SC41/MS SMD 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 Comminsion (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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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES

EMULEX PRODUCT WARRANTY

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

CABLE WARRANTY: All Emulex provided cables are warranted for ninety (90) days from the time of shipment.

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

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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

This manual is designed to help you install and use your SC41/MS SMD 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 SC41/MS.	
Section 2	**SC41/MS Specification:** This section contains the specification for the SC41/MS.	
Section 3	**Application and Configuration:** This section contains the information necessary to plan your installation.	
Section 4	**Installation:** This section contains the information needed to set up and physically install the subsystem.	
Section 5	**Troubleshooting:** This section describes fault isolation procedures that can be used to pinpoint trouble spots.	
Section 6	**Controller Registers:** This section contains a description of the subsystem's UNIBUS 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 controller's UNIBUS and SMD interfaces.	
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 SC41/MS in the field. A list of firmware PROM numbers and their locations on the PCBAs is also provided here.	
Appendix C	**Utilities and Diagnostics:** This appendix contains a list of the utilities and diagnostics that are applicable to the SC41/MS.	
Appendix D	**Disk Drive Modifications:** This appendix describes modifications to common disk drives that move sector and index signals from the A cable to the B cable.	

1.2 SUBSYSTEM OVERVIEW

The SC41/MS connects high-capacity mass-storage peripherals to PDP-11 and VAX-11 computers manufactured by Digital Equipment Corporation (DEC). The SC41/MS 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 SC41/MS uses the versatile, industry standard Storage Module Device (SMD) interface as its peripheral interface. The SMD interface supports many disk drives in a large number of configurations. See Drive Configuration Selection, subsection 4.3.3, for a detailed description of the configurations that are supported by the SC41/MS.

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 SMD compatible peripherals, the SC41/MS provides just such a subsystem. The MSCP functions that the SC41/MS assumes include error checking and correction, bad block replacement, seek optimization, command prioritizing and ordering, and data mapping.

This last feature is perhaps the most important. It 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 determine its capacity--in other words, the number of logical blocks that the subsystem can store.

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

1.3 PHYSICAL ORGANIZATION OVERVIEW

The SC41/MS is a modular, microprocessor-based disk controller that connects directly to the host computer's UNIBUS backplane. The microprocessor architecture ensures excellent reliability and compactness, and allows the SC41/MS to relieve the host CPU of many file maintenance tasks.

The SC41/MS is contained on a single hex-wide printed circuit board assembly (PCBA) that plugs directly into a UNIBUS backplane slot.

The SC41/MS supports up to four disk drives. Aggregate data storage capacities are limited only by the capacities of the peripherals. Currently, drives are available that can be combined to provide several gigabytes of online storage.

Figure 1-1 shows the relationship of the SC41/MS to the host CPU and to the disk drives that it controls.

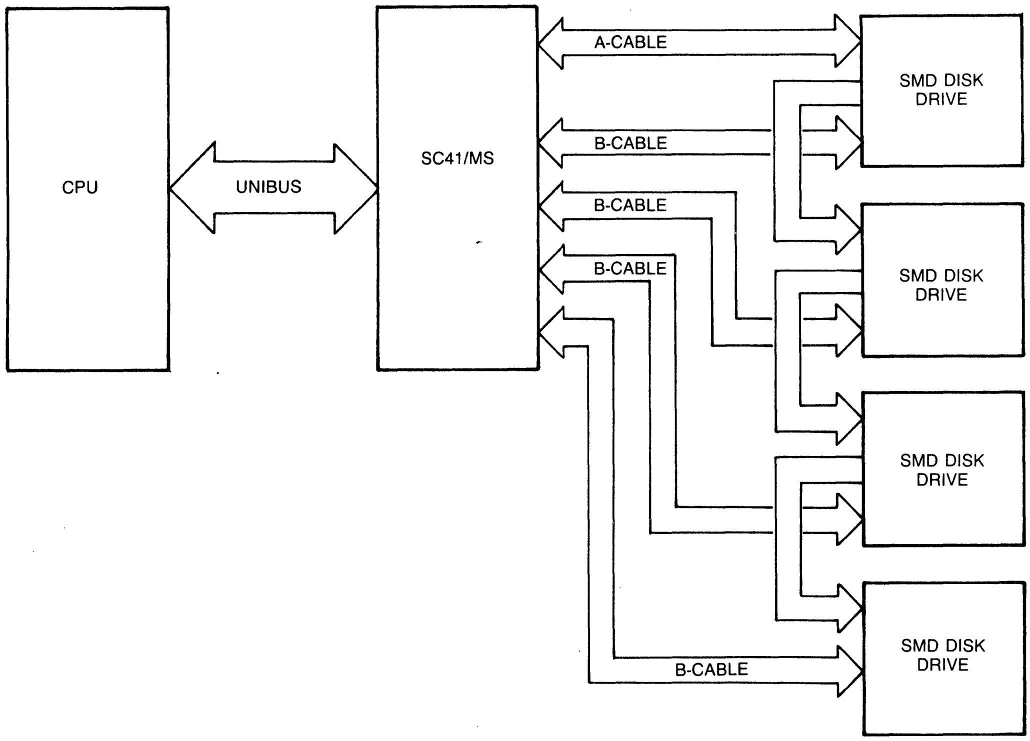


Figure 1-1. SC41/MS Subsystem Configuration

1.4 SUBSYSTEM MODELS AND OPTIONS

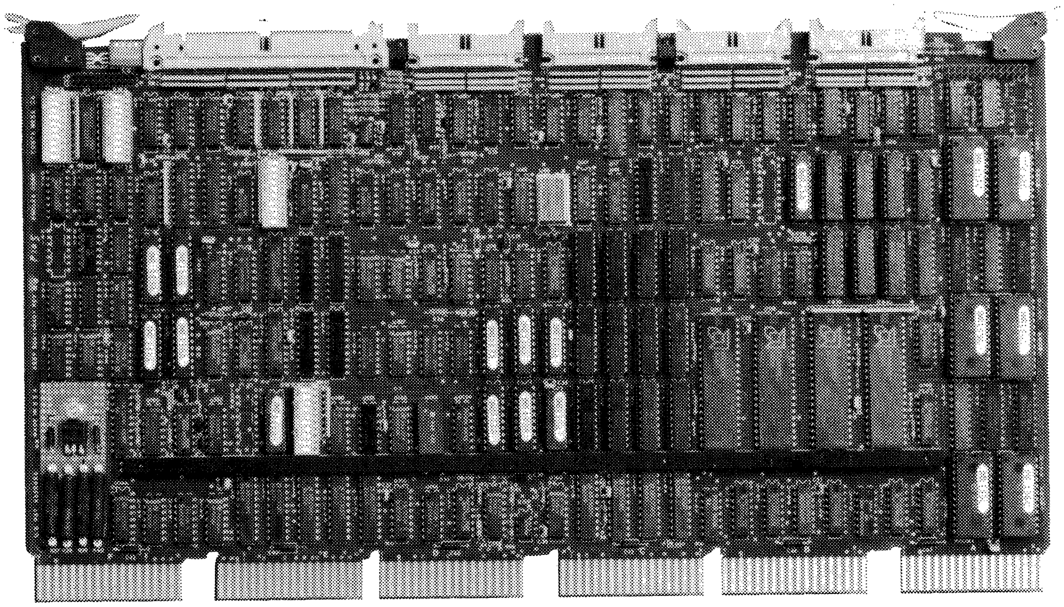
The SC41/MS, with appropriate peripherals, provides a DEC MSCP-compatible mass-storage subsystem. The SC41/MS is pictured in Figure 1-2. A single model of the SC41/MS is offered.

Table 1-1. Basic Subsystem Contents

Itm	Qty	Description	Part Number	Comment
1	1	SC41/MS Disk Controller	SC4110201-MSx	x is firmware revision
2	1	Alternate Address PROM Kit	SC4111717	
3	1	SC41/MS Technical Manual	SC4151001	

1.4.1 SUBSYSTEM OPTIONS

Two software utilities are available for use with the SC41/MS and other Emulex controllers. Those utilities are described in Table 1-2. Other SC41/MS options are limited to cables and cable installation hardware. Tables 4-8 and 4-9 list and describe the applicable cables and hardware.



SC4101-0553

Figure 1-2. SC41/MS Disk Controller

Table 1-2. Subsystem Options

Option	Description
VX9951801	Emulex VAX-11 Diagnostic Monitor and Disk Diagnostics including the FVDMS SC41/MS Formatter and Disk Verification Utility.
PX9951801	Emulex PDP-11 Diagnostics including the AXMX8 SC41/MS Formatter and Disk Verification Utility.
PD9951803	Backup and Restore Program (BRP) for PDP-11 CPUs. Allows image backup and restoration of disk with streaming tape drives in streaming mode. Compatible with Emulex TS11 emulations and all DEC disks.

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	Model Number	Comment/Description
1.	SC41/MS	SMD Disk Controller implementing DEC MSCP.
2.	PX9951801-03	PDP-11 Diagnostics, 0.5" tape, PE, MS boot
3.	PD9951803-01	Backup and Restore Program, 0.5" tape, PE, MS boot

Figure 1-3. Sales Order Example

1.5 FEATURES

The following features enhance the usefulness of the SC41/MS Disk Controller.

1.5.1 MICROPROCESSOR DESIGN

The SC41/MS design incorporates a unique (patented) 16-bit bipolar microprocessor to perform all controller functions. The microprocessor approach provides for a reduced component count, high reliability, easy maintainability, and--most importantly--the ability to adapt a single set of hardware to a wide range of emulation capabilities through the use of microprogramming. Emulex controllers achieve functional capability beyond that of the DEC controllers they emulate by providing enhancement features such as built-in self-test during power-up, built-in disk formatting, and the ability to function with disk drives of various capacities.

1.5.2 CONFIGURATION FLEXIBILITY

The SC41/MS provides complete configuration flexibility. It is capable of supporting as many as four different SMD compatible disk drives of varying capacities.

1.5.3 SELF-TEST

The controller incorporates an internal self-test routine that is executed upon power-up. This test exercises all parts of the microprocessor, the on-board memory, and the SMD interface. Although this test does not completely test all circuitry, successful execution indicates a very high probability that the SC41/MS is operational. If the SC41/MS fails the self-test, it leaves a FAULT light emitting diode (LED) ON and reports its failure to the host operating system.

1.5.4 SEEK OPTIMIZATION

The SC41/MS 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 SC41/MS's ability to arrange seeks in the optimum order can save a great deal of time and makes the entire system more efficient.

1.5.5 COMMAND BUFFER

The SC41/MS contains a buffer that is able to store 15 MSCP commands. This large buffer allows the subsystem to achieve a higher throughput and to operate at a very efficient level.

1.5.6 ADAPTIVE DMA

During each DMA data transfer burst, the SC41/MS monitors the UNIBUS for other pending DMA requests and suspends its own DMA activity to permit other DMA transfers to occur. In addition, burst length is programmable, to ensure that CPU functions (including interrupt servicing) are not locked out for excessive periods of time by high-speed disk transfers.

1.5.7 ERROR CONTROL

The SC41/MS presents an error-free media to the operating system by re-vectoring bad blocks (once bad blocks have been identified by host system software) and transparently correcting soft errors. (Soft errors are logged, however.)

1.6 COMPATIBILITY

1.6.1 DIAGNOSTICS

Emulex provides two diagnostic programs to support the installation and maintenance of the SC41/MS:

Name	Function	Application
FVDMS	Formatter	VAX-11
AXMX8	Formatter	PDP-11

See subsection 1.4 for ordering information.

1.6.2 OPERATING SYSTEMS

Emulex supports MSCP under the following DEC operating systems (indicated versions and above):

Operating System	Version
RT-11	5.1
RSX-11M	4.1
RSX-11M-PLUS	2.1
RSTS/E	8.0
VMS	3.2

1.6.3 HARDWARE COMPATIBILITY

The SC41/MS complies with DEC UNIBUS protocol. Emulex has tested the SC41/MS with the following DEC CPUs:

PDP-11/24	VAX-11/750
PDP-11/34	VAX-11/780
PDP-11/44	VAX-11/785
PDP-11/70	VAX 8600
VAX-11/730	

1.6.4 MEDIA COMPATIBILITY

The disk drives supported by the SC41/MS are not media compatible with comparable DEC MSCP products. The fixed nature of most disk media, however, makes this an unimportant consideration.

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2.1 OVERVIEW

This section contains the general, environmental, physical, and electrical specifications for the SC41/MS SMD Disk Controller. Specifications are contained in tables, which are oriented around areas of interest as listed below:

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

2.2 GENERAL SPECIFICATION

A general specification for the SC41/MS SMD Disk Controller is contained in Table 2-1.

Table 2-1. SC41/MS SMD Disk Controller General Specifications

Parameter	Description
FUNCTION	Provides mass data storage to PDP-11 and VAX-11 computers manufactured by Digital Equipment Corporation (DEC)
Logical CPU Interface	Implementation of DEC's Mass Storage Control Protocol (MSCP)
VAX-11 Diagnostic Software	Emulex FVDMS Disk Formatter
PDP-11 Diagnostic Software	Emulex AXMX8 (or a later revision) Disk Formatter
Operating System Compatibility	RT-11 V5.1 RSX-11M V4.1 RSX-11M PLUS V2.1 RSTE/S V8.0 VMS V3.2

continued on next page

Table 2-1. SC41/MS SMD Disk Controller General Specifications (continued)

Parameter	Description
CPU I/O Technique	Direct memory access, including adaptive techniques
INTERFACE	
CPU Interface	Standard UNIBUS interface
Device CSR Address	
Standard Alternates	772150_8 760334_8, 760340_8, 760344_8, 760350_8, 760354_8, 760360_8, 760364_8
Vector Address	Programmable
Priority Level	BR5
AC Load	2.5
DC Load	1
Peripheral Interface	Storage Module Drive (SMD)
A Cable Length	100 ft (30 m), daisy-chained, cumulative
B Cable Length	50 ft (15 m), radial

2.3 ENVIRONMENTAL SPECIFICATION

Table 2-2 contains the environmental specifications for the SC41/MS SMD Disk Controller.

Table 2-2. SC41/MS SMD Disk Controller Environmental Specifications

Parameter	Description
OPERATING TEMPERATURE	10°C (50°F) to 40°C (104°F) 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 SC41/MS SMD Disk Controller.

Table 2-3. SC41/MS SMD Disk Controller Physical Specifications

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

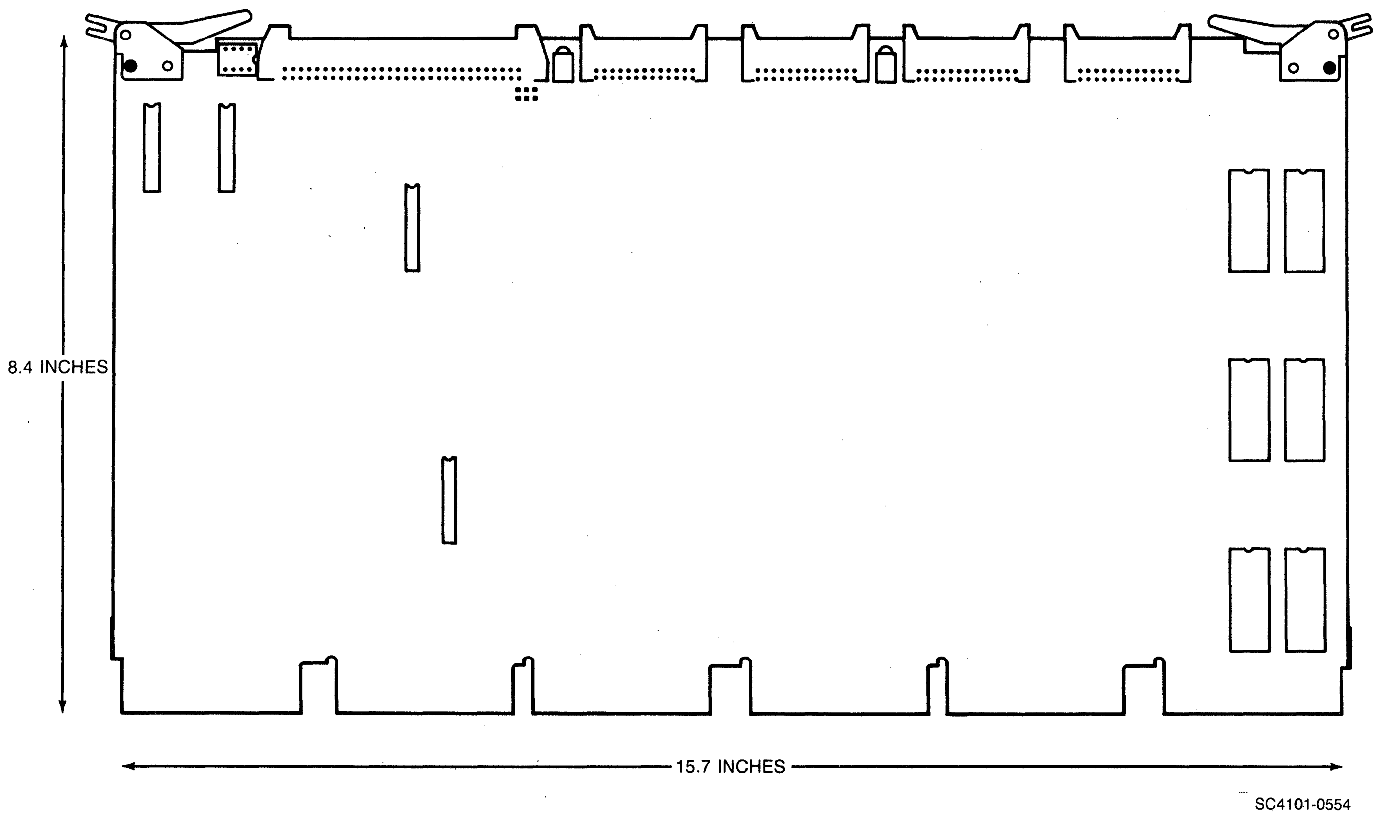

Figure 2-1. SC41/MS Disk Controller Dimensions

2.5 ELECTRICAL SPECIFICATION

Table 2-4 lists and describes the electrical specification for the SC41/MS SMD Disk Controller.

Table 2-4. SC41/MS SMD Disk Controller
Electrical Specifications

Parameter	Description
POWER	5 VDC ± 5%, 7.5 amperes (A)

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3.1 OVERVIEW

This section is designed to help you plan the installation of your SC41/MS SMD Disk Controller. Taking a few minutes and planning the configuration of your subsystem before beginning its installation will result in a smoother installation with less system down time. As a planning tool, this section explains some of the practical matters that need to be considered before you begin your installation.

This section contains SC41/MS 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 SC41/MS MSCP Subsystem
3.5	Operating Systems, Device and Vector Addresses

Following the procedures contained in these subsections will help you get the most from your SC41/MS.

3.2 MSCP SUBSYSTEM CONFIGURATION

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

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 SC41 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 SC41 implements MSCP in mass storage subsystems using SMD as the peripheral interface.

3.2.2 PERIPHERAL NUMBERING

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

With the exception of MicroVMS systems, DEC operating systems require that all MSCP peripherals on a system have different MSCP device numbers, even if they are managed by separate MSCP controllers at separate LSI-11 bus device addresses. For example, under RSX-11M-PLUS, if there are three peripherals on the first MSCP controller (at 772150_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 reports the capacity of a peripheral to the operating system. A 456M byte peripheral such as DEC's RA81 is able to store about 890,625 logical blocks.

