SDC-RQD11-SCSI

MSCP/TMSCP SCSI Controller Manual

Sigma Information Systems

SDC-RQD11-SCSI

MSCP/TMSCP SCSI Controller Manual

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Notes

Table of Contents

List of Figures

List of Tables

1. General Information

1.1 Introduction

This manual provides the information necessary to install and understand the SDC-RQD11-SCSI controller manufactured by Sigma Information Systems, Anaheim, California.

The material in this document is arranged into the following sections.

Section 1 - General Information. This section provides a general description of the SDC-RQD11-SCSI. Features are listed and specifications are included.

Section 2 - Installation. This section describes the procedures necessary to install the SDC-RQD11-SCSI. Jumper configurations are included to set CSR address, interrupt level, and SCSI ID #.

Section 3 - WOMBAT Utilities. This section describes the WOMBAT utilities available for the Winchester drives.

Section 4 - MSCP/TMSCP Programming. This section defines the message-oriented rules by which the SDC-RQD11-SCSI controller and host system communicate.

Section 5 - Operating Systems. This section describes how the operating system affects the SDC-RQD11-SCSI controller. The information serves as a guide for selecting bus address and interrupt levels for the disk subsystem.

Section 6 - SCSI Interface. This section defines the industry standard SCSI interface.

Section 7 - Q-bus Interface. This section defines the Q-bus signals, interrupt priority, and DMA protocol.

1.2 General Description

The SDC-RQD11-SCSI interfaces up to seven SCSI drives to a [1]MicroVAX or LSI-11 system. The controller supports any combination of seven disk and tape drives.

It emulates DEC's mass storage control protocol (MSCP) and tape mass storage control protocol (TMSCP) protocols.

The SDC-RQD11-SCSI interfaces disk drives of any size and data rate to all standard DEC operating system without software modification. The controller includes comprehensive on-board initialization and diagnostic firmware.

- **SCSI Initiator**

  The SDC-RQD11-SCSI supports SCSI bus protocol including disconnect / reconnect. The SCSI initiator software uses ANSI standard X3.131-1986 common command set for sequential access devices. Device-specific SCSI commands are added to support high-capacity tape drives such as the Exabyte EXB 8200.

- **DEC Emulation**

  The SDC-RQD11-SCSI responds to MSCP commands as if it were a standard DEC RQDX2/3 – and to TMSCP commands as a TK50. It surpasses DEC's performance by supporting larger capacity tape drives such as the Exabyte 8200 that stores 2 Gbytes of data on a small 8mm video tape cartridge and the high-capacity Fujitsu M245xx series drives.

- **Virtual Units**

  The SDC-RQD11-SCSI allows the user to partition each winchester drive into virtual units which are addressed by the host as individual drives. Each virtual unit can be any size up to the size of the entire drive with up to 16 virtual units assigned to each controller.

- **Block Mode DMA and DMA Throttle**

  With Block Mode DMA, the SDC-RQD11-SCSI interleaves address references with bursts of data – almost doubling Q-bus throughput. The SDC-RQD11-SCSI fully conforms with Q-bus Block Mode DMA protocol. With non-block mode memory, the controller automatically reverts to burst mode DMA.

  After every 16-word DMA transfer, there is a 4-microsecond delay to service any pending interrupt or DMA requests from other devices. If a DMA request occurs, a "DMA throttle" releases the Q-bus after 8 words to prevent data loss from other DMA devices.

1 Q-bus, MicroVAX, MSCP, TMSCP, RSTS-E, RT-11, RSX11-M, and VMS are registered trademarks of Digital Equipment Corporation, Maynard, MA.

- **Q-bus Interface**

  The SDC-RQD11-SCSI fully implements all current Q-bus enhancements, including block mode transfers, 4-level interrupt structure, 22- bit addressing.

- **On-board WOMBAT Utilities**

  WOMBAT is an interactive formatting and diagnostic utility contained within the SDC-RQD11-SCSI firmware. An on-board serial connector allows running WOMBAT on an ASCII terminal, which permits interactive disk with minimal additional hardware.

  WOMBAT can also load a simple console communication program into the host computer's memory, or it can be invoked on system power- up. No external software, media, or program-loading device is required for maintaining the SDC-RQD11-SCSI or its attached drives. WOMBAT is accessible independently of the host CPU type or the operating system environment.

- **WOMBAT Initialization**

  WOMBAT initializes a fresh disk drive by writing sector addresses and data blocks through the entire recording surface. WOMBAT prompts the user at the terminal to supply parameters such as drive geometry (cylinders, heads, and sectors) and various other options, using defaults provided by the SCSI drive. This data is stored twice in special reserved areas of track zero and retrieved by a simple homeseek-read sequence at each power-up. No special PROMs or switch settings are required to fully characterize the attached disk drives.

- **WOMBAT Self Diagnostics**

  The SDC-RQD11-SCSI contains a comprehensive set of self diagnostic procedures which are executed automatically on power-up. Success is indicated when an on-board green LED is lit.

- **WOMBAT Interactive Diagnostics**

  Terminal oriented engineering utilities contained within the WOMBAT firmware include a continuous read/write/seek exerciser and a disk surface pattern tester.

1.3 Specifications

Q-bus Interface:	MicroVAX II, MicroVAX 3x00, LSI-11/2, -23, -53, -73. -83.
Q-bus Loads:	1 DC and 1 AC.
Interface:	SCSI.
SCSI ID:	Selectable from 0 to 7.
Connector:	Requires standard 50-conductor ribbon cable.
Devices:	Supports up to 7 SCSI drives in any mix/match combination of disk and tape drives.
Transfer Mode:	Block Mode DMA or, alternatively, burst mode DMA.
Memory Address:	4 megabyte capacity (22-bit).
Software Emulation:	DEC MSCP as RQDX2/3 and TMSCP as TK50.
Command Buffer:	Up to 32 commands capacity.
Base (CSR) Address:	Separate address for disk and tape devices.
Tape:	Jumper selectable from 160334_8 to 174500_8. Factory set at 174500_8.
Disk	Jumper selectable from 160334_8 to 174500_8. Factory set at 172150_8.
Vector Interrupt:	Software programmable.
Interrupt Level:	Jumper selectable 4, 5, 6, or 7.
Power Requirements:	+5VDC at 3.65 amps typical.
Boot:	DU:, MS:, DL:, DY:, and MU:.
LSI-11 Bootstrap:	Jumper selectable. Disable or enable at 17773000_8 or 17771000_8.
LED Indicator:	Green. On for successful power-up diagnostics.
RS-232 I/O:	Data transmitted to/from ASCII terminal at 9600 baud.
Connectors:	One 50-pin SCSI interface connector.
	One 10-pin ASCII terminal or front panel connector.

Dimensions: Standard Q-bus dual board.

