DM02 DISK CONTROLLER

TECHNICAL MANUAL

(MSCP COMPATIBLE)

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WARNING

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

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EMULEX PRODUCT WARRANTY

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

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

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

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Section 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The DM02 Disk Controller, designed and manufactured by Emulex Corporation, is a MSCP-compatible controller with an Enhanced Small Device Interface (ESDI) hard disk drive interface and Shugart SA450 floppy disk interface. This manual is designed to help you install and use your DM02 Disk Controller in the most efficient and straightforward manner possible. The contents of the eight sections and four appendices are described briefly below.

Section 1 **General Description:** This section contains an overview of the DM02 Disk Controller.

Section 2 **Controller Specification:** This section contains the specification for the DM02 Disk Controller.

Section 3 **Planning the Installation:** This section contains the information necessary to plan your installation, including MSCP subsystem and operating system considerations.

Section 4 **Installation:** This section contains the information needed to set up and physically install the subsystem, including switch settings and cabling.

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

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

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

Section 8 **Interfaces:** This section describes the subsystem LSI-11 bus, ESDI disk interface, and SA450 floppy interface.

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

Appendix B **PROM Removal and Replacement:** This appendix contains PROM removal and replacement instructions to allow the user to upgrade the DM02 Disk Controller in the field.

Appendix C **Utilities and Diagnostics:** This appendix contains a list of the utilities and diagnostics that are applicable to the DM02.

Appendix D **Disk Drive Configuration Parameters:** This appendix contains configuration parameters for common ESDI disk drives and SA450 floppy drives.

1.2 SUBSYSTEM OVERVIEW

The DM02 Disk Controller connects high-capacity mass storage peripherals to LSI-11 computers manufactured by Digital Equipment Corporation (DEC). The DM02 implements DEC's Mass Storage Control Protocol (MSCP) to provide a software-transparent interface for the host DEC computer. To provide traditional Emulex flexibility in peripheral selection, the DM02 uses the Enhanced Small Device Interface (ESDI) as its hard disk interface and the SA450 as its floppy disk interface. The DM02 supports the magnetic disk drive and serial options of ESDI. For more information on the DM02's ESDI interface, see subsection 8.3. The media used with the floppy disk drive is compatible with DEC RX50 media.

1.2.1 MASS STORAGE CONTROL PROTOCOL (MSCP)

MSCP is a software interface designed to lower the host computer's mass storage overhead by offloading much of the work associated with file management into an intelligent mass storage subsystem. In concert with ESDI compatible peripherals, the DM02 provides just such a subsystem. The DM02 relieves the host CPU of many file maintenance tasks. The DM02 Disk Controller performs these MSCP functions: error checking and correction, bad block replacement, seek optimization, command prioritizing and ordering, and data mapping. (Note that error checking and correction and bad block replacement are not supported with floppy disk drives.)

This last feature is, perhaps, the most important. This feature allows the host computer's operating system software to store data in logical blocks that are identified by simple logical block numbers (LBNs). Thus, the host does not need to have detailed knowledge of the peripheral's geometry (cylinders, tracks, sectors, etc.). This feature also makes autoconfiguration a simple matter. During system start-up, the host operating system queries the subsystem to find its capacity (the number of logical blocks that the subsystem can store).

Because the host operating system does not need to have detailed knowledge of its mass storage subsystem, the complexity of the operating system itself has been reduced. This reduction comes about because only one or two software modules are required to allow many different subsystems to be connected to a host.

1.3 PHYSICAL ORGANIZATION OVERVIEW

The DM02 Disk Controller is a modular, microprocessor-based disk controller that connects directly to the host computer's LSI-11 bus backplane. The microprocessor architecture ensures excellent reliability and compactness.

The DM02 is contained on a single dual-wide printed circuit board assembly (PCBA) that plugs directly into an LSI-11 bus backplane slot.

The DM02 supports a maximum of two, physical hard disk drives and two, physical floppy disk drives. In addition, the DM02 NOVRAM is capable of splitting each hard disk into two logical units. Under RT-11 and MicroVMS, the DM02 supports a maximum of six logical drives; under RSX-11-M, RSX-11-M-PLUS, and RSTS/E, the DM02 supports a maximum of four logical drives.

Figure 1-1 shows one possible DM02 physical subsystem configuration.

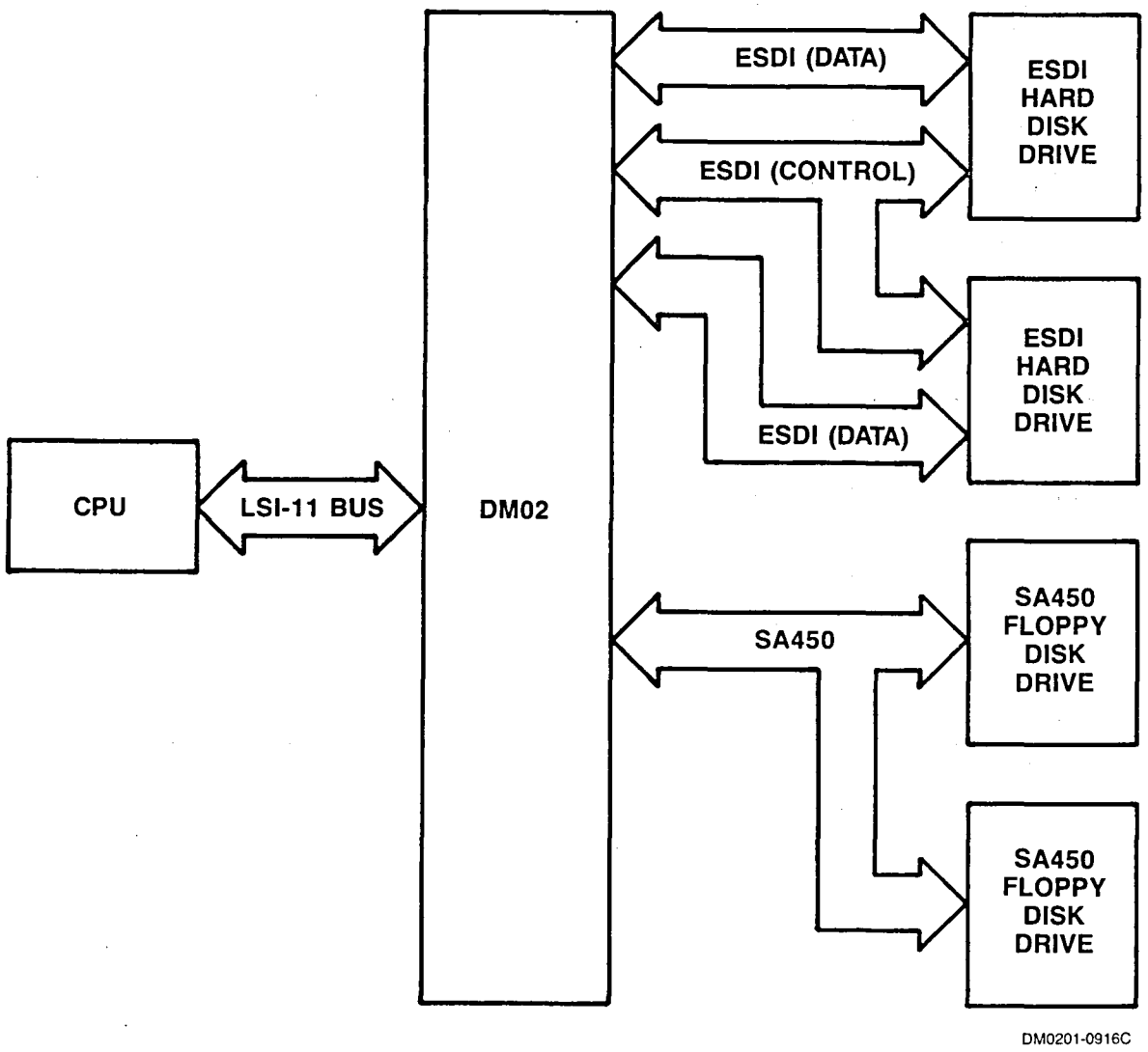


Figure 1-1. DM02 Subsystem Configuration

1.4 SUBSYSTEM MODELS and OPTIONS

The DM02 Disk Controller, with appropriate peripherals, provides a DEC MSCP-compatible mass storage subsystem. The DM02 is pictured in Figure 1-2. The DM02 is identified by a top level assembly tag that is glued to the 8031 microprocessor chip on the PWB. The DM02 top level assembly number is given in Table 1-1 along with the part numbers of the items that are delivered with the DM02.

Table 1-1. Basic Subsystem Contents

Itm	Qty	Description	Part Number
1	1	DM02 Disk Controller	DM0210201
2	1	22-Bit Addressing Kit	QD0113002
3	1	DM02 Technical Manual	DM0251001

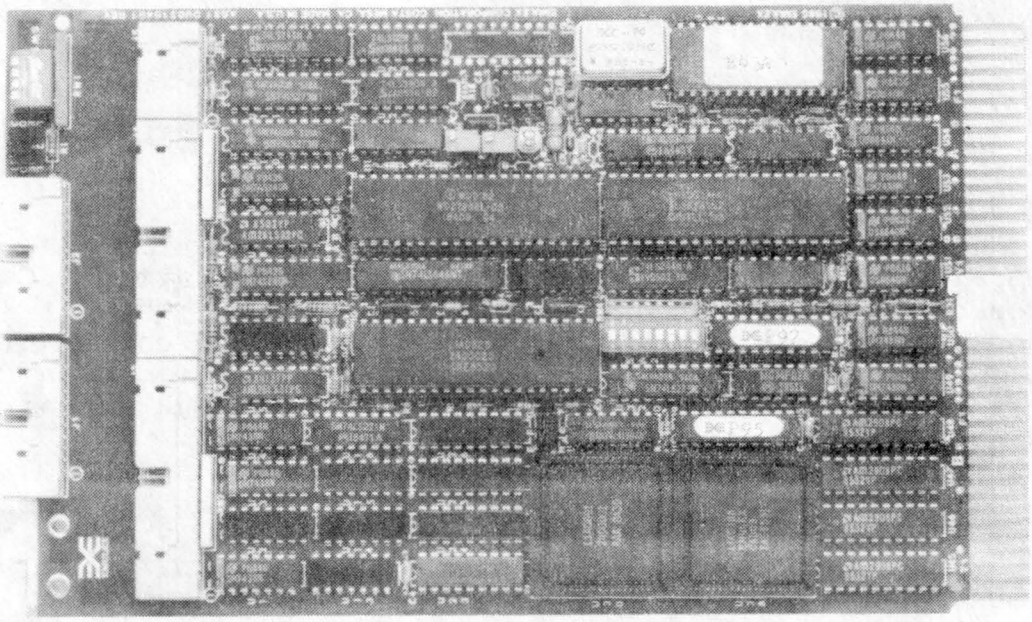
1.4.1 SUBSYSTEM OPTIONS

Table 1-2 lists the options that can be ordered to tailor your DM02 to your particular application. Software programs are offered in distribution kits that include media and documentation.

Table 1-2. Subsystem Options

Option	Description
PX995180n-0n[1]	Includes the Emulex PDP/LSI MSCP Formatter Program (QXMX8B). Distribution kit is per customer order.
VX9951804	Includes the Emulex MicroVAX MSCP Disk Formatter Program (FVD32M).
DM02130-01	DM02 Internal Cabling Kit

[1] See Appendix C for distribution kit part numbers.



DM0201-1013

Figure 1-2. DM02 Disk Controller

Options are specified as separate line items on a sales order. An example of an actual sales order is shown in Figure 1-3.

Item	Qty	Model Number	Comment/Description
1.	1	DM02	Disk Controller implementing DEC MSCP with ESDI hard disk drives and SA450 floppy disk drives.
2.	1	VX9951804	Includes the Emulex MicroVAX MSCP Disk Formatter Program (FVD32M).

Figure 1-3. Sales Order Example

1.5 FEATURES

The following features enhance the usefulness of the DM02 Disk Controller.

1.5.1 MICROPROCESSOR DESIGN

The DM02 design incorporates an eight-bit, high-performance CMOS microprocessor to perform all controller functions. The microprocessor approach provides a reduced component count, high reliability, easy maintainability, and the microprogramming flexibility that allows MSCP to be implemented without expensive, dedicated hardware.

1.5.2 CONFIGURATION FLEXIBILITY

The DM02 Disk Controller can support many different subsystem drive configurations by using the DM02's Nonvolatile Random Access Memory (NOVRAM). The DM02's NOVRAM can be programmed for four physical drive configurations. In addition, the user can change these stored drive configurations by altering the NOVRAM using Emulex software or the DM02's extended command set. The flexibility of the DM02 configuration NOVRAM eliminates the need for special configuration PROMs and field upgrade kits.

1.5.3 SELF-TEST

The DM02 incorporates an internal self-test routine which exercises all parts of the microprocessor, the on-board memory, the buffer controller, the disk formatter controller, the floppy formatter 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 DM02 detects an error during 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).

1.5.4 ERROR CONTROL

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

1.5.5 SEEK OPTIMIZATION

The DM02 is able to pool the various seeks that need to be performed and determine the most efficient order in which to do them. This is an especially important feature in heavily loaded systems. The disk controller's ability to arrange seeks in the optimum order saves a great deal of time and makes the entire system more efficient.

1.5.6 COMMAND BUFFER

The DM02 contains a buffer that is able to store 13 MSCP commands. This large buffer allows the subsystem to achieve a higher throughput and to operate at a very efficient level.

1.5.7 ADAPTIVE DMA

During each DMA data transfer burst, the DM02 monitors the LSI-11 bus for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. The host processor programs the DMA burst length during the MSCP initialization sequence or the DM02 defaults to 16 words per burst. The DM02 firmware design includes a switch selectable DMA burst delay to avoid data late conditions. Because of these adaptive DMA techniques, the DM02 ensures that CPU functions, including interrupt servicing, are not locked out for excessive periods of time by high-speed disk transfers.

In addition, the DM02 allows you to modify its DMA operations by disabling the adaptive DMA (SW2-8 ON) and defaulting to burst transfers of 8 words or less.

1.5.8 BLOCK-MODE DMA

The DM02 supports block-mode DMA for accessing memory. In this mode, the initial address of the data is transmitted, followed by a burst of up to 16 words of data. The memory address is automatically incremented to accommodate this burst. Block mode transfers considerably reduce the overhead associated with DMA operations.

1.5.9 TWENTY-TWO-BIT ADDRESSING

The DM02 supports the 22-bit addressing capability of the extended LSI-11 bus.

1.6 COMPATIBILITY

1.6.1 DIAGNOSTICS

Emulex offers two diagnostic programs to support the use and maintenance of the DM02:

- Emulex PDP/LSI MSCP Formatter Program (QXMX8B)
- Emulex MicroVAX MSCP Disk Formatter Program (FVD32M)

1.6.2 OPERATING SYSTEMS

The DM02 implements MSCP. Emulex supports its implementation of MSCP beginning with the indicated version of the following DEC operating systems:

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

1.6.3 HARDWARE COMPATIBILITY

The DM02 Disk Controller complies with DEC LSI-11 bus protocol, and it directly supports 22-bit addressing and block-mode DMA. The DM02 also supports scatter-write and gather-read operations on the MicroVAX I.

The DM02 supports the serial mode implementation of the ESDI interface on magnetic disk drives that have clocks up to 15 Megahertz. The DM02 does not use the drive's defect list.

Emulex has certified the following ESDI hard disk drives for DM02 support:

- Fujitsu M2246E
- Hitachi DK512-17
- Maxtor EXT-4175
- Maxtor EXT-4380
- Micropolis 1350

These drives have been tested in the following configurations:

- Fujitsu M2246E (soft-sectored) and Maxtor EXT-4380 (soft-sectored)
- Hitachi DK512-17 (hard-sectored)
- Hitachi DK512-17 (soft-sectored)
- Maxtor EXT-4175 (soft-sectored)
- Micropolis 1350 (hard-sectored) and Maxtor EXT-4380 (soft-sectored)
- Micropolis 1350 (hard-sectored) and Fujitsu M2246E (soft-sectored)

The hard disk drives supported by the DM02 are not media compatible with comparable DEC MSCP products; this is not a problem due to the fixed nature of most DEC disk drives.

Emulex has certified the following SA450 floppy disk drives for DM02 support:

- NEC FD1055
- Panasonic JU-465-5
- Tandon TM65-4
- TEAC FD-55F
- TEAC FD-55FV

The floppy disk drives supported by the DM02 are media compatible with DEC RX50 floppy disk drives.

1.6.4 PACK TRANSITION SUPPORT

Pack transition notification alerts the system when new media is inserted in a drive. DM02 pack transition support minimizes the chance of the system writing to a changed floppy as if it were the original diskette.

An SA450 drive may have several, jumper-selectable definitions of READY line (34). To support pack transition, the SA450 READY line must be TRUE as a function of the floppy door being closed.

There are some operating system limitations. RSX-11M and RSTS/E require pack transition support. RSX-11M-PLUS and MicroVMS do not require pack transition support, but the user should exercise caution when changing floppies. The pack transition concept does not apply to RT-11.

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Section 2
CONTROLLER SPECIFICATION

2.1 OVERVIEW

This section contains the general, environmental, physical, electrical, and port specifications for the DM02 Disk Controller.

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

2.2 GENERAL SPECIFICATION

Table 2-1 contains a general specification for the DM02 Disk Controller.

Table 2-1. DM02 General Specifications

Parameter	Description
FUNCTION	Providing mass data storage to Digital Equipment Corporation (DEC) computers that use the LSI-11 bus
Logical CPU Interface	Emulates DEC's Mass Storage Control Protocol (MSCP)
Diagnostic Software	Emulex PDP/LSI MSCP Disk Formatter Program (QXMX8B) and MicroVAX MSCP Disk Formatter Program (FVD32M, Rev 3)
Operating System Compatibility	Micro/VMS V4.0 and above RSTE/S V8.0 and above RSX-11M V4.1 and above RSX-11M PLUS V2.1 and above RT-11 V5.1 and above

(continued on next page)

Table 2-1. DM02 General Specifications (continued)

Parameter	Description
CPU I/O Technique	Direct Memory Access (DMA), including adaptive techniques and block mode; supports scatter-write and gather-read operations on the MicroVAX I
INTERFACE	
CPU Interface	Extended LSI-11 bus interface
Device Base Address	
Standard Alternates	17772150_8 17772154_8 17760334_8 17760340_8 17760344_8 17760350_8 17760354_8 17760360_8
Vector Address	Programmable
Priority Level	BR4 and BR5
Bus Loading	1 DC Load, 2.5 AC Loads
Hard Disk Interface	Enhanced Small Device Interface (ESDI), Serial Mode
Number of Physical Disk Drives Supported	2
Drive Sectoring	Hard or Soft Sectored
Interface Cables	34-line control cable (daisy-chain), maximum 10 ft (3 m) 20-line data cables (radial), maximum 10 ft (3 m)

Table 2-1. DM02 General Specifications (continued)

Parameter	Description
Floppy Disk Interface	Shugart SA450
Number of Physical Drives Supported	2
Disk Transfer Rate	250K bits per second
Maximum Cable Length	10 feet (ft) 3 meters (m)

2.3 ENVIRONMENTAL SPECIFICATION

Table 2-2 contains the environmental specifications for the DM02 Disk Controller.