3.3 A DEC MSCP SUBSYSTEM

A typical DEC MSCP subsystem for the UNIBUS is organized as shown in Figure 3-1. This subsystem combines the MSCP host and controller functions in a single piece of hardware, which is referred to as the UDA50. The hard disk drive that attaches to the UDA50 is referred to as the RA81. The UDA50 plugs directly into the UNIBUS and is attached to the disk drives via a DEC-unique interface. These model numbers are not used to identify peripherals to the operating system, but are displayed to the operator by some operating systems during configuration for informational purposes.

3.4 THE SC41/MS MSCP SUBSYSTEM

Figure 3-2 illustrates a typical SC41/MS MSCP subsystem. As with the DEC implementation, the SC41/MS is connected directly to the UNIBUS. On the other side, however, the SC41/MS uses the SMD interface to communicate with up to four disk drives.

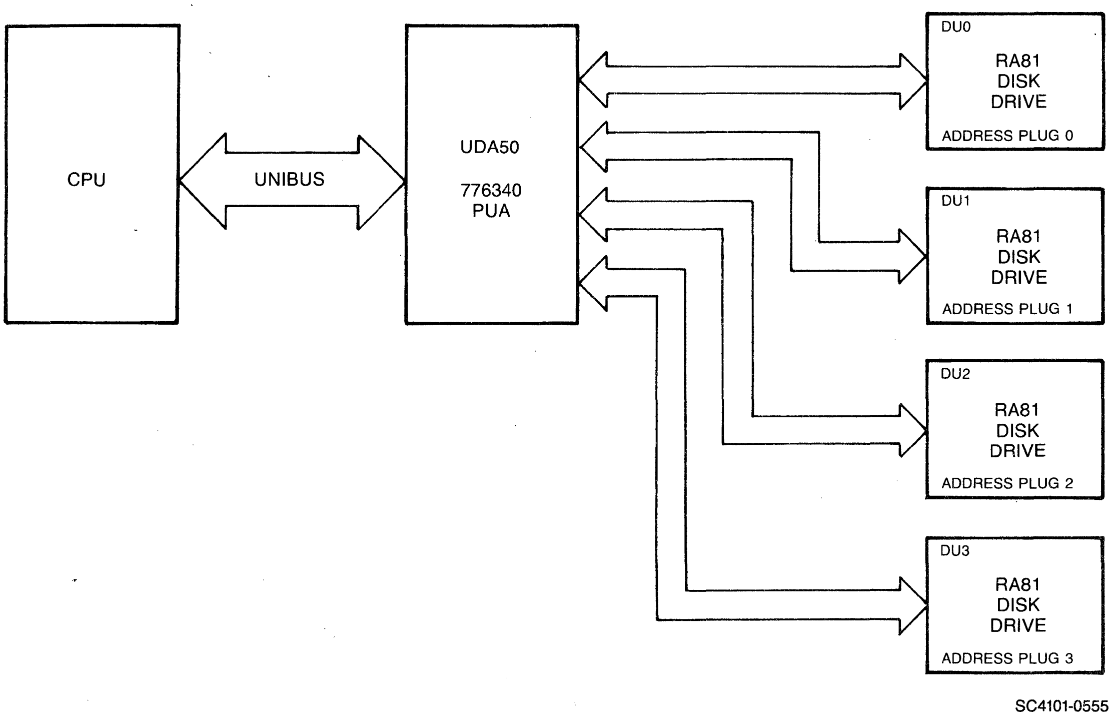

Figure 3-1. DEC MSCP Subsystem Logical and Physical Configuration

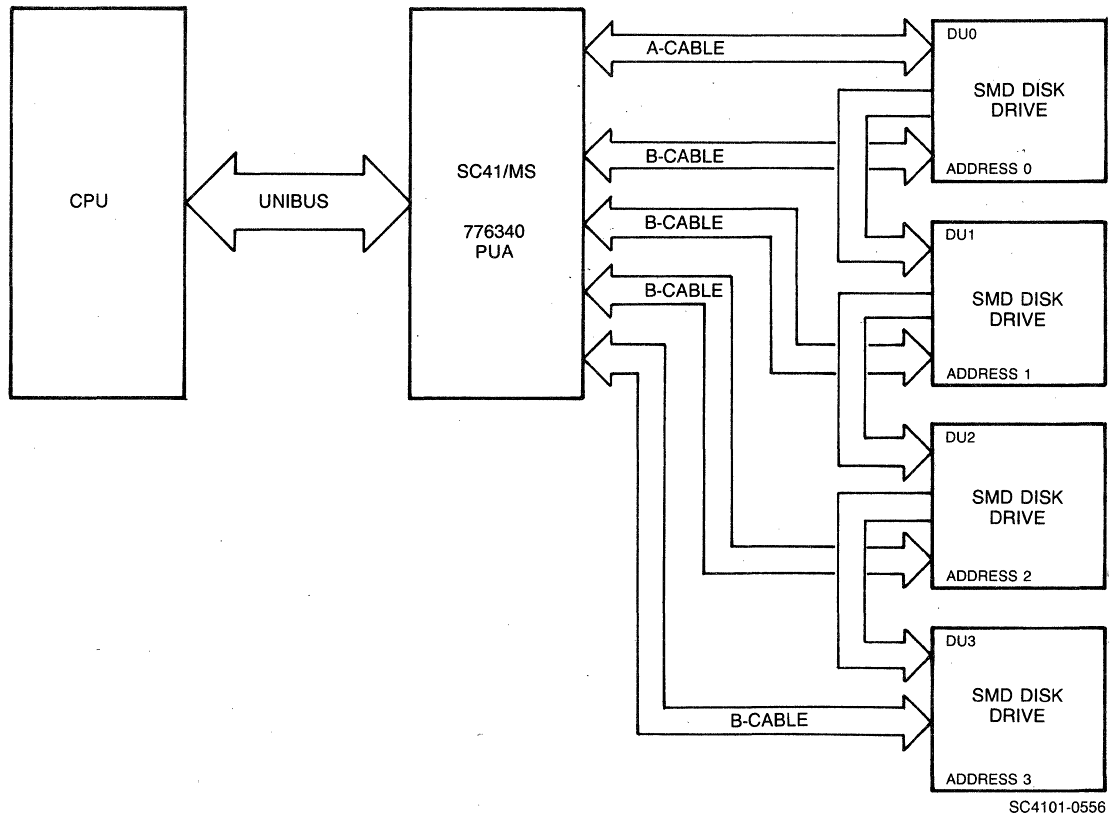

Figure 3-2. SC41/MS Subsystem Logical and Physical Configuration

The MSCP subsystem provided by the SC41/MS is essentially homologous to the DEC MSCP subsystem. As in the DEC subsystem, the SC41/MS MSCP controller connects directly to the UNIBUS and performs many of the same functions as the UDA50. As an MSCP controller, the SC41/MS:

- Receives requests from the host
- Optimizes the requests
- Generates SMD commands to perform the operations
- Transfers data to and from the host
- Transfers data to and from the device
- Buffers data as necessary

When the command is complete, the controller sends a response to the host.

The SC41/MS also performs all of the functions of the peripheral controller, including serialization/deserialization of data. The SC41/MS connects to the peripherals it supports via an SMD interface.

3.4.1 LOGICAL UNIT NUMBERS

The MSCP protocol does not allow any two MSCP disk devices on one computer to have the same unit number, even though they may be controlled by separate MSCP controllers at different UNIBUS addresses.

The SC41/MS can detect only four unique drive addresses (0-3) at its SMD interface. Consequently, it is sometimes necessary (when there are four or more MSCP drives on another controller) to specify a unit number offset.

Example 3-1 An MSCP controller at a standard base address supports four disk drives. An offset of 4 is specified for the SC41/MS. This causes the SC41/MS disk with address 0 to be reported to the operating system as logical unit number 4. SC41/MS disk one is LUN 5, etc.

The offset is specified by using switches on the SC41/MS. See subsection 4.3.4 for switch setting information.

3.4.2 DEVICE IDENTIFIERS

MSCP peripherals (not the MSCP controller itself) identify themselves by model number. This information is usually displayed during configuration and is not really significant. The SC41/MS always identifies its drives as RA81s, even though the SMD drives that it supports frequently have different data storage capacities than the RA81 (this is not a limitation due to the self-sizing nature of MSCP).

3.5 OPERATING SYSTEMS, DEVICE AND VECTOR ADDRESSES

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

An operating system can be made aware of a new resource in any of 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 powered up. All techniques accomplish the same result: they associate a specific device-type with a bus address and interrupt vector.

Operating Systems, Device and Vector Addresses

All recent versions of DEC operating systems use autoconfigure to some extent, and all try to follow the same rules. There are some differences among operating systems, however, especially with regard to MSCP controllers at alternate CSR addresses. The following paragraphs address these differences for each operating system. Choosing appropriate UNIBUS CSR addresses and interrupt vectors for the subsystem is part of that discussion.

CSR Addresses:

The operating system discussions below give procedures for choosing CSR addresses for the first MSCP controller and any subsequent controllers in the host configuration. No instructions are provided for programming the chosen address into the SC41/MS. See subsection 4.3.1 for detailed switch setting information.

MSCP-type controllers contain two registers that are visible to the UNIBUS I/O page. They are the initializing and polling (IP) register and the status and address (SA) register. All of the operating systems described in the following text use the standard CSR address of 772150_8 for the first controller on the host system.

Vector Addresses:

Vector addresses for MSCP controllers are not selected by using switches on the controller PWB (printed wiring board), but are programmed into the controller during the SYSGEN process. Many operating systems select the vector address automatically. If manual input of the vector is required by an operating system, that fact is noted in the procedure.

Device Names:

Although DEC has attempted to standardize treatment of peripherals by operating systems, some differences do exist. Table 3-1 lists and describes the device names assigned to MSCP devices under five operating systems. Two controller names and drive names are given to imply the numbering scheme.

Table 3-1. Device Names

Operating System	Controller First, Second	Drives Supported by First Controller
RSTS/E	DUA, DUB	DU0, DU1
RT-11	Port1, Port2	DU0, DU1
RSX-11M	DUA, DUB	DU0, DU1
RSX-11M-PLUS	--	DU0, DU1
VAX/VMS	PUA, PUB	DU0, DU1

Assumptions:

The following discussions make these assumptions:

- This is the first pass that is being made through SYSGEN, therefore, no saved answer file exists. Answer NO to questions such as "Use as input saved answer file?"
- Your host system configuration conforms to the standard PDP-11 and VAX-11 (UNIBUS) device configuration algorithm (otherwise autoconfigure results are not reliable). All of the operating systems discussed here use some type of autoconfigure algorithm to identify devices in the host system. The procedures that follow use autoconfigure as much as possible.
- You are generating a mapped version of the operating system on the appropriate hardware.

3.5.1 RSTS/E OPERATING SYSTEMS (V8.0)

RSTS/E scans the hardware to determine the 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 CSR address, 772150_8. If an SC41/MS is used as an alternate MSCP controller, it must be located in floating CSR address space. If there are no other devices in floating CSR address space, the proper address would be 760334_8. The presence of other devices on the bus could affect the SC41/MS's address. See Appendix A.

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

3.5.2 RT-11 OPERATING SYSTEMS (V5.0)

The RT-11 Operating System supports up to four MSCP controllers with up to 256 devices (total) on the four controllers. The following paragraphs discuss the CSR 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 CSR address of 772150_8. The RT-11 version of autoconfigure will find and install the handler (driver) for that controller. In single MSCP controller configurations, it is not necessary to run SYSGEN. You can use one of the pregenerated monitors that are provided with the RT-11 Distribution. To get the most out of your MSCP subsystem, however, you must modify the system start-up command file, STARTx.COM, to partition the disk drives properly. 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 can modify the MSCP handler as described in the **RT-11 Software Support Manual** or perform a SYSGEN. The following procedure describes the SYSGEN technique.

1. Initiate SYSGEN:

   R SYSGEN.COM<return>

   Answer questions 1 through 25 appropriately.

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

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

   The start-up command file is required to allow additional MSCP controller CSR addresses to be specified and to partition the disks consistently when the system is bootstrapped. Answer questions 27 through 32 appropriately.

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

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

   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>**

   SYSGEN does not prompt here for the number of DU devices. Answer questions 33 through 66 appropriately.

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

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

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

5. 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 used, where x is S, F, or X for single-job, foreground/background, or extended memory.) Edit the command file to include the following statements:

   ```
   SET DU CSR=772150
   SET DU CSR2=760334
   SET DU VECTOR=154
   SET DU VEC2=300
   ```

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

3.5.2.3 Disk Partitioning

RT-11 is unable to handle DU-type drives with a capacity of more than 65,535 blocks (33.5M 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, to ensure 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 assign to each physical drive.

1. Consult Table 4-5. Find the configuration that you intend to use. Note down the capacity given in the MSCP Disk Capacity column for each MSCP unit. If the SC41/MS is at an alternate CSR address (not 772150_8), then you must specify an MSCP unit number offset by using switches SW5-1 through SW5-4 (see subsection 4.3.4). Add the selected offset to the MSCP unit number, which is determined by the drive address, to determine the proper unit number to use in the SET statements.

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

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

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

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

Example 3-2 You have selected configuration number 02 from Table 4-5. This drive configuration provides a capacity of 790,130 blocks.

$$\frac{790{,}130}{65{,}535} = 12.05 \text{ (13 logical units)}$$

Dividing the unit capacities by 65,535 and rounding the result up to the nearest whole number gives the number of logical units into which each should be partitioned. (In this example, however, unit 13 is so small that it could be ignored.)

Repeat this computation for each drive on the SC41/MS.

Then you must assign logical names to the partitions beginning with DU0. Assign logical names to the partitions on MSCP unit 0 first. The assignments are made as follows:

```
SET DU0 UNIT=0 PART=1
SET DU1 UNIT=0 PART=2
SET DU2 UNIT=0 PART=3
SET DU3 UNIT=0 PART=4
SET DU4 UNIT=0 PART=5
SET DU5 UNIT=0 PART=6
SET DU6 UNIT=0 PART=7
SET DU7 UNIT=0 PART=8
SET DU8 UNIT=0 PART=9
SET DU9 UNIT=0 PART=10
SET DU10 UNIT=0 PART=11
SET DU11 UNIT=0 PART=12
```

For the next MSCP unit (1), the set statements would be identical, except for the unit number, which would be 1.

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

RSX-11M SYSGEN is an interrogative program that allows a complete, running RSX-11M system to be configured for a particular hardware environment. SYSGEN is well documented in the **RSX-11M System Generation and Installation Guide**, and you are expected to rely primarily on that manual. This explanation is provided only to remove some ambiguities that the installation of the SC41/MS 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 CSR address. Additional MSCP controllers at alternate addresses must be attached to the operating system manually.

3.5.3.1 Installing a Single MSCP Controller

If you have only one SC41/MS, 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.

3.5.3.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say an UDA50 and a SC41/MS, we recommend that you use autoconfigure to connect the first at the standard address (772150_8). We recommend that the UDA50 be installed at the standard CSR address. Locating the SC41/MS at the alternate CSR address does not prevent its being used as the system device. The second MSCP controller is connected to the operating system after the initial SYSGEN is complete and the system is running. To connect the second controller, use the Add a Device option of SYSGEN. The following procedure describes the process.

1. Invoke SYSGEN.

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

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

   * 1. 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:

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

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

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

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

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

5. When you reach the PERIPHERAL OPTIONS section, SYSGEN 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 (15), then SYSGEN asks questions on those devices.)

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

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

   The standard vector address for MSCP controllers in 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 CSR address for MSCP controllers is 772150_8. The second unit can be located in floating CSR 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 SC41/MS, or on the number of drives that are attached to a DEC MSCP controller.

When you select a configuration for the SC41/MS, you are taking into account the number of physical disk drives that you are attaching to the SC41/MS's SMD interface. When you select a configuration, you are also specifying a logical arrangement for the SC41/MS MSCP subsystem.

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

RX50
RD51
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.

The SC41/MS supports up to eight command and eight response rings; the number of command and response ring you specify depends on your application. Four command and four response rings are reasonable and adequate for most applications.

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

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

   For the UDA50, indicate that you have the appropriate RA-type drives.

   For the SC41/MS, indicate that you have one RA81 for each logical disk.

   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.

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

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 SC41/MS 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 CSR 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 SC41/MS, 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.

3.5.4.2 Installing Multiple MSCP Controllers

If you have two MSCP controllers, say a UDA50 and an SC41/MS, we recommend that you use autoconfigure to connect the first at the standard address (772150_8). We recommend that the UDA50 be installed at the standard CSR address. Locating the SC41/MS at the alternate CSR address does not prevent its being used as the system device. The second MSCP controller is connected to the operating system after the initial SYSGEN is complete and system the is running. To connect the second controller, use the Add a Device option of SYSGEN. The following procedure describes the process.

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:

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

   * SU130 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:

   * SU150 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:

   * SU160 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 will now ask 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 zero (0) for all types of controllers until you are prompted for the number of UDA-type devices.

   There is an exception: If your system has MASSBUS controllers (RH-type), specify the proper number when asked. Answer 0, however, to all the questions that follow about MASSBUS devices that are attached to the MASSBUS controller (DB, DR, DS, EM, and MM types).

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

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

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

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

   The answer to this question depends on the configuration that you have selected for the SC41/MS and on the number of drives that are attached to any DEC MSCP controllers.

   When you select a configuration for the SC41/MS, you are taking into account the number of physical disk drives that you are attaching to the SC41/MS's SMD interface. When you select a configuration, you are also specifying a logical arrangement for the SC41/MS MSCP subsystem.

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

RX50
RD51
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.

6. SYSGEN then asks you to specify the controller to which a disk drive is connected.

   * CP3044 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 disk drives that you have indicated are on the system. RSX-11M-PLUS does not tolerate gaps in sequence; the unit numbers must be contiguous. In addition, the unit numbers specified for each controller must be the same as those reported by the controller during initialization.

7. Enter the vector address for each MSCP controller:

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

   The standard vector address for MSCP 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.

8. Enter the CSR address for each MSCP controller:

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

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

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

   * CP3076 Enter the number of command rings for DUA [D R:1.-8. D:4.] **4<return>**

The SC41/MS supports up to eight command rings. The value you specify depends on your application. Four command rings are reasonable and adequate for most applications.

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

    * CP3076 Enter the number of response rings for DUA [D R:1.-8. D:4.] **4<return>**

    The SC41/MS supports up to eight response rings. The value you specify depends on your application. Four response rings are reasonable and adequate for most applications.

3.5.5 VMS OPERATING SYSTEMS (4.0)

VAX/VMS supports MSCP controllers at the standard address, 772150_8, and in floating address space. VMS has a software utility called SYSGEN that can be used to determine the UNIBUS address and interrupt vector address for any I/O devices to be installed on the computer's UNIBUS. A running VAX/VMS computer system is required to use this utility. If you do not have access to a running system, you must determine the UNIBUS addresses and vector addresses manually (although autoconfigure can still be used to connect the devices to the computer on automatically power-up). See Appendix A for a description of the algorithm used by SYSGEN to determine UNIBUS addresses.

The following procedure tells how to use VMS SYSGEN to determine UNIBUS CSR addresses and interrupt vectors, as well as how to use autoconfigure to connect the SC41/MS.

1. Login to the system manager's account.

2. Run the SYSGEN utility:

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

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

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

    SYSGEN> **SHOW/CONFIGURATION<return>**

    SYSGEN lists the devices already installed in the UNIBUS by logical name. Make a note of the devices with floating addresses (greater than 760000_8) or floating vectors (greater than 300_8) that you plan to re-install with your SC41/MS.

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

   SYSGEN> **CONFIGURE<return>**
   DEVICE>

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

   DEVICE> **UDA,2<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 radix.

   For the installation of the SC41/MS, you need specify only 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.

5. 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 3-3.

```
SYSGEN>  CONFIGURE
DEVICE> DZ11
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
```

*Floating address or vector.

