but their functions are not used by the QD35.

9.3.1.2 B Cable

For the QD35-III, the B cable originates from the PCBA and connects to the drive(s) through a distribution panel (see subsection 3.7.4.3). For the QD35, the B cables connect directly to connectors J1, J2, J3, and J4. The 26-conductor B cable is radial to all drives and contains the data and clock signals. The function of the signals in the B cable are listed in Table 9–3.

The flat-ribbon B cable should be a 26-conductor flat cable with ground plane and drain wire. The impedance should be 130 ohms. (If you are using SMD 850 drives, or other drives with a transfer rate of 3M bytes per second, use the round-shielded cables listed in Table 1–4). For each drive, the cumulative length of the B cables should not be greater than 50 feet.

Table 9–3. SMD-E B Cable Interface Connections

B CABLE Pins, Lo, Hi	Signal	From/ To Drive
8, 20	Write Data	To
6, 19	Write Clock	To
2, 14	Servo Clock	From
3, 16	Read Data	From
5, 17	Read Clock	From
10, 23	Seek End	From
22, 9	Unit Selected	From
12, 24	Index	From
13, 26	Sector	From

9.3.1.3 Drivers and Receivers

The drivers for the A and B cables are 26LS31, which are equivalent to 75110A drivers. The receivers are 41LF quad differential receivers, which are equivalent to 75108 receivers. The lines of both the A and B Cables are terminated to be compliant with the SMD and SMD-E interface.

9.3.2 I/O Signal Processing

I/O signals from the controller initiate and control all drive operations except power on. The I/O signals are sent to receivers in the drive and are routed from the receivers to the appropriate drive logic. The drive in turn sends information concerning the operation back to the controller through the transmitters.

There are two basic types of I/O signals: (1) tag/bus and (2) discrete. the two types differ in that the tag and bus signals work in conjunction to perform a variety of functions. Generally, the discrete signals work independently, each performing a specific function. Both types are described in the following subsections.

9.3.2.1 Tag/Bus Signals

All commands (except unit select) are sent to the drive through the tag and bus signal lines. The tag lines define the basic operation to be performed and the bus lines supply the parameters for the operation. Table 9–3 explains all the tag/bus commands recognized by the drive.

9.3.2.2 Discrete Signals

In addition to the tag/bus signals, there are various discrete signal lines going between drive and controller. These lines carry clock, status, control and read/write data signals. The function of each of the discrete lines is also explained in Tables 9–3 and 9–4.

Table 9–4. A Cable Signal Line Functions

Signal	Function
Pick In	Used for power sequencing. When the controller is ON, and not RESET, this line is pulled low to power up the disk drive(s). The drive's LOCAL/REMOTE switch must be set to REMOTE and the START switch must be ON. This signal is daisy-chained from drive to drive. It is not passed from one drive to the next until the first drive is up to speed. The ground is passed on to the next drive as Pick Out (Pick Out is terminated at last drive in daisy chain).
Hold	Used for power sequencing. This line is pulled low to power up the disk drive. The drives LOCAL/REMOTE switch must be set to REMOTE, and the START switch must be ON. This signal is daisy-chained from drive to drive. This line must be grounded at the controller for the drive to complete and hold the remote power-up sequence.
Open Cable	The controller holds this signal TRUE when it is powered on. When false, the drive cannot be selected. This prevents any unwanted command such as Write Gate when the A cable is disconnected or the controller power is lost.
Unit Select Tag	Initiates unit select sequence, and in dual channel units it also reserves drive to that controller, provided unit selection is successful (refer to the discussion on Unit Selection).
Unit Select Lines 2^0 thru 2^3	Used to select the drive. The binary code on these lines must match the code of the drive logical address for the drive to be selected. These lines are used in conjunction with the Unit Select Tag pin A cable I/O (refer to the discussion on Unit Selection).
Tag 1 (Cylinder Select)	Initiates seek functions used in conjunction with Bus Bit lines. This tag strobes the cylinder address, contained on Bus Bit lines, into drive logic. Drive must be on cylinder before this tag is sent. Bus Bits are interpreted as follows: Bus Bit / Functions / Bus Bit / Functions 0 / Cyl Adrs 2^0 / 5 / Cyl Adrs 2^5 1 / Cyl Adrs 2^1 / 6 / Cyl Adrs 2^6 2 / Cyl Adrs 2^2 / 7 / Cyl Adrs 2^7 3 / Cyl Adrs 2^3 / 8 / Cyl Adrs 2^8 4 / Cyl Adrs 2^4 / 9 / Cyl Adrs 2^9
Tag 2 (Head Select)	Initiates head select functions and is used in conjunction with Bus Bit Lines. This tag strobes the head address, contained on bus bit lines, into the drive logic. The Bus Bits are interpreted as follows: Bus Bit / Function / Bus Bit / Function 0 / Cyl Adrs 2^0 / 5 / Not Used 1 / Cyl Adrs 2^1 / 6 / Not Used 2 / Cyl Adrs 2^2 / 7* / Cyl Adrs 2^{10} 3 / Cyl Adrs 2^3 / 8* / Cyl Adrs 2^{11} 4 / Cyl Adrs 2^4 / 9 / Not Used *The extended cylinder address bits are strobed with the head select bits for the SMD-E-compatible drives.