Table 2-2. DM02 Environmental Specifications

Parameter	Description
OPERATING TEMPERATURE	10°C (50°F) to 40°C (104°F), where maximum temperature is reduced 1.8°C per 1000 meters (1°F per 1000 feet) altitude
RELATIVE HUMIDITY	10% to 90% with a maximum wet bulb of 28°C (82°F) and a minimum dewpoint of 2°C (3.6°F)
COOLING	6 cubic feet per minute
HEAT DISSIPATION	82 BTU per hour

2.4 PHYSICAL SPECIFICATION

Table 2-3 contains the physical specifications for the DM02 Disk Controller.

Table 2-3. DM02 Physical Specifications

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

2.5 ELECTRICAL SPECIFICATION

Table 2-4 lists and describes the electrical specification for the DM02 Disk Controller.

Table 2-4. DM02 Electrical Specifications

Parameter	Description
POWER	5 VDC $\pm$ 5%, 2.6 amperes (A)

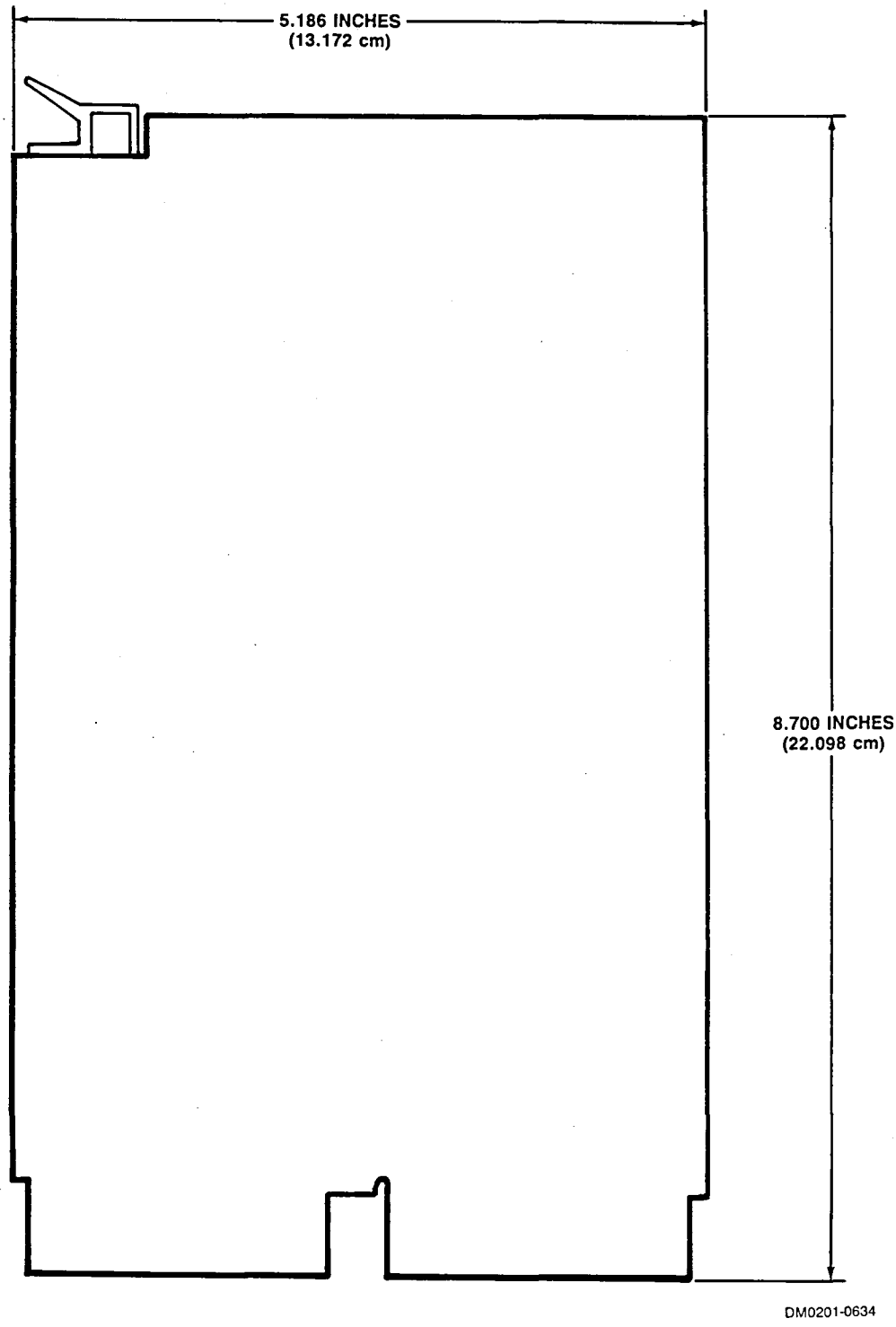

Figure 2-1. DM02 Disk Controller Dimensions

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Section 3
PLANNING THE INSTALLATION

3.1 OVERVIEW

This section is designed to help you plan the installation of your DM02 Disk Controller. Taking a few minutes and planning the configuration of your subsystem before beginning its installation should result in a smoother installation with less system down time. This section contains DM02 application examples and configuration procedures. The subsections are listed in the following table:

Subsection	Title
3.2	MSCP Subsystem Configuration
3.3	A DEC MSCP Subsystem
3.4	The DM02 MSCP Subsystem
3.5	Operating Systems, Device and Vector Addresses

3.2 MSCP SUBSYSTEM CONFIGURATION

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

3.2.1 ARCHITECTURE

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

- **Host Layer.** An MSCP class-driver in the host system receives requests from the operating system and then relays data and commands to the controller in MSCP message packets.
- **Controller Layer.** The MSCP controller communicates with both the host layer and the mass storage layer. The controller transmits MSCP message packets to and from the host MSCP class-driver and performs data-handling functions for the mass storage devices. The DM02 functions as the controller layer.
- **Mass Storage Layer.** The mass storage peripheral devices communicate with the MSCP controller and send or receive data as specified by the MSCP controller.

MSCP defines the form of the message packets that are exchanged by the host and the MSCP controller. The DM02 implements MSCP in mass storage subsystems using ESDI as the hard disk drive interface and SA450 as the floppy disk drive interface.

3.2.2 PERIPHERAL NUMBERING

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

With the exception of MicroVMS systems, DEC operating systems require that all MSCP peripherals on a system have different MSCP device numbers, even if they are managed by separate MSCP controllers at separate LSI-11 bus device addresses. For example, under RSX-11M-PLUS, if there are three peripherals on the first MSCP controller (at 772150$_8$), then the first peripheral on the second MSCP controller (in floating CSR address space) is numbered DU3.

3.2.3 PERIPHERAL CAPACITIES

The capacity of peripherals in an MSCP subsystem is measured in logical blocks. Each logical block contains 512 bytes of data. The MSCP controller can report the capacity of a peripheral to the operating system. A 10M byte peripheral such as DEC's RD51 is able to store about 20,000 logical blocks.

3.3 A DEC MSCP SUBSYSTEM

Figure 3-1 shows the organization of a typical DEC MSCP subsystem for the LSI-11 bus. The MSCP host and controller functions (see section 3.2.1) are combined in a single piece of hardware, in this example the DEC RQDX3. The RQDX3 supports RD51, RD52, and RD53 hard disk drives and the RX50 5.25-inch floppy drive. The RQDX3 plugs directly into the LSI-11 bus and is attached to the disk drives via a disk-drive-native interface.

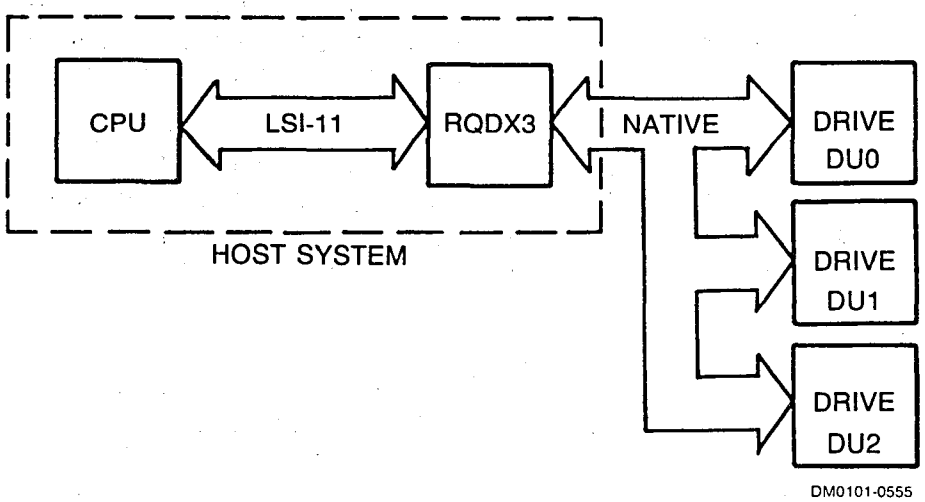

Figure 3-1. DEC MSCP Subsystem Logical and Physical Configuration

3.4 THE DM02 MSCP SUBSYSTEM

Figure 3-2 illustrates a typical DM02 MSCP subsystem. As with the DEC implementation, the DM02 is connected directly to the LSI-11 bus. However, the DM02 uses the ESDI peripheral interface to communicate with one or two hard disk drives and the SA450 interface to communicate with one or two floppy disk drives.

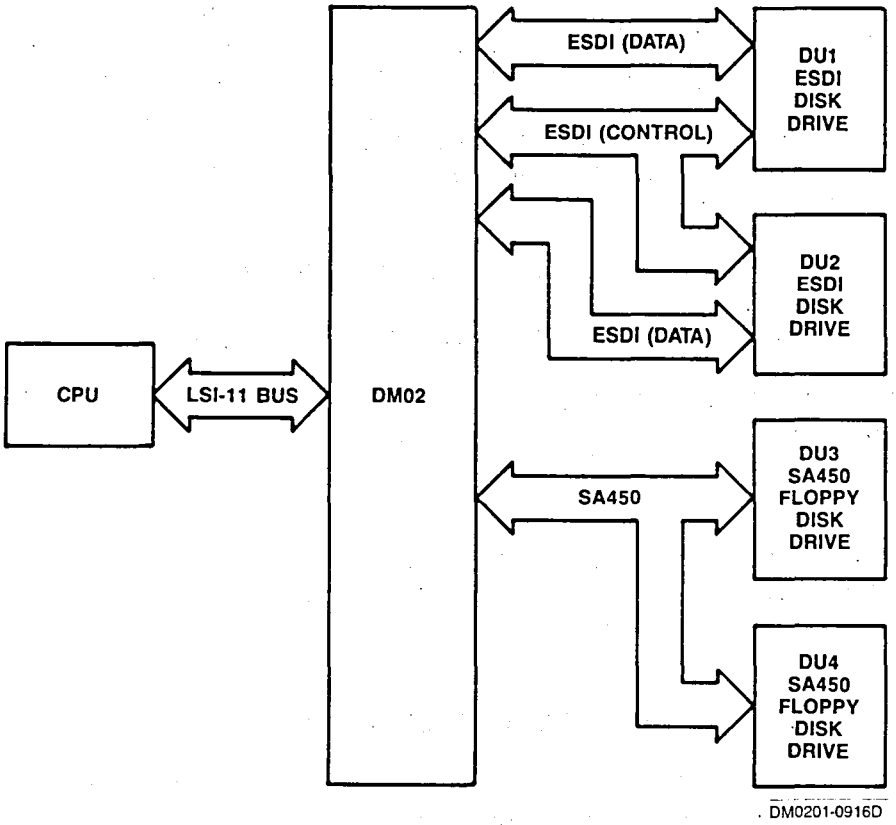

Figure 3-2. DM02 Subsystem Logical and Physical Configuration

The MSCP subsystem provided by the DM02 is essentially analogous to the DEC MSCP subsystem. As in the DEC subsystem, the DM02 MSCP controller connects directly to the LSI-11 bus. As an MSCP controller, the DM02 receives requests from the host, optimizes the requests, generates ESDI and SA450 commands to perform the operations, transfers data to and from the host, transfers data to and from the device, and buffers data as necessary. When the command is complete, the controller sends a response to the host.

The DM02 also performs all of the functions of the peripheral controller, including serialization and deserialization of data. The DM02 connects to the hard disk peripherals it supports via the ESDI interface and to the floppy disk peripherals via the SA450 interface.

3.4.1 LOGICAL UNIT NUMBERS

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

DEC MSCP-type drives can accept unit identification plugs that define addresses from 0 to 255. Disk drives controlled by the DM02 do not have this flexibility. The DM02 can detect only two unique drive addresses at its ESDI peripheral interface - 1 and 2; at its SA450 interface - 0 and 1. To prevent a unit-number conflict between the DM02's drives and another MSCP controller's drives, the DM02 employs switches to change the drive logical unit number that is reported to the operating system.

Example 3-1 An MSCP controller at a standard base address supports four disk drives; a DM02 at an alternate base address supports two disk drives. An offset of 4 is specified for the DM02. This causes the DM02 ESDI disk with disk address 1 to be reported to the operating system as logical unit number (LUN) 4. The DM02 disk address 2 is reported as LUN 5.

The offset for the logical unit number is specified by using switches SW1-2 through SW1-4 on the DM02. See subsection 4.3.3.2.2 for switch setting information.

3.4.2 DM02 MSCP SUBSYSTEM LOGICAL CONFIGURATION

This subsection explains the algorithm used by the DM02 to map logical MSCP peripherals onto the physical hard disk drives provided by the DM02 subsystem. Note that the floppy drives may not be divided into multiple logical units.

3.4.2.1 Logical Devices

The phrase "logical MSCP disk drive" refers to the disk drive as it appears to the operating system. That is, the operating system associates a disk drive of known type (in this case, an MSCP disk drive) with a unit number and a capacity. The DM02 MSCP controller presents that information to the operating system after initialization on command.

Because the MSCP controller is responsible for establishing the relationship between unit number and capacity, it is possible for the controller to divide its physical disk drives into more than one logical unit. For example, if a physical disk drive has a capacity of 584,000 blocks, the MSCP controller can divide that capacity into two parts of 292,000 blocks each.

Each part is then assigned a separate unit number, and the the unit number and capacity of each part is presented to the operating system. The operating system then sees the two parts as separate disk drives, even though the data is actually stored on the same physical drive. The two parts are called logical disk drives, and the numbers that identify them are called MSCP unit numbers.

A drive configuration that supports multiple logical units is specified by the data that is stored in the configuration Nonvolatile Random Access Memory (NOVRAM). Information for programming the configuration NOVRAM is given in Section 6, Registers and Programming. The field that causes a hard disk drive to be divided into multiple logical units is called the Split Code (word 10). There are four types of split codes: no split, cylinder split, head split, and reverse head split:

- When no split is specified, the entire physical drive is one logical drive.
- Cylinder split codes divide a physical drive by cylinders. A Starting Cylinder Offset field in the NOVRAM specifies the first cylinder of the second logical drive. Alternate cylinders are divided evenly between drives. For example, a Maxtor 4380, which has 1224 cylinders, might be divided so that the first logical unit is assigned cylinders 0 through 611 and the second logical unit assigned cylinders 612 through 1224. In this example, the Starting Cylinder Offset has a value of 612.
- Head split codes divide the drive by data heads. A Starting Head Offset field in the NOVRAM specifies the first head of the second logical drive. When the drive is split by data heads, each logical drive has its own platter(s); consequently, the lower blocks of one logical drive are in the same physical cylinder as the lower blocks of the other logical drive. For example, a Maxtor 4380 with a total of 15 heads might be divided so that the first logical unit is assigned heads 0 through 7, and the second logical unit is assigned heads 8 through 14. The Starting Head Offset has a value of 8.
- Reverse head split codes also divide the drive by data heads, but assign the lower numbered heads to drive 1 and the higher numbered heads to drive 0. If you entered a reverse split code for the previous Maxtor 4380 example, the first logical unit is assigned heads 8 through 14 and the second logical unit is assigned heads 0 through 7. The Starting Head Offset has a value of 8. (One advantage of the reverse head split codes is that you may use a fixed media unit as your system disk without modifications to the operating system.)

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

3.4.2.2 Device Numbers

The drives supported by the DM02 are assigned MSCP device names by the operating system. As described in subsection 3.2.2, an MSCP device name consists of a device class prefix and a device unit number. Drives are assigned MSCP device numbers beginning with zero (0). The conventions for numbering multiple MSCP drives vary by operating system.

Under RSX-11M, RSX-11M-PLUS, and RT-11, 0 is assigned to the first drive on the first MSCP controller, where "first" means the controller located at the standard base address. Unit number 1 would be the second drive on the first controller, etc. If there are two MSCP controllers on the system, the units installed on the second begin numbering at n+1, where n equals the highest unit number of the first MSCP controller.

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

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

Table 3-1 is an MSCP unit numbering example under the RSX-11M operating system which shows the MSCP number versus the actual physical addresses assigned to all the components. The physical disk drive (unit number 0) of the second controller is split into two logical units. Note that two device names are associated with that drive.

Table 3-1. Subsystem Configuration Example

DM02 Address	Device Description	Drive Unit Number	Device Name
772150	Micropolis 1350	1	DU0
	Micropolis 1350	2	DU1
760334 (Floating)	TEAC FD-55F	0	DU2
	TEAC FD-55F	1	DU3

NOTE

The device identifier for hard disk drives supported by the DM02 is RA81; the device identifier for floppy disk drives supported by the DM02 is RX50.

3.5 OPERATING SYSTEMS, DEVICE AND VECTOR ADDRESSES

Before the installation of any peripheral device can be considered complete, the computer's operating system must be made aware of the new resource. The information provided in this section is intended to supplement your DEC operating system resources and to be used as an aid in planning the installation of your DM02.

An operating system can be made aware of a new resource in three ways:

- The operating system can poll the computer's I/O device address space.
- The device can be manually connected using CONNECT or CONFIGURE statements.
- The user can tell the operating system about a device during an interactive SYSGEN procedure.

The first technique is referred to as autoconfigure, and it is essentially automatic. The second technique requires that CONNECT statements be placed in a special command file that is executed each time the computer is bootstrapped. The third technique, interactive SYSGEN, creates a configuration file that the operating system references when the system is bootstrapped. All techniques accomplish the same result: they associate a specific device type with a bus address and interrupt vector.

Most recent versions of DEC operating systems use autoconfigure to some extent, and try to follow the same rules. The RT-11 operating system does not use autoconfigure, but can locate devices that reside at a standard address. There are some differences among operating systems, however, especially with regard to MSCP controllers at alternate LSI-11 bus addresses. The following paragraphs address these differences for each supported operating system. This discussion includes information on choosing appropriate LSI-11 bus device addresses and interrupt vectors for the subsystem.

The following operating system discussions give procedures for choosing LSI-11 bus addresses for the first MSCP controller and any subsequent controllers in the host configuration. No instructions are provided for programming the chosen address into the DM02. See subsection 4.5.1 for detailed switch setting information.

MSCP-type controllers contain two registers that are visible to the LSI-11 bus I/O page. They are the Initialization and Polling (IP) register (base address) and the Status and Address (SA) register (base address plus 2). The IP register, the CSR address, LSI-11 bus address and the base address all refer to the same register. All of the operating systems described in the following subsections use the standard LSI-11 bus address of 1772150_8 for the first controller on the host system.