Figure 3-3. CONFIGURE Command Listing

6. Note the CSR addresses listed for the UNIBUS devices in floating address space. Program the listed addresses into non-Emulex devices as instructed by the manufacturer's documentation. For the SC41/MS, program the address given for the SC41/MS (lowest numerical address) into the board as described in subsection 4.3.1.

7. Although autoconfigure is essentially automatic, a command to start the autoconfigure process must be included in one of several start-up command files on the system. Generally, these command files are located in two places: the main system account, SYS$SYSROOT:[SYSEXE], and the system manager's account, SYS$SYSROOT:[SYSMGR]. The command file in SYS$SYSROOT:[SYSEXE] is called STARTUP.COM, and the file in SYS$SYSROOT:[SYSMGR] is called SYSTARTUP.COM (3.n) or SYSCONFIG.COM (4.n).

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4.1 OVERVIEW

The procedure for installing the SC41/MS SMD 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	Controller Installation
4.5	SMD Disk Drive Preparation
4.6	Subsystem Cabling
4.7	Recording the Subsystem Configuration
4.8	Testing

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

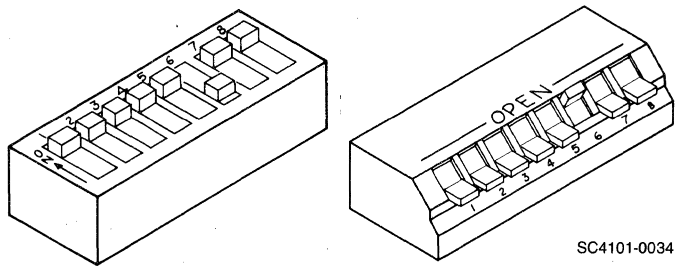
4.1.1 SUBSYSTEM CONFIGURATIONS

This section is limited to switch setting data and physical installation instructions. No attempt is made to describe the many subsystem configurations that are possible. **IF YOU ARE NOT FAMILIAR WITH THE POSSIBLE CONFIGURATIONS, WE STRONGLY RECOMMEND READING SECTION 3, APPLICATION and CONFIGURATION, BEFORE ATTEMPTING TO INSTALL THIS SUBSYSTEM.**

4.1.2 DIP SWITCH TYPES

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

The two DIP switch types used in this product are shown in Figure 4-1. Both are set to the code shown in the switch setting example.



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

Figure 4-1. Switch Setting Example

4.1.3 MAINTAINING FCC CLASS A COMPLIANCE

Emulex has tested the SC41/MS SMD Disk Controller with DEC computers that comply with FCC Class A limits for radiated and conducted interference. When properly installed, the SC41/MS does not cause compliant computers to exceed Class A limits.

There are two possible configurations in which the SC41/MS and its associated SMD peripheral can be installed:

- With the SC41/MS Disk Controller and the SMD disk drive both mounted in the same cabinet
- With the SC41/MS mounted in the CPU cabinet and the drive 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). When you are installing the SC41/MS, you must do nothing that would reduce this shield's effectiveness. That is, when the SC41/MS installation is complete, no gap in the shield that would allow RFI to escape can be allowed.

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

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

4.2 INSPECTION

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

Unpack the SC41/MS Disk Controller 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.

Visually inspect the SC41/MS 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 SC41/MS Disk Controller before inserting it into the chassis. These are made by option switches SW1, SW2, SW3, SW4, and SW5.

Figure 4-2 shows the locations of the configuration switches referenced in the paragraphs below.

NOTE

> If you change a switch position on the SC41/MS, either reset the unit using switch SW1-1 or remove and restore the unit's power. This reset is required because the switches are read by an initialization routine in the unit's firmware.

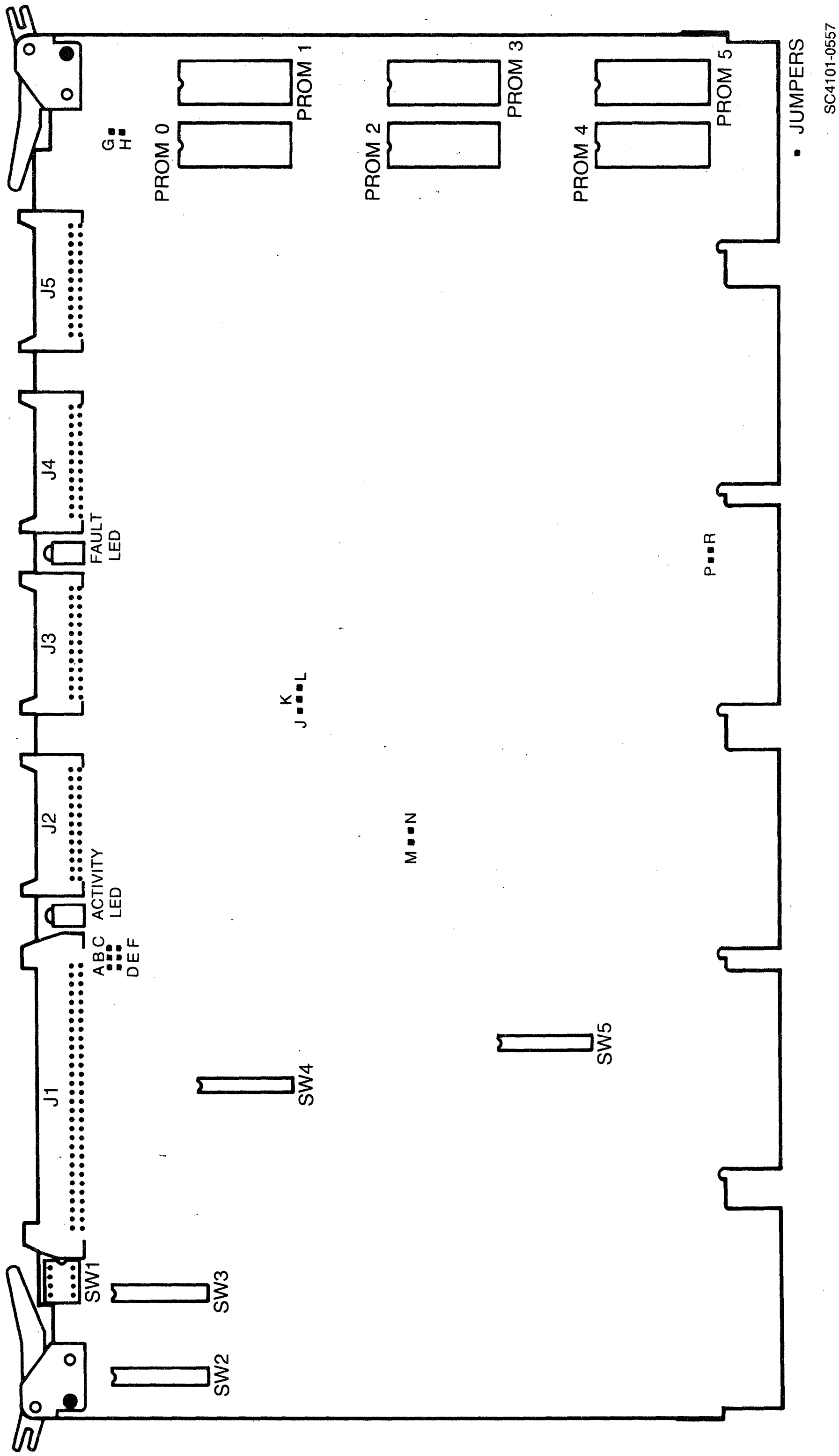


Figure 4-2. SC41/MS Disk Controller Assembly

Table 4-1 defines the function and factory configuration of all switches on the SC41/MS Controller. The factory configuration switch settings are representative of most SC41/MS Disk Controller applications.

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

Table 4-1. SC41/MS Switch Definitions and Factory Configuration

SW	OFF(0)	ON(1)	Fact	Function	Section
SW1-1	Run	Halt-Reset	OFF(0)	Disk Controller Run vs Halt	
SW1-2	-	-	OFF(0)	DMA Burst Delay	4.3.5.2
SW1-3	-	-	OFF(0)	DMA Burst Delay	4.3.5.2
SW1-4	-	-	OFF(0)	Not Used	
SW2-1	-	-	NS	Drive 0 Configuration	4.3.3
SW2-2	-	-	NS	Drive 0 Configuration	4.3.3
SW2-3	-	-	NS	Drive 0 Configuration	4.3.3
SW2-4	-	-	NS	Drive 0 Configuration	4.3.3
SW2-5	-	-	NS	Drive 0 Configuration	4.3.3
SW2-6	-	-	NS	Drive 1 Configuration	4.3.3
SW2-7	-	-	NS	Drive 1 Configuration	4.3.3
SW2-8	-	-	NS	Drive 1 Configuration	4.3.3
SW2-9	-	-	NS	Drive 1 Configuration	4.3.3
SW2-10	-	-	NS	Drive 1 Configuration	4.3.3
SW3-1	-	-	NS	Drive 2 Configuration	4.3.3
SW3-2	-	-	NS	Drive 2 Configuration	4.3.3
SW3-3	-	-	NS	Drive 2 Configuration	4.3.3
SW3-4	-	-	NS	Drive 2 Configuration	4.3.3
SW3-5	-	-	NS	Drive 2 Configuration	4.3.3
SW3-6	-	-	NS	Drive 3 Configuration	4.3.3
SW3-7	-	-	NS	Drive 3 Configuration	4.3.3
SW3-8	-	-	NS	Drive 3 Configuration	4.3.3
SW3-9	-	-	NS	Drive 3 Configuration	4.3.3
SW3-10	-	-	NS	Drive 3 Configuration	4.3.3
SW4-1	-	-	OFF(0)	Not Used	
SW4-2	-	-	OFF(0)	Not Used	
SW4-3	-	-	OFF(0)	Not Used	
SW4-4	-	-	OFF(0)	Not Used	
SW4-5	-	-	OFF(0)	Not Used	
SW4-6	Disable	Enable	OFF(0)	DMA Burst Length	4.3.5.1
SW4-7	Disable	Enable	OFF(0)	DMA Bandwidth Control	4.3.5.2
SW4-8	-	-	OFF(0)	Not Used	
SW4-9	-	-	OFF(0)	Not Used	
SW4-10	-	-	OFF(0)	Not Used	

continued next page

Table 4-1. SC41/MS Switch Definitions and Factory Configuration (continued)

SW	OFF(0)	ON(1)	Fact	Function	Section
SW5-1	-	-	OFF(0)	LUN Offset	4.3.4
SW5-2	-	-	OFF(0)	LUN Offset	4.3.4
SW5-3	-	-	OFF(0)	LUN Offset	4.3.4
SW5-4	-	-	OFF(0)	LUN Offset	4.3.4
SW5-5	0-1F	20-3F	ON(1)	Drive Configuration	4.3.3
SW5-6		772150	ON(1)	Standard CSR Address	4.3.1
SW5-7		-	OFF(0)	CSR Address Select	4.3.1
SW5-8		-	OFF(0)	CSR Address Select	4.3.1
SW5-9	-	-	OFF(0)	CSR Address Select	4.3.1
SW5-10	-	-	OFF(0)	Not Used	

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

Table 4-2. SC41/MS Jumper Definition and Factory Configuration

Jumper	OUT	IN	FACT	Comment
A-D E-F	See B-D See C-F	Sector pulse detect Sector pulse detect	IN IN	Hard sectored applications
B-D C-F	See A-D See E-F	Address mark detect Address mark detect	OUT OUT	Soft Sectored Applications
G-H	2K Program Store	4K Program Store	IN	Must be IN
J-K	Normal Operation	Factory Test	OUT	Must be OUT
K-L	Factory Test	Normal Operation	IN	Must be IN
M-N	SACK Detect Enable	SACK Detect Disable	OUT	See 4.3.5.3
P-R	Normal Operation	Factory Test	OUT	Must be OUT

FACT = Factory Setting

4.3.1 DISK CONTROLLER BUS ADDRESS

The CSR address for the SC41/MS is selected by using PROMs and DIP switches. Two address PROMs are shipped with the SC41/MS; each PROM allows four different CSR addresses to be selected by using switches SW5-6 through SW5-9. See Table 4-2 for a list of the PROMs, their corresponding addresses, and the switch settings.

The PROM that selects the standard address is shipped in the socket at U129 in the SC41/MS. The other PROM is shipped as kit SC4111717. To select one of the addresses supplied by the other PROM, remove the standard PROM and replace it with the appropriate alternate.

The standard address for MSCP Servers is 772150. Additional MSCP Servers are located in floating address space. See subsection 3.5 for a discussion of MSCP Severs and their CSR addresses.

Table 4-3. Controller Address Switch Settings

PROM Number	CSR Address (octal)	---- SW5 ---- 6	7	8	9	Factory
D04	772150	1	0	0	0	√
	760334	0	1	0	0	
	760340	0	0	1	0	
	760344	0	0	0	1	
D12	760350	1	0	0	0	
	760354	0	1	0	0	
	760360	0	0	1	0	
	760364	0	0	0	1	

4.3.2 INTERRUPT VECTOR ADDRESS

The interrupt vector address for the SC41/MS is programmed into the device by the operating system during power-up. See subsection 3.5 for a discussion of device configuration.

4.3.3 DRIVE CONFIGURATION SELECTION

The type of disk drive that is connected to the SC41/MS Disk Controller is specified by using switches. The 20 switches in DIPs SW2 and SW3 are used for that purpose. Five switches are reserved for each drive, so up to 32 different drive types can be selected.

DIP Switches	Drive
SW2-1 through SW2-5	0
SW2-6 through SW2-10	1
SW3-1 through SW3-5	2
SW3-6 through SW3-10	3

The drive number is the unit address that is selected for that drive by using an ID plug or switches on the drive. See the drive installation manual for more information.

Use the following procedure to determine the proper switch settings for your disk drives.

1. Find the disk drive that you want to use as drive 0 in Table 4-4. Note the KEY assigned to that drive. Note the configuration numbers for that drive (listed in the Config column).

   If the SC41/MS and its drives are being installed in a PDP-11 environment and there is an asterisk (*) by the configuration number, you MUST use that configuration for that drive. The marked configurations limit the drives to capacities that PDP-11 operating systems can use. Configurations with greater capacities are not recognized by PDP-11 operating systems.

2. Look at the indicated configurations in Table 4-5 or 4-6. In some cases, the difference between two configurations for the same drive is the number of sectors per track. Choose the configuration that best suits your application. If you are using more than one configuration, be certain to use either Table 4-5 OR Table 4-6. You can mix configurations from within one table, but do not mix configurations from the two tables.

   Set switches SW2-1 through SW2-5 as indicated in the Switch Setting column, and SW5-5 as indicated for each table.

3. Set the disk drive's sector switches as indicated in the Sec column of Table 4-5 or Table 4-6.

4. Repeat steps 1 through 3 for drives 1, 2, and 3, but use the appropriate switches (see table in subsection 4.3.3) to specify the drive type.

Table 4-4. Disk Drive Type

Manufact	Model	KEY	Config	Manufact	Model	KEY	Config
AMPEX	330	330	0A	FUJITSU	2343	383	20
AMPEX	9300	301	0B	FUJITSU	2344	690	21*
CDC	9710-80	80	00	FUJITSU	2344	690	22, 23,
CDC	9715-160	160	0E				24, 25,
CDC	9715-340	340	06				26
CDC	9715-515	530	07	FUJITSU	2351A	470	08
CDC	9720	311	19	FUJITSU	2351A	500	02
CDC	9730-160	160	0E	FUJITSU	2361A	671	0C, 0D*
CDC	9762	80	00	FUJITSU	2331K	161	03
CDC	9766	300	01	FUJITSU	2333K	331	04
CDC	9771	660	05, 12*	HITACHI	DKS15-5	815	1B
CDC	9771	800	09	HITACHI	810-10	893	1C
CDC	9775	670	10*, 0F	MEMOREX	677	200	15
CDS	AMS 315	300	01	NEC	2351	540	14
CDS	AMS 571	600	11	NEC	2362	640	1D*, 1E
FUJITSU	2284	160	0E	N TELECOM	8210X	180	
FUJITSU	2294	330	0A	PERTEC	DX332	332	1F
FUJITSU	2298	660	05, 12*	PERTEC	DX368	311	19
FUJITSU	2312	81	13	PERTEC	DX548	548	1A
FUJITSU	2321	80	00	PRIAM	806-23	184	16
FUJITSU	2322	160	0E	PRIAM	807-23	279	17
				TEXTOR	160	137	18

*For PDP-11 applications with this drive, this configuration must be selected.

Table 4-5. Drive Configuration

NOTE

With this table, SW5-5 MUST be ON.

Config Number	KEY	Device Characteristics Cyl	Trk	Sec	Device Capacity (logical)	Switch Setting 1 6	2 7	3 8	4 9	5 10	Rev Level
00	80	823	5	32	127,349	0	0	0	0	0	A
01	300	823	19	32	483,991	1	0	0	0	0	A
02	500	842	20	48*	790,130	0	1	0	0	0	A
03	161	823	5	64	258,741	1	1	0	0	0	A
04	331	823	10	64	517,538	0	0	1	0	0	A
05	660	1024	16	64	1,030,358	1	0	1	0	0	A
06	340	711	24	32	528,162	0	1	1	0	0	A
07	530	711	24	50	834,492	1	1	1	0	0	A
08	470	842	20	44	722,770	0	0	0	1	0	A
09	800	1024	16	84	1,257,252	1	0	0	1	0	A
0A	330	1024	16	32	507,118	0	1	0	1	0	A
0B	301	815	19	32	479,291	1	1	0	1	0	A
0C	671	842	20	64	1,059,030	0	0	1	1	0	A
0D	671	816	20	64	1,026,326	1	0	1	1	0	A
0E	160	823	10	32	254,722	0	1	1	1	0	A
0F	670	842	40	32	1,042,478	1	1	1	1	0	A
10	670	816	40	32	1,010,292	0	0	0	0	1	A
11	600	941	19	54	945,871	1	0	0	0	1	D
12	660	1020	16	64	1,026,326	0	1	0	0	1	A
13	81	589	7	33	131,648	1	1	0	0	1	A
14	540	760	19	60	850,336	0	0	1	0	1	B
15	200	815	19	22	326,281	1	0	1	0	1	C
16	184	1023	11	32	348,297	0	1	1	0	1	C
17	279	1552	11	32	392,010	1	1	1	0	1	C
18	137	700	12	32	259,986	0	0	0	1	1	C
19	311	1217	10	50	595,142	1	0	0	1	1	C
1A	548	1649	11	50	887,071	0	1	0	1	1	C
1B	815	1241	14	50	849,658	1	1	0	1	1	C
1C	893	1737	15	67	1,716,318	0	0	1	1	1	D
1D	640	709	23	64	1,025,507	1	0	1	1	1	D
1E	640	850	23	64	1,229,466	0	1	1	1	1	D
1F	332	1649	10	32	510,398	1	1	1	1	1	D

0 = OFF, open
1 = ON, closed
Cyl = Cylinders
Trk = Tracks
Sec = Sectors per Track

* To configure the Fujitsu 2351A for 48 sectors, the jumpers at location BC7 must be set so that bit one is jumpered 2-3, bit 2 is jumpered 6-7, and all other jumpers are per the Fujitsu manual.

Table 4-6. Drive Configuration

NOTE

With this table, SW5-5 MUST be ON.