SCSI Support

SCSI Commands for TMSCP Operation:

Code	Command Name
00	Test Unit Ready
01	Rewind
03	Request Sense
08	Read
0A	Write
10	Write Filemarks
11	Space
12	Inquiry
15	Mode Select
19	Erase
1A	Mode Sense
1B	Load/Unload

SCSI Commands for MSCP Operation:

Code	Command Name
00h	Test Unit Ready
01h	Rezero Unit
03h	Request Sense
04h	Format Unit
07h	Reassign Block
08h	Read
0Ah	Write
12h	Inquiry
15h	Mode Select
1Ah	Mode Sense
25h	Read Capacity
28h	Extended Read (2)
2Ah	Extended Write (2)
2Bh	Extended Seek (2)

SCSI Status Codes:

Code	Status Name
00	Good
02	Check Condition
08	Busy

SCSI Messages:

Code	Message Name
00	Command Complete
02	Save Data Pointer
03	Restore Pointer
04	Disconnect
05	Initiator Detect Error
07	Message Reject
08	No Operation
09	Message Parity Error
80-FF	Identify

J1 Pin Assignments

Pin	Signal	Pin	Signal
2	-DB0	26	TERMPWR
4	-DB1	28	GROUND
6	-DB2	30	GROUND
8	-DB3	32	-ATN
10	-DB4	34	GROUND
12	-DB5	36	-BSY
14	-DB6	38	-ACK
16	-DB7	40	-RST
18	-DB(P)	42	-MSG
20	GROUND	44	-SEL
22	GROUND	46	-C/D
24	GROUND	48	-REQ
		50	-I/O

Minus = Active low.
*Odd numbered pins are grounds (except pin 25, which is open).

2. Installation

2.1 Unpacking and Inspection

The SDC-RQD11-SCSI is shipped in a special packing carton designed to keep the module from vibrating and to give it maximum protection during shipment. The packing carton should be retained in case the unit requires reshipment.

Contact Sigma Information Systems for a Return Merchandise Authorization (RMA) before returning any equipment to the factory.

2.2 Jumper Configurations

The SDC-RQD11-SCSI is shipped configured with DEC standard tape address 174500_8, disk address 172150_8, bus interrupt level 4, and SCSI ID #7. The location of the jumpers that determine these parameters is shown in Figure 2-1.

Before installing the board, verify that the jumpers are set properly for your configuration. The following sections describe the jumpers to verify and/or reconfigure factory-set parameters.

Figure 2-1: SDC-RQD11-SCSI Factory Set Configurations

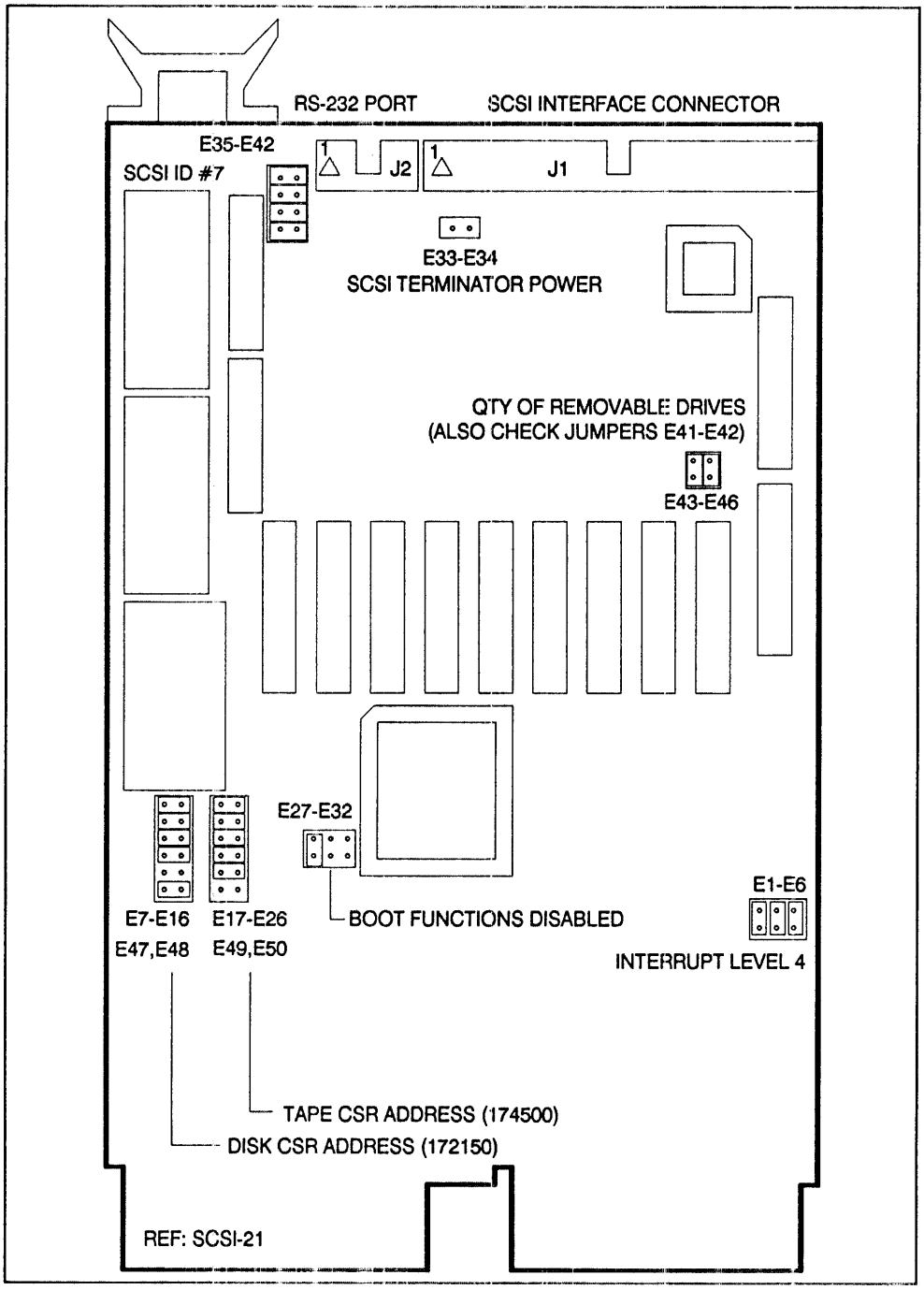


Table 2-1: Factory Set Parameters

FUNCTION	FACTORY SET
Tape CSR Address	174500_8
Disk CSR Address	172150_8
Boot (LSI-11)	Disabled
SCSI ID#	7
Number of Removable Drives	0
SCSI Terminator	Out

2.2.1 CSR Address Selection

The tape CSR address is factory set to 174500_8 and the disk CSR address is factory set to 172150_8. Jumpers E17 through E26 and E49-E50 define the tape CSR address. Jumpers E7 through E16 and E47-E48 define the disk CSR address. Figure 2-2 shows these jumpers.

Table 2-2 lists other address configurations for tape drives, and Table 2-3 lists other address configurations for disk drives.

Note

If either a tape or disk drive is not connected to the SDC-RQD11-SCSI, the tape or disk CSR address must be disabled. See last entry in Table 2-2 for tape CSR disable, and table 2-3 for disk CSR disable.