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

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

Table 3-2. Device Names

Operating System	Controller First, Second	Drives Supported by First Controller
RSTS/E	RU0, RU1	DU0, DU1
RSX-11M	---- ----	DU0, DU1
RSX-11M-PLUS	DUA, DUB	DU0, DU1
RT-11	Port0, Port1	DU0, DU1
MicroVMS	PUA, PUB	DUA0, DUA1

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

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

3.5.1 RSTS/E OPERATING SYSTEMS (V8.0 and above)

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

The RSTS/E operating system can support two MSCP controllers. The first MSCP controller must be located at the standard LSI-11 bus address, 772150_8. According to DEC documentation, the second unit should be located in floating address space. For an alternate DM02, Emulex suggests specifying a LSI-11 bus address in floating address space using the HARDWARE option of the INIT.SYS program.

The INIT.SYS program uses a user-specified table, located in the currently installed monitor, to make exceptions to the autoconfigure algorithm. This table is modified by the HARDWARE option of the INIT.SYS program. Use of this table allows an MSCP controller to be placed at virtually any address on the I/O page. Note that this table must be reset any time a new monitor is installed. Emulex suggests using a LSI-11 bus address of in floating address space for an alternate DM02. An MSCP controller must be located at the standard address to be a bootstrap device.

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

3.5.1.1 Adding MSCP Support

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

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

3.5.2 RT-11 OPERATING SYSTEMS (V5.1 and above)

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

3.5.2.1 Installing a Single MSCP Controller

If your host system includes only one MSCP controller, install it with a LSI-11 bus address of 772150_8. RT-11 will find and install the handler (driver) for that controller. In single MSCP controller configurations, it is not necessary to run SYSGEN. You may use one of the pregenerated monitors that are provided with the RT-11 Distribution. Emulex recommends that you modify the system start-up command file, STARTx.COM, to properly partition the disk drives. See subsection 3.5.2.3.

3.5.2.2 Installing Multiple MSCP Controllers

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

1. Initiate SYSGEN:

   IND SYSGEN<return>

   Answer the next group of questions appropriately.

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

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

   The start-up command file is required to allow additional MSCP controller LSI-11 bus addresses to be specified and to partition the disks consistently when the system is bootstrapped. Answer the next set of questions appropriately.

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

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

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

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

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

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

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

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

```
SET DU CSR=772150          (Default)
SET DU CSR2=760334₈        (Floating)
SET DU VECTOR=154          (Default)
SET DU VEC2=300
```

   The LSI-11 bus for the second device can be any unused address in the I/O page which is supported by DM02 address switch settings; the vector address can be any unused address in the vector page. Default statements are not required.

7. Complete SYSGEN according to the DEC documentation.

3.5.2.3 Disk Partitioning

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

1. Determine the drive configuration(s) that you intend to use. You need to know the LUN of each logical drive and the data storage capacity (in logical blocks) of each logical unit. Refer to Appendix D for the logical block capacity of supported drives. If the DM02 is at an alternate LSI-11 bus address (not 772150₈), then you must specify an MSCP device number by using switches SW1-2 through SW1-4 (see subsection 4.3.3.2.2).

2. Divide the capacity for each MSCP Unit by 65,535. If the result is a number greater than 1, then that MSCP Unit should be partitioned into multiple logical units. (The last partition on a disk may be smaller that 65,535 blocks.) Round the result up to the nearest whole number. That whole number equals the number of logical disks into which that MSCP unit should be partitioned.

3. You must then include a series of statements in the system start-up command file, STARTx.COM, that assigns logical names to each partition. Each statement has the following format:

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

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

Example: You have selected a Maxtor 4380 drive that has a capacity of 584,000 blocks (unit 0) and a floppy drive that has a capacity of 800 blocks (unit 1).

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

$$\frac{800}{65{,}535} = 0.012 \quad \text{(1 logical unit)}$$

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

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

```
SET DU0 UNIT=0 PART=0 PORT=0
SET DU1 UNIT=0 PART=1 PORT=0
SET DU2 UNIT=0 PART=2 PORT=0
SET DU3 UNIT=0 PART=3 PORT=0
SET DU4 UNIT=0 PART=4 PORT=0
SET DU5 UNIT=0 PART=5 PORT=0
SET DU6 UNIT=0 PART=6 PORT=0
SET DU7 UNIT=0 PART=7 PORT=0
SET DU8 UNIT=0 PART=8 PORT=0
SET DU9 UNIT=1 PART=0 PORT=0
```

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

3.5.3 RSX-11M OPERATING SYSTEMS (V4.0 and above)

RSX-11M SYSGEN is an interrogative program that allows a complete, running RSX-11M system to be configured for a particular hardware environment. SYSGEN is well documented in the RSX-11M System Generation and Installation Guide, and you are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the DM02 may present.

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

NOTE

If the DM02 controls the system disk, you must select 22-bit addressing (SW2-6 ON) even if your system has only 256K bytes of memory.

3.5.3.1 Installing a Single MSCP Controller

If you have only one DM02, install it at the standard address (772150_8) and use autoconfigure to connect your peripherals. The procedure given in the RSX-11M System Generation and Configuration Guide is adequate for this purpose.

3.5.3.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say a DEC MSCP controller and a DM02, you must perform a complete manual initialization. We recommend that the DEC MSCP controller be installed at the standard LSI-11 bus address. Locating the DM02 at the alternate LSI-11 bus address does not prevent its being used as the system device. Both MSCP controllers are connected to the operating system by using the following procedure.

1. Invoke SYSGEN.

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

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

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

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

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

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

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

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

   This entry supersedes the value of 1 that autoconfigure has determined. Typing a period (.) terminates device input.

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

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

   The first question requests information about the controller's interrupt vector address, LSI-11 bus address, the number of DU-type disk drives (there is no default value for this parameter), the number of command rings, and the number of response rings. The question is asked twice, once for controller 0 and once for controller 1, because we have specified two DU-type controllers. The dialog uses the abbreviation contr to indicate controller.

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

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

The standard LSI-11 bus address for MSCP controllers is 772150_8. The second unit can be located at 772154_8 or in floating LSI-11 bus address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

The number of DU-type disk drives depends on the configuration that you have selected for the DM02, or on the number of drives that are attached to a DEC MSCP controller.

When you select a configuration for the DM02, you are taking into account the number of physical disk drives that you are attaching to the DM02's peripheral interfaces. When you select a configuration, you are also specifying a logical arrangement for the DM02 MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each drive when you program the DM02's NOVRAM; see Section 6.

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

- RX50
- RD51
- RD52
- RD53
- RC25
- RA60
- RA80
- RA81

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

RSX-11M supports up to eight command and eight response rings; the number of command and response rings that you specify depends on your application. Four command and four response rings are reasonable and adequate for most applications. For further information about command and response rings, refer to the MSCP documentation listed in subsection 6.3 of this manual. In most instances, further information is not required to install the DM02.

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

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

   For the DEC MSCP controller, indicate the appropriate peripherals.

   For the DM02, indicate that you have one RA81 for each logical disk drive.

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

7. Complete the SYSGEN procedure according to DEC documentation.

3.5.4 RSX-11M-PLUS OPERATING SYSTEMS (V2.1 and above)

RSX-11M-PLUS SYSGEN is an interrogative program that allows a complete, running RSX-11M-PLUS system to be configured for a particular hardware environment. SYSGEN is well documented in the RSX-11M-PLUS System Generation and Installation Guide, and you are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the DM02 may involve.

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

3.5.4.1 Installing a Single MSCP Controller

If you have only one DM02, install it at the standard address (772150_8) and use autoconfigure to connect your peripherals. The procedure given in the RSX-11M-PLUS System Generation and Configuration Guide is adequate for this purpose.

3.5.4.2 Installing Multiple MSCP Controllers

If your initial system configuration includes two MSCP controllers, connect the alternate MSCP controller to the operating system during the initial SYSGEN. We recommend that you use autoconfigure to connect the first controller at the standard address (772150_8). We recommend that the DEC MSCP controller be installed at the standard LSI-11 bus address; locating the DM02 at the alternate LSI-11 bus address does not prevent its being used as the system device.

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

1. Invoke SYSGEN.

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

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

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

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

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

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

4. Select the Add a Device section of SYSGEN:

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

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

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

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

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

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

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

   The answer to this question depends on the configuration that you have selected for the DM02 and on the number of drives that are attached to any DEC MSCP controllers.

   When you select a configuration for the DM02, you are taking into account the number of physical disk drives that you are attaching to the DM02's peripheral interfaces. When you select a configuration, you are also specifying a logical arrangement for the DM02 MSCP subsystem. Some configurations split one physical drive into two logical drives to make file management easier. You determine the configuration of each drive when you program the DM02's NOVRAM (see Section 6).

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

   - RX50
   - RD51
   - RD52
   - RD53
   - RC25
   - RA60
   - RA80
   - RA81

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

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

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

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

8. Enter the vector address for each MSCP controller:

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

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

9. Enter the CSR address for each MSCP controller:

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

The standard CSR address for MSCP controllers is 772150_8. The second unit can be located at 772154_8, or in floating CSR address space. See Appendix A for a description of the DEC algorithm for assigning floating addresses.

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

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

RSX-11M-PLUS supports up to eight command rings. The value you specify depends on your application. Four command rings are reasonable and adequate for most applications. For further information about command and response rings, refer to the MSCP documentation listed in subsection 6.3 of this manual. In most instances, further information is not required to install the DM02.

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

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

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

11. Complete SYSGEN according to DEC documentation.

3.5.5 MicroVMS OPERATING SYSTEMS

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

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

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

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

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

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

2. Obtain a list of devices already installed on the MicroVAX LSI-11 bus by typing:

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

```
Name: PUA  Units: 1  Nexus: 0  CSR: 772150   Vector1: 154  Vector2: 000
Name: TTA  Units: 1  Nexus: 0  CSR: 760100*  Vector1: 300* Vector2: 304*
Name: TXA  Units: 1  Nexus: 0  CSR: 760500*  Vector1: 310* Vector2: 000

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

Figure 3-3. Sample SHOW CONFIGURATION

SYSGEN lists by logical name the devices already installed on the LSI-11 bus. Make a note of these other devices with floating addresses (greater than 760000$_8$) or floating vectors (greater than 300$_8$) that you plan to re-install with your DM02.

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

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

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

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

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

In addition to the DM02, you need only specify devices that have floating addresses or vectors. Devices with fixed addresses or vectors do not affect the address or vector assignments of devices with floating addresses and vectors.

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