(Continued on next page)

Table 9–4. A Cable Signal Line Functions (Continued)

Signal	Function
Tag 3 (Control Select)	Initiates various operations to be performed by the drive. Used in conjunction with Bus Bit lines. Specific operation initiated depends on the content of these lines, defined as follows: Bus Bit — Function 0 Write Gate - Enable write drivers. 1 Read Gate - Enables the digital read data lines. With the PLO option, leading edge triggers read chain to sync on all zeros pattern. 2 Servo Offset Plus - Offsets the actuator from the nominal on cylinder position toward the spindle. 3 Servo Offset Minus - Offsets the actuator from the nominal on cylinder position away from the spindle. 4 Fault Clear - Pulse sent to drive clears the fault summary flip-flop. 5 Address Mark Enable - Not used. 6 RTZ - Pulse sent to drive causes actuator to seek track zero. 7 Data Strobe Early - Enables the PLO data separator (optional) to strobe the data at a time earlier than optimum. 8 Data Strobe Late - Enables the PLO data separator (optional) to strobe the data at a time later than optimum. 9 Release - Releases dual channel drives from reserved and/or priority selected condition (refer to the discussion on Unit Selection). Not used for single channel drives.
Tag 4 (Current Sector)	Line is terminated, but the function is not used by the QD35.
Tag 5 (Extended Status)	Line is terminated, but the function is not used by the QD35.
Bus Bits (0-9)	Used in conjunction with Tags 1, 2, and 3.
Unit Ready	Indicates that the drive is selected, up to speed, heads are loaded, and no fault exists.
Busy (applicable only to dual channel units)	TRUE when a drive selection is attempted, but the drive is already reserved by the other controller. This signal is returned to the controller attempting selection along with the unit selected signal (refer to the discussion on Unit Selection).
On Cylinder	Indicates that the drive has positioned the heads over a track.
Seek Error	Indicates that the unit was unable to complete a move within 500 msec, or that the carriage has moved to a position outside the recording field.
Address Mark Found	Not used.
Write Protect	Indicates that the drive's writer circuits are disabled.
Fault	Indicates that one or more of these faults exists: DC power fault, head select fault, write fault, write or read while off cylinder, and Write Gate during a Read operation.

Table 9–5. B Cable Signal Line Functions

Signal	Function
Write Data	Carries NRZ data to be recorded on disk pack.
Write Clock	Synchronized to NRZ Write Data, it is a return of the Servo Clock. The QD35 transmits this signal continuously.
Index	Occurs once per revolution of the disk pack. Its leading edge is considered the leading edge of sector zero.
Sector	Derived from servo surface of the disk pack, this signal can occur any number of times per revolution of the disk pack. The number of sector pulses occurring depends on the configuration of the disk drive.
Servo Clock	Clock signals derived from the drive's servo track.
Read Data	Carries NRZ data recovered from the disk pack.
Seek End	Seek End is a combination of ON CYL or SEEK ERROR, indicating that a seek operation has terminated.
Unit Selected	Indicates that the drive is selected. This line must be active before the drive will respond to any commands from the controller. However, on dual channel units, if Busy is returned in conjunction with Unit Selected, it indicates that the drive is reserved to the other controller and selection was unsuccessful (refer to the discussion on Unit Selection).

Appendix A
PROM REMOVAL AND REPLACEMENT

A.1 Overview

This appendix provides the instructions for replacing the QD35's firmware PROM.

A.2 Exchanging PROMs

The QD35 firmware PROM is located in the socket at U93. Remove the existing PROM from its socket using an IC puller or an equivalent tool.

The QD35 PROM is identified by the part number on top of the PROM. Place the QD35 PROM in U93. Make sure that the PROM is oriented properly relative to the QD35 PCBA, as shown in Figure A–1. The notch at the bottom of the chip should be pointing down when the Q-Bus connectors are at the right with the component side facing toward you.

Make certain that the PROM is firmly seated and that no pins are bent or misaligned. If the two rows of PROMs 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
G146	U93

NOTE: Installation of a different revision of firmware could result in corrupt NOVRAM values. Re-enter appropriate NOVRAM values after a PROM exchange.