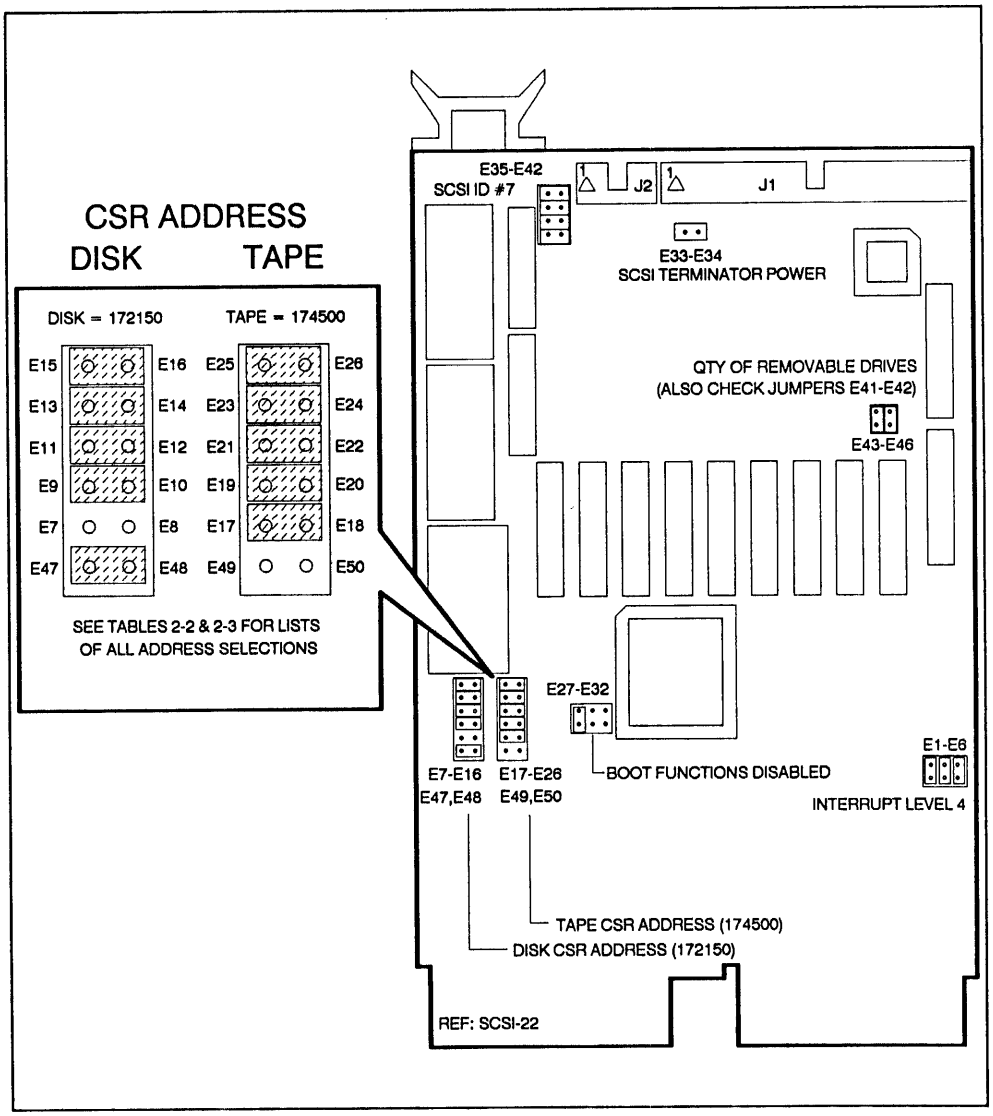


Figure 2-2: Disk and Tape CSR Address Selection

Table 2-2: Tape CSR Address Selection

MicroVAX II	LSI-11	E25-E26	E23-E24	E21-E22	E19-E20	E17-E18	E49-E50
20001940	17774500*	IN	IN	IN	IN	IN	OUT
20001468	17772150	IN	IN	IN	IN	OUT	IN
200000DC	17760334	IN	IN	IN	OUT	IN	IN
200000E0	17760340	IN	IN	IN	OUT	OUT	IN
200000E4	17760344	IN	IN	OUT	IN	IN	IN
200000E8	17760350	IN	IN	OUT	IN	OUT	IN
200000EC	17760354	IN	IN	OUT	OUT	IN	IN
200000F0	17760360	IN	IN	OUT	OUT	OUT	IN
200000F4	17760364	IN	OUT	IN	IN	IN	IN
200000F8	17760370	IN	OUT	IN	IN	OUT	IN
200000FC	17760374	IN	OUT	IN	OUT	IN	IN
20000100	17760400	IN	OUT	IN	OUT	OUT	IN
20000104	17760404	IN	OUT	OUT	IN	IN	IN
20000108	17760410	IN	OUT	OUT	IN	IN	OUT
2000010C	17760414	IN	OUT	OUT	IN	OUT	OUT
20000110	17760420	IN	OUT	OUT	OUT	IN	OUT
20000114	17760424	IN	OUT	OUT	OUT	OUT	OUT
20000118	17760430	OUT	IN	IN	IN	IN	OUT
2000011C	17760434	OUT	IN	IN	IN	OUT	OUT
20000120	17760440	OUT	IN	IN	OUT	IN	OUT
20000124	17760444	OUT	IN	IN	OUT	OUT	OUT
20000128	17760450	OUT	IN	OUT	IN	IN	OUT
2000012C	17760454	OUT	IN	OUT	IN	OUT	OUT
20000130	17760460	OUT	IN	OUT	OUT	IN	OUT
20000134	17760464	OUT	IN	OUT	OUT	OUT	OUT
20000138	17760470	OUT	OUT	IN	IN	IN	OUT
2000013C	17760474	OUT	OUT	IN	IN	OUT	OUT
20000140	17760500	OUT	OUT	IN	OUT	IN	OUT
20000144	17760504	OUT	OUT	IN	OUT	OUT	OUT
20000148	17760510	OUT	OUT	OUT	IN	IN	OUT
2000014C	17760514	OUT	OUT	OUT	IN	OUT	OUT
DISABLE CSR	DISABLE CSR	OUT	OUT	OUT	OUT	OUT	OUT

*Factory Set.