```
DEVICE> ^Z
```

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

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

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

Figure 3-4. CONFIGURE Command Listing

5. Note the CSR addresses listed for the LSI-11 bus devices in floating address space. Program the listed addresses into non-Emulex devices as instructed by the manufacturer's documentation. For the DM02, program the address given for the DM02 (lowest numerical address) into the board as described in subsection 4.3.1.

6. Complete SYSGEN according to the DEC documentation.

If you want to select a non-standard address for the DM02, that is one that differs from the address selected by the CONFIGURE command, you must enter CONNECT statements in the SYCONFIG.COM file that is in the system manager's account, SYS$MANAGER. Use the syntax of the CONNECT statements as described in the DEC documentation on MicroVMS SYSGEN.

NOTE

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

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Section 4
INSTALLATION

4.1 OVERVIEW

The procedure for installing the DM02 Disk Controller is described in this section. The subsection titles are listed below to serve as an outline of the procedure.

Subsection	Title
4.2	Inspection
4.3	Disk Controller Setup
4.4	Physical Installation
4.5	Drive Preparation
4.6	Cabling
4.7	Integration and Operation

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

4.1.1 SUBSYSTEM CONFIGURATIONS

This section is limited to switch setting data and physical installation instructions. No attempt is made to describe the many subsystem configurations that are possible. If you are not familiar with the possible configurations, we strongly recommend reading Section 3, PREPARING THE INSTALLATION, before attempting to install this subsystem.

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

DM02 CONFIGURATION REFERENCE SHEET

GENERAL INFORMATION

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

DRIVE CONFIGURATION PARAMETERS

- Hard Drive Model (0) _____ Hard Drive Model (1) _____
- Floppy Drive Model (0) _____ Floppy Drive Model (1) _____
- NOVRAM Parameters:

HARD DISK DRIVE 1

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

HARD DISK DRIVE 2

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

FLOPPY DISK DRIVE 0

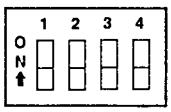
1	Number Units	_____
2	Type Code	_____
15	Step Code	_____

FLOPPY DISK DRIVE 1

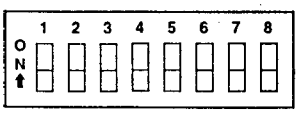
1	Number Units	_____
2	Type Code	_____
15	Step Code	_____

DM02 CONFIGURATION

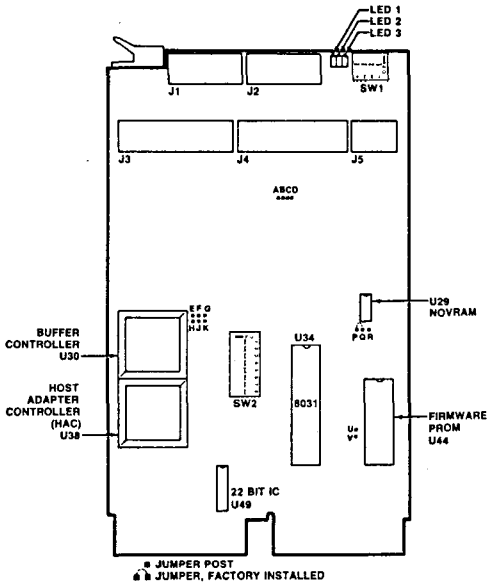
- Firmware revision number _____
- Top assembly number _____
- LSI-11 Bus address _____
- Warranty expiration date _____
- Serial number _____
- Interrupt vector address _____
- 22-bit addressing IC (AMD 7438) installed (Y or N) _____
- Switch settings (□ = OFF ■ = ON)



SW1



SW2



Use Pencil

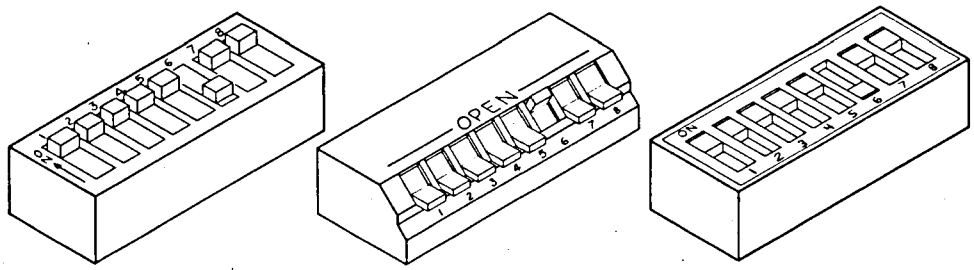
DM0201-1009

Figure 4-1. DM02 Configuration Reference Sheet

4.1.2 DIP SWITCH TYPES

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

The three DIP switch types used in this product are shown in Figure 4-2. Each is set to the code shown in the switch setting example.



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

Figure 4-2. Switch Setting Example

4.1.3 MAINTAINING FCC CLASS A COMPLIANCE

Emulex has tested the DM02 Intelligent Disk Controller with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the DM02 does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the DM02 and its associated peripherals can be installed:

- With both the DM02 Disk Controller and the hard and floppy disk drives all mounted in the same cabinet, and
- With the DM02 and the floppy disk drive mounted in the CPU cabinet and the hard disk drives mounted in a separate cabinet.

To limit radiated interference, DEC completely encloses the components of its computers that generate or could conduct radio-frequency interference (RFI) with a grounded metal shield (earth ground). During installation of the DM02, nothing must be done that would reduce this shield's effectiveness. That is, when the DM02 installation is complete, no gap in the shield that would allow RFI to escape can be allowed.

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

The steps that must be taken to maintain the integrity of the shield and to limit conducted interference are explained fully in subsection 4.1.2.

4.2 INSPECTION

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

Unpack the DM02 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. Paragraph 1.4 explains model numbers and details kit contents. These verifications are important to confirm warranty. If evidence of physical damage or identity mismatch is found, notify an Emulex representative immediately. If the equipment must be returned to Emulex, it should be shipped in the original container.

4.2.1 DM02 DISK CONTROLLER INSPECTION

Visually inspect the DM02 Disk Controller after unpacking. Check for such items as bent or broken connector pins, damaged components, or any other evidence of physical damage.

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

4.3 DISK CONTROLLER SETUP

Several configuration setups must be made on the DM02 Disk Controller before inserting it into the chassis. These setups are made by option switches SW1 and SW2, shown in Figure 4-3.

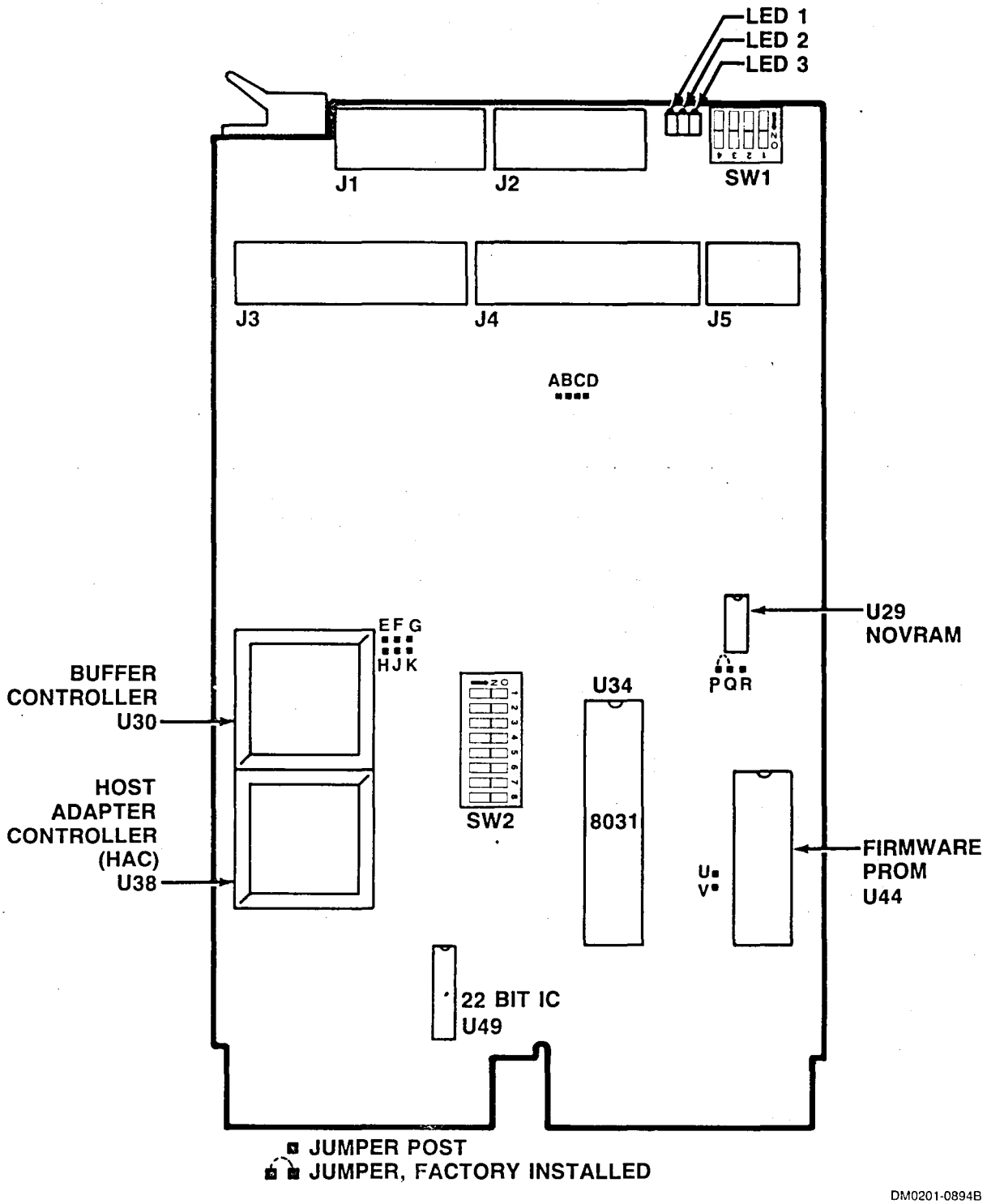


Figure 4-3. DM02 Disk Controller Assembly

NOTE

If you change a switch position on the DM02, you must also reset the DM02 so that the host operating system's initialization sequence reads the codes established by the switch settings. To reset the DM02, either toggle switch SW1-1 (ON then OFF), or power-down and power-up the the system.

Table 4-1 defines the function and factory configuration of all switches on the DM02 controller. The factory configuration switch settings are representative of most DM02 Disk Controller applications.

Table 4-1. DM02 Switch Definitions and Factory Configuration

SW	OFF(0)	ON(1)	Fact	Function	Section
SW1-1	Run	Reset/Halt	OFF(0)	Run vs. Reset/Halt	
SW1-2	-	-	OFF(0)	MSCP Device Number (LSB)	4.3.3.2
SW1-3	-	-	OFF(0)	MSCP Device Number	4.3.3.2
SW1-4	-	-	OFF(0)	MSCP Device Number (MSB)	4.3.3.2
SW2-1	Disable	Enable	OFF(0)	Loop on Self-Test Error	
SW2-2	Disable	Enable	OFF(0)	Automatic Bootstrap	4.3.3.1
SW2-3	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-4	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-5	-	-	OFF(0)	LSI-11 Bus Address	4.3.1
SW2-6	18-bit	22-bit	OFF(0)	Twenty-Two-Bit Addressing	4.3.3.3
SW2-7	4 usec	8 usec	OFF(0)	DMA Burst Delay	4.3.3.4
SW2-8	Enable	Disable	OFF(0)	Adaptive DMA Mode	4.3.3.5

ON(1) = Closed
OFF(0) = Open

NOTE

The Nonvolatile Random Access Memory (NOVRAM) on the DM02 is factory-configured to support one, SA450 floppy drive in a standard configuration. This allows the user to load the Emulex software program, which is supplied on RX50 media, to configure the NOVRAM to support any other drives.

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

Table 4-2. DM02 Jumper Definitions and Factory Configuration

Jumper	OUT	IN	FACT	Comment
A-B-C-D	Not Used	Not Used	OUT	Must be OUT
E-F-G	Not Used	Not Used	OUT	Must be OUT
H-J-K	Not Used	Not Used	OUT	Must be OUT
L-M-N	Not Used	Not Used	OUT	Must be OUT
P-Q	Disable Clock	Enable Clock	IN	Must be IN
R	Normal Operation	Ground (Test)	OUT	Must be OUT
U-V	Normal Operation	Factory Test	OUT	Must be OUT

FACT = Factory Setting

4.3.1 DISK CONTROLLER BUS ADDRESS

Every LSI-11 bus I/O device has a block of several registers through which the system can command and monitor that device. The registers are addressed sequentially from a starting address assigned to that controller, in this case an MSCP-class Disk Controller.

The address for the first of the DM02's two LSI-11 bus registers is selected by DIP switches SW2-3 through SW2-5. See Table 4-3 for register address switch settings. For more information on determining the LSI-11 bus address, see Section 3 and Appendix A.

Table 4-3. Controller Address Switch Settings

Bus Address (in octal)	-- SW2 -- 3	4	5	Factory
772150	0	0	0	√
772154	1	0	0	
* 760334	0	1	0	
760340	1	1	0	
760344	0	0	1	
760350	1	0	1	
760354	0	1	1	
760360	1	1	1	

4.3.2 INTERRUPT VECTOR ADDRESS

The interrupt vector address for the DM02 is programmed into the device by the operating system during the MSCP initialization sequence. See subsection 3.5 for a discussion of vector addresses.

4.3.3 OPTIONS

There are other DM02 options that can be implemented by the user. These features are selected by physically installing the option on the PCBA or by enabling the option using a switch.

4.3.3.1 Automatic Bootstrapping

The automatic bootstrapping option causes the system to boot automatically from logical unit 0 through 3 on power-up when the DM02 is at the standard base address. To enable this option, set SW2-2 ON and set switches SW1-2 through SW1-4 as described in Table 4-4. This option cannot be enabled with a MicroVAX or in a system that uses an 11/73B CPU module.

Switch	OFF	ON	Factory
SW2-2	Disable	Enable	OFF

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

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

If the bootstrap device is not powered-up or safe (e.g., it failed its self-test), the autoboot routine in the DM02 halts the CPU after 1 minute. This causes the CPU to enter Console ODT. You can then examine the Status and Address (SA) register (base address plus 2) for an MSCP error code (Table 5-3) and bootstrap the system from another device.

4.3.3.2 MSCP Device Number

DM02 switches SW1-2 through SW1-4 specify MSCP device numbers. The functions of these switches are dependent on the options you select for your DM02:

- If the DM02 is installed at the standard LSI-11 bus address, these switches identify the MSCP device number of the drive from which to bootstrap. The DM02 automatic bootstrap option supports only MSCP units 0 through 5 at the standard address. See subsection 4.3.3.2.1.
- If the DM02 is installed at an alternate LSI-11 bus address, these switches identify the MSCP device number of the first drive supported by that alternate DM02. The first drive supported by the DM02 at alternate address may be drive 1 through 8. See subsection 4.3.3.2.2.

4.3.3.2.1 Logical Unit to Autoboot From

If the DM02 automatic bootstrapping option is enabled (SW2-2 ON) and the DM02 is at the standard LSI-11 bus address (772150_8), switches SW1-2 through SW1-4 define the MSCP device number of the drive from which the DM02 bootstraps. By using these switches, you may select one of six logical units to bootstrap from. Table 4-4 defines the MSCP device numbers selected by switches SW1-2 through SW1-4 if the DM02 is at a standard address.

Table 4-4. Bootstrap MSCP Device Number

Bootstrap MSCP Device Number	----- SW1 ----- 2 (LSB)	3	4 (MSB)	Factory
0	0	0	0	√
1	1	0	0	
2	0	1	0	
3	1	1	0	
4	0	0	1	
5	1	0	1	

4.3.3.2.2 First Logical Unit Number for an Alternate DM02

If your DM02 is installed at an alternate address, switches SW1-2 through SW1-4 select the MSCP device number of the first drive supported by the DM02. MSCP device numbering schemes may vary by DEC operating system (see subsection 3.4.2.2). Table 4-5 defines the MSCP device numbers selected by switches SW1-2 through SW1-4 if the DM02 is at an alternate address.

Example 4-1: Your system operates under RSX-11M-PLUS and has two DM02 Disk Controllers. The first DM02 is at the standard base for MSCP controllers, 772150_8, and it supports three logical drives, Unit 0, Unit 1, and Unit 2. The second DM02 is at an alternate base address, and it supports two logical drives. RSX-11M-PLUS requires that the first drive on the alternate DM02 have an MSCP device number of 3 and that the second drive have an MSCP device number of 4. On the alternate DM02, set switches SW1-2 in the ON position, SW1-3 in the ON position, and SW1-4 in the OFF position to specify a MSCP device number of 3 for the first drive.

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

Table 4-5. MSCP Device Number for the First Drive Supported by a DM02 at an Alternate Address

Starting MSCP Device Number	----- SW1 ----- 2 (LSB)	3	4 (MSB)
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1
8	0	0	0

4.3.3.3 22-Bit Memory Addressing

Twenty-two-bit addressing capability is a standard option for the DM02. The DM02 22-Bit Addressing Kit, part number DM0211302, is supplied with the DM02. To enable 22-bit addressing, install the single 7438 IC in socket U51 on the DM02 PCBA and set SW2-6 ON (1).

CAUTION

Some manufacturers of LSI-11 bus backplanes use the backplane lines now devoted to extended addressing for power distribution. Installing a DM02 with the extended addressing option in such a system **will** damage the option IC. Before installing the option, confirm that there is neither positive nor negative potential between lines BC1, BD1, BE1, BF1, and logic ground. A DM02 without the extended addressing option will not be damaged if power is present on those lines.

4.3.3.4 DMA Burst Delay

The DM02 firmware design includes a switch-selectable DMA burst delay to avoid data late conditions. Switch SW2-7 selects either a 4-microsecond or 8-microsecond delay between DMA bursts. Even with the DM02 adaptive DMA, some applications may require a longer burst delay to allow other devices adequate time on the bus.

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

4.3.3.5 DMA Adaptive Mode

Depending on the other devices on the bus and their priority, the DM02 may use more or less bus time than optimal for your application. The DM02 allows you to modify its DMA operations by disabling adaptive DMA. If adaptive DMA is disabled, the host processor programs the DMA burst length to a maximum of 8 words per burst.

When adaptive DMA is enabled (SW2-8 OFF), the DM02 monitors the LSI-11 bus for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. If the DM02 is not getting the bus time your application requires, you may want to disable the adaptive DMA. When adaptive DMA is disabled, the DM02 performs a burst transfer of 8 words of less, relinquishes the bus, then performs another DMA burst transfer.

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

NOTE

If you are using the DM02 with adaptive DMA enabled in a MicroVAX II subsystem, be aware that the CPU module has a bus priority of 7 and may interfere with the DM02's bus access. You may consider disabling adaptive DMA for improved throughput.

4.4 PHYSICAL INSTALLATION

4.4.1 SYSTEM PREPARATION

To prepare your CPU to accept the DM02, use the following procedures:

MICRO/PDP-11 and MicroVAX I and II Preparation:

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

LSI-11 Series Preparation:

1. Power down the system by switching OFF the main AC breaker.
2. Remove the cover from the chassis so that the backplane is exposed.

Do not replace the covers or patch panels until the installation is verified (subsection 4.7).

4.4.2 SLOT SELECTION

The DM02 may be assigned to any desired slot because it uses the LSI four-level interrupt scheme to perform distributed interrupt arbitration.

Be sure to find out whether your backplane is straight or serpentine and choose a slot accordingly. On straight backplanes, the DM02 must be plugged into connectors A and B, since connectors C and D carry no signals. On a serpentine backplane, the DM02 can be plugged into either connectors A and B or connectors C and D.

There must be no unused slots, however, between the CPU and the DM02. If you have a DEC RQDX1 in your backplane, be sure to install the DM02 in front of the RQDX1; not all RQDX1 controllers pass grant signals.

4.4.3 MOUNTING

The DM02 Disk Controller PWB should be plugged into the LSI-11 backplane with components oriented in the same direction as the CPU and other modules. Always insert and remove the boards with the computer power OFF to avoid possible damage to the circuitry. Be sure that the board is properly positioned in the throat of the board guides before attempting to seat the board by means of the extractor handle.

4.5 ESDI DISK DRIVE PREPARATION

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

4.5.1 DRIVE PLACEMENT

Uncrate and install the disk drives according to the manufacturer's instructions. Position and level the disk drives in their final places before beginning the installation of the DM02. This positioning allows the I/O cable routing and length to be accurately judged.

4.5.2 SECTORING

The DM02 supports both hard and soft sectored drives. The drive parameter tables in Appendix D will recommend either soft or hard sectoring; set jumpers and switches as indicated. In general, if a drive is capable of both hard and soft sector format, hard-sectoring is preferred as long as the number of hard sectors does not reduce the possible drive capacity. For more information on setting the drive's switches, refer to the drive manufacturer's manual.

4.5.3 DRIVE NUMBERING

An address from 1 to 2 must be selected for each drive. Be careful that no two drives are assigned the same number. The logical unit number is determined by the address given to the drive (see subsection 3.2.2.).

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

4.5.4 SPINDLE MOTOR SPIN-UP