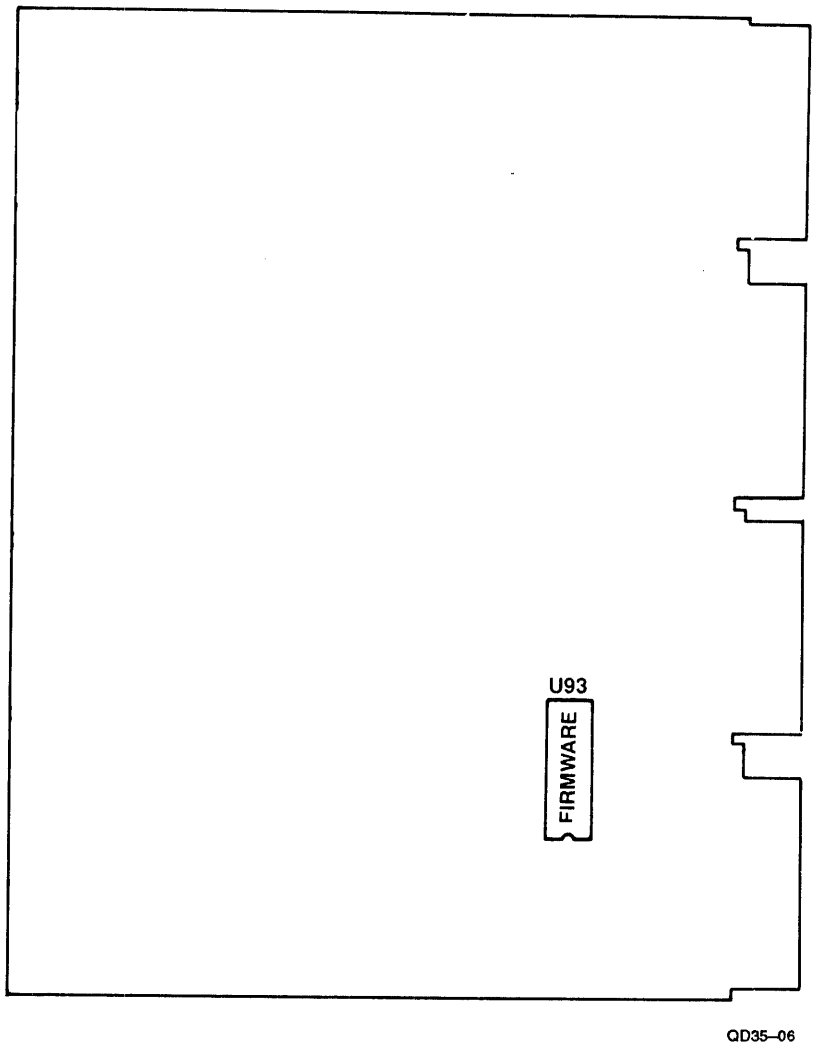


Figure A–1. QD35 Firmware PROM Location

Appendix B
DISK DRIVE CONFIGURATION

B.1 Overview

This appendix lists the configuration parameter values recommended for disk drives supported by Emulex for use with the QD35 Disk Controller. Subsection 4.7 describes the disk drive configuration parameter menu within the QD35 Firmware-Resident Utilities (FRU). When a supported drive type is selected from this menu, the values for that drive, which are listed in this appendix, are automatically selected for loading into the NOVRAM.

Configuration parameters selected by the FRU for each supported disk drive are included for your reference purposes and for those situations when you are loading values into the NOVRAM without using the FRU.

Some drive option information for setting up your disk drives for use with the QD35 is also provided. Use the recommended drive option information to plan your configuration. Refer to the drive manufacturer's manual for specific instructions on setting the drive for required options.

The following is a list of disk drives supported by Emulex for use with the QD35 Disk Controller:

CDC LMD 9457	CDC 9720-850	Fujitsu M2322	NEC 2363
CDC 9710-80	CDC 9720-1230	Fujitsu M2333	Northern Telecom
CDC 9715-340	CDC 9771 XMD	Fujitsu M2351A	Toshiba MK-186FC
CDC 9715-515	CDC 9772 XMD	Fujitsu M2361A	Toshiba MK-186FB
CDC 9720-368	CDC 9772-13 XMD	Fujitsu M2381K	
CDC 9720-500	CDS 315	Fujitsu M2382K	
CDC 9720-736	Fujitsu M2298	NEC 2352	
CDC 9720-750	Fujitsu M2321	NEC 2362	

B.2 Parameter Values

The drive configuration parameters listed in this table are for use with the NOVRAM loading, editing, and displaying options of the QD35's Firnmware-Resident Utilities (FRU). They relate to the physical geometry of the disk drives; options such as logical splits are left to you.