Table 2-3: Disk CSR Address Selection

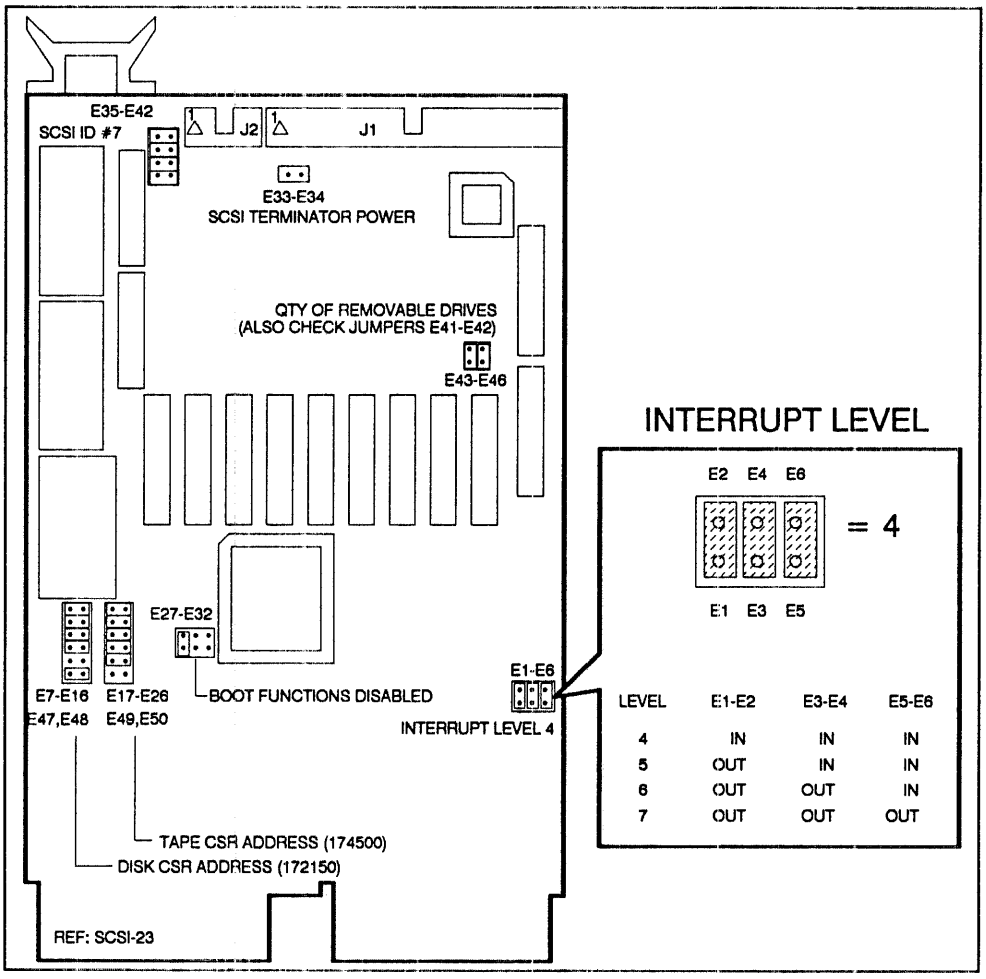
MicroVAX II	LSI-11	E15-E16	E13-E14	E11-E12	E9-E10	E7-E8	E47-E48
20001940	17774500	IN	IN	IN	IN	IN	OUT
20001468	17772150*	IN	IN	IN	IN	OUT	IN
200000DC	17760334	IN	IN	IN	OUT	IN	IN
200000E0	17760340	IN	IN	IN	OUT	OUT	IN
200000E4	17760344	IN	IN	OUT	IN	IN	IN
200000E8	17760350	IN	IN	OUT	IN	OUT	IN
200000EC	17760354	IN	IN	OUT	OUT	IN	IN
200000F0	17760360	IN	IN	OUT	OUT	OUT	IN
200000F4	17760364	IN	OUT	IN	IN	IN	IN
200000F8	17760370	IN	OUT	IN	IN	OUT	IN
200000FC	17760374	IN	OUT	IN	OUT	IN	IN
20000100	17760400	IN	OUT	IN	OUT	OUT	IN
20000104	17760404	IN	OUT	OUT	IN	IN	IN
20000108	17760410	IN	OUT	OUT	IN	IN	OUT
2000010C	17760414	IN	OUT	OUT	IN	OUT	OUT
20000110	17760420	IN	OUT	OUT	OUT	IN	OUT
20000114	17760424	IN	OUT	OUT	OUT	OUT	OUT
20000118	17760430	OUT	IN	IN	IN	IN	OUT
2000011C	17760434	OUT	IN	IN	IN	OUT	OUT
20000120	17760440	OUT	IN	IN	OUT	IN	OUT
20000124	17760444	OUT	IN	IN	OUT	OUT	OUT
20000128	17760450	OUT	IN	OUT	IN	IN	OUT
2000012C	17760454	OUT	IN	OUT	IN	OUT	OUT
20000130	17760460	OUT	IN	OUT	OUT	IN	OUT
20000134	17760464	OUT	IN	OUT	OUT	OUT	OUT
20000138	17760470	OUT	OUT	IN	IN	IN	OUT
2000013C	17760474	OUT	OUT	IN	IN	OUT	OUT
20000140	17760500	OUT	OUT	IN	OUT	IN	OUT
20000144	17760504	OUT	OUT	IN	OUT	OUT	OUT
20000148	17760510	OUT	OUT	OUT	IN	IN	OUT
2000014C	17760514	OUT	OUT	OUT	IN	OUT	OUT
DISABLE CSR	DISABLE CSR	OUT	OUT	OUT	OUT	OUT	OUT

*Factory Set.

2.2.2 Interrupt Level Selection

The interrupt level is set to 4. Jumpers E1 through E6 determine the interrupt level as shown in Figure 2-3. Interrupt level can be reconfigured to 5, 6, or 7.

Figure 2-3: Interrupt Level Jumper Selection



2.2.3 SCSI Terminator Power

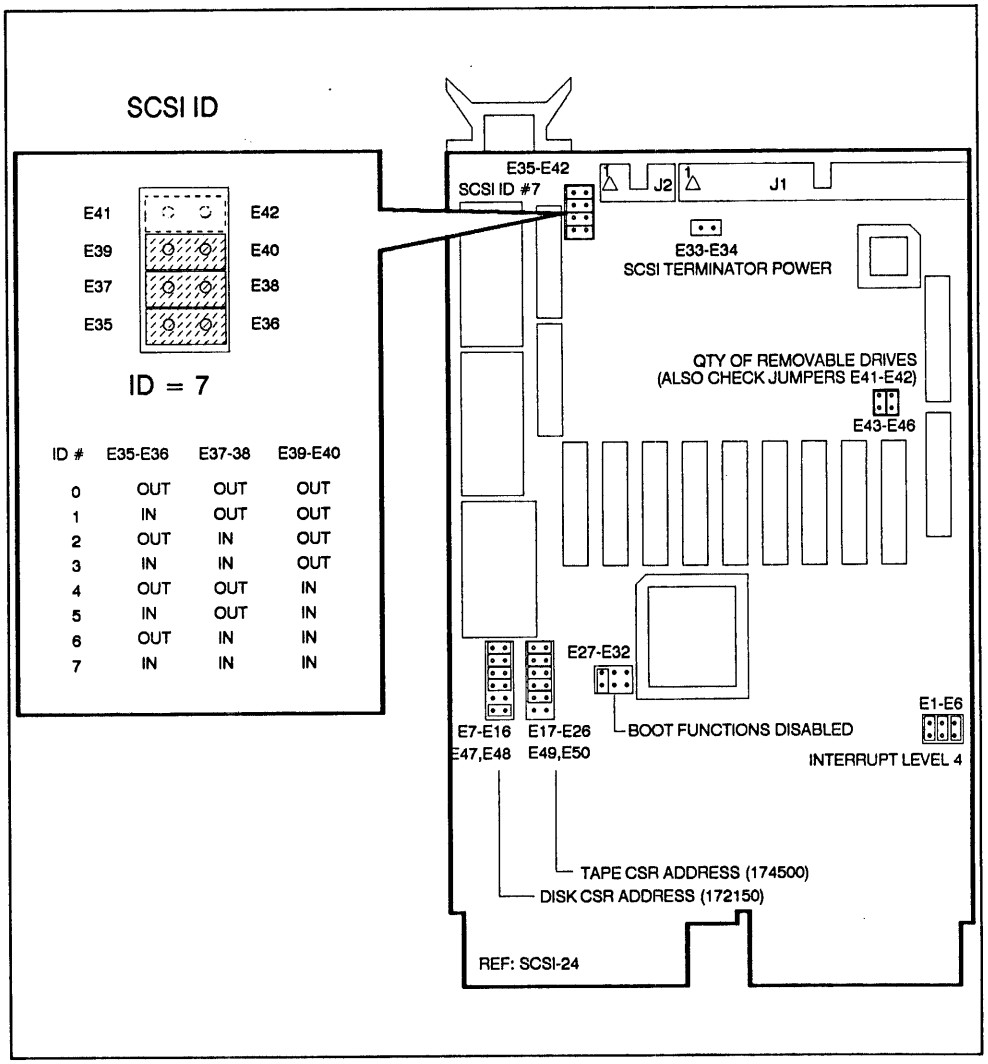
The jumper (E33-E34) that provides power for termination is OUT. If the tape drive (target device) does not have termination power, add a jumper shunt in E33-E34.

2.2.4 SCSI ID

Each device on the SCSI bus requires a unique SCSI ID number (0 through 7). SCSI ID 0 has the highest priority on the bus, and SCSI ID 7 has the lowest priority.