Config Number	KEY	Device Characteristics Cyl	Trk	Sec	Device Capacity (logical)	Switch Setting 1 / 6	2 / 7	3 / 8	4 / 9	5 / 10	Rev Level
20	383	624	15	64	588,602	0	0	0	0	0	D
21	690	604	27	64	1,025,570	1	0	0	0	0	D
22	690	624	27	64	1,059,534	0	1	0	0	0	D

0 = OFF, open
1 = ON, closed
Cyl = Cylinder
Trk = Track
Sec = Sectors per Track

4.3.4 LOGICAL UNIT NUMBER OFFSET

MSCP requires that the Logical Unit Numbers (LUNs) for all drives on the same system be unique.

SW5-1 through SW5-4, as listed in Table 4-6, allow you to specify an LUN-offset for the drives that are supported by the SC41/MS. You must specify an offset if there is another MSCP server on the system and if the LUNs of the two servers would overlap. If no offset is specified (zero offset), the LUNs of the drives on the SC41/MS will be the same as their drive addresses. (The SC41/MS only recognizes drive addresses in the range 0 through 3.) See Example 4-1.

Example 4-1: Your system has two SC41/MS Disk Controllers. The first SC41/MS is at the primary UNIBUS address for MSCP Servers, 772150, and it supports four drives, LUN 0 through LUN 3. The second SC41/MS is at the alternate UNIBUS address, and it also supports four drives. According to MSCP, these two drives must have LUNs of 4 through 7. Set SW5-3 ON (1) and SW5-1, SW5-2, SW5-4 OFF(0) on the second SC41/MS to specify a LUN of 4 for the first drive.

This example would also apply if the first MSCP Server were a DEC UDA50 with four drives.

Table 4-7. First LUN for an SC41/MS at an Alternate UNIBUS Address

Starting LUN	-- SW5 --- 1	2	3	4	Factory
0	0	0	0	0	√
1	1	0	0	0	
2	0	1	0	0	
3	1	1	0	0	
4	0	0	1	0	
5	1	0	1	0	
6	0	1	1	0	
7	1	1	1	1	
8	0	0	0	1	
9	1	0	0	1	
10	0	1	0	1	
11	1	1	0	1	
12	0	0	1	1	
13	1	0	1	1	
14	0	1	1	1	
15	1	1	1	1	

4.3.5 DMA OPTIONS

The SC41/MS allows you to optimize its DMA routines for your application by selecting one or more options. These options allow the maximum UNIBUS bandwidth that the SC41/MS can consume to be varied. The SC41/MS allows three factors to be adjusted that affect controller bandwidth consumption. The first of these factors is the length of a DMA burst. This factor is expressed in terms of the number of data words transferred during a burst. The greater the burst length, the greater the percentage of bandwidth consumed by the controller. The second factor is the length of time that the controller waits between bursts. The less time the controller waits between bursts, the less opportunity other devices on the UNIBUS have to use the the bus. Neither of these factors take the requirements of other devices on the UNIBUS directly into account. To do that, the controller is programmed to relinquish the UNIBUS when it detects a request for bus mastership while performing a DMA. By relinquishing the bus, the SC41/MS allows other devices that request bus mastership to use the UNIBUS in a timely fashion.

The SC41/MS allows these factors to be adjusted to suit your application. These options are described in the following subsections.

4.3.5.1 DMA Burst Length

This option allows you to select specific DMA parameters that are optimized for specific UNIBUS applications. All PDP-11 and the smaller VAX-11 UNIBUSes do not have special requirements. The UNIBUS Adapters used in the VAX-11/750 and VAX-11/78x, however, do require special parameters. For PDP-11 and small VAX-11 applications, set SW4-6 OFF. For VAX-11/750 and VAX-1178x applications, set SW4-6 ON.

Switch	OFF	ON	Factory
SW4-6	PDP-11 VAX-11/730 VAX-11/725	VAX-11/750 VAX-11/78x	NS

If switch SW4-6 is OFF, then DMA burst length is programmable per MSCP port requirements. The burst length is set during Step 4 of the MSCP port initialization dialog. If a particular operating system does not specify a burst length, the SC41/MS defaults to 16 words. The time between bursts in this mode is 7.5 to 8.0 usec.

If SW4-6 is ON, then the burst length is not programmable, and it is set at four words. The time between bursts is 1.75 usec to 2.0 usec. These parameters provide optimum performance with VAX-11/750 and VAX-11/78x UNIBUS adapters.

4.3.5.2 DMA Bandwidth Control

This option allows the percentage of UNIBUS bandwidth occupied by the SC41/MS to be reduced. This option is selected by setting option switch SW4-7 ON. When SW4-7 is ON, the time between bursts is increased by the amount selected by using SW1-2 and SW1-3. See Table 4-7.

Switch	OFF	ON	Factory
SW4-7	No Added Delay	Selectable Delay	OFF

Table 4-8. DMA Burst Delay

Additional Delay (usec)	-SW1- 2	3	Factory
5.0	0	0	√
9.0	1	0	
13.0	0	1	
17.0	1	1	

Use this feature if the UNIBUS contains one or more terminal controllers that use programmed I/O for received characters (DH11, DZ11, DV11, etc.). Heavy disk I/O may prevent the CPU from responding to received-character interrupts in time to prevent buffer overflow. If you experience this type of problem specify the minimum amount of delay necessary to eliminate buffer overflow.

Users who just want to allocate as much real-time bus bandwidth to the CPU as practical may also make use of this feature.

4.3.5.3 Stall on Bus SACK

Bus SACK (BSACK) is generated by DMA devices requesting bus mastership. It is a part of overlapped NPR/NPG arbitration on the UNIBUS. If the SC41/MS detects BSACK while performing a DMA burst, the SC41/MS terminates its burst within one or two DMA cycles and calls a stall routine. The amount of stall depends upon the number of DMA cycles the controller was able to execute since previously detecting BSACK. If the SC41/MS was able to execute more than eight DMA cycles since the previous BSACK, then it delays 2 usec before starting another DMA cycle. If the controller was able to execute eight or fewer DMA cycles since detecting the previous BSACK, then it delays 10 usecs before starting another DMA cycle. You can defeat this feature by installing jumper M-N. Note that device interrupts do not generate BSACK signals, as this feature is not activated by interrupts.

4.4 PHYSICAL INSTALLATION

4.4.1 SYSTEM PREPARATION

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

4.4.2 SLOT SELECTION

The SC41/MS can be inserted into any SPC slot in either a DEC PDP-11 computer chassis or a UNIBUS expansion chassis. The closer a module is to the CPU, the higher its interrupt priority. The SC41/MS can be placed fairly far from the CPU because of its large buffer capacity.

Each CPU slot should contain a module. Card slots that would otherwise remain unoccupied should contain bus grant modules to provide interrupt acknowledge continuity.

NOTE

> The nonprocessor grant (NPG) jumper on the SPC card slot in which the controller is being installed **must be removed** to allow the controller to trap the NPG signal during DMA requests. See subsection 4.4.3.

4.4.3 NPG SIGNAL JUMPER

The Nonprocessor Grant (NPG) jumper on the SPC card slot must be removed to allow the trapping of the NPG signal during DMA requests. Therefore, remove the NPG signal jumper between pins CA1 and CB1 on the backplane so that the NPG signal passes through the SC41/MS module.

Figure 4-3 shows a DD11-DK nine-slot backplane, with the enlargement depicting the layout of a typical socket as seen from the rear. (The enlargement is valid for each of the sockets on the backplane.) The figure of the backplane includes letters and numbers that are not actually on the backplane; they are included to help identify pin locations. Also, the numbers shown in the enlargement do not appear in the same location on the backplane; rather, they are located in about the center of the backplane.

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

1. Find the appropriate socket (in this case C). The sockets of pins are lettered sequentially, beginning with A at the top and proceeding to the bottom socket, F.

2. Find the appropriate card slot. In Figure 4-3, the card slots are numbered 1 through 9 from right to left. The column of pins shown in the socket enlargement corresponds to card slot 3. Note that each card slot is four pins wide, as the enlargement shows.

3. Find the appropriate row of pins. As the enlargement shows, each number is labeled A through V, excluding G, I, O, and Q. Also, each row of pins is offset from the row on either side.

4. Find the appropriate number corresponding to the desired pin. As the enlargement shows, each number differentiates between two pins on the same row that correspond to the same card slot. A number 1 indicates the left pin of that column in a particular row; a number 2 indicates the right.

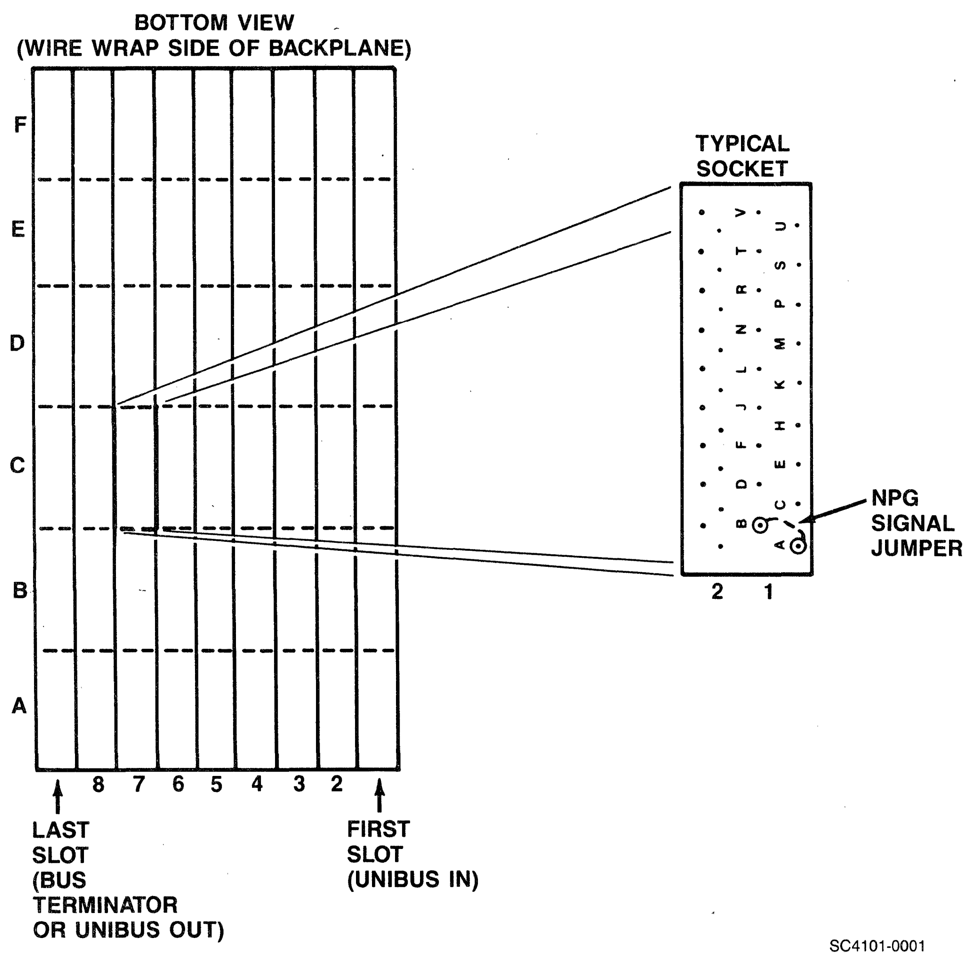


Figure 4-3. NPG Jumper Location

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

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

If the SC41/MS is removed from the backplane, either reconnect the NPG jumper, or insert a dual-width grant continuity module into connectors C and D of the slot vacated by the module. The dual-width grant continuity module (DEC part number G7273) jumpers all grant signals (interrupt grants and nonprocessor grants). It can be ordered from Emulex using part number ZU1110812.

4.4.4 MOUNTING

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

4.5 SMD DISK DRIVE PREPARATION

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

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 SC41/MS. This positioning allows the I/O cable routing and length to be accurately judged. Place the drives side by side to simplify installation of the daisy-chained A Cable.

4.5.2 LOCAL/REMOTE

The local/remote switch controls whether the disk drive can be powered up from the drive (local) or from the controller (remote). Place the switch in the REMOTE position. With the CPU powered down, press the Start switch on the front panel of each of the drives (the

Start LED will light, but the drive will not spin up and become ready). When the CPU is powered up, the drives spin up sequentially. This sequential power-up prevents the heavy current draw that would be caused if all the drives were powered up at once. When in the remote mode, the drives power down when the CPU is powered down. While the CPU is powered on, the drives can be powered up and down individually (to change disk media, for example) by using the drive Start switch.

4.5.3 SECTORING

See subsection 4.3.3, Drive Configuration Selection, for the correct sector count settings for the disk drives in use. The exact method of entering the sector count differs from one drive manufacturer to another, and the appropriate drive manual should be consulted for the exact procedure.

4.5.4 DRIVE NUMBERING

An address from 0 to 3 must be selected for each drive. Be careful that no two drives are assigned the same number. The address assigned to a drive determines which SC41/MS drive configuration switches are used to specify drive configuration. See subsection 4.3.3. The MSCP logical unit number is also determined by the address given to the drive. See subsections 3.2.2 and 4.3.4.

CDC drive addresses are selected by means of an ID plug. Drives from other manufacturers have their addresses selected by switches on one of the logic cards. Consult the appropriate drive manual for the exact procedure.

4.5.5 SECTOR AND INDEX SIGNAL MODIFICATIONS

The SC41/MS controller is designed to have the Index and Sector signals on the B Cable from each physical drive. The signals are necessary for proper operation of the sector counters associated with each drive.

Depending on the disk drive, the Index and Sector pulse signals may be carried on the A instead of the B Cable. For example, some CDC drives provide the Index and Sector signals on the A Cable; however, they may be moved to the B Cable by minor rewiring of the drive backplane or by ordering this configuration from the factory. Appendix D describes the procedure for making this modification to several of the more common drives. If the procedure for the drive in question is not covered there, it is probably described in the drive manual.

4.6 CABLING

The SC41/MS interfaces with the disk drives that it controls via one control cable (A cable) and four data cables (B cables). The A cable originates from connector J1 on the SC41/MS. This cable is daisy-chained from the controller to all of the drives that are supported by the SC41/MS. The four B cables originate from connectors J2 through J5. Each B cable is connected directly from the SC41/MS to each disk drive. Figure 4-4 shows this cabling scheme.

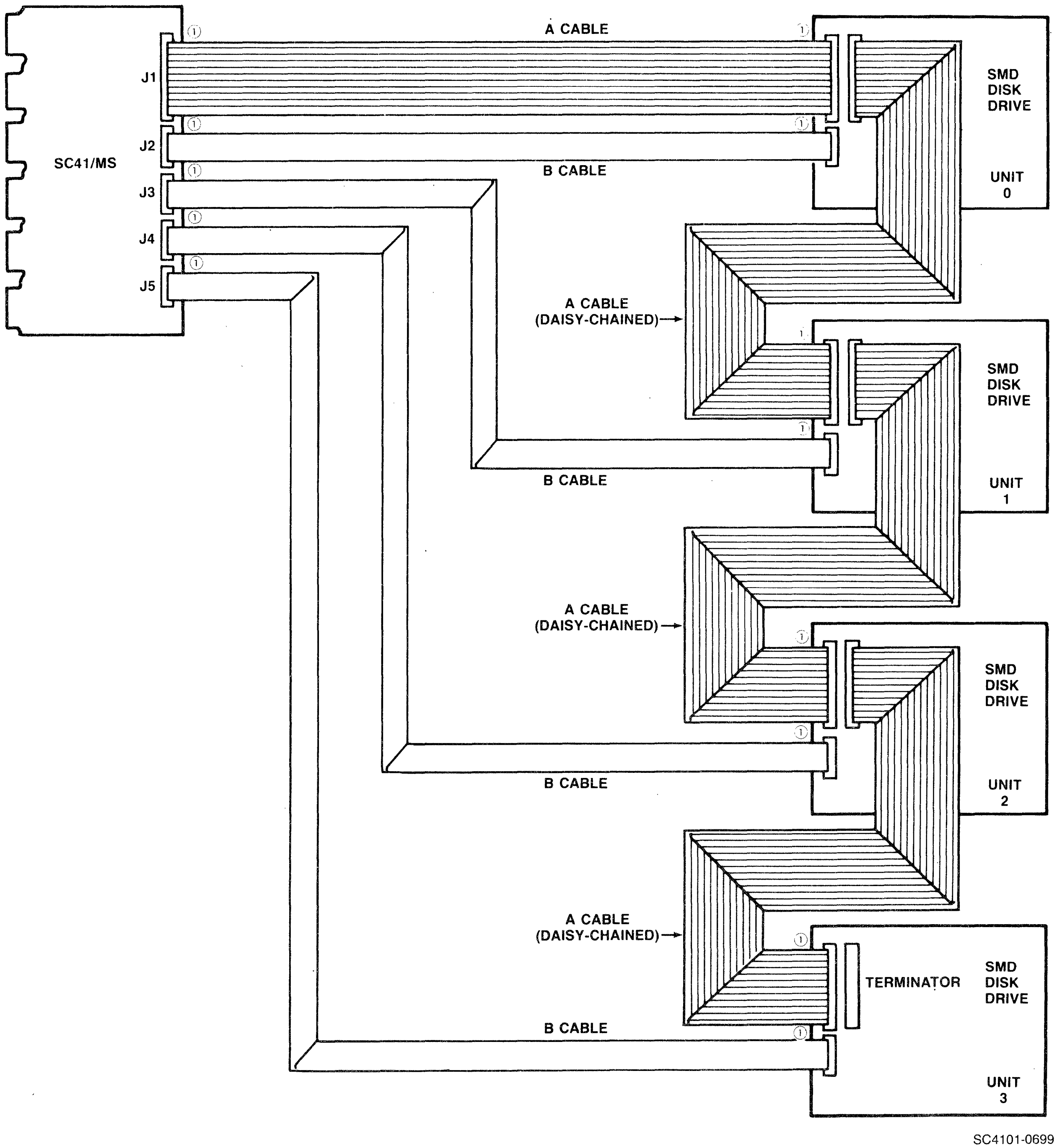


Figure 4-4. Drive Cabling

To prevent excessive EMI, DEC surrounds its computers with a grounded metal shield. These shields are built into the computer cabinet.

As noted in subsection 4.1.3, cabling has a direct effect on the amount of electromagnetic interference radiated by a computer system. When installing the SC41/MS and its drives, you must take steps to preserve the integrity of the shield built into FCC-compliant DEC cabinets.

If both the controller and the peripheral are installed in the same cabinet, then you need only replace the shields that you have removed to keep the computer compliant with FCC regulations.

If the controller and the disk drives are located in separate cabinets, then you must shield the cables that run between the cabinets. Also, you must install the cables so that their points of cabinet exit and entry do not cause the computer installation to exceed FCC limits for EMI. To allow you to do this easily, Emulex makes shielded A cables, B cables, and transition adapters that are designed to keep EMI within FCC limitations.

As previously noted, the SC41/MS and its SMD disk drives can be installed in either of two configurations:

- With the SC41/MS Disk Controller and the drives mounted in the same cabinet
- With the SC41/MS mounted in the CPU cabinet and the drives mounted in a separate cabinet

The following paragraphs describe the cabling between the SC41/MS and drives for both these configurations. The separate-cabinet installations rely on Emulex cabling kits to limit EFI, and thus the procedures for installing the kits are described in subsection 4.6.2.

4.6.1 SAME CABINET INSTALLATIONS

When the SC41/MS and its SMD drives are installed in the same cabinet, it is possible that the cabinet itself provides sufficient shielding. In such cases, it is not necessary to shield the A and B cables that connect the subsystem.

NOTE

> If the cabinet in which the SC41/MS and CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive EMI radiation or conduction. In case of complaint, it is the operator's responsibility to take what ever steps are necessary to correct the interference.

Emulex makes unshielded A and B cables in several lengths. Table 4-8 lists the available cables.