Most ESDI drives have a spindle motor control option which allows the the drive controller to control the timing of the drive spindle motor spin-up. Emulex recommends that you allow the DM02 controller to start the spindle motor spin-up of the drive(s). If there is more than one drive, the DM02 issues the spin-up commands to each drive sequentially. This will minimize any power surge on multiple drive systems. Refer to drive parameter tables in Appendix D for the drive's jumper position to select for DM02 control of motor start-up.

4.6 SA450 FLOPPY DRIVE PREPARATION

Most SA450 floppy disk drive(s) have a number of jumper-selectable options. The DM02 requires that you select a drive unit number. Recommendations for these and other options are described in the following subsections.

4.6.1 DRIVE NUMBERING

An address from 0 to 1 must be selected for each drive. Be careful that no two drives are assigned the same number. The logical unit number is determined by the address given to the drive. See subsection 3.2.2.

Most SA450 drive addresses are selected by jumper positions. Refer to the manufacturer's drive manual for the proper jumper positions.

4.6.2 HEAD LOADING CONDITIONS

If the SA450 interface on the floppy drive uses HEAD LOAD on pin 4, the DM02 requires that the HEAD LOAD function be selected only when the DRIVE SELECT signal for that unit is true. Refer to Appendix D of this manual for the proper jumper positions. Consult the appropriate drive manual for the exact procedure.

4.6.3 MOTOR ON CONDITIONS

The DM02 requires that the MOTOR ON function be true when DRIVE SELECT is true. The DM02 will operate with drives that must have both MOTOR ON true and DRIVE SELECT true for the MOTOR ON function. Refer to Appendix D of this manual for the proper jumper positions. Consult the appropriate drive manual for the exact procedure.

4.6.4 INDICATORS

Because the DM02 does not support the IN USE option on pin 4 of the SA450 interface, configure the floppy drive so that the indicators are updated when DRIVE SELECT is true. Refer to Appendix D of this manual for the proper jumper positions. Consult the appropriate drive manual for the exact procedure.

4.6.5 PACK TRANSITION SUPPORT

The READY line (34) on an SA450 floppy drive interface may have several, optional definitions, according the drive manufacturer. The READY line must be TRUE as a function of the floppy door being closed in order to support pack transition. The READY conditions are usually jumper selectable; refer to Appendix D for jumper setting information for certified SA450 drives.

The DM02 does not support pack transition notification with SA450 floppy drives that do not have the required READY line condition.

4.7 CABLING

The DM02 Disk Controller controls its two physical hard disk drives via the ESDI interface and the floppy drive via a SA450 interface.

The DM02 Disk Controller interfaces with each EDSI disk drive that it controls via one 34-line control cable and a 20-line data cable. The control cable originates from connector J3 on the DM02 and is daisy-chained to all of the supported ESDI drives, terminating on the last drive. Maximum cumulative cable length for the control cable is 10 feet (3 meters). The data cables originate from connectors J1 and J2 on the DM02; each data cable is connected directly from the DM02 to each supported disk drive. Maximum cable length for each data cable is 10 feet (3 meters).

The SA450 34-line signal interface is implemented by header J4 on the DM02 module. Maximum cable length is 10 ft (3m). (For more information on pin/signal assignment, refer to Section 8.4.)

Emulex offers the DM02 Internal Cabling Kit (P/N DM02130-01) which allows you to install the DM02, the floppy drive(s), and the hard disk drive(s) in the CPU cabinet. Table 4-5 describes the components of this cabling kit; Figure 4-4 shows basic cable installation.

In addition, Emulex offers the DM02 External Cabling Kit (P/N DM02130-02) which allows you to install the floppy drives in the CPU cabinet and the hard disk drives in a separate cabinet; instructions for installing this kit are described in the DM02 Cabling Kit Instruction Sheet (P/N DM0252401).

Table 4-6. DM02 Internal Cabling Kit (P/N DM02130-01)

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

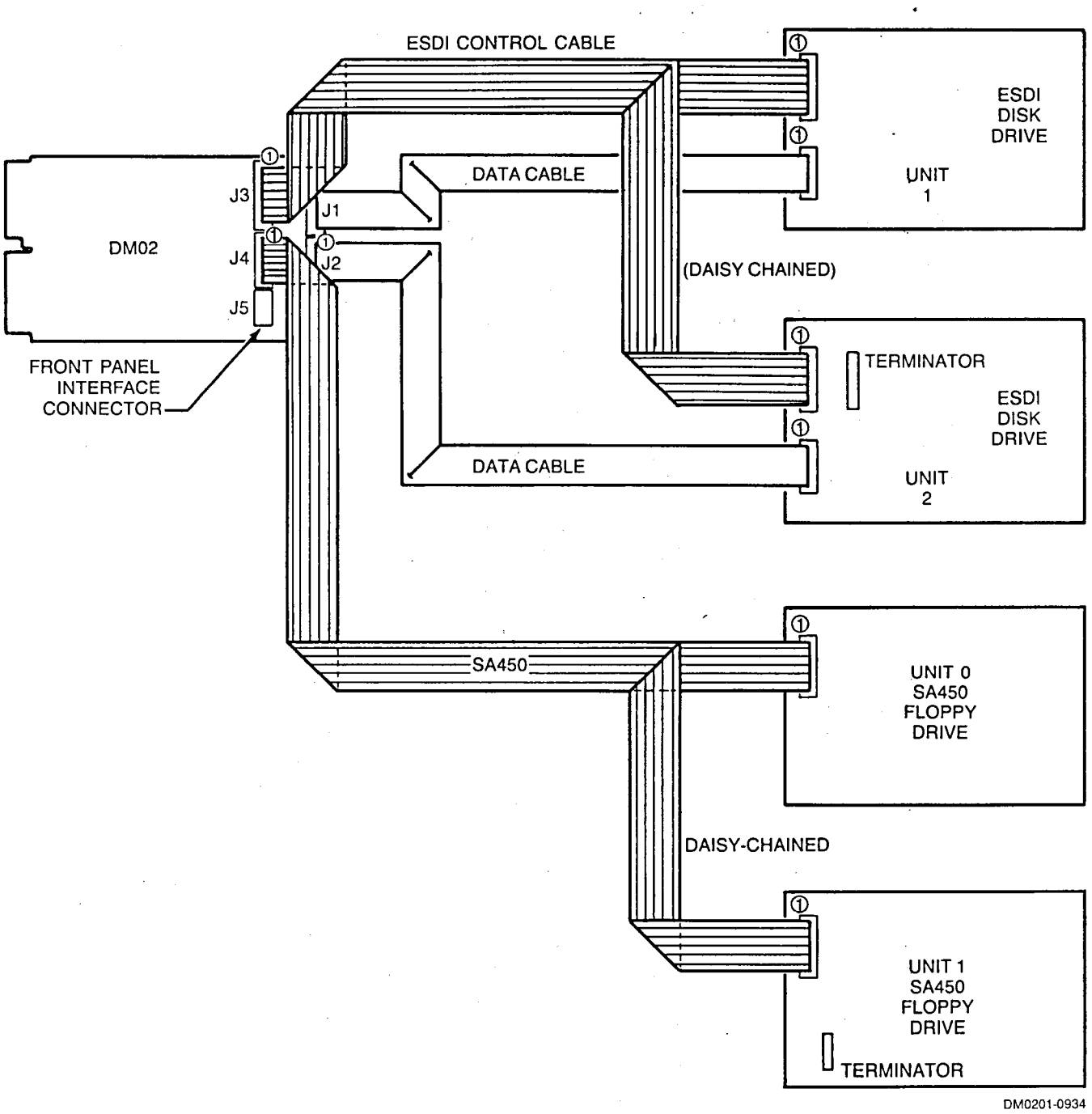


Figure 4-4. DM02 Cabling Diagram

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

When installing the DM02 and its drives, you must take care that the shield that DEC has built into its equipment cabinets is not defeated.

The routing of the cables that connect the DM02 and its disk drives can have a major impact on the amount of EMI that is radiated by the subsystem (the combination of the DM02 and its drives), especially if the DM02 and the disk drives are installed in separate cabinets.

As noted in subsection 4.1.3, the DM02 and its drive(s) can be installed in either of two configurations:

- With the DM02 Disk Controller and the ESDI hard disk drive(s) and SA450 floppy disk drive(s) that it supports mounted in the same cabinet
- With the DM02 and the ESDI disk drive(s) mounted in the CPU cabinet and the SA450 floppy drive(s)mounted in a separate cabinet

When the DM02 and the ESDI disk drive(s) and SA450 floppy disk drive(s) are installed in the same cabinet, it is possible that the cabinet itself provides sufficient shielding. In such cases, it is not usually necessary to shield the cables that carry the ESDI interface and SA450 interface between the DM02 and the drive peripherals.

NOTE

If the cabinet in which the DM02 and LSI-11 CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsibility to take whatever steps are necessary to correct the interference.

If the ESDI disk drives are mounted in a separate cabinet from the DM02 Disk Controller and the SA450 floppy drive(s), then the cables that connect the DM02 to the disk drives should be shielded, because they run outside the shielded cabinet environment.

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

4.8 INTEGRATION AND OPERATION

Before you can use the DM02, you must load the NOVRAM with the configuration parameters of the drives that are controlled by the DM02. This can be done in two ways: by using a console emulator or by using a software program. Subsection 6.5 describes the console emulator technique. The Emulex PDP/LSI MSCP Formatter Program (QXMX8B) and the MicroVAX MSCP Disk Formatter Program (FVD32M) are supplied on several Emulex diagnostic program distributions as listed and described in Appendix C.

NOTE

The Nonvolatile Random Access Memory (NOVRAM) on the DM02 is factory-configured to support one, SA450 floppy drive in a standard configuration. This allows the user to load the Emulex software program, which is supplied on RX50 media, to configure the NOVRAM to support any other drives.

4.8.1 DRIVE FORMATTING

Before data can be stored on the DM02's disk drives, the drives must be formatted. The same program that Emulex provides to load the DM02's drive configuration NOVRAM can also format the disk drives, verify the disk media, and reassign the blocks that it finds to be bad. The DM02 implements a format option that allows it to format its disk drives without help from system software; however, the DM02 does not verify the disk media or reassign bad blocks. See subsection 6.7. We strongly recommend using the Emulex software programs to format and verify the disk media. See subsection 1.4 for ordering information.

Although the floppy disk media must be formatted, there is no verification option for floppy media.

4.8.2 TESTING

Successfully loading the NOVRAM and formatting the disk drives gives good indication that the DM02 and its disk drives are in good operating condition. Figure 5-1 illustrates the loading and formatting procedure in flow chart format, and the figure gives fault isolation information that can be used with the procedure. The Emulex PDP/LSI MSCP Formatter Program (QXMX8B) and MicroVAX MSCP Disk Formatter Program (FVD32M, Rev 3) follow a similar path, and the fault isolation information can be used with these programs as well.

4.8.3 OPERATION

There are no operational instructions. The DM02 is ready for MSCP initialization as soon as it is powered up and the NOVRAM has been configured.

Pack transition support requires attention to some operational conditions:

- If a diskette is changed while the floppy drive select light is ON, the DM02 is not able to detect the new diskette and completes the disk operation on the new media.
- To support pack transition, the DM02 polls the READY line every 5 seconds on floppy drives that are not busy. Diskettes that are changed in less than 5 seconds (unlikely) would not register a pack transition notification.

4.8.3.1 Indicators

There are three light emitting diodes (LED) on the DM02 PWB. These LEDs are used for both diagnostics and for normal operations.

If switch SW2-1 is OFF, the DM02 executes a self-test at the following times:

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

The self-test routine consists of two test sequences: preliminary and self-test. The preliminary test sequence exercises the 8031 microprocessor chip and the Disk Formatter chips. When the DM02 completes the preliminary test, LED3 illuminates indicating that the DM02 is waiting for the MSCP initialization sequence.

During the MSCP initialization sequence, initiated by host software control, the DM02 executes a second self-test that exercises the buffer controller chip, the Host Adapter Controller (HAC) chip and its associated circuitry, the on-board RAM, and the control memory PROM. If the DM02 passes this sequence of its self-test successfully, all the LED indicators on the edge of the DM02 are OFF.

If a fatal error is detected either during self-test or while the system is running, all three of the edge-mounted LED indicators are ON (illuminated). If the DM02 fails to pass its power-up self-tests, you can select a special diagnostic mode (switch SW2-1 ON) which causes the LED indicators to display an error code. See Self-Test Error Reporting, in Section 5, TROUBLESHOOTING.

LED1 indicates normal the LSI-11 bus activity and LED2 indicates either ESDI or SA450 interface drive activity.

Section 5
TROUBLESHOOTING

5.1 OVERVIEW

This section describes the several diagnostic features with which the DM02 Disk Controller is equipped, and outlines fault isolation procedures that use these diagnostic features.

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

5.2 SERVICE

Your Emulex DM02 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 DM02 is not working properly, the product must be returned to the factory or to one of Emulex's authorized repair centers for service. Emulex products are not designed to be repaired in the field.

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

Do not return a component to EMULEX without authorization. A component returned for service without an authorization will be returned to the owner at the owner's expense.

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

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

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

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

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

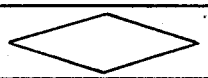
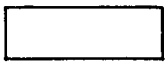
5.3 FAULT ISOLATION PROCEDURE

This fault isolation procedure is provided in flowchart format. The procedure is based on the self-diagnostics incorporated into the DM02. The procedure is designed to be used if the product's self-diagnostic fails or if many errors are flagged by the subsystem during normal operation. If neither of these events happens, it is not necessary to follow these procedures.

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

If the fault isolation procedure indicates that a component needs to be returned to Emulex, see subsection 5.2 for instructions on how to do so.

Table 5-1. Flow Chart Symbol Definitions

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

DM0201-0106

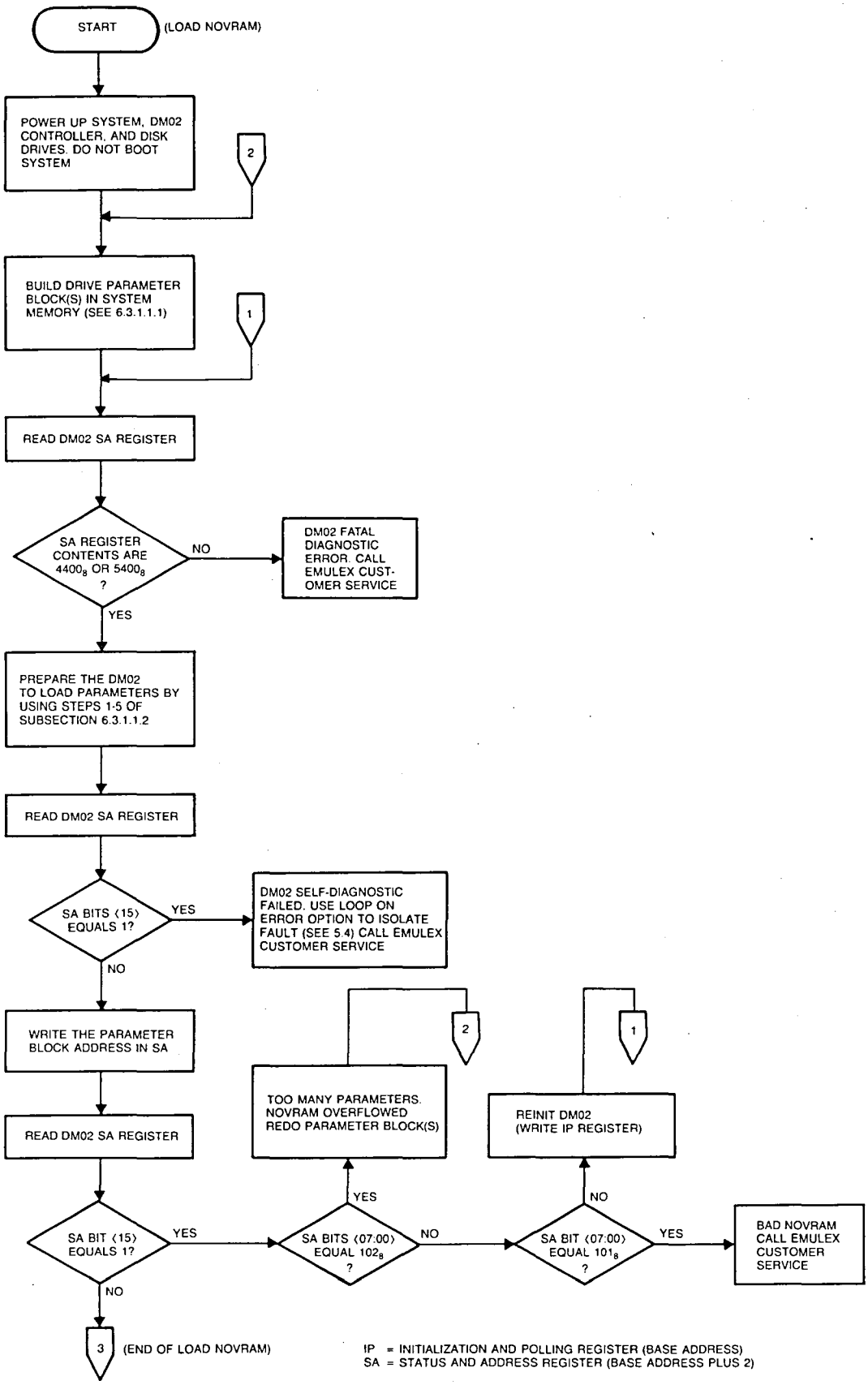


Figure 5-1. Fault Isolation Chart (sheet 1 of 2)

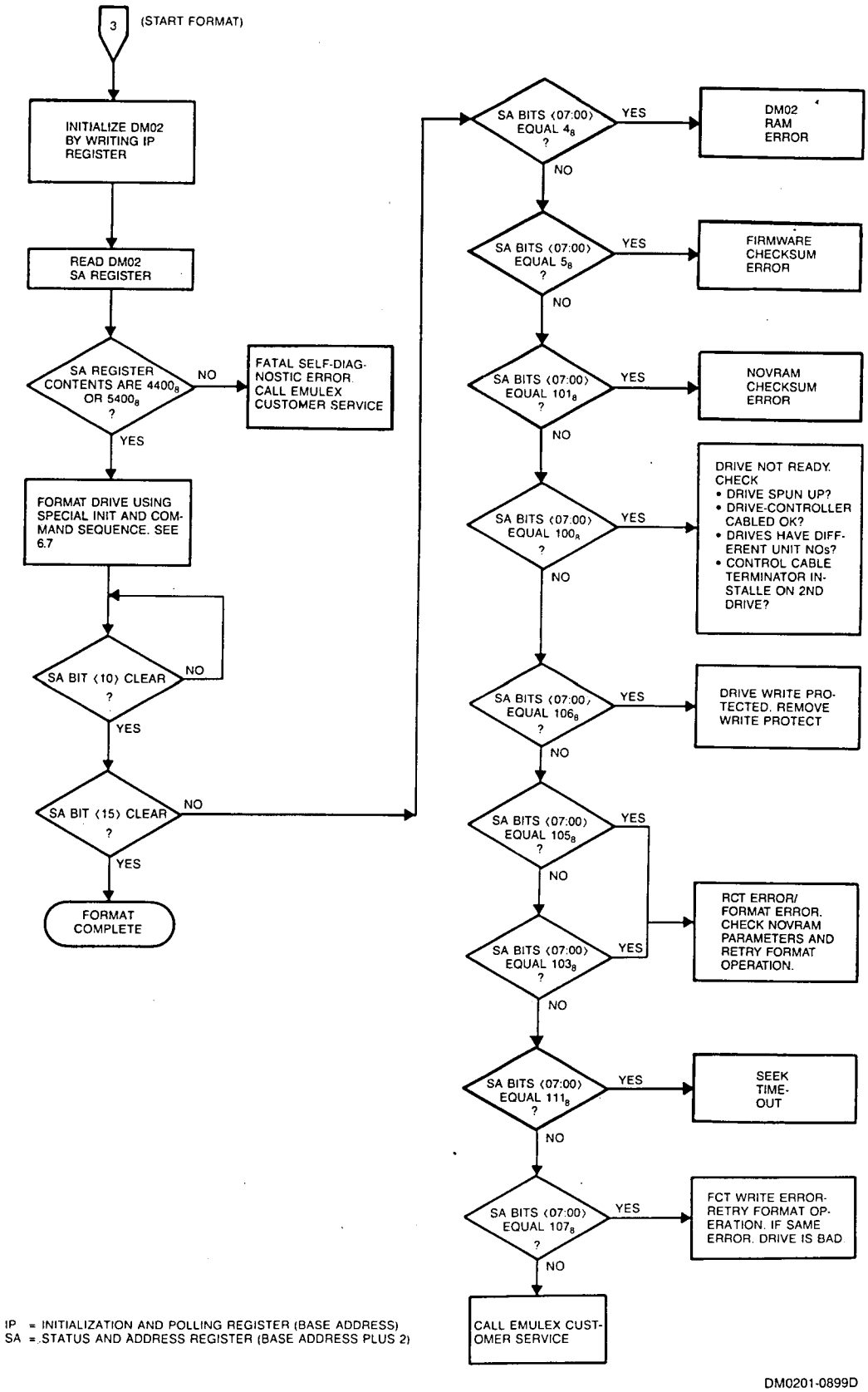


Figure 5-1. Fault Isolation Chart (Sheet 2 of 2)

5.4 POWER-UP SELF-DIAGNOSTIC

The DM02 executes an extensive self-diagnostic to ensure that the disk controller is in good working order. The self-diagnostic is divided into several parts. Table 5-2 lists the tests in the order in which they are performed.

The first two tests are executed immediately after power-up, a reset, a bus INIT, or a write to the IP register (base address). The other tests are executed as the controller interacts with the MSCP initialization routine. If the DM02 fails any of the tests, it posts an MSCP fatal error code in the low-byte of the SA register (base address plus 2) and turns on three LEDs which are located on the outside edge of the PWB. The MSCP fatal error codes used by the DM02 are listed in Table 5-3. Note that some fatal errors may not allow access to the SA register from the console.

To help determine the location of the problem, the operator can select a special diagnostic mode that causes the LEDs to display an error code. To enable this diagnostic mode, place the CPU halt switch in the ON position and set DM02 switch SW2-1 ON (1). After setting SW2-1 ON, the host computer must be powered down or DM02 switch SW1-1 must be toggled (turned ON and then OFF) to cause the DM02 to again perform its self-test.

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

If the DM02 completes the diagnostic mode without errors, all three LEDs are OFF. Set switch SW2-1 in the OFF position and reset the DM02 controller before using.

Table 5-2. LED Error Codes

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

5.5 FATAL ERROR CODES

If the DM02 detects a fatal error during operation, all three LEDs are illuminated and an error code is posted in the low-byte of the SA register (base address plus 2). Table 5-3 lists the MSCP fatal error codes used by the DM02.

Table 5-3. MSCP Fatal Error Codes used by the DM02

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the DM02 attempted to read data from a message packet.
2	2	Possible parity or timeout error when the DM02 attempted to write data to a message packet.
4	4	DM02 diagnostic self-test indicated a controller RAM error.
5	5	DM02 diagnostic self-test indicated a firmware checksum error.
6	6	Possible parity or timeout error when the DM02 attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the DM02 attempted to write an envelope address to a command ring.
11	9	Host did not communicate with DM02 within the time frame established while bringing the controller online.
12	A	Operating system sent more commands to the DM02 than the controller can accept.

Table 5-3. MSCP Fatal Error Codes used by the DM02 (continued)

Octal Code	Hex Code	Description
13	B	Controller unable to perform DMA transfer operation correctly.
14	C	DM02 diagnostic self-test indicated controller fatal error.
16	E	The MSCP connection identifier is invalid.
23	13	An error occurred during the MSCP initialization sequence.

Table 5-4 lists the error codes for any vendor unique fatal error messages may appear during DM02 operation.

Table 5-4. Vendor Unique Error Codes

Octal Code	Hex Code	Description
100	40	Drive not ready
101	41	NOVRAM checksum error
102	42	NOVRAM capacity exceeded
103	43	RCT Write error
105	45	Format error
106	46	Drive write protected
107	47	FCT Write error
111	49	Seek timeout

BLANK

Section 6
DEVICE REGISTERS and PROGRAMMING

6.1 OVERVIEW

This section contains an overview of the DM02 device registers that are accessible to the LSI-11 bus and that are used to monitor and control the DM02 Disk Controller. The registers are functionally compatible with DEC implementations of MSCP controllers.

The following table outlines the contents of this section.

Subsection	Title
6.2	Overview of MSCP Subsystem
6.3	Programming
6.4	Registers
6.5	NOVRAM Commands
6.6	Bootstrap Command
6.7	Firmware Formatting Command

6.2 OVERVIEW OF MSCP SUBSYSTEM

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

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

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

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

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

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

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

6.3 PROGRAMMING

A complete description of MSCP commands and the corresponding status responses which the DM02 Disk Controller posts is beyond the scope of this manual. A comprehensive description of MSCP may be ordered from the DEC Software Distribution Center, Order Administration/ Processing, 20 Forbes Rd., Northboro, Massachusetts 01532.

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

The DM02 Disk Controller executes the Minimal Disk Subset of MSCP Commands.

6.3.1 MSCP COMMAND SUPPORT

No currently available MSCP Controller supports the entire range of MSCP commands. The following subsections describe the extent of MSCP command support by the DM02.

6.3.1.1 Minimal Disk Subset

The DM02 Disk Controller supports the entire minimal disk subset of MSCP commands.

6.3.1.2 Diagnostic and Utility Protocol (DUP)

The DM02 Disk Controller does not support any of the DUP commands or maintenance read/write commands. Therefore, the DM02 is not compatible with DEC diagnostics that use the MSCP DUP commands.

6.4 REGISTERS