The SDC-RQD11-SCSI is factory configured for SCSI ID 7. Jumpers E35 through E40 determine the SCSI ID. SCSI ID number can be reconfigured by changing the jumpers shown in Figure 2-4.

Figure 2-4: SCSI ID# Jumper Configurations



2.2.5 On-Board Boot (LSI-11 Only)

The SDC-RQD11-SCSI contains jumpers to configure the controller as the primary boot device at address 173000 or as the secondary boot device at address 171000. The boot function can also be disabled (factory set).

The on-board boot function is applicable only for LSI-11 systems.

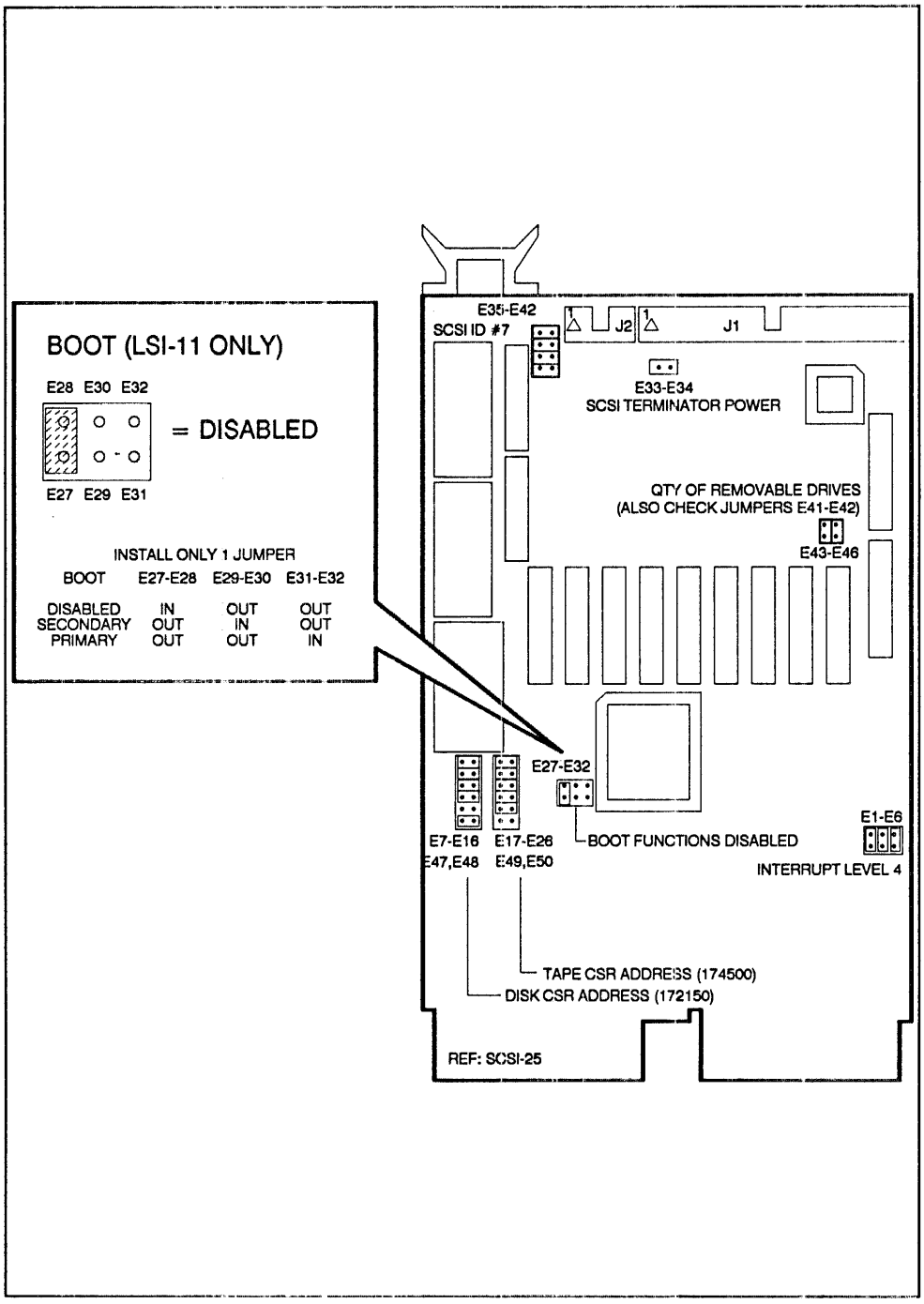


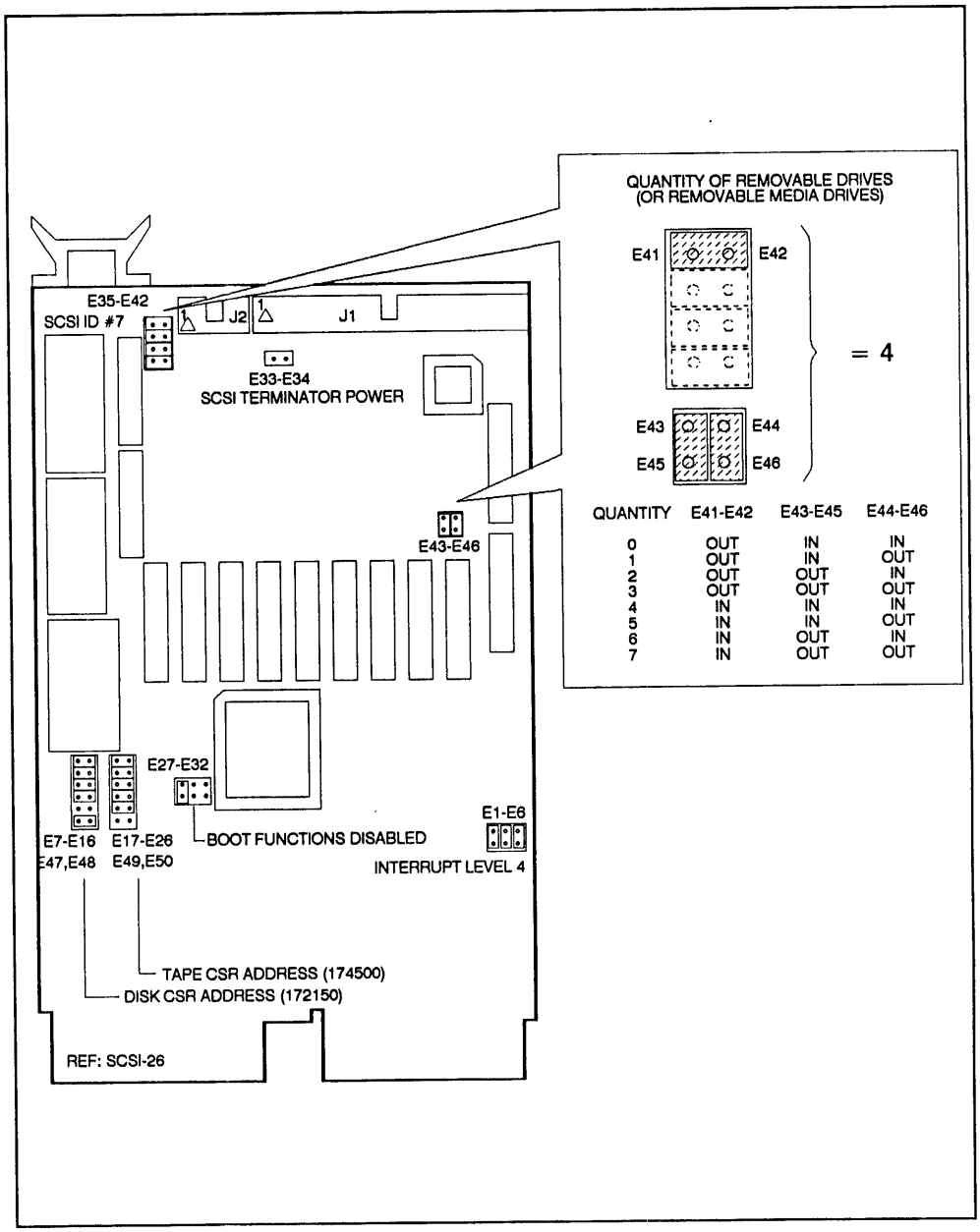
Figure 2-5: On-board Boot Configurations

2.2.6 Removable Drive Configuration

The number of removable media drives (or removable drives) connected to the SDC-RQD11-SCSI controller is defined by installing/removing jumpers E43-E45, E44-E46 and E41-42.