Table 4-9. Unshielded Cables

Item	Part Number	Description	Length	Interface
1	SU1111201	Cable, Unshielded	8 ft	SMD A-Cable
	SU1111203	Cable, Unshielded	15 ft	SMD A-Cable
	SU1111205	Cable, Unshielded	25 ft	SMD A-Cable
	SU1111207	Cable, Unshielded	35 ft	SMD A-Cable
	SU1111209	Cable, Unshielded	50 ft	SMD A-Cable
2	SU1111202	Cable, Unshielded	8 ft	SMD B-Cable
	SU1111204	Cable, Unshielded	15 ft	SMD B-Cable
	SU1111206	Cable, Unshielded	25 ft	SMD B-Cable
	SU1111208	Cable, Unshielded	35 ft	SMD B-Cable
	SU1111210	Cable, Unshielded	50 ft	SMD B-Cable

The items listed in Table 4-8 can be ordered from your Emulex sales representative or directly from the factory. The factory address is:

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

To cable the subsystem, see Figure 4-4 and use the following procedures:

4.6.1.1 A Cable

1. Look at the header at either end of the A cable. Find the molded-in arrow that identifies pin 1 of the connector.

2. Find the arrow that that is molded into connector J1 on the SC41/MS. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the header is fully seated in the connector.

3. Find the molded-in arrow on the cable header at the other end of the A cable.

4. Find the arrow on the disk drive's A cable connector. Most SMD drives have two A cable interfaces to allow daisy chaining; use either. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the header is fully seated in the connector.

5. Connect the first drive to the second drive supported by the SC41/MS using another A cable. Run the cable from the second A cable connector on the first drive to the second drive using steps 1 through 4. If the drive(s) have dual ports, there will be four A-cable connectors. Make sure that you use connectors from the same port.

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

End of Procedure

4.6.1.2 B Cable

1. Look at the header at either end of the B cable. Find the molded-in arrow that identifies pin 1 of the connector.

2. Find the arrow that that is molded into connector J2 on the SC41/MS. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the header is fully seated in the connector.

3. Find the molded-in arrow on the cable header at the other end of the B cable.

4. Find the arrow on the first disk drive's B cable connector. If the drive is a dual port model, make sure you connect the B cable to the same port to which you connected the A cable. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the locking tabs on the connector are fully flush with the sides of the cable header.

5. Repeat steps 1 through 4 for each drive, using J3 though J5 on the SC41/MS.

End of Procedure

4.6.1.3 Grounding

For proper operation of the disk subsystem, there must be a good connection between the disk drive logic ground and the CPU logic ground. The ground connection should be braid (preferably insulated) that is 0.25 inches wide or wider, or AWG No. 10 wire or heavier. The grounding wire may be daisy-chained between disk drives. If the disk drive has a switch or jumper that connects the logical signal ground to the cabinet ground (DC ground to AC ground), this connection should be removed once the disk drive is placed online. It can be connected for performing local offline maintenance on the disk drive.

NOTE

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

4.6.2 SEPARATE CABINETS

If the disk drives are mounted in a separate cabinet from the SC41/MS Disk Controller, then the A and B cables that connect the drives to the SC41/MS must be shielded because they run outside the shielded cabinet environment.

Emulex makes extension cables, transition adapters, and shielded cables that are designed to be used with the SC41/MS in separate-cabinet installations. Extension cables connect the controller (or drive) with the transition adapter. Transition adapters ground the shields on the shielded cables and maintain the integrity of the cabinet shield. Shielded cables are run between cabinets.

The cables are available in various lengths, and there are several different types of transition adapters. Table 4-9 gives the part numbers of these accessories and describes their application. The items listed in Table 4-9 can be ordered from your Emulex sales representative or directly from the factory. See the address given in subsection 4.6.1.

The transition adapters are designed to fit directly into the I/O bulkhead that is built into most FCC-compatible DEC CPU and UNIBUS expansion cabinets. See Figure 4-5. If there is no I/O bulkhead in the cabinet, item 6, the bulkhead distribution panel, holds two transition adapters and mounts in any standard 19-inch RETMA rack. The distribution panel is shown in Figure 4-6.

There are two possible separate cabinet configurations. In one, the drives are mounted in a freestanding RETMA rack (a RETMA rack attached to a VAX or PDP CPU cabinet would not count as a separate cabinet installation at all). In the other configuration, the drives have their own cabinets and are themselves freestanding. These two configurations are shown in Figures 4-7 and 4-8. The cabling procedure that follows is a generic one that is for use with either configuration. Consult the illustrations for details.

Table 4-10. Shielded Cables and Transition Adapters

Item	Part Number	Description	Length	Qty Rqd	Application
1	SU7811212-01 SU7811212-02 SU7811212-03 SU7811212-04 SU7811212-05 SU7811212-06	Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded	4 8 15 25 35 50	1 1 1 1 1 1	SMD A-Cable SMD A-Cable SMD A-Cable SMD A-Cable SMD A-Cable SMD A-Cable
2	SU7811219-01 SU7811219-02 SU7811219-03 SU7811219-04 SU7811219-05	Cable, Extension Cable, Extension Cable, Extension Cable, Extension Cable, Extension	2 4 6 8 10	2 2 2 2 2	SMD A-Cable SMD A-Cable SMD A-Cable SMD A-Cable SMD A-Cable
3	SU7811213-01 SU7811213-02 SU7811213-03 SU7811213-04 SU7811213-05 SU7811213-06	Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded Cable, Shielded	4 8 15 25 35 50	1-4 1-4 1-4 1-4 1-4 1-4	SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable
4	SU7811218-01 SU7811218-02 SU7811218-03 SU7811218-04 SU7811218-05 SU7811218-06	Cable, Extension Cable, Extension Cable, Extension Cable, Extension Cable, Extension Cable, Extension	2 4 6 8 10 12	2-8 2-8 2-8 2-8 2-8 2-8	SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable SMD B-Cable
5	SU1110201	Transition Adapter	NA	2-5	
6	CU2220301	Bulkhead Distribution Panel	NA	2-5	(optional)
7	SU7813104	Peripheral Cable Adapter Panel Kit	NA	1-4	Freestanding disk drive cable adapter

1. Open the rear bulkhead door or panel of the equipment cabinet.

2. Install the SC41/MS disk controller in an appropriate CPU bus slot.

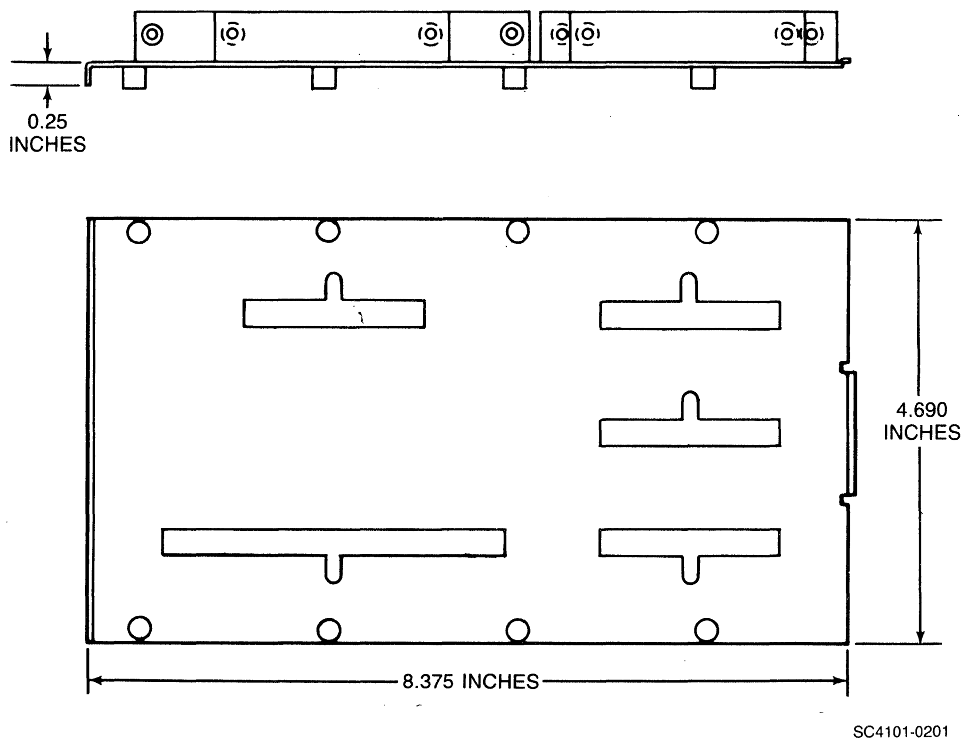


Figure 4-5. Transition Adapter

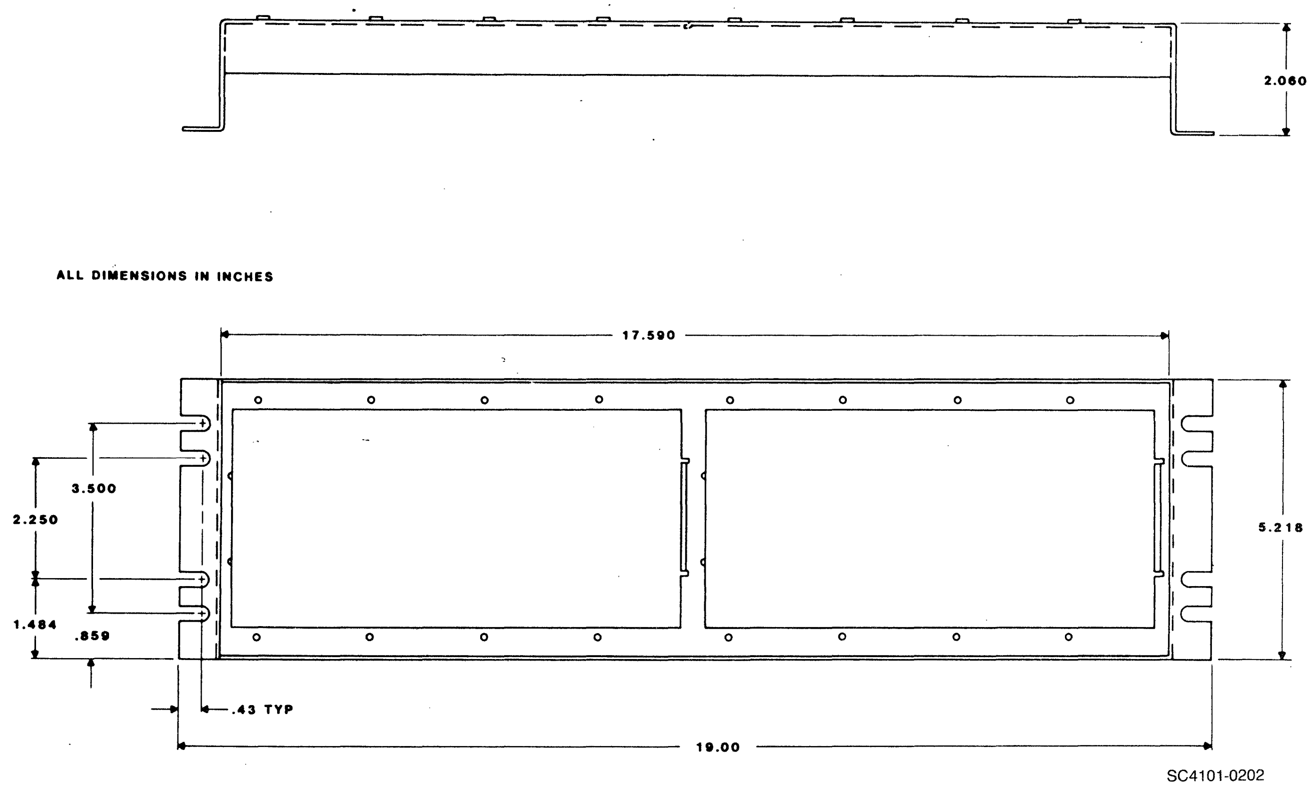


Figure 4-6. Bulkhead Distribution Panel

3. Install a transition adapter in a convenient aperture in the rear bulkhead of the CPU or expansion cabinet and secure it with the eight captive screws. Tighten the screws finger-tight. Make sure that no gaps are present above or below the transition adapter.

4. Install a bulkhead distribution panel in the RETMA rack (Figure 4-7) or peripheral cable adapter kit in each of the drive cabinets (Figure 4-8).

5. Select an extension A cable that is long enough to reach from J1 of the SC41/MS to the transition adapter in the CPU or expansion cabinet.

6. Find the arrow that is molded into the female cable header of the extension cable. Align the cable arrow with the corresponding arrow in connector J1 and press the header into the connector. Make sure that the latches on the connector fully engage the cable header.

7. Select an extension B cable that is long enough to reach from J2 of the SC41/MS to the transition adapter in the CPU or expansion cabinet.

8. Find the arrow that is molded into the female cable header of the extension cable. Align the cable arrow with the corresponding arrow in connector J2 and press the header into the connector. Make sure that the latches on the connector fully engage the cable header. Repeat this step for each port that is to have a drive attached to it (J3 through J5).

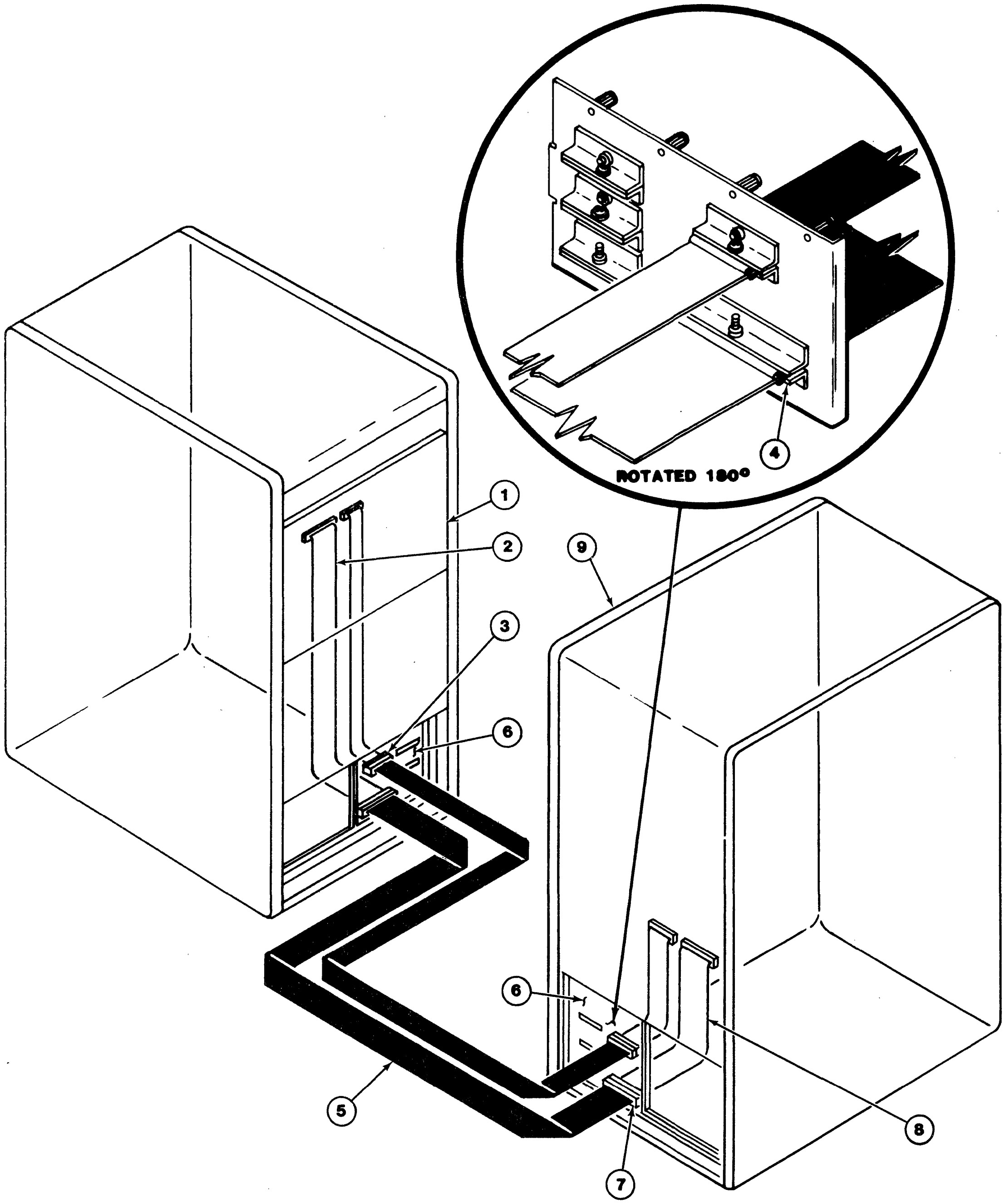
9. Select a shielded A cable that is long enough to reach from the CPU or expansion cabinet to the RETMA rack or the first freestanding drive.

10. Strip about 1 inch of shield insulation from each end of the cable to expose the shield. Cut the shield at each edge to allow it to be folded back over the insulation, and then fold it back over the insulation.

11. Remove (or loosen) the clamping bars on the widest slot of the transition adapter in the CPU or expansion cabinet.

12. Route one end of the prepared cable through the widest slot in the transition adapter (see detail in Figure 4-7). Clamp the bare shielding against the transition adapter with the clamping bar.

13. Find the arrow that is molded into the male cable header of the extension cable. Align this arrow with the corresponding arrow in the female header of the shielded cable and press the headers together.



1. Disk Controller PCBA
2. Nonshielded Extension Cable
3. Cable Connectors, Extension Cable to Shielded Cable
4. Clamp - Shield of Shielded Cable Clamped Within
5. Shielded/Jacketed Cable, External to Equipment Cabinets
6. Personality Panels
7. Cable Connectors, Shielded Cable to Extension Cable
8. Nonshielded Extension Cable
9. Peripheral Device

Figure 4-7. Rack-Mount Drive Cabling Configuration

14. Repeat steps 10 through 13 for each B cable, substituting B cable for A cable as appropriate and using the narrow slots in the transition adapters.

Use the Following Steps for Rack Mount Configurations

15. Repeat steps 11 and 12 at the disk end of the cable.

16. Select an extension A cable that will reach from the transition adapter in the RETMA rack to the first (lowest) disk drive (the position in the A cable daisy chain has no effect on unit number).

17. Find the arrow that is molded into the female cable header of the extension cable. Align the cable arrow with the corresponding arrow of one of the disk drive's A cable connectors and press the header into the connector. Make sure that the latches on the connector fully engage the cable header.

18. Select an extension B cable that will reach from the transition adapter in the RETMA rack to the first (lowest) disk drive.

19. Find the arrow that is molded into the female cable header of the extension cable. Align the cable arrow with the corresponding arrow on the disk drive's B cable connector and press the header into the connector. Make sure that the latches on the connector fully engage the cable header.

20. Daisy-chain the A cable from the first disk drive to the remaining drives as described in step 5 of subsection 4.6.1.1. (You can use the unshielded cables listed Table 4-8 to interconnect the drives.)