During normal operation, the DM02 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 DM02 has two 16-bit registers in the LSI-11 Bus I/O page that are used primarily to initialize the subsystem. During normal operation, the registers are used only to initiate polling or to reset the subsystem. These registers are always read as words. The register pair begins on a longword boundary. Table 6-1 lists the octal and hexadecimal values for the Initialization and Polling (IP) register (base address) and the Status and Address (SA) register (base address plus 2) supported by the DM02.

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

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

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

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

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

Table 6-1. DM02 IP and SA Registers

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

6.5 NOVRAM COMMANDS

The DM02 allows the user to specify media geometry for the ESDI disk drives that it supports. The geometry data is stored in a Nonvolatile Random Access Memory (NOVRAM) on the DM02. When used with the DM02, the NOVRAM can store configurations for two physical ESDI disk drives and two SA450 floppy drives. In addition, the DM02 NOVRAM is capable of splitting each hard disk into two logical units. Under RT-11 and MicroVMS, the DM02 supports a maximum of six logical drives; under RSX-11-M, RSX-11-M-PLUS, and RSTS/E, the DM02 supports a maximum of four logical drives.

The NOVRAM is programmed while the DM02 is installed by loading the drive geometry parameters into the host computer's memory and by executing a command sequence that causes the DM02 to read those parameters. Both operations can be performed manually by using the CPU console (or a console emulator such as ODT), or automatically by using a special utility. Emulex provides utilities for MicroVAX, PDP-11, and LSI-11 processors: the MicroVAX MSCP Disk Formatter Program (FVD32M) and the Emulex LSI/PDP MSCP Formatter Program (QXMX8B). See subsection 1.4.1, Subsystem Options, for ordering information.

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

6.5.1 DRIVE GEOMETRY PARAMETERS

The DM02 NOVRAM defines a maximum of four physical drive configurations and uses a separate parameter information block to define each drive configuration type. Each block contains the 16 words that define the drive parameters. Figure 6-1 shows the format of the parameters and lists them. Emulex recommends that you document the parameters you select for your drive types using the Drive Configuration Parameter Block Worksheet in Figure 6-1.

The blocks are placed anywhere in the first 64K of memory and must be contiguous. The first word of the parameter block can be stored at any even address. The addresses of subsequent words and parameter blocks are contiguous and numerically higher. Note that for MicroVAX II systems, the first word must be located at 0 (see subsection 6.5.2, Loading the NOVRAM).

The parameter block at the lowest numerical address defines the first drive connected to the DM02. If a second drive is configured exactly as the first drive, that first parameter block can define both drives. If a second drive is configured differently, a second parameter block must be defined. If you are using the console emulator, be sure that the memory location following the last word in the last parameter block contains 0.

Registers

M224XC/E CDC
↓ 94196-422
182MB unf. WREN 3 flop

Word	Parameter	Type 1	Type 2	Type 3	Type 4
1	Number of Units of this Type	1	1		1
2	Type Code	1	1		2
3	Starting Head Offset	0	0		0
4	Number of Sectors per Track	35	34		
5	Number of Heads	10	15		
6	Number of Cylinders	823	1412		
7	Number of Spare Sectors per Track	1	1		
8	Number of Alternate Cylinders	2	2		
9	Configuration Bits	5	6		
10	Split Code	0	0		
11	Removable Media Flag	0	0		
12	Gap 0 Parameter	3093	2318		
13	Gap 1 Parameter	3084	2827		
14	Gap 2 Parameter	3337	521		
15	Cylinder Offset or Step Pulse				
16	Spiral Offset (interleave)	2	2		

Figure 6-1. Drive Configuration Parameter Worksheet

Number of Units of this Type (1)

This word specifies the number of physical disk drives that this parameter block defines. This number cannot be larger than 2. If this word is 0, then words 2 through 16 are ignored.

Type Code (2)

This word indicates the type drive supported by the DM02. The valid range is 1 through 5 with values assigned as follows:

Type	Description
1	ESDI
2	Single-sided, double-density floppy, RX50-compatible, pack transition not supported
3	Double-sided, double-density floppy, not compatible with the RX50, pack transition not supported
4	Single-sided, double-density floppy, RX50-compatible, pack transition supported
5	Double-sided, double-density floppy, not compatible with the RX50, pack transition supported

Starting Head Offset (3)

For type 1 drives, this word specifies the physical drive head that is to be used as the first head of the second logical drive. This field has meaning only if a Split Code 2 or 3 (word 10) is specified. The valid range is from 0 through 63. If a Split Code 0 or 1 is selected, this word must be 0.

This word is only used for type 1.

Number of Sectors per Track (4)

For type 1 drives, this word specifies the number of logical sectors per physical track. Spare sectors are not included in this number (but are specified in word 7). The valid range is from 1 through 255. See Appendix D for recommended parameters for certified drives.

This word is only used for type 1.

Number of Heads (5)

For type 1 drives, this word specifies the number of data heads per physical drive. The valid range is from 1 through 63.

This word is only used for type 1.

Number of Cylinders (6)

For type 1 drives, this word specifies the number of logical cylinders per physical drive. Spare cylinders are not included in this number (but are specified in word 8). The valid range is from 1 through 4095. If you are entering this value under a console emulator, be sure to subtract one cylinder from the total disk size to preserve the defect list on the drive.

This word is only used for type 1.

Number of Spare Sectors per Track (7)

For type 1 drives, this word specifies the number of spare sectors reserved per track. This number plus the number of logical sectors per track (word 4) equals the total number of physical sectors per track. The valid range is 0 or 1. If 0 is specified, no spare sectors are reserved. Emulex recommends a value of 1 for MSCP implementation of the replace block command.

This word is only used for type 1.

Number of Alternate Cylinders (8)

For type 1 drives, this word specifies the number of spare cylinders per physical drive. This number plus the number of logical cylinders (word 6) equals the total number of physical cylinders. The valid range is from 0 through 15. At least one cylinder must be specified as an alternate for MSCP implementation of the replace block command. (If spare sectors are specified, the sector replacement algorithm needs one track for working space.)

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

This word is only used for type 1.

Configuration Bits (9)

For type 1 drives, this word defines some additional configuration parameters of the drive. The valid range is from 0 through 15. This word uses 4 bits in a 6-bit field that is defined as follows:

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

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

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

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

This word is only used for type 1.

Split Code (10)

For type 1 drives, this word allows the drive(s) defined by this parameter block to be split into two logical disk units (two each, if more than one drive is defined by this block). The split codes are:

Code 0: No split.

Code 1: The cylinders are divided between the two logical drives. A starting cylinder offset value (word 15) specifies the first cylinder of the second logical drive.

Code 2: The drives data heads are divided between the two logical drives. A starting head offset value (word 3) specifies the first head of the second logical drive. If you select a head split code on a drive with both fixed and removable media, the removable media may be configured as logical unit number (LUN) 0 and the fixed media as LUN 1.

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

By using Codes 2 and 3, you can partition drives that use both fixed and removable media so that either the fixed media or removable media is the lower logical unit number.

The DM02's seek-ordering and overlapped seek processing capabilities are not effective when both logicals of a split physical drive are active. Therefore, we do not recommend using this option unless necessary to allow for convenient file backup and restoration.

For more information on split codes, see subsection 3.4.2.1.

This word is only used for type 1.

Removable Media (11)

For type 1 drives, this word indicates whether the disk media is fixed or removable. If you are defining 1 physical/logical drive, this word uses a 1-bit field and valid values are 0 and 1 where 0 indicates fixed media and 1 indicates removable media.

If you are defining a drive with a logical split, this word uses a 2-bit field and the valid range is 0 though 3:

Parameter Word Value	Bit 1 0	Definition
0	0 0	LUN 0 and LUN 1 are both fixed.
1	0 1	LUN 0 is removable, LUN 1 is fixed.
2	1 0	LUN 0 is fixed, LUN 1 is removable.
3	1 1	LUN 0 and LUN 1 are both removable.

This word is only used for type 1.

Gap 0 Parameter (12)

For type 1 drives, this word (in conjunction with words 13 and 14) specifies the recording format for each sector on the drive. The only valid values are contained in Appendix D, Disk Drive Configuration Parameters. These values are factory parameters and are the only values to be used with Emulex certified drives. If any of these factory parameters are altered, the DM02 may not support the disk drive.

This word is only used for type 1.

Gap 1 Parameter (13)

For type 1 drives, this word (in conjunction with words 12 and 14) specifies the recording format for each sector on the drive. The only valid values are contained in Appendix D, Disk Drive Configuration Parameters. These values are factory parameters and are the only values to be used with Emulex certified drives. If any of these factory parameters are altered, the DM02 may not support the disk drive.

This word is only used for type 1.

Gap 2 Parameter (14)

For type 1 drives, this word (in conjunction with words 12 and 13) specifies the recording format for each sector on the drive. The only valid values are contained in Appendix D, Disk Drive Configuration Parameters. These values are factory parameters and are the only values to be used with Emulex certified drives. If any of these factory parameters are altered, the DM02 may not support the disk drive.

This word is only used for type 1.

Cylinder Offset or Step Pulse for Floppy Drives (15)

For type 1 drives, this word specifies the physical cylinder that is to be used as the first cylinder of the second logical drive. This field has meaning only if a Split Code 1 (word 10) is specified. If a Split Code 0, 2, or 3 is selected, this word must be 0.

For floppy drive types 2 and 3, bits 0 and 1 of this word are used to specify one of these head stepping codes:

Code	Stepping Timing
0	3 msec
1	6 msec
2	10 msec
3	15 msec

Spiral Offset (16)

For type 1 drives, this word specifies the number of sectors by which sector 0 is offset from sector 0 of the previous track. Offsetting sector 0 from one track to the next is a technique that is used to reduce latency when performing write or read operations that cross a track boundary. When the drive is formatted, sector 0 of a track is offset a certain number of sectors from the position of sector 0 on the previous track. When this is done, spiral write and read operations are more efficient because the drive has time to seek from track to track before encountering sector 0.

The valid range is from 0 through 15. See Appendix D for recommended parameters for certified drives.

This word is only used for type 1.

6.5.2 LOADING THE NOVRAM

A special sequence of commands causes the DM02 to load the parameter blocks from memory into the NOVRAM. The process uses the Initialization and Polling (IP) register (DM02 base address) and the Status and Address (SA) register (base address plus 2). See section 6.4 for register octal and hexadecimal notation.

To load the NOVRAM on a MicroVAX II, you must first prepare the system for DMA transfer operations:

1. Apply power to the system and initialize the LSI-11 bus by depositing 0 in internal memory register 37. If you have a running system, you must bring it down before executing this step.

   >>>D/I 37 0<return>

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

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

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

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

4. Proceed to step 1 of the NOVRAM command sequence. Be sure to store the NOVRAM parameters at memory location 0.

To load the NOVRAM:

1. Initialize the DM02 by writing any value into the IP register (base address). The DM02 performs its self-test and begins the initialization dialog.

Register	Octal	Hexadecimal
IP: Write	000001	0001

2. The DM02 indicates that initialization step 1 has begun by setting bit 11 in the SA register (base address plus 2). The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set. If 22-bit addressing is enabled, bit 9 will be set.

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

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

Register	Octal	Hexadecimal
SA: Write	030003	3003

4. The controller acknowledges the initialization code with: 00400.

Register	Octal	Hexadecimal
SA: Read	000400	0100

5. Write the Define Unit Geometry command into the SA register (base address plus 2):

Register	Octal	Hexadecimal
SA: Write	041000	4200

6. The DM02 finishes its self-test (about two seconds) before acknowledging with:

Register	Octal	Hexadecimal
SA: Read	001011	0209

You must wait until the DM02 acknowledges before proceeding.

7. Write the 16-bit memory address of the first word of the first parameter block into the SA register (base address plus 2).

   For example, if you loaded the first word of the first parameter block at memory address 000000:

Register	Octal	Hexadecimal
SA: Write	000000	0000

8. The DM02 begins loading the parameter blocks. Word 17 of the last parameter block must be 0 to indicate that there is no more data (Word 17 would be the first word of the next parameter block, if there were another).

   After the DM02 has stored the parameter data in the NOVRAM, it reads the data from the NOVRAM and computes a one-byte checksum. It places the checksum in the SA register (base address plus 2). The host knows that the checksum is available when bit 09 of SA register (base address plus 2) is clear (0).

   If the DM02 sets SA register (base address plus 2) bit 15 after it clears bit 09, an error has occurred. The low byte contains the error code.

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

6.6 BOOTSTRAP COMMAND

To allow the system to be easily bootstrapped from peripherals attached to the DM02 Disk Controller, Emulex has incorporated a Bootstrap Command into the controller. This feature is not part of the standard MSCP command set nor is it supported on the MicroVAX or on systems using an 11/73B CPU module.

The Bootstrap Command can be issued from the console after the system is powered up, or it may be incorporated into a firmware routine that is located in a Bootstrap ROM. (The ROM would not be located on the DM02 PWB, but on some other module in the system.) The Bootstrap Command causes the DM02 to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the DM02:

1. Initialize the DM02 by writing any value into the IP register (base address). The DM02 performs self-test and begins the initialization dialog.

Register	Octal
IP: Write	000001

2. The DM02 indicates that initialization step 1 has begun by setting bit 11 in the SA register (base address plus 2). The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set. If 22-bit addressing is enabled, bit 9 will be set.

Register	Octal	Addressing
SA: Read	0044000	18-Bit
	005400	22-Bit

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

Register	Octal
SA: Write	030003

4. The controller acknowledges the initialization code with 00400.

Register	Octal
SA: Read	000400

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

Register	Octal
SA: Write	040000

6. Read the contents of the SA register (base address plus 2). When the SA register contains zero, go to step 7.

Register	Octal
SA: Read	0000000

7. Re-initialize the DM02 by writing any value into the IP register (base address).

Register	Octal
IP: Write	00001

8. Load CPU register R0 with the MSCP unit number of the unit to bootstrap from. In this example, the unit is 0.

Register	Octal
R0: Write	00000

9. Load CPU register R1 with the base address of the DM02. In this example, the DM02 is at the standard base address.

Register	Octal
R1: Write	772150

10. Load the Processor Status Word (PSW) register with 340. The PSW register is 777776 for 18-bit systems and 1777776 for 22-bit systems.

Register	Octal
RS: Write	340

11. Load CPU register R7 with 0.

Register	Octal
R7: Write	0

12. At the console emulator prompt, enter P to begin:

```
@P
```

6.7 FORMAT DRIVE COMMAND

The DM02 also has the ability to format the disk drives attached to it. This format operation is performed autonomously by the DM02 in response to a special initialization command. The process uses the IP register (base address) and SA register (base address plus 2). Refer to subsection 6.4 for octal and hexadecimal notation.

To initiate the format operation, use the following procedure:

1. Initialize the DM02 by writing any value into the IP register (base address). The DM02 performs self-test and begins the initialization dialog.

Register	Octal	Hexadecimal
IP: Write	000001	0001

2. The DM02 indicates that initialization step 1 has begun by setting bit 11 in the SA register (base address plus 2). The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set. If 22-bit addressing is enabled, bit 9 will be set.

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

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

Register	Octal	Hexadecimal
SA: Write	030003	3003

4. The controller acknowledges the initialization code with 00400.

Register	Octal	Hexadecimal
SA: Read	000400	0100

5. Write the Format Unit command into the SA register (base address plus 2):

Register	Octal	Hexadecimal
SA: Write	0420nn	440n

where n is the number of the logical unit to be formatted. Valid values for a maximum of 11 logical drives are $0\text{-}13_8$ and $0\text{-}B_{16}$. If the logical drive is supported by an alternate DM02 controller, add the unit offset specified by switches SW1-2 through SW1-4.

6. The DM02 acknowledges the command with:

Register	Octal	Hexadecimal
SA: Read	001000	0200

7. Write the 16-bit volume serial number into the SA register (base address plus 2). This number may be any value from 1 to 177777_8 ($FFFF_{16}$).

Register	Octal	Hexadecimal
SA: Write	000001	0001

8. The DM02 acknowledges the serial number with:

Register	Octal	Hexadecimal
SA: Read	002000	0400

9. Write the format parameter word into the SA register (base address plus 2). (The format parameter word is not defined and is reserved for future use. Write all zeros into the register.) The DM02 begins formatting the selected drive.

Register	Octal	Hexadecimal
SA: Write	000000	0000

10. Poll the SA register (base address plus 2) until the DM02 clears SA bit 10 to indicate that the format operation concluded. If the operation was not successful, the DM02 sets bit 15 in the SA register (base address plus 2). The low-byte of the register contains the error code:

Error Code Octal	Error Code Hex	Description
004	04	RAM error
005	05	Firmware checksum error
014	0C	Self-test fatal error
100	40	Drive not ready
101	41	NOVRAM checksum error
102	42	NOVRAM capacity exceeded
103	43	RCT Write error
105	45	Format error
106	46	Drive write protected
107	47	FCT Write error
111	49	Seek timeout

Section 7
FUNCTIONAL DESCRIPTION

7.1 OVERVIEW

This section contains a description of the DM02 Disk Controller's architecture.

7.2 DM02 DISK CONTROLLER ARCHITECTURE

The DM02 is a microprocessor-based emulating disk controller that is contained on a single dual-wide PCBA. The DM02's major functional blocks are shown in Figure 7-1. The disk controller is organized around the eight-bit 8031 microprocessor. The board has an eight-bit internal data bus with 16-bit addressing capability. The Host Adapter Controller (HAC), the Hard Disk Formatter Controller, the Floppy Disk Formatter Controller, and the Buffer Controller are addressed as memory (memory-mapped I/O).

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

The DM02 uses a 27256 erasable programmable read-only memory (EPROM), which contains the control program, and 32K bytes of random access memory (RAM), which is used for data buffering and working storage.

The LSI-11 bus interface contains 22 lines. Sixteen of the lines are multiplexed for both address and data; six are used for only address. The Host Adapter Controller is used for programmed I/O, CPU interrupts, and DMA data transfers. The microprocessor responds to all programmed I/O and carries out the I/O functions required for the addressed disk controller register. The Host Adapter Controller has automatic LSI-11 bus address generation capability that, in conjunction with a byte counter, allows the interface to conduct LSI-11 bus DMA transfers without direct microprocessor intervention after the interface is set up for a transfer. This automatic DMA capability is used with the DM02 Buffer Controller to transfer large blocks of data directly between host memory and the DM02's RAM.

The Buffer Controller is implemented on a single chip. This multi-channel DMA is responsible for moving large blocks of data between the 32K RAM buffer and the ESDI and SA450 interfaces, and between the LSI-11 bus interface and the 32K RAM buffer. After being set up for an operation by the microprocessor, either interface requests DMA service from the Buffer Controller by driving an individual request signal active. The transfer then proceeds without direct intervention by the microprocessor. This allows high-speed data transfers to occur while the microprocessor is focused on other processes.

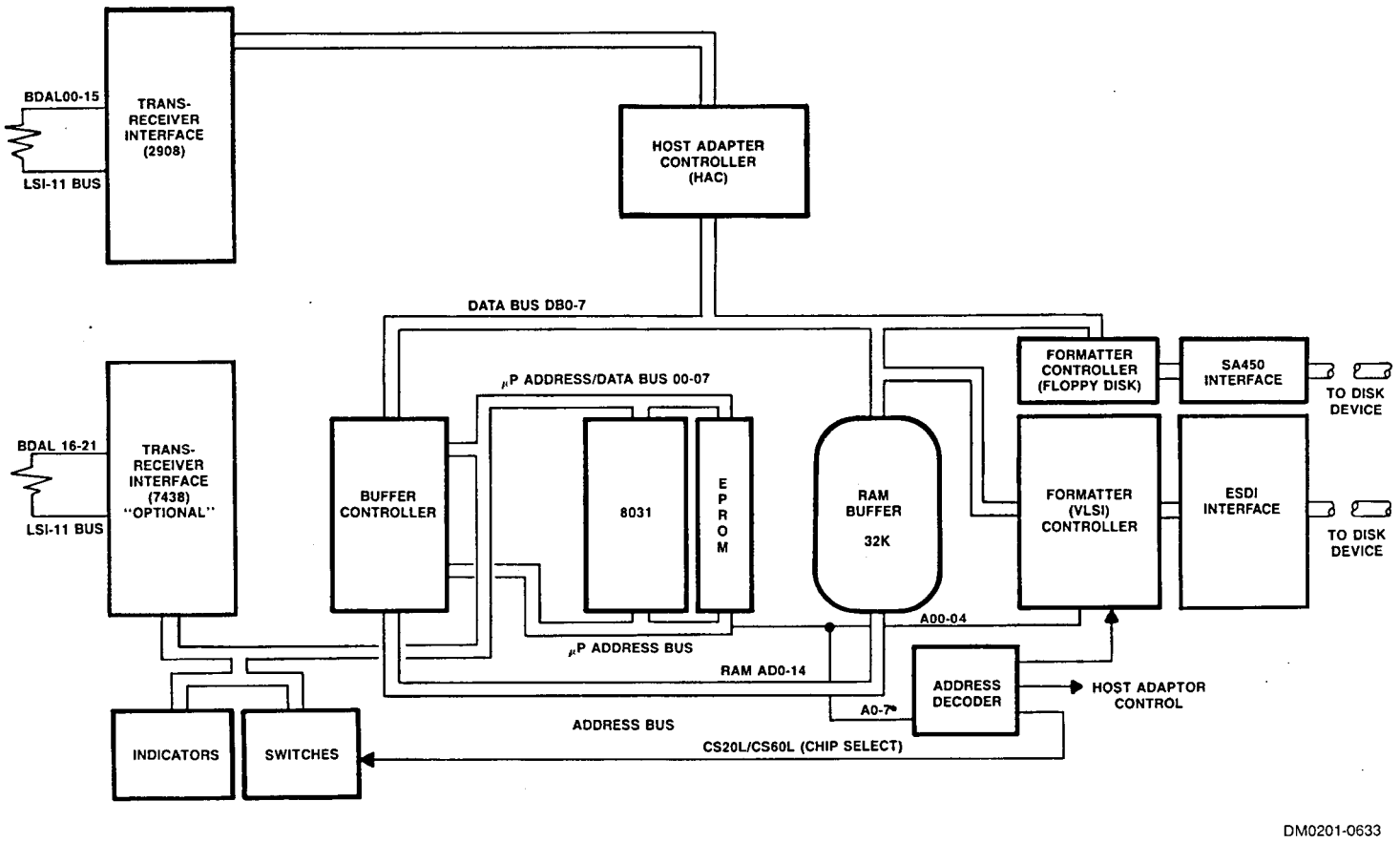


Figure 7-1. DM02 Block Diagram

Section 8
INTERFACES

8.1 OVERVIEW

This section describes the interfaces that the DM02 Disk Controller incorporates. It includes information on the DM02 implementation of SMD interface electrical and mechanical requirements. Excluding this overview, the section is divided into the following subsections.

Subsection	Title
8.2	DM02 LSI-11 Bus Interface
8.3	DM02 ESDI Drive Interface
8.4	DM02 SA450 Drive Interface

8.2 LSI-11 BUS INTERFACE

The LSI-11 bus between the CPU and the DM02 Disk Controller contains 42 bidirectional signal lines and two unidirectional signal lines on connectors A and B, and two unidirectional signal lines on connector C. LSI-11 bus interface pin assignments are listed and described in Figure 8-1. These signal lines provide the means by which the CPU and the DM02 Disk Controller communicate with each other.

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

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

- **Six Data Transfer Control Lines** BBS7, BDIN, BDOUT, BRPLY, BSYNC, and BWTBT.

- **Six Direct Memory Access (DMA) Control Lines** BDMR, BSACK, BDMGI, and BDMGO (the last two are on both connectors A and C).

- **Seven Interrupt Control Lines** BEVNT, BIAKI, BIAKO, BIRQ4, BIRQ5, BIRQ6, and BIRQ7.

- **Five System Control Lines** BDCOK, BHALT, BINIT, BPOK, and BREF.

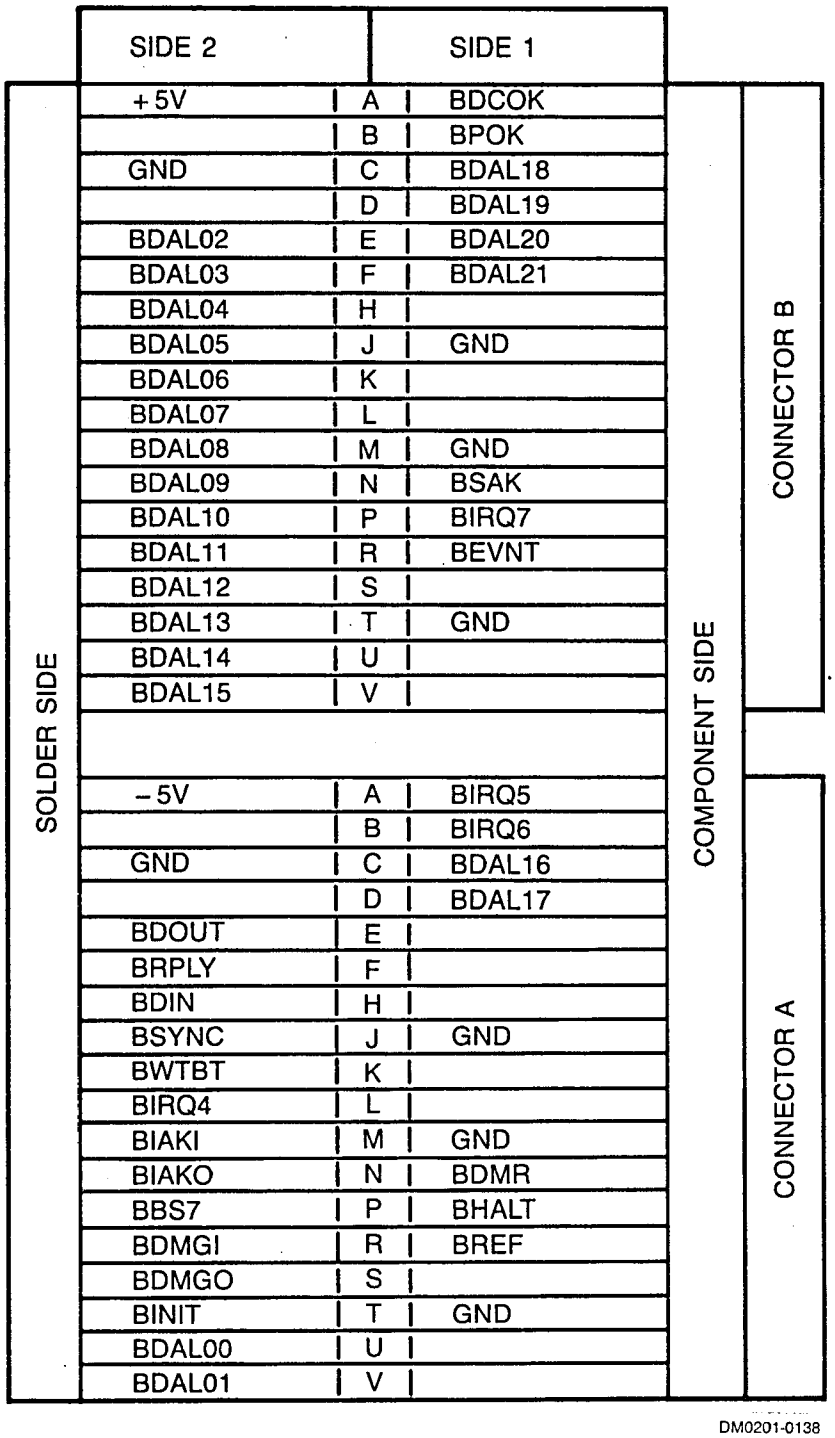


Figure 8-1. LSI-11 Bus Interface Connections

8.2.1 INTERRUPT PRIORITY LEVEL

The DM02 is hardwired to issue both level 4 and level 5 interrupt requests. The level 4 request is necessary to allow compatibility with either an LSI-11 or LSI-11/2 CPU.

8.2.2 REGISTER ADDRESS

The DM02 Disk Controller has two registers visible to the LSI-11 bus. Their addresses are determined by DIP switches SW2-3 through SW2-5. See Section 4 for detailed address and switch setting information.

8.2.3 DMA OPERATIONS

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

8.2.4 SCATTER/GATHER

The DM02 Disk Controller supports the MicroVAX I I/O technique of scatter-write operations and gather-read operations.

8.3 DM02 ESDI DISK DRIVE INTERFACE

This subsection provides information on the DM02 implementation of the Enhanced Small Device Interface (ESDI) interface. The DM02 controller's hard disk interface conforms to the ESDI Specification and supports the serial mode for magnetic disk drives. The DM02 does not use the drive's defect list.

The DM02 Controller interfaces with disk drives via a 34-pin control cable and a 20-pin data cable (for each disk drive). A 34-pin male connector at reference designator J3 on the DM02 Controller plugs directly into the ESDI disk drive control cable. The DM02 Controller contains two 20-pin male connectors, one at reference designator J1 and one at reference designator J2.

The DM02 Controller can integrate up to a maximum of two disk drives. Either 20-pin connector (reference designator J1 or J2) can plug directly into the data cable for the first disk drive. If a second disk drive is configured, the unused 20-pin connector is plugged into the data cable for that disk drive.

The pin/signal assignments for control signal interface between the DM02 Controller and an ESDI disk drive are shown in Figure 8-1.

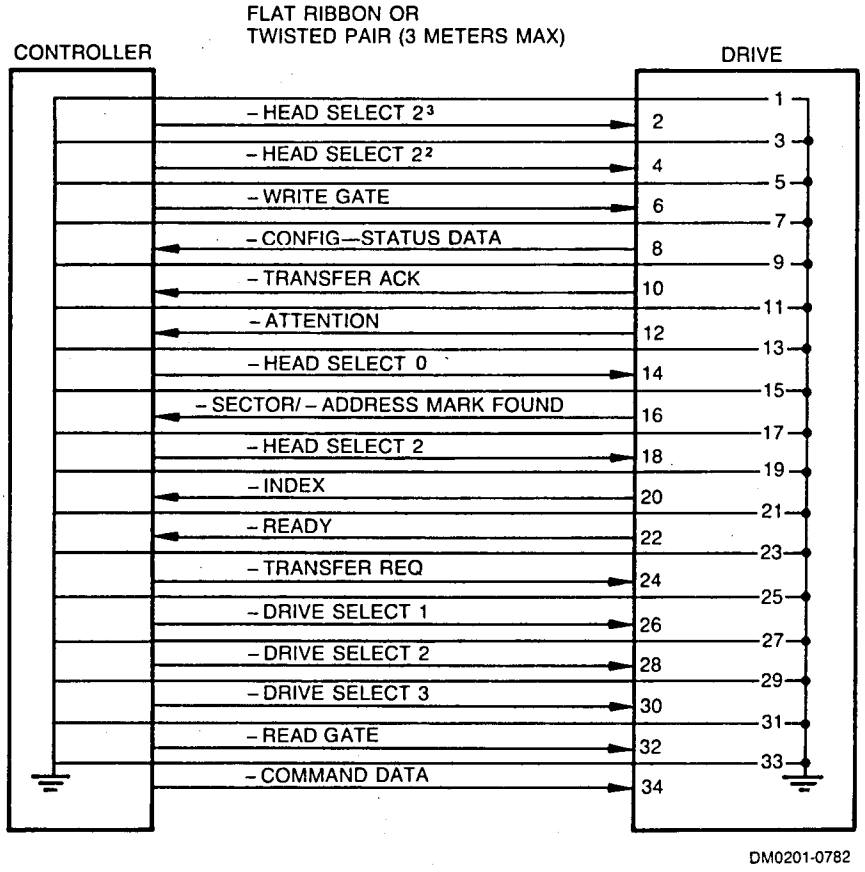


Figure 8-2. Control Pin/Signal Assignments at ESDI Disk Drive Interface (Connector J3)

The pin/signal assignments for data signal interface between the DM02 Controller and an ESDI disk drive are shown in Figure 8-2. As indicated in Figure 8-2, lines 2, 5, 9, and 20 are not connected at the DM02 data interface. Lines 5 and 9 are reserved for step mode implementation (according to the EDSI specification) and are not used with the DM02 serial mode implementation. The DM02 does not use lines 2 and 20 to report the sector and index positions from each drive, but uses the sector and index lines on the control cable for the selected drive (see Figure 8-1).

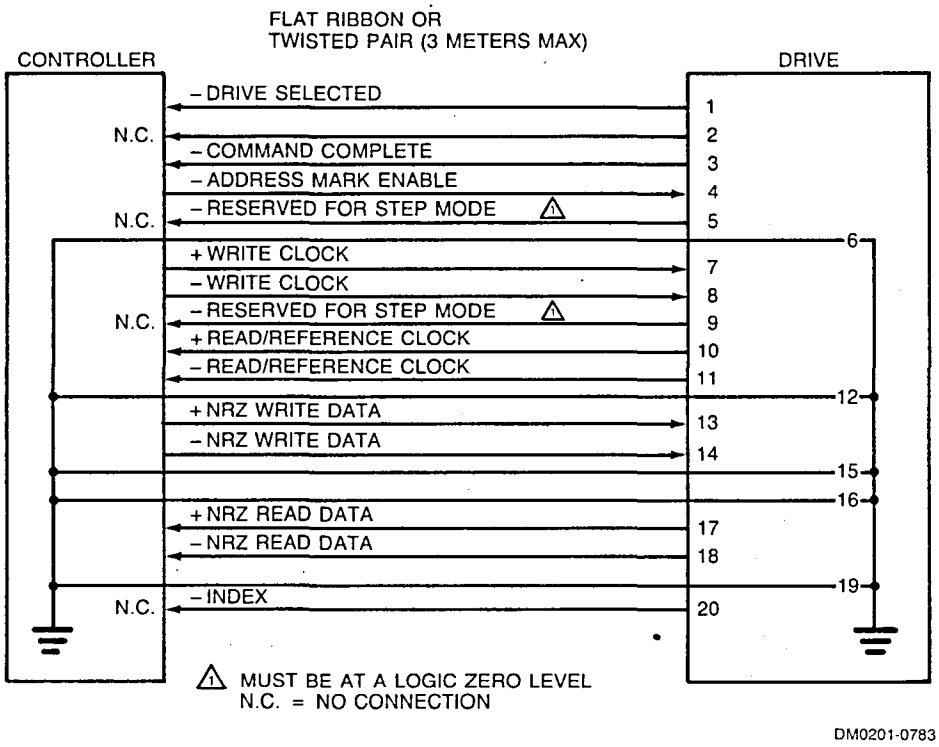


Figure 8-3. Data Pin/Signal Assignments at ESDI Disk Drive Interface (Connector J1 or J2)

8.4 DM02 SA450 FLOPPY DRIVE INTERFACE

The DM02 Controller interfaces with each SA450 floppy drive via a 34-pin cable from a 34-pin male connector at reference designator J4 on the DM02 PCBA. Figure 8-4 shows the pin/signal assignments for SA450 signal interface between the DM02 Controller and an SA450 floppy disk drive. The SA450 signal interface has a maximum cable length of 10 feet.

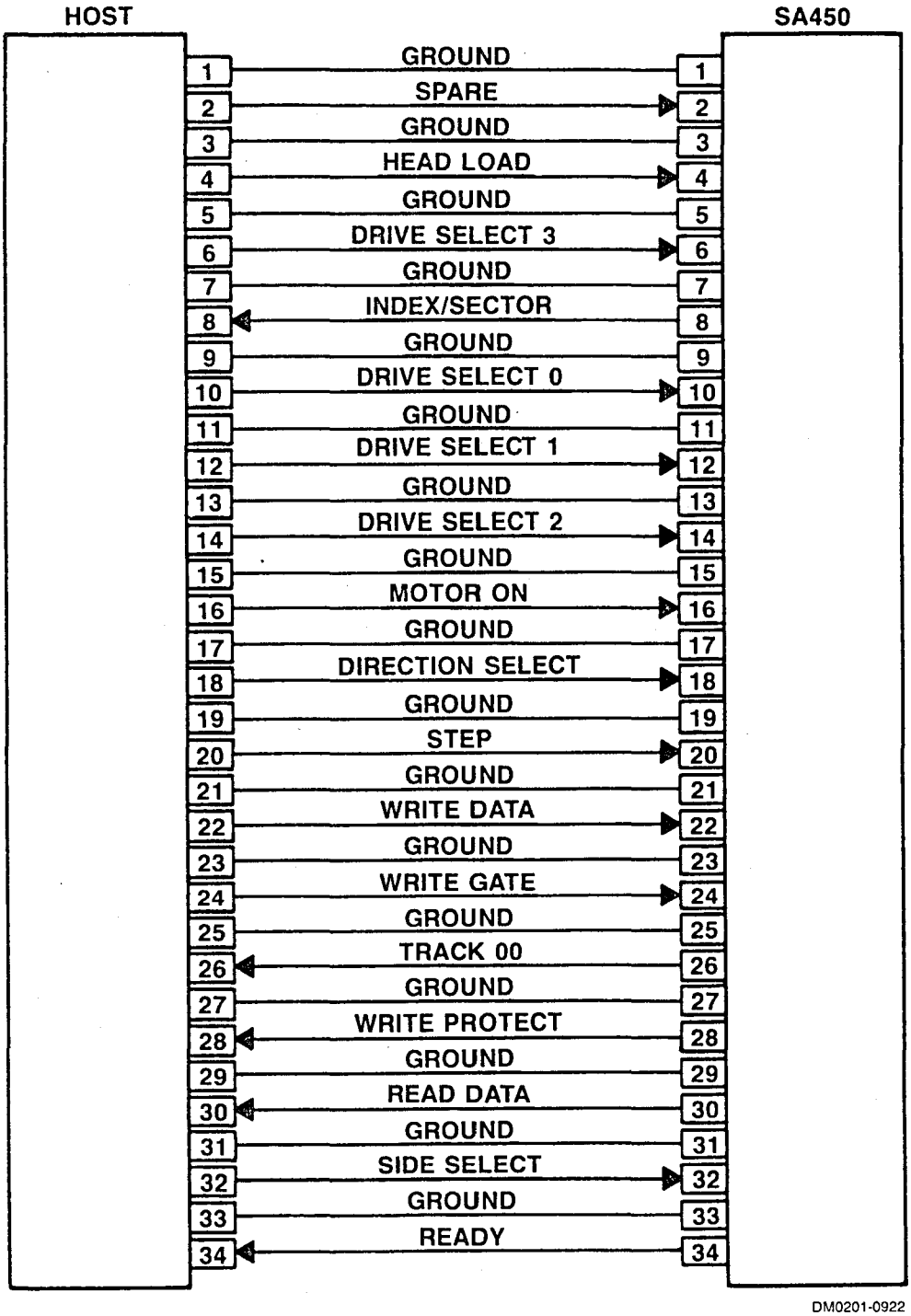


Figure 8-4. Pin/Signal Assignments at SA450 Floppy Drive Interface

8.5 FRONT PANEL INTERFACE

The DM02 provides an interface that allows a remote control and status panel to be connected to the controller. The interface allows write-protect switches for each ESDI drive to be connected, and it provides drivers for ready and write-protected status LEDs, and allows for write-protect status for two floppy drives. Note that the DM02 only updates the floppy write-protect LEDs on a write operation to the floppy drives.

The interface is implemented by using a four-wall, right-angle header (3M part number 3591-5002) designated J5. The header has 10 pins. The function of each pin is described in Table 8-2. Figure 8-5 shows the pin-outs and a sample user interface.

Table 8-1. Control and Status Interface Pin Function Description

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

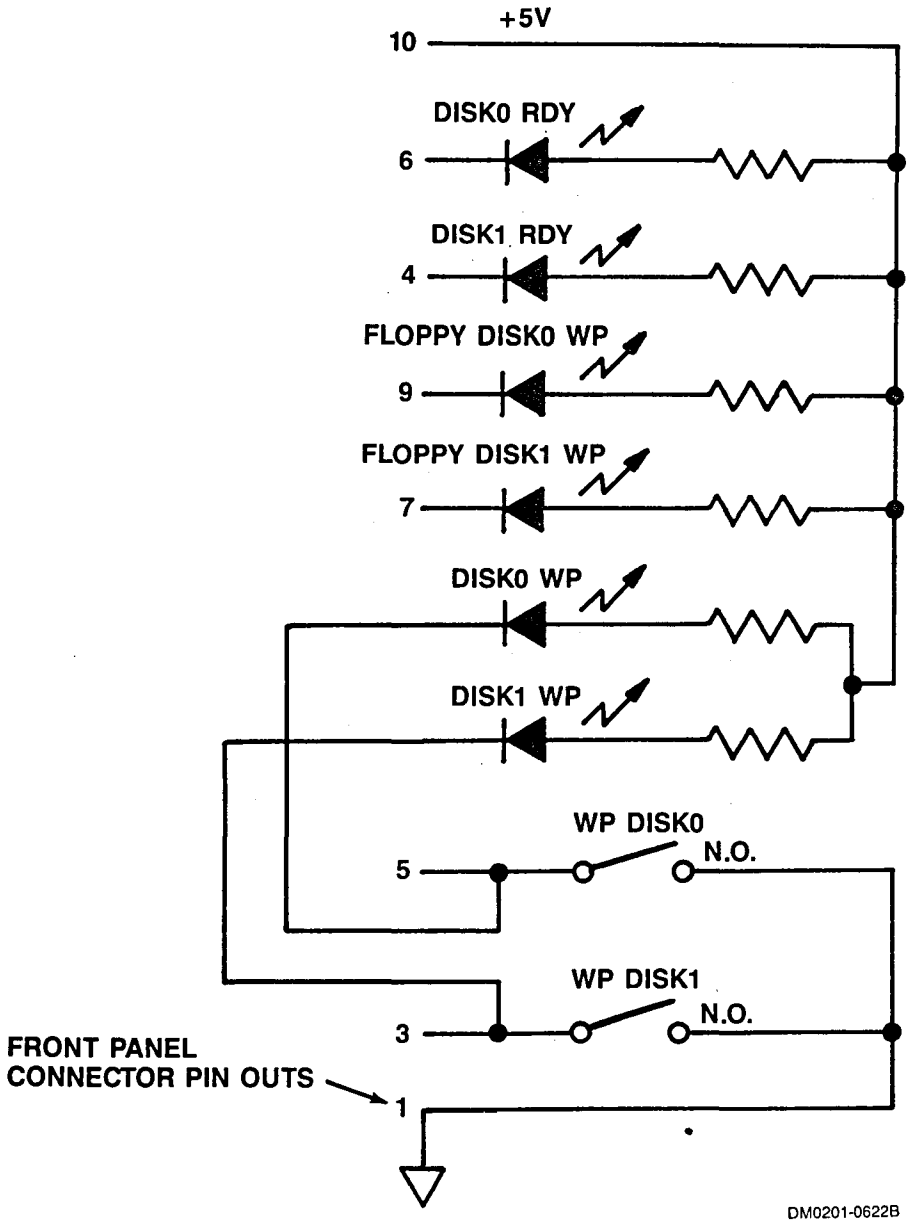


Figure 8-5. Status and Control Interface

Appendix A
AUTOCONFIGURE, CSR and VECTOR ADDRESSES

A.1 OVERVIEW

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

A.2 DETERMINING THE CSR ADDRESS FOR USE WITH AUTOCONFIGURE

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

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

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

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

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

When a device is detected, a block of addresses is reserved for the device according to the number of registers it employs. The utility then looks at the next CSR for that device type. If there is a device there, it is assumed to be of the same type as the one before it and a block is reserved for that device. If there is no response at the next address, that space is reserved to indicate that there are no more devices of that type. Then the utility checks the CSR address (at the appropriate boundary) for the next device in the table.

Table A-1. SYSGEN Device Table

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

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

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

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

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

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

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

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

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

3. An 8-byte gap must follow the register block of any installed device to indicate that there are no more of that type of device. This gap must start on the proper CSR address boundary for that type of device.

4. An 8-byte gap must be reserved in floating address space for each device type that is not installed in the current system. The gap must start on the proper word boundary for the type of device the gap represents. That is, a single DJ11 installed at 760010 would be followed by a gap starting at 760020 to show a change of device types. A gap to show that there are none of the next device on the list, a DH11, would begin at 760040, the next legal boundary for a DH11-type device.

A.3 DETERMINING THE VECTOR ADDRESS FOR USE WITH AUTOCONFIGURE

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

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

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

(continued on next page)

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