The factory set configuration is for no removable drives. Figure 2-6 shows the jumper for reconfiguring the number of removable drives.

Figure 2-6: Number of Removable Drives Configurations



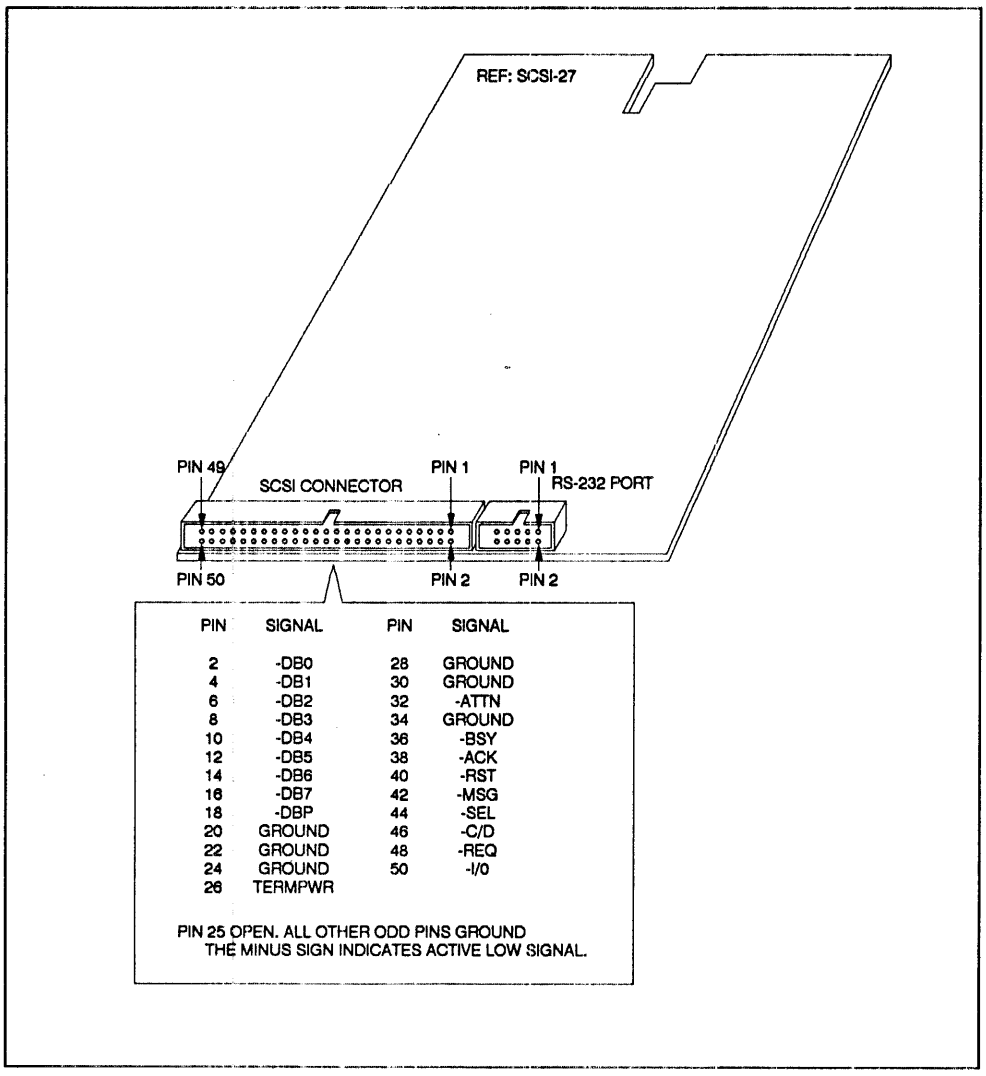
2.3 Cabling

A 50-conductor flat ribbon cable interfaces between the controller and the first drive via 50-pin male Berg connectors on either end of the cable. Additional drives are daisy-chained. The maximum cable length must not exceed 6 meters (20 feet).

The SDC-RQD11-SCSI also contains a 10-pin RS-232 connector for cabling directly to an ASCII terminal for WOMBAT operation, or for cabling to a front panel with write protect switches and LEDs.

The SCSI connector pinouts and RS-232 port are shown in Figure 2-7.

Figure 2-7: Connectors



PIN	SIGNAL	PIN	SIGNAL
2	-DB0	28	GROUND
4	-DB1	30	GROUND
6	-DB2	32	-ATTN
8	-DB3	34	GROUND
10	-DB4	36	-BSY
12	-DB5	38	-ACK
14	-DB6	40	-RST
16	-DB7	42	-MSG
18	-DBP	44	-SEL
20	GROUND	46	-C/D
22	GROUND	48	-REQ
24	GROUND	50	-I/O
26	TERMPWR		

PIN 25 OPEN. ALL OTHER ODD PINS GROUND
THE MINUS SIGN INDICATES ACTIVE LOW SIGNAL.

3. WOMBAT Utilities

3.1 Invoking WOMBAT

WOMBAT provides a controller resident means of formatting, testing and maintaining the drive and controller subsystem. All WOMBAT functions are menu driven and are designed to simplify the process of structuring, formatting and testing drives.

WOMBAT can be invoked by any of the following methods:

a. By selecting the 'W' option during the system bootstrap operation if the SDC-RQD11-SCSI boot is enabled. This allows disk testing and diagnostics to be performed from the user console. The console link is formed by a communication program which WOMBAT downloads into main memory.

b. By entering 250 (LSI-11) or 254 (MicroVAX II) from the console terminal using ODT. This allows disk testing and diagnostics to be performed from the user console. The console link is formed by a communication program which WOMBAT downloads into main memory.

c. By connecting a 9600 baud auxiliary terminal to the SDC-RQD11-SCSI Maintenance Connector and entering 260 from the console terminal using ODT. This allows disk testing and diagnostics to be performed from an auxiliary terminal which communicates directly with on-board WOMBAT utilities.

d. By depositing 272 into the IP register a user-written communication routine can communicate directly with WOMBAT. This call does not outload any communication routine into the host memory.

Table 3-1 summarizes the procedures that invoke WOMBAT.

Table 3-1: WOMBAT Initialization Procedure

ACTION		CONDITIONS	CONTROL
*OCTAL	*HEX		
000250	00AB	ODT	LSI-11 Console
000254	00AC	ODT	MicroVAX Console
000260	00B0	ODT	Aux Terminal on Maintenance Connector
000272	00BA	ON-LINE	User Communication Program
W		Via Boot	System Console

*These codes are deposited into the IP register.