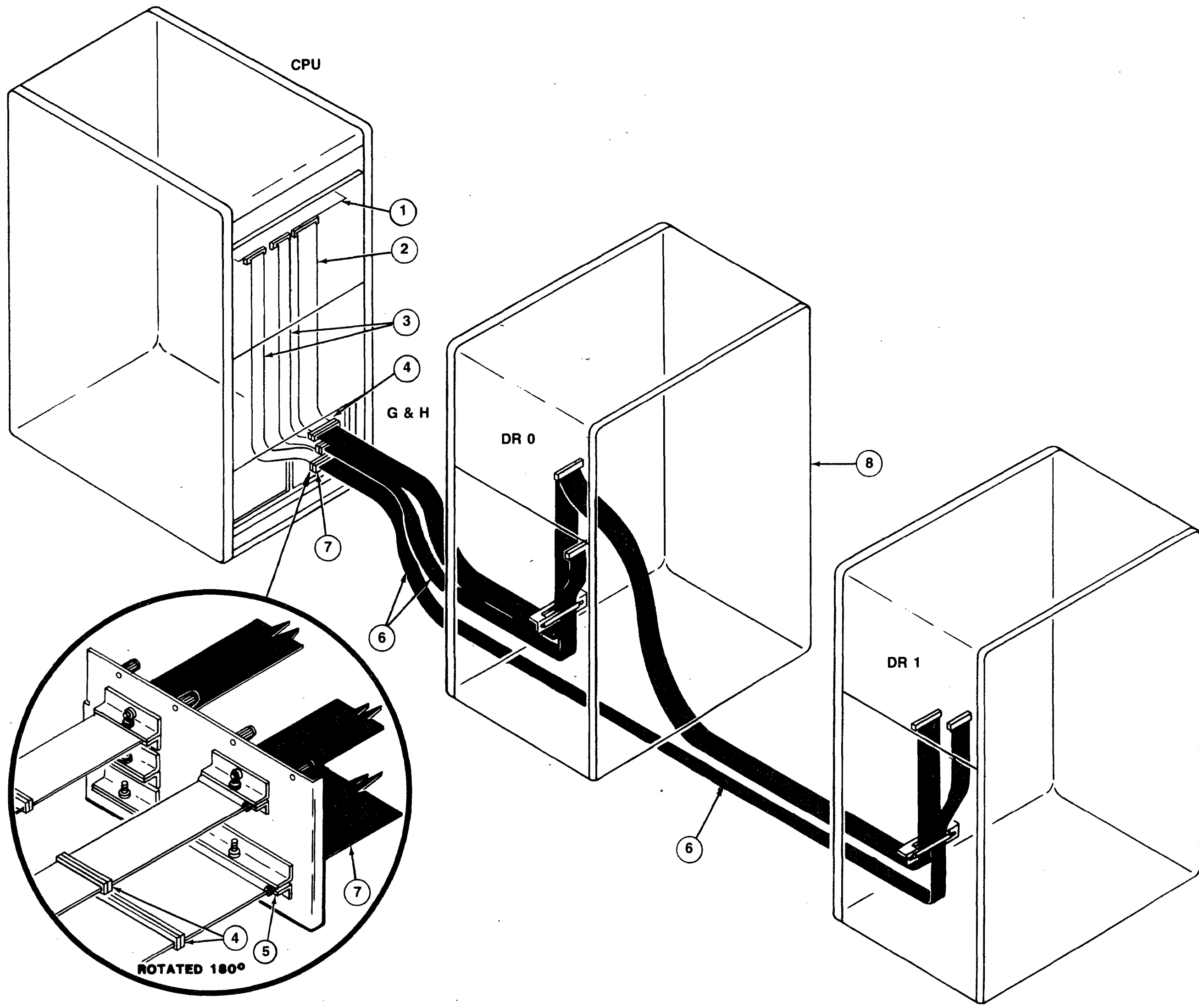
21. Repeat step 18 of this procedure for the other disk drives in the rack.

22. Terminate the A cable at the last drive in the daisy chain by installing a terminator (included with the drive) on the drive's unused A cable connector.

23. Connect a ground cable from the logic ground of the CPU to the logic ground of the disk drives.

Use the Following Steps for Freestanding Drive Configurations

24. Select two extension A cables long enough to reach from the drive's A cable connector to the peripheral cable adapter. (Alternatively, you can strip enough insulation off the shielded A cable to allow the shield to be clamped at the adapter and the cable head to connect at the drive's A cable connectors. If you use this approach, select a shielded A



1. Disk Controller PCBA
2. Nonshielded Extension A Cable
3. Nonshielded Extension B Cable
4. Cable Connectors, Extension Cables to Shielded Cables
5. Clamp - Shield of Shielded Cable Clamped Within
6. Shielded/Jacketed Cable, External to Equipment Cabinets
7. Personality Panel
8. Peripheral Device

Figure 4-8. Freestanding Drive Cabling Configuration cable that is long enough to reach to the next drive in the daisy chain at this point, and prepare it by stripping the shield insulation at both ends.)

25. Connect both A cables to the drive's A cable connectors by matching pin 1 (molded-in arrow on cable header) and pressing the header onto the connector.

26. Select a shielded A cable that is long enough to reach the next drive in the daisy-chain, and prepare it as described in step 10.

27. Clamp both shielded A cables in the wide section of the peripheral cable adapter.

28. Connect the extension cables to the shielded cables as described in step 13.

29. Select an extension B cable that will reach from the peripheral cable adapter rack to the drive's B cable connector.

30. Clamp the shielded B cable from the controller in the peripheral adapter. Connect the extension cable and the shielded cabled as described in step 18.

31. Repeat steps 24 through 30 for the rest of the drives in the subsystem.

32. Terminate the A cable at the last drive in the daisy chain by installing a terminator (included with the drive) on the drive's unused A cable connector.

End of Procedure

4.7 RECORDING THE SUBSYSTEM CONFIGURATION

Now that you have completed the installation of the controller and the disk drives, a record of the subsystem configuration and environment should be made. Figure 4-9 is a Configuration Record Sheet, which lists the information required and the shows where the data can be found. This information will be of help to an Emulex service representative should your subsystem require service.

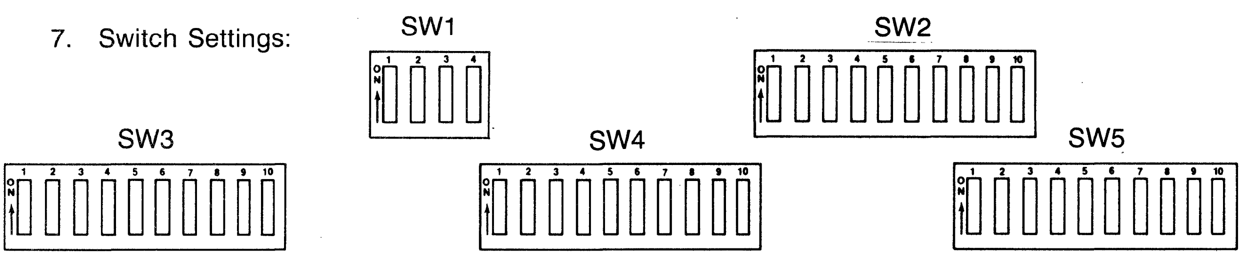
SC41/MS CONFIGURATION REFERENCE SHEET

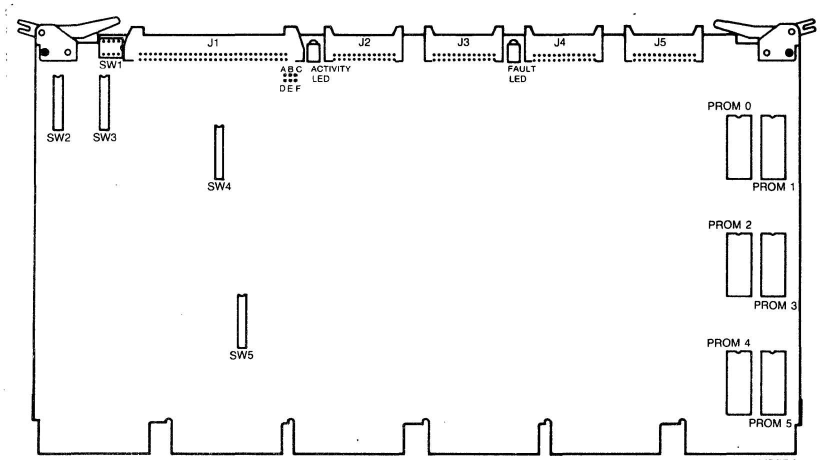
GENERAL INFORMATION

1. Host Computer Type____________________
2. Host Computer Operating System____________________
   Version __________
3. SMD Disk Drive Manufacturer and Model:
   Port 0 ____________________
   Port 1 ____________________
   Port 2 ____________________
   Port 3 ____________________

SC41 SETUP RECORD

1. Controller Top Assembly Number ____________________
2. Serial Number ____________________
3. Warranty Expiration Date ____________________
4. UNIBUS Address ____________________
5. Interrupt Vector Address ____________________
6. Drive Configuration Selections:
   Port 0 ____________________
   Port 1 ____________________
   Port 2 ____________________
   Port 3 ____________________
7. Switch Settings:





Label at U1 identifies Top Assembly and Serial Number

Use Pencil

Figure 4-9. SC41/MS Configuration Reference Sheet

4.8 INTEGRATION AND OPERATION

Before you place the SC41/MS into service, you must format the disks that it controls and you should run diagnostics to ensure that the subsystem is fully operational. The following subsections outline the integration procedure.

4.8.1 DRIVE FORMATTING

Before data can be stored on the SC41/MS's disk drives, the drives must be formatted. The SC41/MS implements a format option that allows it to format its disk drives with out help from system software; however, the SC41/MS can not verify the disk media or reassign bad blocks. See subsection 6.3.1.2. Emulex provides programs to format the disk drives, verify the disk media, and reassign the blocks that it finds to be bad. We strongly recommend using the appropriate Emulex formatter:

Program Name	CPU	Order Number	Function
AXMX8	PDP-11	PX9951801-xx	Format and Verification
FVDMS	VAX-11	VX9951801-xx	Format and Verification

See subsection 1.4 for ordering information.

4.8.2 TESTING

Successfully formatting the disk drives gives good indication that the SC41/MS and its disk drives are in good operating condition.

4.8.3 OPERATION

There are no operational instructions. The SC41/MS is ready for MSCP initialization as soon as it is powered up.

4.8.3.1 Indicators

There are two Light Emitting Diodes (LED) on the SC41/MS PWB. These LEDs are used for both diagnostics and for normal operations.

When power is applied to the CPU, the Disk Controller automatically executes a built-in self-test. This self-test is executed with every bus INIT and on powering up. When the self-test has been executed successfully, the FAULT LED, which is ON initially, goes OFF.

During normal operation, a second LED, ACTIVITY, and flickers occasionally. This LED is used to indicate UNIBUS activity.

If the SC41/MS fails its power-up self-test (FAULT LED ON or BLINKING), see Section 5, Troubleshooting.

5.1 OVERVIEW

This section describes the several diagnostic features with which the SC41/MS SMD Disk Controller is equipped, and outlines fault isolation procedures that use these diagnostic features. The following table outlines the contents of this section.

Subsection	Title
5.2	Power-Up Self-Diagnostics
5.3	Fault Isolation Procedures
5.4	Fatal Error Codes

5.1.1 SERVICE

Your Emulex SC41/MS has been designed to give years of trouble-free service, and it was thoroughly tested before leaving the factory.

Should one of these fault isolation procedures indicate that the SC41/MS is not working properly, the product must be returned to the factory or one of Emulex's authorized repair centers for service. Emulex products are not designed to be repaired in the field.

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

DO NOT RETURN A COMPONENT TO EMULEX WITHOUT AUTHORIZATION. A component returned for service without an authorization will be returned to the owner at the owner's expense.

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

Emulex Technical Support
3545 Harbor Boulevard
Costa Mesa, CA 92626
(714)662-5600 TWX 910-595-2521
(800) 854-7112 (outside California)

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 4-9.

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.

5.2 POWER-UP SELF-DIAGNOSTIC

The SC41/MS executes an extensive self-diagnostic to ensure that the disk controller is in good working order. The self-diagnostic is divided into two parts.

The first part of the diagnostic consists of a series of tests that are performed on the internal components of the disk controller. These tests are executed immediately after power-up. At the beginning of the diagnostic, the SC41/MS's microprocessor turns the red FAULT LED at the outside edge of the board ON. The SC41/MS indicates that the internal tests were executed successfully by turning the LED OFF at the end of the diagnostic. If the LED does not go OFF within 2 seconds after the SC41/MS is powered on or initialized, then the board has failed its self-diagnostic.

As part of this first self-diagnostic, the SC41/MS attempts to spin up and communicate with all SMD disk drives that are attached to it. If it fails to receive a response from at least one drive, the SC41/MS causes the FAULT LED to FLASH.

The second part of the self-diagnostic is executed by the SC41/MS during its initialization by the MSCP port driver. These tests are more extensive and include tests of the SMD interface and the Unibus interface. Any errors detected during the initialization process are reported to the operating system via the SC41/MS SA register. See **Storage System UNIBUS Port Description,** DEC document number AA-L621A-TK.

5.3 FAULT ISOLATION PROCEDURE

This fault isolation procedure is provided in tabular format (Table 5-1). The table is divided into three columns: symptom, possible cause, and remedy. The most probable or most easily confirmed cause for a given symptom is listed first. Check the causes or try the remedies in the order given. If the symptom persists, call Emulex Customer Service at the number given in subsection 5.1.1. If none of the symptoms listed occur, it is not necessary to follow these procedures.

Table 5-1. Fault Isolation

Symptom	Probable Cause	Remedy
1. FAULT LED is ON steadily	a. SC41 switch SW1-1 (reset) is ON	Turn SW1-1 OFF
	b. UNIBUS INIT or DCLO signals are TRUE or floating	Eliminate bus problem condition, toggle SW1-1
	c. SC41 Controller failed	Call Emulex Customer Service
2. SC41 FAULT LED is BLINKING	a. No power to disk drives or drives not spun-up	Power on the drives or spin them up
	b. Disk drives incorrectly cabled to SC41	Check cabling; look for reversed header/ connector relation-ships
	c. Disk drives bad	Call Emulex Customer Service or drive manufacturer
3. Intermittent hard or soft read errors reported by the operating system	a. Improper subsystem grounding	Check grounding and rectify if necessary
	b. Dirty head or media	Service drive and clean media as specified by drive manufacturer
	c. Bad spot on media	Reformat and verify disk pack

5.4 FATAL ERROR CODES

If the SC41/MS encounters a fatal error anytime during operation, an error code is posted in the low-byte of the SA register (base address plus 2). Table 5-2 lists the MSCP fatal error codes used by the SC41/MS.

Table 5-2. MSCP Fatal Error Codes used by the SC41/MS

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the SC41/MS attempted to read data from a message packet.
2	2	Possible parity or timeout error when the SC41/MS attempted to write data to a message packet.
4	4	SC41/MS diagnostic self-test indicated a controller RAM error.
5	5	SC41/MS diagnostic self-test indicated a firmware checksum error.
6	6	Possible parity or timeout error when the SC41/MS attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the SC41/MS attempted to write an envelope address to a command ring.
11	9	Host did not communicate with SC41/MS within the time frame established while bringing the controller online.
12	A	Operating system sent more commands to the SC41/MS than the controller can accept.

Table 5-2. MSCP Fatal Error Codes used by the SC41/MS (continued)

Octal Code	Hex Code	Description
13	B	Controller unable to perform DMA transfer operation correctly.
14	C	SC41/MS 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.

In addition, fatal error messages may appear during the firmware formatting procedure (subsection 6.4.2). These error codes are listed in Table 5-3.

Table 5-3. Error Codes Unique to Firmware Formatting

Octal Code	Hex Code	Description
100	40	Drive not ready
103	43	RCT Write error
105	45	Format error
106	46	Drive write protected
107	47	FCT Write error
110	48	Invalid Request

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6.1 OVERVIEW

This section contains an overview of the SC41/MS device registers that are accessible to the UNIBUS and that are used to monitor and control the SC41/MS MSCP Server. The registers are functionally compatible with DEC implementations of MSCP Servers.

The following table outlines the contents of this section.

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 (DEC). MSCP allows a host system to be connected to subsystems with a variety of capacities and geometries. This flexibility is possible because MSCP defines data locations in terms of sequential, logical blocks, not in terms of a physical description of the data's location (i.e., cylinder, track, and sector). This scheme gives the MSCP subsystem the responsibility for converting MSCP logical block numbers into physical addresses that the peripheral device can understand.

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

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

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

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

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

6.3 PROGRAMMING

A complete description of MSCP commands and the corresponding status responses which the SC41/MS MSCP Server posts is beyond the scope of this manual.

The SC41/MS MSCP Server executes the Minimal Disk Subset of MSCP Commands. This subsection contains a description of the extra commands that the SC41/MS executes and a list of the MSCP functions that are not supported by the SC41/MS MSCP Server.

6.3.1 EXPANDED COMMANDS

There are no expanded commands that use the MSCP packet format. The non-MSCP commands implemented by the SC41/MS are described in Registers, subsection 6.4.

6.3.2 UNSUPPORTED COMMANDS

The SC41/MS MSCP Server supports the entire range of MSCP commands in the minimal disk subset.

The SC41/MS MSCP Server does not support any of the Diagnostic and Utility Protocol (DUP) commands or functions.

6.4 REGISTERS

During normal operation the SC41/MS MSCP Server is controlled and monitored using the command and status packets that are exchanged by the Class Driver (host) and the MSCP Server. The SC41/MS has two 16-bit registers in the UNIBUS 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.

The register names, addresses, and functions are:

IP	7xxxx0/4	Initialization and Polling
SA	7xxxx2/6	Status, Address and Purge

The IP register has two functions as detailed below:

- When written with any value, it causes a hard initialization of the MSCP Server.

- When read while the port is operating, it causes the controller to initiate polling.

The SA register 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-specfic 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 both initialization and normal operation, it signals the port that the host has successfully completed a bus controller purge in response to a port-initiated purge request.

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

6.4.1 REGISTER ADDRESS OFFSETS ON VAX-11 SYSTEMS

The VAX-11/730, VAX-11/750 and VAX-11/780 systems use offset start addresses for UNIBUS devices. These offsets are automatically computed by SYSGEN when devices are connected to the operating system, but these offset must be taken into account when device registers are accessed directly from the system console. If you manually enter the codes required to start the firmware format function, use the offsets given in Table 6-1.

Table 6-1. VAX-11 Offsets

SC41/MS Address Octal	SC41/MS Address Hex	VAX-11/730 VAX-11/750 Hex Address With Offset	VAX-11/780 Hex Address with Offset UBA #0	UBA #1	UBA #2	UBA #3
772150	F468	FFF468	2013F468	2017F468	201BF468	201FF468
772152	F46A	FFF46A	2013F46A	2017F46A	201BF46A	201FF46A
772154	F46C	FFF46C	2013F46C	2017F46C	201BF46C	201FF46C
772156	F46E	FFF46E	2013F46E	2017F46E	201BF46E	201FF46E
760334	E0DC	FFE0DC	2013E0DC	2017E0DC	201BE0DC	201FE0DC
760336	E0DE	FFE0DE	2013E0DE	2017E0DE	201BE0DE	201FE0DE
760340	E0E0	FFE0E0	2013E0E0	2017E0E0	201BE0E0	201FE0E0
760342	E0E2	FFE0E2	2013E0E2	2017E0E2	201BE0E2	201FE0E2
760344	E0E4	FFE0E4	2013E0E4	2017E0E4	201BE0E4	201FE0E4
760346	E0E6	FFE0E6	2013E0E6	2017E0E6	201BE0E6	201FE0E6
760350	E0E8	FFE0E8	2013E0E8	2017E0E8	201BE0E8	201FE0E8
760352	E0EA	FFE0EA	2013E0EA	2017E0EA	201BE0EA	201FE0EA
760354	E0EC	FFE0EC	2013E0EC	2017E0EC	201BE0EC	201FE0EC
760356	E0EE	FFE0EE	2013E0EE	2017EOEE	201BEOEE	201FEOEE
760360	E0F0	FFE0F0	2013E0F0	2017E0F0	201BE0F0	201FE0F0
760362	E0F2	FFE0F2	2013E0F2	2017E0F2	201BE0F2	201FE0F2

6.4.2 FORMATTING

The SC41/MS also has the ability to format the disk drives attached to it. This format operation is performed autonomously by the SC41/MS in response to a special initialization command. To initiate the format operation, use the following procedure.