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

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

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

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

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

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

A.4 A SYSTEM CONFIGURATION EXAMPLE

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

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

Table A-3. CSR and Vector Address Example

Controller	Vector	CSR
1 UDA50	154	772150
1 DZ11	300	760100
1 UDA50	310	760354
2 DHV11	320	760500
	330	760520

Table A-4. Floating CSR Address Assignment Example

Installed	Device		Octal Address
	DJ11	Gap	760010
	DH11	Gap	760020
	DQ11	Gap	760030
	DU11	Gap	760040
	DUP11	Gap	760050
	LK11A	Gap	760060
	DMC11	Gap	760070
---->	DZ11		760100
		Gap	760110
	KMC11	Gap	760120
	LPP11	Gap	760130
	VMV21	Gap	760140
	VMV31	Gap	760150
	DWR70	Gap	760170
	RL11	Gap	760200
	LPA11-K	Gap	760220
	KW11-C	Gap	760230
	Reserved	Gap	760240
	RX11	Gap	760250
	DR11-W	Gap	760260
	DR11-B	Gap	760270
	DMP11	Gap	760300
	DPV11	Gap	760310
	ISB11	Gap	760320
	DMV11	Gap	760340
	DEUNA	Gap	760350
---->	**UDA50 (DM02)**		**772150**[1]
---->	**UDA50 (DM02)**		**760354**
		Gap	760360
	DMF32	Gap	760400
	KMS11	Gap	760420
	VS100	Gap	761440
	TU81	Gap	761450
	KMV11	Gap	761460
---->	DHV11		761500
---->	DHV11		761520
		Gap	761530
	DMZ32	Gap	761540
	CP132	Gap	761600

[1]Fixed address

BLANK

B.1 OVERVIEW

This appendix provides instructions for replacing the DM02's firmware PROM.

B.2 EXCHANGING PROMS

The DM02 firmware PROM is located in the socket at U44. Pry the existing PROM from its socket using an IC puller or an equivalent tool.

The DM02 PROM is identified by the part numbers on top of the PROMs. Place the DM02 PROM in socket U44. Make certain that the PROM is firmly seated and that no pins are bent or misaligned. (If the two rows of PROM pins are too far apart to fit in the socket, grasp the PROM at its ends using your thumb and forefinger and bend one of the pin rows inward by pressing it against a table top or other flat surface.)

PROM Number	PCBA Location
E65	U44

BLANK

Appendix C
UTILITIES AND DIAGNOSITCS

C.1 OVERVIEW

This appendix contains a list of the diagnostics and utilities software that are available for use with the DM02. The list includes a description of the function of the software and a description of the media on which the software is distributed. The media and supporting documentation are supplied in diagnostic distribution kits as described in Table C-1.

All of the diagnostic and utility media listed contain all of the software provided for the DM02 by Emulex.

Table C-1. Utility and Diagnostic Software

Part Number	Media Type	Boot Type	Description
PX9951801-01	0.5-inch tape, 800 bpi	MT	All tape, disk, communications, and subsystem software
PX9951801-02	0.5-inch tape, 1600 bpi	MT	All tape, disk, communications, and subsystem software
PX9951801-03	0.5-inch tape, 1600 bpi	MS	All tape, disk, communications, and subsystem software
PX9951801-04	0.25-inch tape, TC05/15	MS	All tape, disk, communications, and subsystem software
PX9951801-05	RX02 floppy	DY	All tape, disk, communications, and subsystem software
PX9951801-06	0.25-inch tape, QT12	MS	All tape, disk, communications, and subsystem software

continued next page

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

Part Number	Media Type	Boot Type	Description
PX9951802-01	IOMEGA disk cartridge	DL	Emulex Subsystem software (subset of above)
PX9951802-02	0.25-inch tape, TC05/15	MS	Emulex Subsystem software (subset of above)
PX9951802-03	IOMEGA Disk Cartridge	DU	Emulex Subsystem software (subset of above)
PX9951802-04	0.25-inch tape, QT12	MS	Emulex Subsystem software (subset of above)
VX9951804-01	RX50 Floppy	DU	MicroVAX Diagnostics
VX9951804-02	TK50 cartridge	DU	MicroVAX Diagnostics
VX9951805-00	0.5-inch tape, 1600 bpi	DL	All tape, disk, communications, and subsystem software

Appendix D
DISK DRIVE CONFIGURATION PARAMETERS

D.1 OVERVIEW

This appendix contains the configuration parameters and sector settings for the following drives which have been certified by Emulex for DM02 support:

ESDI Disk Drives	Tables
Fujitsu M2246E	D-1
Hitachi DK512-17	D-2, D-3, D-4, D-5
Maxtor EXT-4175	D-6
Maxtor EXT-4380	D-7
Micropolis 1350 Series	D-8, D-9,
Siemens 1300	D-10

SA450 Disk Drives	Tables
NEC FD1055	D-11, D-12
Panasonic JU-465-5	D-13, D-14
Tandon	D-15, D-16
TEAC-FD55F	D-17, D-18
TEAC-FD55FV	D-19, D-20

The drive configuration parameters listed in this appendix relate to the physical geometry of the disk drives; options such as logical splits are left to the user (see subsection 6.3.1.1).

These tables are designed to be used with a console emulator. If you plan to configure the NOVRAM with the software program, refer to the FVD32M manual (for VAX, P/N VX9950918-00) or the QXMX8C manual (for PDP/LSI, P/N PX9950912-00) for drive parameter tables.

Any drive configuration information required for DM02 operation, such as sector settings, is specified after the parameter table for each drive. If you require further instructions, consult the appropriate manufacturer's drive manual.

Note that Emulex has tested the ESDI drives in the configurations listed in subsection 1.6.3 of this manual.

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-1. Fujitsu M2246E
Soft-Sectored Format

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	34 42	22	Sectors per Track
5	10 12	A	Heads
6	820 1464	334	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	5	5	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12 3093	6025	0C15	Gap 0 Parameter
13 3084	6014	0C0C	Gap 1 Parameter
14 3337	6411	0D09	Gap 2 Parameter
15	0	0	Cylinder Offset
16	0	0	Spiral Offset
--	204	84	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

To set the Fujitsu M2246E for soft-sectored format, pins CNH7 13-14 must be jumpered IN and CNH7 15-16 must be jumpered OUT.

Jumper pins CNH7 3-4 OUT to select the serial mode of the ESDI interface.

Drive motor start control pins CNH7 1-2 must be jumpered OUT so that the DM02 controls the drive spin-up.

Because the DM02 requires that drive output signals be enabled only when a drive is selected, pins CNH6 15-16 must be jumpered OUT for ALL drive configurations.

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-2. Hitachi DK512-17
Hard-Sectored Format

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	42	22	Sectors per Track
5	12	A	Heads
6	1464	334	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	14	C	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	4415	090D	Gap 0 Parameter
13	5413	0B0B	Gap 1 Parameter
14	1011	0209	Gap 2 Parameter
15	0	0	Cylinder Offset
16	1	1	Spiral Offset
--	326	D6	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

Set the jumpers on the drive for 584-byte hard sectors as indicated in Table D-3.

Table D-3. Hitachi DK512-17 Jumper Positions
Hard-Sectored Format

PCBA	Jumper	Positions	Setting
SZ123 Rev 0	JP25	7-10	IN
	JP25	3-14	IN
	JP25	1-16	IN
	JP31	7-16	IN
	JP31	8-15	IN
	JP31	9-14	IN
	JP31	10-13	IN
SZ123 Rev 1,2	JP22	1-16	IN
	JP22	2-15	IN
	JP22	3-14	IN
	JP22	7-10	IN
	JP32	10-13	IN
	JP32A	1-22	IN
	JP32A	2-21	IN

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-4. Hitachi DK512-17
Soft-Sectored Format

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	42	22	Sectors per Track
5	12	A	Heads
6	1464	334	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	15	D	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	6035	C1D	Gap 0 Parameter
13	5413	0B0B	Gap 1 Parameter
14	12410	1508	Gap 2 Parameter
15	0	0	Cylinder Offset
16	1	1	Spiral Offset
--	342	E2	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

Set the jumpers on the drive for soft sectors as indicated in Table D-5.

Table D-5. Hitachi DK512-17 Jumper Settings
Soft-Sectored Format

PCBA	Jumper	Positions	Setting
SZ123 Rev 0	JP31 JP31	9-14 10-13	OUT IN
SZ123 Rev 1,2	JP32A JP32A	1-22 2-21	OUT IN

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-6. Maxtor EXT-4175

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	41	21	Sectors per Track
5	7	7	Heads
6	2305	4C5	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	15	D	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	6016	0C0E	Gap 0 Parameter
13	15032	1A1A	Gap 1 Parameter
14	6027	0C17	Gap 2 Parameter
15	0	0	Cylinder Offset
16	1	1	Spiral Offset
--	66	36	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

Drive spindle motor spin-up jumper JP10 should be OUT so that the DM02 controls the drive spin-up.

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-7. Maxtor EXT-4380

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	41	21	Sectors per Track
5	17	F	Heads
6	2305	4C5	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	15	D	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	6016	0C0E	Gap 0 Parameter
13	15032	1A1A	Gap 1 Parameter
14	6027	0C17	Gap 2 Parameter
15	0	0	Cylinder Offset
16	1	1	Spiral Offset
--	121	51	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

Set drive spindle motor spin-up jumper JP10 OUT so that the DM02 controls the drive spin-up.

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-8. Micropolis 1350 Series Hard-Sectored Format

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	42	22	Sectors per Track
5	10	8	Heads
6	1775	3FD	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	16	E	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	4414	90C	Gap 0 Parameter
13	5413	0B0B	Gap 1 Parameter
14	1011	0209	Gap 2 Parameter
15	0	0	Cylinder Offset
16	1	1	Spiral Offset
--	312	CA	NOVRAM Checksum

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

Table D-9. Micropolis 1350 Series Jumper Settings Hard-Sectored Format

Jumper	Position	Description
W1	OUT	Hard-sectored format
W2	OUT	
W3	OUT	595-byte sectors
W4	OUT	
W5	IN	DM02 spindle control

The Siemens 1300 is supported by firmware Rev. B and above.

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-10. Siemens 1300
Hard-Sectored Format

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	1	1	Type Code
3	0	0	Head Offset
4	42	22	Sectors per Track
5	14	C	Heads
6	2276	4BE	Cylinders*
7	1	1	Spare Sectors per Track
8	2	2	Spare Cylinders
9	10	8	Configuration Bits
10	0	0	Split Code
11	0	0	Removable Media Flag
12	6420	D10	Gap 0 Parameter
13	10020	1010	Gap 1 Parameter
14	1016	20E	Gap 2 Parameter
15	0	0	Cylinder Offset
16	13	B	Spiral Offset

* This cylinder value has already had 1 cylinder subtracted for the drive defect list (refer to subsection 6.5.1).

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-11. NEC FD1055

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	2	2	Type Code
3	0	0	Not Used
4	0	0	Not Used
5	0	0	Not Used
6	0	0	Not Used
7	0	0	Not Used
8	0	0	Not Used
9	0	0	Not Used
10	0	0	Not Used
11	0	0	Not Used
12	0	0	Not Used
13	0	0	Not Used
14	0	0	Not Used
15	0	0	Step Pulse Code
16	0	0	Not Used
--	130	58	NOVRAM Checksum

Table D-12. NEC FD1055 Jumper Settings

Jumper	Setting
HS 1	IN
USE 2	IN
MON 3	IN
LED 2	IN
LED 4	IN

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-13. Panasonic JU-465-5 (Pack Transition Support)

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	4	4	Type Code
3	0	0	Not Used
4	0	0	Not Used
5	0	0	Not Used
6	0	0	Not Used
7	0	0	Not Used
8	0	0	Not Used
9	0	0	Not Used
10	0	0	Not Used
11	0	0	Not Used
12	0	0	Not Used
13	0	0	Not Used
14	0	0	Not Used
15	0	0	Step Pulse Code
16	0	0	Not Used
--	54	2C	NOVRAM Checksum

Table D-14. Panasonic JU-465-5 Jumper Settings

Jumper	Setting
DS	IN
MS	IN
WP	IN
SW	IN
RR	IN

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-15. Tandon TM65-4
(Pack Transition Support)

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	4	4	Type Code
3	0	0	Not Used
4	0	0	Not Used
5	0	0	Not Used
6	0	0	Not Used
7	0	0	Not Used
8	0	0	Not Used
9	0	0	Not Used
10	0	0	Not Used
11	0	0	Not Used
12	0	0	Not Used
13	0	0	Not Used
14	0	0	Not Used
15	0	0	Step Pulse Code
16	0	0	Not Used
--	54	2C	NOVRAM Checksum

Table D-16. Tandon TM65-4 Jumper Settings

Jumper	Setting
S1	IN
S2	OUT
S3	OUT
S4	OUT

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-17. TEAC FD-55F

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	2	2	Type Code
3	0	0	Not Used
4	0	0	Not Used
5	0	0	Not Used
6	0	0	Not Used
7	0	0	Not Used
8	0	0	Not Used
9	0	0	Not Used
10	0	0	Not Used
11	0	0	Not Used
12	0	0	Not Used
13	0	0	Not Used
14	0	0	Not Used
15	0	0	Step Pulse Code
16	0	0	Not Used
--	130	58	NOVRAM Checksum

Table D-18. TEAC FD-55F Jumper Settings

Model	Jumper	Position	Jumper	Position	Jumper	Position
FD-55F	H-S	IN	M-L	IN	U-0	OUT
	H-M	OUT	I-U	OUT	U-1	OUT
	M-X	OUT	H-L	OUT	R-E	OUT
	U-R	OUT	S-M	IN	P-M	OUT

These parameter values are only valid for NOVRAM loaded under a console emulator.

Table D-19. TEAC FD-55FV

Word	Octal	Hex	Description
1	1	1	Number of Drives
2	2	2	Type Code
3	0	0	Not Used
4	0	0	Not Used
5	0	0	Not Used
6	0	0	Not Used
7	0	0	Not Used
8	0	0	Not Used
9	0	0	Not Used
10	0	0	Not Used
11	0	0	Not Used
12	0	0	Not Used
13	0	0	Not Used
14	0	0	Not Used
15	0	0	Step Pulse Code
16	0	0	Not Used
--	130	58	NOVRAM Checksum

Table D-20. TEAC FD-55FV Jumper Settings

Model	Jumper	Position	Jumper	Position	Jumper	Position
FD-55FV	I-U U-2	OFF OFF	H-L F-G	OFF IN	U-1	OFF

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