The matrix below lists each parameter, as well as each drive certified for use with the QD35. Parameter values in this table are based on one spare sector per track with no logical splits. Values are listed and entered in decimal.

Drive Configuration Values Matrix for QD35 (Sheet 1)

Parameter	Drive Name								
	CDC LMD 9457	**CDC RSD 9710**	**CDC 9715-340**	**CDC 9715-515**	**CDC 9720-368**	**CDC 9720-500**	**CDC 9720-736**	**CDC 9720-750**	**CDC 9720-850**
Physical Sectors per Track	32	32	33	52	52	70	52	70/71*	70/71*
Physical Heads	4	5	24	24	10	10	15	15	15
Physical Cylinders	624	823	711	711	1217	1217	1635	1217	1381
Spare Sectors per Track	1	1	1	1	1	1	1	1	1
Spare Cylinders	2	2	2	2	2	2	3	3	3
Head Select Negates on Cylinder	Yes	Yes	No	No	No	No	No	No	No
Lower Limit (RPS)	1	1	3	3	3	3	3	3	3
Upper Limit (RPS)	4	4	7	7	7	8	7	7	8
Removable Media	Yes	Yes	No	No	No	No	No	No	No
Gap 0 Parameter	3080	3080	261	261	261	261	261	261	261
Gap 1 Parameter	5654	5654	2827	2827	2827	2827	2827	2827	2827
Gap 2 Parameter	788	788	777	777	777	777	777	777	777
Spiral Offset	4	2	0	1	1	1	1	1	1
Bytes per Sector	646	630	600	576	582	579	582	579	579
*NOVRAM /Drive setting									
Additional drives and their parameters are listed on the next page.									

Drive Configuration Values Matrix for QD35 (Sheet 2)

Parameter	Drive Name								
	CDC 9720-1230	**CDC 9771 XMD**	**CDC 9772 XMD**	**CDC 9772-1 3 XMD**	**CDS 315**	**Fujitsu 2298**	**Fujitsu 2321/22**	**Fujitsu M2333**	**Fujitsu M2351A**
Physical Sectors per Track	86	85	85	85	35	69	34	68	48
Physical Heads	15	16	16	19	19	16	5/10	10	20
Physical Cylinders	1635	1024	1064	1420	821/ 823**	1024	823	823	842
Spare Sectors per Track	1	1	1	1	1	1	1	1	1
Spare Cylinders	3	2	2	2	2	2	2	2	2
Head Select Negates on Cylinder	No	No	No	No	No	No	No	No	No
Lower Limit (RPS)	3	3	4	4	1	3	1	3	3
Upper Limit (RPS)	8	7	10	10	4	7	4	8	7
Removable Media	No	No	No	No	No	No	No	No	No
Gap 0 Parameter	261	261	261	261	259	259	259	259	259
Gap 1 Parameter	2827	2827	2827	2827	2827	4112	4112	4112	4112
Gap 2 Parameter	777	777	777	777	777	780	780	780	780
Spiral Offset	1	2	0	0	1	1	1	1	0
Bytes per Sector	585	587	587	587	576	593	586	594	587
**Depends on drive model									
Additional drives are listed on the next page.									

Drive Configuration Values Matrix for QD35 (Sheet 3)

Parameter	Drive Name							
	Fujitsu M2361A	**Fujitsu M2381K/ 82K**	**NEC 2352**	**NEC 2362**	**NEC 2363**	**Northern Telecom 2312-50**	**Toshiba MK-186FB**	**Toshiba MK-286FC**
Physical Sectors per Track	68	84	63	71	71	51	32	69
Physical Heads	20	15/27*	19	23	27	5	5	11
Physical Cylinders	842	745	760	850	1024	1370	823	823
Spare Sectors per Track	1	1	1	1	1	1	1	1
Spare Cylinders	2	2	2	2	3	2	2	2
Head Select Negates on Cylinder	No	No	No	No	No	No	No	No
Lower Limit (RPS)	3	3	3	3	4	3	3	3
Upper Limit (RPS)	8	8	7	8	10	8	7	7
Removable Media	No	No	No	No	No	No	No	No
Gap 0 Parameter	259	259	261	261	261	259	259	259
Gap 1 Parameter	4112	4112	2827	2827	2827	4112	4112	4112
Gap 2 Parameter	780	780	777	777	777	780	780	780
Spiral Offset	0	0	0	1	1	1	1	1
Bytes per Sector	594	592	576	576	576	—	630	599
*Depends on drive model								

EMULEX

QD35
Disk Controller
Installation and User Manual
QD3550901-00, Rev F

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What improvements would you like to see?_____

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