1. Initialize the SC41/MS by writing any value into the IP register. The SC41/MS performs self-test and begins the initialization dialog.

2. The SC41/MS indicates that initialization step 1 has begun by setting bit 11 in the SA register. The host must poll the register for this value (no interrupt is generated). Bit 8 should also be set.

Register	Octal	Hexidecimal
SA: Host Read	004400	0900

3. When the controller indicates that step 1 of the initialization dialog is begun, load the SA register with the "special initialization code:"

Register	Octal	Hexidecimal
SA: Host Write	030003	3003

4. The controller acknowledges the initialization code with bit 8 set.

Register	Octal	Hexidecimal
SA: Host Read	000400	0100

5. Write the Format Unit command into the SA register:

Register	Octal	Hexidecimal
SA: Host Write	04200n	440n

   where n is the number of the MSCP logical unit to be formatted.

6. The SC41/MS acknowledges the command with:

Register	Octal	Hexidecimal
SA: Host Read	001000	0200

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

8. The SC41/MS acknowledges the serial number with:

Register	Octal	Hexidecimal
SA: Host Read	002000	0400

9. Write the format parameter word into the SA register. (The format parameter word is not defined and is reserved for future use. Write all zeros into the register.) The SC41/MS begins formatting the selected drive.

10. Poll the SA register until the SC41/MS clears SA bit 11 to indicate that the format operation concluded. If the operation was not successful, the SC41/MS sets bit 15 in the SA register. The low byte of the register contains the error code:

Error Code		Description
100_8	40_{16}	Drive not ready
103_8	43_{16}	RCT Write error
105_8	45_{16}	Format error
106_8	46_{16}	Drive write protected
107_8	47_{16}	FCT Write error
110_8	48_{16}	Invalid Request

6.4.3 BOOTSTRAPPING

To allow the system to be easily bootstrapped from peripherals attached to the SC41/MS, Emulex has incorporated a Bootstrap Command into the controller. This feature is not part of the standard MSCP command set.

The Bootstrap Command can be issued from the console after the system is powered up, or it may be incorporated into a firmware routine that is located in a Bootstrap ROM. (The ROM would not be located on the SC41/MS PWB, but on some other module in the system.)

The Bootstrap Command causes the SC41/MS to load the first logical block from the selected peripheral into host memory starting at location E0000.

To issue the Bootstrap Command to the SC41/MS, use the following procedure:

1. Load the SA register with 30003_8

2. Immediately following this, load the SA register with $4000n_8$, where n is the MSCP logical unit number (see Section 3). No other operation can be performed between the loading of the two numbers.

3. Load register R0 with the unit number of the SC41/MS.

4. Load register R1 with the CSR address of the SC41/MS.

5. At the ODT prompt, start execution.

Remember to use the appropriate offset values if you are doing this on the VMS monitor on a VAX-11/730, VAX-11/750, or 11/780.

Remember to use the appropriate offset values if you are doing this on the VMS monitor on a VAX-11/730, VAX-11/750, or 11/780.

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7.1 OVERVIEW

This section contains a description of the SC41/MS SMD Disk Controller's architecture. The following table outlines the contents of this section.

7.2 SC41/MS DISK CONTROLLER ARCHITECTURE

A block diagram showing the major functional elements of the SC41/MS is shown in Figure 7-1. The controller is organized around a 16-bit, high-speed bipolar microprocessor. The arithmetic logic unit (ALU) and register file portion of the microprocessor are implemented with four 2901 bit-slice components. The microinstruction is 48 bits in length and the control memory of 4K words is implemented with six 4K x 8 bit PROMs.

The controller incorporates a 12K x 16 bit high-speed RAM buffer, which is used to store the controller's device registers, plus 42 sectors of data buffering.

The A Cable Register (ACR) provides the storage of all A Cable signals going to the disk drives. The inputs from the selected drive are testable by the microprocessor.

Serial data from the drive is converted into 16-bit parallel data and transferred to the buffer via the microprocessor. Likewise, the data accessed from the buffer by the microprocessor is serialized and sent to the drive under the control of the servo clock received from the drive. A 32-bit ECC shift register is used to generate and check the ECC for the data field. The same register is also used in a 16-bit CRC mode for the headers. The actual ECC polynomial operation is done independently of the microprocessor, but determination of the error position and error pattern is done under the control of the microprocessor.

The UNIBUS interface consists of a 16-bit bi-directional set of data lines and an 18-bit set of address lines. The UNIBUS interface is used for programmed input/output (I/O), CPU interrupts, and data transfers. The microprocessor responds to all programmed I/O and carries out the I/O functions required for the addressed controller register. The microprocessor also controls all NPR operations and transfers data between the UNIBUS data lines and the buffer.

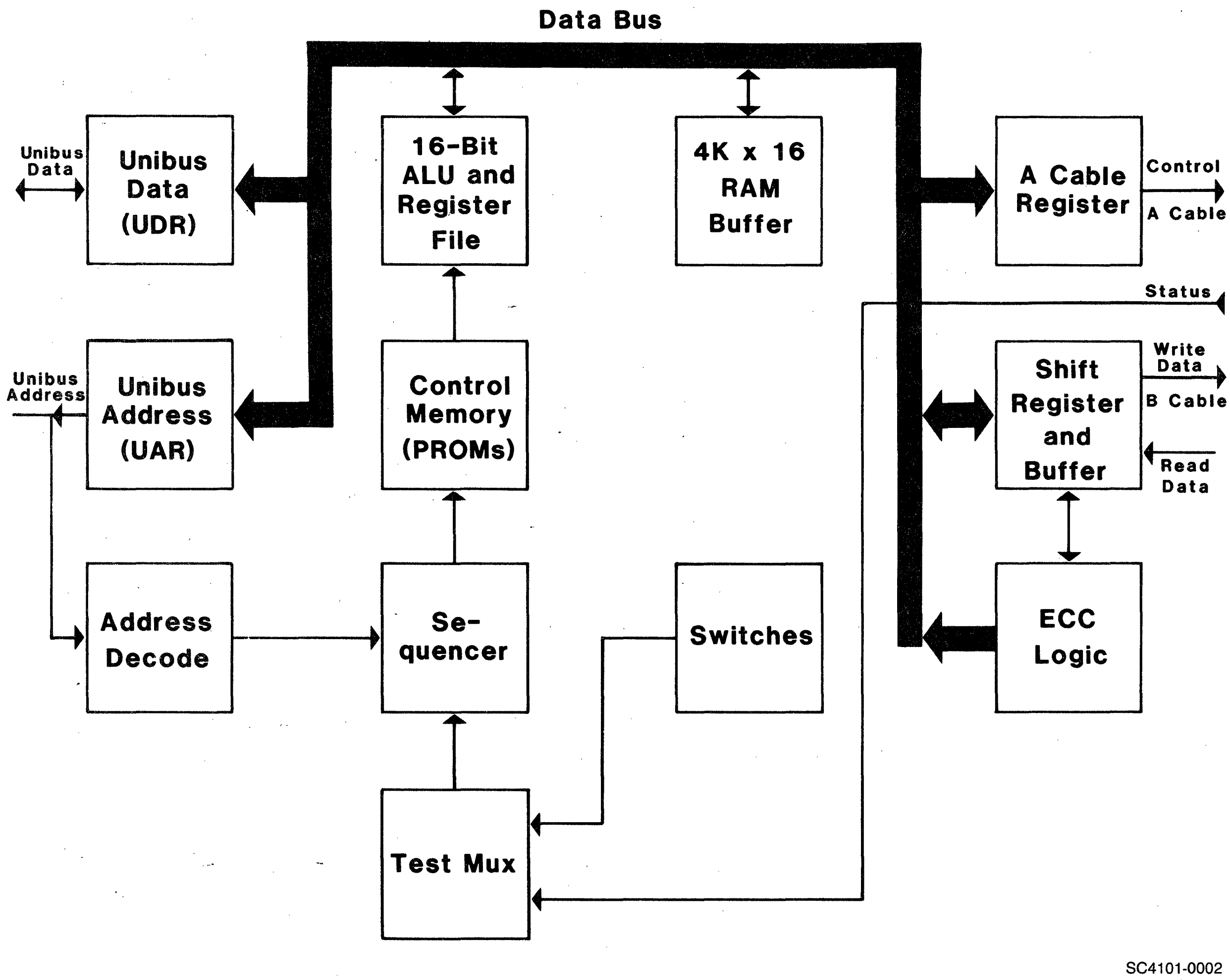

Figure 7-1. SC41/MS Block Diagram

7.3 DISK FORMAT

This subsection describes the physical and logical format of the disk.

7.3.1 PHYSICAL ORGANIZATION

The SC41/MS uses the SMD disk drives that it controls to emulate RA-type disk drives. The format used by the SC41/MS on the disk drives, however, is not the same as that used by DEC on RA-type drives. The formats do not have to be the same because MSCP relies on logical block numbers instead of cylinder, track, and sector addresses to reference data; and because MSCP allows the capacity of disk drives to vary (the host system polls the disk subsystem for capacity).

In fact, the format used by the SC41/MS varies depending on the type and capacity of disk drives connected to it. The following paragraphs describe the format that SC41/MS uses for disk drives connected to it.

Figure 7-2 shows the sector format used by the SC41/MS Disk Controller. Each track is divided into some number of sectors depending on the drive connected to the SC41/MS. Each sector is about 630 bytes in length. Again, this figure varies depending on the drive type. The four-byte header is preceded by one synchronization (sync) byte. The header is followed by a two-byte CRCC. The 512-byte data field is preceded by a data gap of 4 bytes and another sync byte. The data field is followed by a four byte ECC.

If the actual amount of useful data information is less than 512 bytes, the remainder of the data field is filled with zeros until 512 bytes have been written. During disk formatting procedures, each data track is located and recorded with header information by the SC41/MS. A disk pack should be formatted and the format verified before any real data is written on it.

```
--------------------- Sector Length  630 Bytes -------------------
-                                                                -
Preamble+Sync|Header|CRCC|Preamble+Sync|Data Field| ECC |Recovery|
-                                                                -
-----30------ --4--- -2-- -----20------ ---512---- --4-- ---58---
```

Figure 7-2. Sector Format

7.3.1.1 Header

Figure 7-3 shows the header format, which consists of the following two words:

Word One -

Bits 15 and 14 of this word are used as bad sector flags. If either or both are zero, this sector is bad. During normal operation, a read or write to a bad sector causes the controller to vector to the replacement sector defined in the data field of this sector. Bit 13 is not used. Bit 12 defines the word format of the data in this sector. A one defines a 16-bit word, and a zero defines a 18-bit word. For this emulation, a 16-bit data word is always defined. Bits <11:00> are the cylinder address.

Word Two -

Bits <15:08> contain the track (head) address. Bits <07:00> contain the sector address.

Word Three -

These two bytes contain the Cyclic Redundancy Check (CRC) code which is generated and checked by the logic in the SC41/MS to ensure the integrity of the header. This word is not available to the software.

Header Word 1

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
1	1	SSF	1	Cylinder Address											

Header Word 2

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Track Address								Sector Address							

Header Word 3

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Cyclic Redundancy Check Character (CRCC) Code															

Figure 7-3. Header Format

7.3.1.2 Header Field Handling

After the disk drive reports it is on the addressed cylinder, the SC41/MS locates the desired sector by means of sector counters maintained in its circuitry. A sector counter is maintained for each physical disk drive unit. The SC41/MS compares the first two words of the header with the, desired (addressed) cylinder, track and sector, and then checks the CRC field for errors. An error in the header field is indicated by reporting the appropriate error status in the command end message. A logical block that reports a header compare error should be considered bad and replaced.

7.3.2 LOGICAL ORGANIZATION

The operating system is effectively isolated from the physical geometry of the disk by assigning each usable sector of the disk a logical block number (LBN). LBNs are assigned sequentially beginning with zero. Figure 7-4 shows the logical organization of the disk media and the logical block numbering scheme.

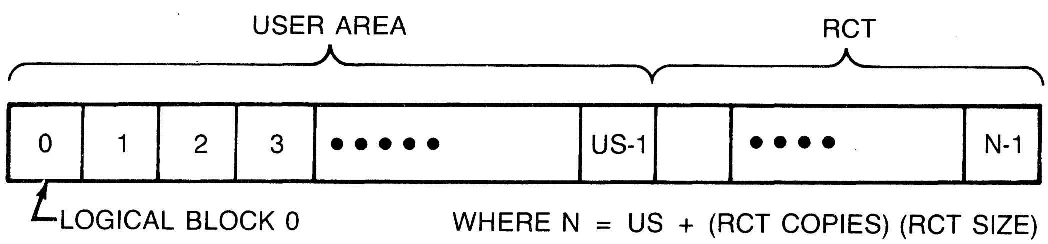

Figure 7-4. Disk Logical Organization

The number of LBNs varies depending on the capacity of the disk and the number of replacement blocks per sector.

The portion of the disk that is reserved for user data storage is called the host area. The size of this area is the unit size. The logical blocks in the user area are numbered from zero to unit size minus one.

The user area does not include the replacement and caching table (RCT). The RCT immediately follows the user area, and it is also divided into logical blocks. The RCT blocks are addressed using logical block numbers. The LBN of the first RCT block is equal to the unit size. The size of a single copy of the RCT and the number of copies that are maintained vary depending on the capacity of the disk and the number of replacement blocks. The RCT format is described in subsection 7.3.2.1.

7.3.2.1 RCT Format

The Replacement and Caching Table is used to log replaced blocks and to cache data from a block that is being replaced. Figure 7-5 shows the organization of the RCT. Note that the RCT varies in length depending on the number of spare sectors (replacement blocks or RBNs).

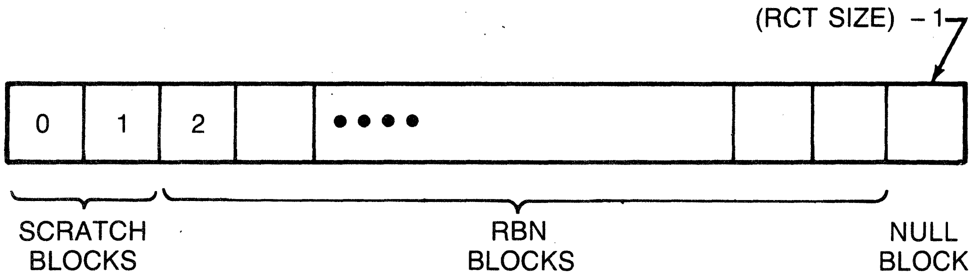

Figure 7-5. RCT Organization

To perform its two functions, the table has two parts. The first two logical blocks of the table are used as cache by the operating system, especially when replacing bad blocks. Data from the bad block is written here while the bad block is replaced.

The replacement table begins with the third logical block. The replacement table contains a four-byte entry for each replacement block number (RBN) on the disk. The entries are indexed by the order in which they appear. For example, the first RBN on the disk is associated with the first four bytes of the replacement table, the second RBN is associated with the second four bytes, etc. Each RCT copy terminates with an extra block of null entries to flag the end of the copy.

The 32 bits of each replacement table entry are used as shown in Figure 7-6 and Table 7-1.

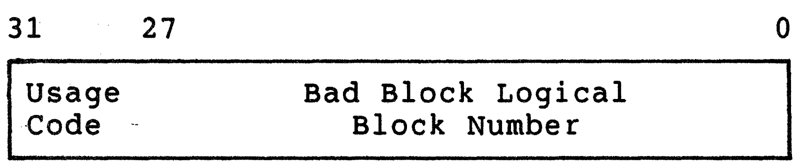

Figure 7-6. RCT Entry Format

Table 7-1. Usage Codes

Code	Usage	Description
0	Unused	This RBN not allocated
2	Allocated, primary	This RBN was the first choice for the LB that was replaced
3	Allocated, secondary	This RBN was the second choice for the LB that was replaced
4	Bad RBN	The RBN is bad
8	Null	This entry is beyond the last RBN entry in the table

7.4 BAD BLOCK REPLACEMENT

The disks that are controlled by the SC41/MS must be formatted by using the controller's firmware format command. See subsection 6.4.2. The controller reserves a number of spare sectors per track and the spare cylinders based on the capacity and physical configuration of the disk drive that is being formatted. A Replacement and Caching Table (RCT) and Manufacturer's Caching Table (MCT) are allocated during format as well. Because Emulex continues to add support for new drives, it is impractical to list the number of spare sectors and tracks, and the size of the RCT and MCT on a per configuration basis. Once a disk is formatted, however, the controller will provide that information for a drive when a Get Unit Status command is issued. The information is contained in the twelfth and last long word of the End Message. That long word takes the following format:

```
31                                  0
+-----------------------------------+
|copies   |   RBT   |     RCT size   |
+-----------------------------------+
```

- Copies - The number of copies of the RCT. There must be more than one to ensure that at least one copy is flawless.
- RBT - The number of replacement blocks per track.
- RCT size - This value is the size in logical blocks of each copy of the RCT, including the two cache blocks and the extra null block.

After the disk has been formatted, the disk media's ability to store data reliably must be verified. This is done by using the following procedure:

1. Write data patterns on the disk by using the Write command with the compare, inhibit error correction, and inhibit error recovery modifiers. This will allow media flaws to be detected without having to perform a separate read operation. If a compare error occurs, the error will be flagged in the command end message for that particular write operation. When an error occurs, we may presume that the media is flawed for that logical block.

2. To achieve the MSCP goal of error free media, flawed blocks are replaced with spare blocks that are reserved for this purpose. The spare blocks are known as replacement blocks, and one or two are reserved on each track of the disk. They are numbered sequentially from zero starting with the first block on the first track. To identify the replacement block to use with a given bad logical block, use the following formula:

$$RBN = \frac{LBN}{Track\ Size} * RBNs$$

   Where:

   RBN = Replacement block number to use for the bad LBN

   LBN = The bad logical block by number

   Track size = The number of logical blocks per track as reported in the get unit status command end message

   RBNs = The number of replacement blocks per track as reported in the get unit status command end message

3. When the RBN is identified, you must check the RCT to make sure that that replacement block is not already in use. If that RBN is not, you must flag the record for that RBN as used, and mark the record with the LBN of the bad block (see subsection 7.3.2.1 for a description of the RCT). If the RBN is already used, check the RBNs one either side of it, starting with the numerically higher one. Keep checking back and forth until an unused RBN is found. If there are no unused RBNs, the media is unusable.

4. After you have updated the RCT, use the Replace command to cause the controller to reassign the bad logical block to the replacement block.

5. Verify the integrity of the replaced logical block by writing the original LBN as before.

6. Continue the verifying the disk until you have checked all of the user area.

During the process just outlined, the RCT may be kept and updated in host memory. The copies of the RCT that are recorded on the disk may be ignored and updated only when verification is complete. However, if you replace bad blocks without updating the RCT and the computer should crash, then the bad blocks would be remapped to RBNs, but you would have no way of knowing which RBNs had been used. In that case, the disk would have to be reformatted and the process begun again.

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8.1 OVERVIEW

This section describes the interfaces that the SC41/MS SMD Disk Controller incorporates. It includes information on the SC41/MS implementation of SMD interface electrical and mechanical requirements. The section is divided into the following subsections.

Subsection	Title
8.2	SC41/MS UNIBUS Interface
8.3	SC41/MS SMD Interface

8.2 UNIBUS INTERFACE

The SC41/MS interfaces with PDP-11 or VAX-11 CPUs via a UNIBUS Small Peripheral Coupler (SPC) connector. The UNIBUS consists of 18 address lines and 16 bidirectional data lines, plus control signals for data and interrupt vector address transfer and for becoming bus master. Pin/signal assignments are listed and described in Table 8-1.

8.2.1 BR (INTERRUPT) PRIORITY LEVEL

The SC41/MS is hardwired for interrupt priority level BR5. The other three Bus Grant signals are jumpered through.

8.2.2 DCLO AND INIT SIGNALS

The DCLO and INIT signals both perform a Clear operation on the SC41/MS; however, the Self-Test routine is performed only if the DCLO signal has been asserted.

8.2.3 NPR OPERATIONS

All NPR Data Transfer operations are performed under microprocessor control. When doing a read from memory operation, a check is made for memory parity errors, and if an error is detected, the PDP-11 Bus Parity Error (UPE) error status bit is set.

Table 8-1. UNIBUS Interface Pin Assignments

Connector C			Connector D		
Component Side	Pin	Solder Side	Component Side	Pin	Solder Side
NPGIN	A	+5V		A	+5V
NPGOUT	B			B	
PA	C	GND		C	GND
	D	D15		D	BR7
	E	D14		E	BR6
	F	D13		F	BR5
D11	H	D12		H	BR4
	J	D10		J	
	K	D09		K	BG7IN
	L	D08	INIT	L	BG7OUT
	M	D07		M	BG6IN
DCLO	N	D04		N	BG6OUT
	P	D05		P	BG5IN
	R	D01		R	BG5OUT
PB	S	D00		S	BG4IN
GND	T	D03	GND	T	BG4OUT
	U	D02		U	
ACLO	V	D06		V	

Connector E			Connector F		
Component Side	Pin	Solder Side	Component Side	Pin	Solder Side
	A	+5V		A	+5V
	B	-15V		B	-15V
A12	C	GND		C	GND
A17	D	A15	BBSY	D	
MSYN	E	A16		E	
A02	F	C1		F	
A01	H	A00		H	
SSYN	J	C0	NPR	J	
A14	K	A13		K	
A11	L			L	
	M		INTR	M	
A08	N			N	
A10	P	A07		P	
A09	R			R	
	S			S	
GND	T		GND	T	SACK
A06	U	A04		U	
A05	V	A03		V	

8.2.4 REGISTER ADDRESS

The SC41/MS has two registers visible to the UNIBUS. Their addresses are determined by DIP switch SW5-6 through SW5-9. See Section 4 for detailed address and switch setting information.

8.3 SC41/MS SMD INTERFACE

This subsection provides information on the SC41/MS implementation of the SMD interface electrical and mechanical requirements.

The SC41/MS controller's disk interface conforms to the Flat Cable Interface Specification for the SMD, MMD, and CMD (CDC Document No. 64712400). The controller has been tested with most drives using the SMD interface and is compatible with the electrical and timing characteristics of such disk drives.

All communications between the SC41/MS and its drives must pass through the interface. This communication includes all commands, status, control signals, and read/write data transmitted and received by the controller.

The interface cases, consists of the I/O cables and the logic required to carry and process the signals sent between drive and controller (or controllers).

The following describes both the I/O cables and I/O signal processing.

8.3.1 I/O CABLES

All the signal lines between the controller and drive are contained in two I/O cables. They are referred to as the A and B cables. Table 8-2 lists all lines (except those not used) in both cables.

8.3.1.1 A Cable

The 60-conductor A Cable is daisy-chained to all disk drives and terminated at the last drive. The purpose of the signals in this cable, along with their function when the control tag (Tag 3) is asserted, are listed in Table 8-3.

The A Cable should be a 30 twisted pair flat cable with an impedance of 100 ohms and a cumulative length not greater than 100 feet.

8.3.1.2 B Cable

The 26-conductor B Cable is radial to all drives and contains the data and clock signals. The function of the signals in this cable are listed in Table 8-4.

Table 8-2. SMD Interface Connections

Pins Lo,Hi	Signal	(Tag 3 Function)	From/To
A Cable:			
22,52	Unit Select Tag		To
23,53	Unit Select bit 0		To
24,54	Unit Select bit 1		To
26,56	Unit Select bit 2		To
27,57	Unit Select bit 3		To
1,31	Tag 1		To
2,32	Tag 2		To
3,33	Tag 3		To
4,34	Bit 0	(Write Gate)	To
5,35	Bit 1	(Read Gate)	To
6,36	Bit 2	(Servo Offset Plus)	To
7,37	Bit 3	(Servo Offset Minus)	To
8,38	Bit 4	(Fault Clear)	To
9,39	Bit 5	(AM Enable)	To
10,40	Bit 6	(Return to Zero)	To
11,41	Bit 7	(Data Strobe Early)	To
12,42	Bit 8	(Data Strobe Late)	To
13,43	Bit 9	(Release)	To
30,60	Bit 10		To
14,44	Open Cable Detect		To
15,45	Fault		From
16,46	Seek Error		From
17,47	On Cylinder		From
18,48	Index		From
19,49	Unit Ready		From
20,50	Address Mark Found		From
21,51	Busy (dual port only)		From
25,55	Sector		From
28,58	Write Protected		From
29	Power Sequence Hold		To
59	Power Sequence Pick		To
B Cable:			
8,20	Write Data		To
6,19	Write Clock		To
2,14	Servo Clock		From
3,16	Read Data		From
5,17	Read Clock		From
10,23	Seek End		From
22,9	Unit Selected		From
12,24	Index		From
13,26	Sector		From

The B Cable should be a 26-conductor flat cable with ground plane and drain wire. The impedance should be 130 ohms and the length not greater than 50 feet.

8.3.1.3 Drivers and Receivers

The drivers for the A and B Cables are MC3453, which are equivalent to 75110A drivers. The receivers are MC3450 quad differential receivers, which are equivalent to 75108 receivers. The lines of the A Cable are terminated with 82 ohms to ground. The lines of the B Cable are terminated with 56 ohms to ground.

8.3.2 I/O SIGNAL PROCESSING

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

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

8.3.2.1 Tag/Bus Signals

All commands (except unit select) are sent to the drive via the tag and bus signal lines. the tag lines define the basic operation to be performed and the bus lines modify or further define the basic operation.

Table 8-3 explains all the tag/bus commands recognized by the drive.

8.3.2.2 Discrete Signals

In addition to the tag/bus signals, there are various discrete signal lines going between drive and controller. these lines carry clock, status, control and read/write data signals. The function of each of the discrete lines is also explained in Tables 8-3 and 8-4.

Table 8-3. A Cable Signal Line Functions

Signal	Function
Pick In	Used for power sequencing. When the controller is ON, this line is pulled low to power up the disk drive(s). The drive's LOCAL/REMOTE switch must be set to REMOTE and the START switch must be ON. This signal is daisy-chained from drive to drive. It is not passed from one drive to the next until the first drive is up to speed (spindle reaches 2700 rpm). The ground is passed on to the next drive as Pick Out (Pick Out is terminated at the last drive in the daisy chain).
Hold	Used for power sequencing. This line is pulled low to power up the disk drive. The drive's LOCAL/ REMOTE switch must be set to REMOTE and the START switch must be ON. This signal is daisy-chained from drive to drive. This line must be grounded at the controller for the drive to complete and hold remote power-up sequence.
Open Cable	The controller holds this signal TRUE when it is powered on. When FALSE, the drive cannot be selected. This prevents unwanted command detection (such as Write Gate) when the A cable is disconnected or controller power is lost.
Unit Select Tag	Initiates unit select sequence, and in dual channel units it also reserves the drive to that controller, provided unit selection is successful.
Unit Select lines 2^0 and 2^3	Used to select the drive. The binary code on these lines must match the code of the drive logical address for the drive to be selected. These lines are used in conjunction with the Unit Select Tag pin A cable I/O).
Tag 1 (Cylinder Select)	Initiates seek functions and is used in conjunction with Bus Bit lines. This tag strobes the cylinder address, contained on the Bus Bits lines, into the drive logic. The drive must be on cylinder before this tag is sent. Bus Bits are interpreted as follows:

Continued on next page

Table 8-3. A Cable Signal Line Functions (continued)

Signal	Function
	<u>Bus Bit</u> <u>Function</u> <u>Bus Bit</u> <u>Function</u> 0 Cyl Adrs 2^0 5 Cyl Adrs 2^5 2^1 6 Cyl Adrs 2^6 2 2^2 7 2^7 3 2^3 8 2^8 4 2^4 *9 Cyl Adrs 2^9
Tag 2 (Head Select)	Initiates head select functions and is used in conjunction with Bus Bit lines. This tag strobes the head address, contained on bus bit lines, into drive logic. Bus Bits are interpreted as follows: <u>Bus Bit</u> <u>Functions</u> 0 Head Adrs 2^0 1 2^1 2 2^2 3 2^3 4 Head Adrs 2^4 5-9 Not Used
Tag 3 (Control Select)	Initiates various operations to be performed by the drive. Used in conjunction with Bus Bit lines. The specific operation initiated depends on content of these lines which is defined as follows: <u>Bus Bit</u> <u>Function</u> 0 Write Gate - Enable write drivers. 1 Read Gate - Enables the digital read data lines. With PLO option, leading edge triggers read chain to sync on all-zeros pattern. 2 Servo Offset Plus - Offsets the actuator from the nominal on cylinder position toward the spindle. 3 Servo Offset Minus - Offsets the actuator from the nominal on cylinder position away from the spindle. 4 Fault Clear - Pulse sent to drive to clear the fault summary flip-flop.

Continued on next page

Table 8-3. A Cable Signal Line Functions (continued)

Signal	Function
Tag 3 (continued)	<u>Bus Bit</u> — <u>Function</u> 5 — Address Mark Enable - When combined with a Write Gate, Address Mark is written. When combined with a Read Gate, an Address Mark search is initiated. 6 — RTZ - Pulse sent to drive to cause actuator to seek to track zero. 7 — Data Strobe Early - Enables the PLO data separator (optional) to strobe the data at a time earlier than optimum. 8 — Data Strobe Late - Enables the PLO data separator to strobe the data at a time later than optimum. 9 — Release - Releases dual channel drives from reserved and/or priority selected condition (refer to discussion on Unit Selection). Not used for single-channel drives.
Bus Bits (0 - 9)	Used in conjunction with Tags 1, 2, and 3 (also used with Unit Select Tag on units with 50 pin A Cable I/O.
Unit Ready	Indicates that drive is selected and up to speed, heads are loaded, and no fault exists.
Busy (applicable only to dual channel units).	TRUE when a drive selection is attempted but the drive is already reserved by the other controller. This signal is returned to the controller attempting selection along with the unit selected signal (refer to discussion on Unit Selection).
On Cylinder	Indicates drive has positioned the heads over a track.
Seek Error	Indicates that the unit was unable to complete a move within 500 msec, or that the carriage has moved to a position outside recording field. A seek error interrupt also occurs if an address greater than track 822 (410) has been selected. Refer to discussions on Seek Functions for more information.

Continued on next page

Table 8-3. A Cable Signal Line Functions (continued)

Signal	Function
Address Mark Found	Indicates that the drive has detected an Address Mark.
Write Protect	Indicates the that drive's write circuits are disabled.
Fault	Indicates that one or more of these faults exists: DC power fault, head select fault, write fault, Write or Read while off cylinder, and Write Gate during a Read operation.
Unit Selected	Indicates that the drive is selected. This line must be active before the drive will respond to any commands from the controller. However, on dual channel units, if Busy is returned in conjunction with Unit Selected, it indicates the drive is reversed to the other controller and selection was unsuccessful.

Table 8-4. B Cable Signal Functions

Signal	Function
Write Data	Carries NRZ data to be recorded on the disk media.
Write Clock	Synchronized to NRZ Write Data, it is a return of the Servo Clock. The drive transmits this signal continuously.
Index	Occurs once per revolution of disk media and its leading edge is considered leading edge of sector zero.
Sector	Derived from servo surface of the disk media, this signal can occur any number of times per revolution of the pack. The number of sector pulses occurring depends the configuration of the disk drive.
Servo Clock	9.677 MHz clock signals derived from the drive's servo track.
Read Data	Carries NRZ data recovered from the disk media.
Read Clock	Clock signals derived from HRZ Read Data.
Seek End	Seek End is a combination of ON CYL or SEEK ERROR indicating that a seek operation has terminated.

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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 (SC41/MS)**		**772150**[1]
---->	**UDA50 (SC41/MS)**		**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

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B.1 OVERVIEW

It may be necessary, either for maintenance reasons or because you wish to change your Emulex controller from one emulation to another, to remove and replace the SC41's firmware PROM set. This appendix provides instructions for changing from a SC41/XX emulation to a SC41/MS emulation or for simply replacing the PROMs for maintenance reasons.

B.2 EXCHANGING PROMS

You may wish to take advantage of the flexibility of Emulex hardware by replacing your existing emulation PROM set with the SC41/MS emulation PROM set. The PROM set consists of the emulation firmware set and the configuration PROMs.

There are three classes of programmable read-only memories (PROMs) on the SC41. All three sets of PROMs must be changed to upgrade the SC41 to an /MS emulation.

Refer to Table B-1 for PROM numbers and locations.

B.2.1 EMULATION PROMS

The six existing emulation PROMs are located in sockets labeled PROM 0 through PROM 5. Pry the existing PROMs from their sockets using an IC puller or an equivalent tool.

The SC41/MS Emulation PROM set is identified by the part numbers on top of the PROMS (A56-A61). Place the SC41/MS PROMs in numerical order beginning with the socket labeled PROM 0 (see Table B-1). Make certain that the PROMs are firmly seated and that no pins are bent or misaligned. (If the two rows of PROM pins are too far apart to fit in the socket, grasp the PROM at its ends using your thumb and forefinger and bend one of the pin rows inward by pressing it against a table top or other flat surface.)

B.2.2 CONFIGURATION PROMS

There is a single Configuration PROM that defines the types of drives that the SC41 can support. It is identified by the number C02. Remove the existing PROM and replace it as described above.

B.2.3 ADDRESS PROMS

These is a single Address PROM that defines the addresses to which the SC41 can respond. It is identified by the number D04. Remove the existing PROM and replace it as described above.

B.3 SWITCH SETTINGS

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

B.4 JUMPERS

No changes are required.

Table B-1. SC41 PROM Locations

PROM Number	Socket	PCBA Location
A56	PROM 0	U59
A57	PROM 1	U60
A58	PROM 2	U122
A59	PROM 3	U123
A60	PROM 4	U173
A61	PROM 5	U174
D04	Address	U129
C02	Config.	U137
D12	Alt Address	U129

C.1 OVERVIEW

This appendix contains a list of the diagnostics and utilities software that are available for use with the SC41/MS. The list includes a description of the function of the software and a description of the media on which the software is distributed. This information is contained in Table C-1.

All of the diagnostic and utility media listed contain all of the software provided for the SC41/MS 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 cartridge tape	MS	All tape, disk, communications, and subsystem software
VX9951801-01	TU58 Cartridge		VAX Disk Diagnostics
VX9951801-02	RX02 Floppy	DY	VAX Disk Diagnostics

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D.1 INTRODUCTION

This appendix provides modifications to commonly used drives for moving the Sector and Index signals from the A Cable to the B Cable.

D.2 CDC 9766

Remove (Ch. I)		Remove (Ch. II)	
Sector +	J4-55	Sector +	J4-55
Sector -	J4-25	Sector -	J4-25
Index +	J4-48	Index +	J4-48
Index -	J4-18	Index -	J4-18

Move Wire (Ch. I)	Origin	From	To
Sector +	PA01-5B	J3-55	J2-26
Sector -	PA01-5A	J3-25	J2-13
Index +	PA01-6B	J3-48	J2-24
Index -	PA01-6A	J3-18	J2-12

Move Wire (Ch. II)	Origin	From	To
Sector +	PA03-5B	J3-55	J2-26
Sector -	PA03-5A	J3-25	J2-13
Index +	PA03-6B	J3-48	J2-24
Index -	PA03-6A	J3-18	J2-12

Rework transmitter card FTVV in location A01 (Ch. I) and A03 (Ch. II). Locate the jumper at the center bottom of the board (as viewed with connector on the right). Remove the jumper and reinsert one set of holes lower (i.e., from the center hole to hole below the original jumper). Remove the letter F from the card type designation FTVV, and mark G in its place so that the card type becomes GTVV.

NOTE

On later models of the 9766, CDC shipped units with an enhancement feature that allows easy switchover to the B Cable as follows: Cut the cable tie securing PD90 to the I/O cable and plug PD90 into JD90 pins 13 and 14 (Ch. I) and pins 11 and 12 (Ch. II) as indicated on the top of the connector.

D.3 TRIDENT DRIVES

Sector and Index are on both the A and B Cables.

D.4 FUJITSU DRIVES

Sector and Index are on both the A and B Cables.

D.5 CDC 9775

Rework transmitter-receiver card CFAX in location A04 (Ch. I) and B04 (Ch. II). When viewing the card with the connector on the right, locate four jumpers to the left of the I/O connectors and above the terminator ground lug. The bottom end of the jumpers must be removed from the holes to which they are soldered and moved to the holes immediately above. Next, find the small jumper to the right of the third IC from the connector edge of the board on the bottom row of ICs. This jumper must be removed and re-inserted so that it connects the top and middle holes rather than the original connection of the bottom and middle. This connection ungates the sector and index driver.

Remove the letter C from the card type designation CFAX, and mark a D in its place so that the card type becomes DFAX.

D.6 CDC 9762

Remove (Ch. I)	Add (Ch. I)
B01-06B to JA82-18B	B01-06B to JA82-43B
B01-06A to JA82-18A	B01-06A to JA82-44A
B01-05B to JA82-25B	B01-05B to JA82-45B
B01-05A to JA82-25A	B01-05A to JA82-45A

Remove (Ch. II)	Add (Ch. II)
B03-06B to JA83-18B	B03-06B to JA83-43B
B03-06A to JA83-18A	B03-06A to JA83-44A
B03-05B to JA83-25B	B03-05B to JA83-45B
B03-05A to JA83-25A	B03-05A to JA83-45A

Rework transmitter card FTVV in location B01 (Ch. I) and B03 (Ch. II). Locate the jumper at the center bottom of the board (as viewed with the connector on the right). Remove the jumper and reinsert one set of holes lower (i.e., from center hole to the hole below the original jumper). Remove the letter F from the card type designation FTVV, and mark a G in its place so that the card type becomes GTVV.

NOTE

On later models of the 9775, CDC shipped units with an enhancement feature that allows easy switchover to the B Cable as follows: Remove the jumper plug on (B07) of the logic chassis back panel.

D.7 CDC 9730

Rework transmitter-receiver card CFAX in location A04 (Ch. I) and B04 (Ch. II). When viewing the card with the connector on the right, locate four jumpers to the left of the I/O connectors and above the terminator ground lug. The bottom end of the jumpers must be removed from the holes to which they are soldered and moved to the holes immediately above. Next, find the small jumper to the right of the third IC from the connector edge of the board on the bottom row of ICs. This jumper must be removed and re-inserted so that it connects the top and middle holes rather than the original connection of the bottom and middle. This connection ungates the sector and index driver.

Remove the letter C from the card type designation CFAX, and mark a D in its place so that the card type becomes DFAX.

D.8 CDC FSD DRIVES

The sector and index jumper on the I/O board must be moved to the "B" position. You can tie all three lugs together to get sector and index on both A and B cables.

The number of sectors per track is set by using switches SW0 - SW11. The two switch packs are one above the other. SW0 is the top most switch.

The write protect jumper (in upper right corner of same board that has sector counter switches) must be in unprot position. Sector counters for both 9715-340 and 9715-515 are done the same way (i.e., the drive automatically adjusts for the number of bytes per track, so 32 sectors on one is still 32 sectors on the other).

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