The procedures for invoking WOMBAT on LSI-11, and the MicroVAX II are given below. WOMBAT can be stopped by simply re-booting the system.

LSI-11 CPU

The following details the procedure for invoking WOMBAT on an LSI-11 CPU system using console ODT.

Halt the processor.

'CSR' /	**000000**	**250**	(ask WOMBAT to load the communications program)
R7 /	**XXXXXX**	**2000**	(set up the program start address)
RS /	**000000**	**340**	(set PSW to block interrupts)
P			(now start the program without a bus reset.)

MicroVAX II

The following details the procedure for invoking WOMBAT in a MicroVax II using ODT.

Halt the CPU at the end of its start-up diagnostics by turning on the "halt enable" switch at the back of the CPU.

When it halts:

D/P/W	**20001F40**	**20**	(enable Q-bus access to memory)
D/L	**20088008**	**80000002**	(set-up the appropriate Q-bus map entry)
D/W	**2000xxxx**	**AC**	(ask WOMBAT to load the communications program into memory)
S	**400**		(start the program)

where xxxx is defined in Table 2-2.

3.2 WOMBAT Menu Options

When WOMBAT is invoked it will display an announcement and then print a list of all drives and units and prompts for the drive number on which to perform operations.

SDC-RQD11-SC **WOMBAT Version: 1.x** **HOST SCSI ID: 1**
(where x is the firmware revision level.)

DISK DRIVE UNIT INFORMATION

UNIT	DRIVE	OFFSET	SIZE	STATUS
0	5	35	274999	AVAIL

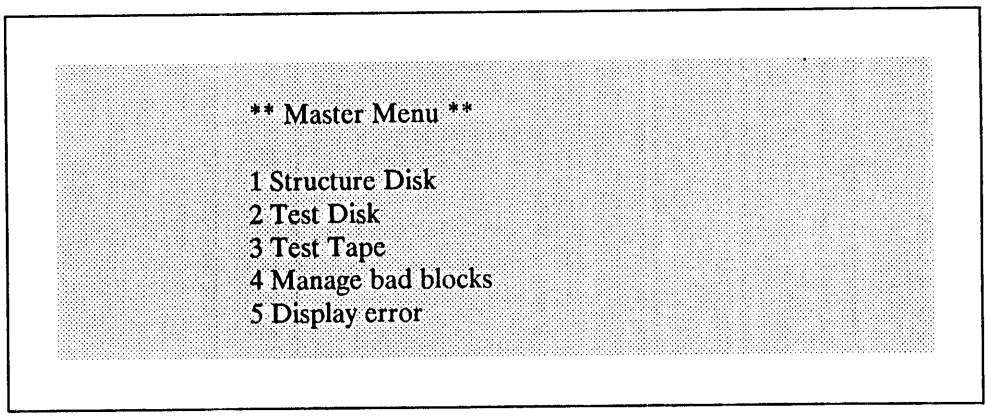
DISK DRIVE GEOMETRY INFORMATION

DRIVE	BLOCK	DRIVE TYPE
5	275034	FIXED

COMBINED DISK AND TAPE SCSI INFORMATION

DRIVE	SID	LUN	STATUS	VENDOR	PRODUCT
0	0	0	SPUN DN	EXABYTE	EXB-8200
5	5	0	SPUN UP	FUJITSU	M2246SA

Drive number :
Enter the drive number (zero on a single-drive system). WOMBAT will then display the Master Menu options.



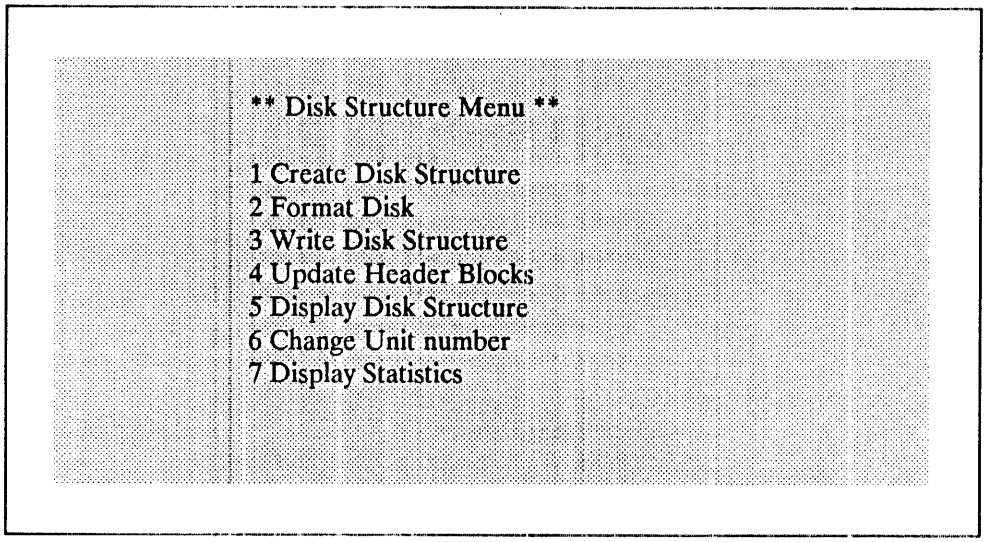
Select an option by typing the option number followed by RETURN. Options 1 through 3 will provide sub menus while option 4 displays the last controller detected fatal error. To return to the master menu from a sub menu type **RETURN.**

To exit from the master menu to the announcement (to select a different drive) type **RETURN.** WOMBAT will not allow you to do this before verifying whether the disk structure data has been written to disk. 'NO' is the default value.

3.3 Master Menu Options

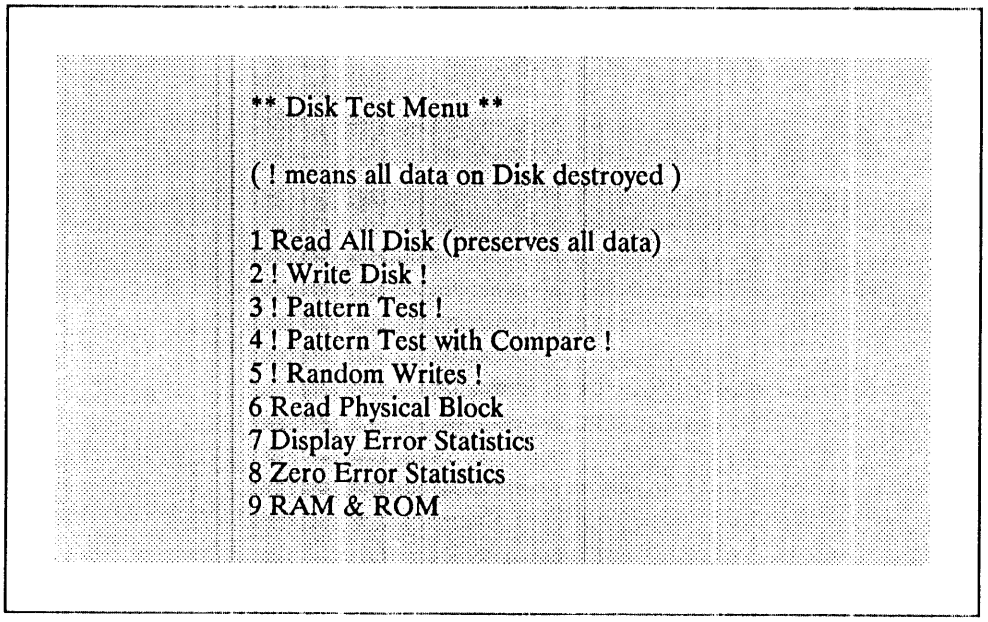
Option 1 - Structure Disk

Selecting this option causes a sub menu to be displayed as follows:



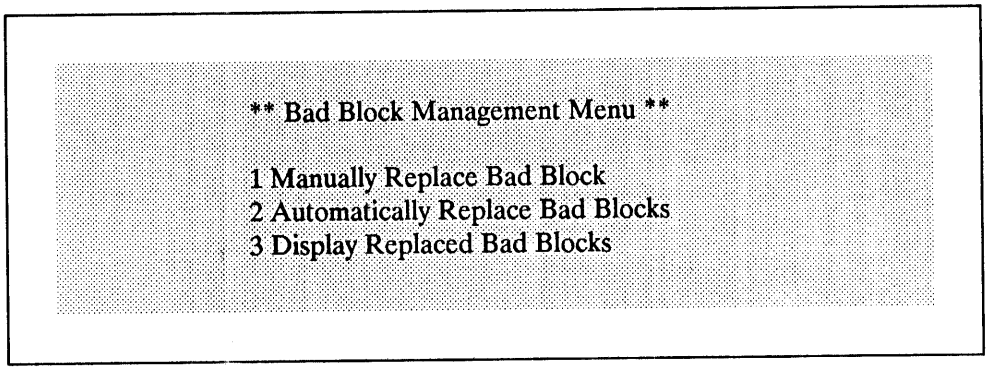
Option 2 - Test Disk

Selecting this option causes a sub menu to be displayed as follows:



Option 3 - Manage Bad Blocks

Selecting this option causes a sub menu to be displayed as follows:



Option 4 - Display Error

Selecting this option causes WOMBAT to display a message which explains the most recent controller detected error. An error message in the format shown below is designed to aid controller trouble shooting. It describes the internal contents of the WD33C93 chip.

WD ERROR DID:07 AUX:00 STS:42 TC:00001A CP:00 DID:07 CMD:030000001A00 TS:00

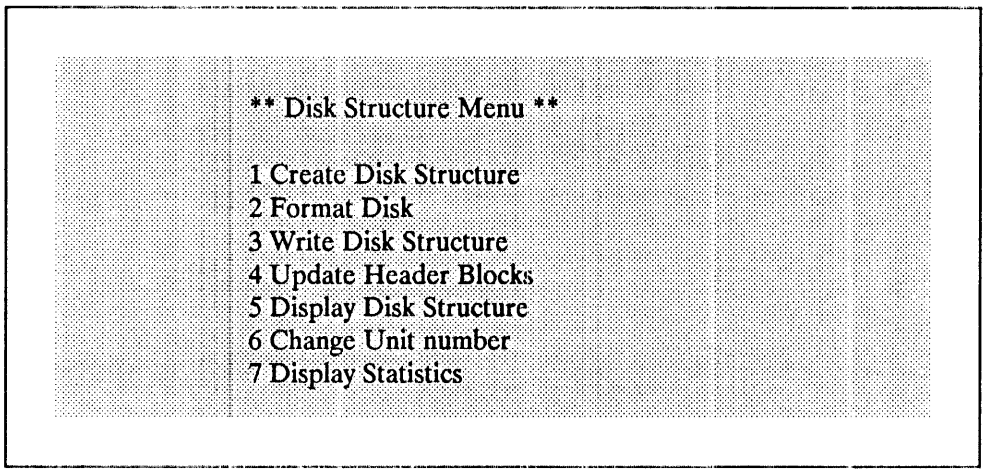
Setting Up a New Disk

The procedure for structuring a new disk is as follows:

1. Create disk structure.
2. Format the disk. (Optional)
3. Write the disk structure.
4. Pattern test the disk.
5. Replace bad blocks detected by pattern test.

Once these 5 steps have been undertaken the host operating system may use the disk.

3.4 Disk Structure Menu Options



Option 1 - Create Disk Structure

The Create Disk Structure option must be performed when a new disk is connected to the SDC-RQD11-SCSI. This allows the various disk geometry, controller wide tuning parameters and virtual unit structure to be specified. The virtual unit structure allows a single large drive appear to the host operating system as multiple drives.

This option enters an interactive question and answer dialogue which specifies the disk structure. WOMBAT displays either the current or the default value for a parameter and gives you the option of accepting or changing it to a new value. To accept the displayed value, hit RETURN. To change it, type in the new value followed by RETURN. If WOMBAT detects improper values it will issue a warning.

The create disk structure dialogue is divided into three parts.

a. The drive structure specification, which describes the physical geometry of the drive.

b. The unit structure specification, which is executed once for each virtual unit defined where the size of each unit and unit specific parameters is described.

c. The controller wide tuning parameters, where read lookahead and command queue size are specified.

Drive Structure Specification

Blocks: The number of blocks on the drive. There is normally no need to change this value. Note that this will be less than the number of blocks specified by the manufacturer - this is to preserve the manufacturer recorded defect list.

WOMBAT next prompts for a unit number. Type the unit number of the next unit to be defined, then hit RETURN. When the unit is completely defined, WOMBAT will again prompt for a unit number. If there are no more units to define hit RETURN. WOMBAT will then proceed to the controller wide parameter definition. Note that if no units are defined, the operating system will not see anything attached to the controller.

Unit Structure Specification

Unit size: If an existing unit number is specified WOMBAT will display the size in blocks. If a new unit number is specified WOMBAT will display the size in blocks of the first unallocated disk area it finds beginning at the start of the disk. On a new disk this will be the entire user area. This can be changed to a smaller value if necessary. To delete an existing unit, specify zero for this field.

Media type: This field is displayed by some operating systems when you enquire about the type of drive. As a part of unit status when a "Get Unit Status" command is issued the MSCP protocol returns a 5 character media type. The first two characters must be 'DU'- for example - DURD54. To change this enter 1 to 5 alphabetic characters and 2 digits, e.g. RD52, to emulate DEC's 31 megabyte Winchester. For example, RSX-11M-PLUS responds to a "DEV DU:" command with : "DU0: Public Mounted Loaded Label = RSX11MPBL15 Type = RA81".

Serial number: The MSCP protocol returns a 32-bit volume serial number as a part of its response when an "on-line" command is issued. WOMBAT defaults this field to zero. To change this enter the desired serial number. This field is used, for example, by RSX-11M-PLUS, when a disk is initialized with the "INI DU:" command. It sets up the volume serial number.

Front Panel Type: This option allows the correct selection of front panel type.

0 - None
1 - Passive
2 - Active

This completes the disk structure definition. WOMBAT now checks the tables for consistency and returns to the disk structure menu.

Option 2 - Format Disk

WOMBAT asks you to confirm this drastic action as it will destroy ALL data that resides on the disk. WOMBAT will then initiate a SCSI format operation. WOMBAT then writes the disk structure onto the reserved areas.

Option 3 - Write Disk Structure

WOMBAT will ask you to confirm this drastic action as any existing disk structure will be destroyed. WOMBAT will then write the new structure onto special reserved areas of track zero. The data is recorded twice for improved recoverability. A total of 6 blocks is written on track zero.

Option 4 - Update Header Blocks

This is similar to Write disk structure. This option is used after changes to the disk structure such as changing unit numbers or redefining the virtual units. Unless the header blocks have been updated, the changes are not recorded on disk.

Option 5 - Display Disk Structure

WOMBAT displays the structure of the currently selected drive in a form similar to the create disk structure dialogue. This is useful for checking that the newly created structure is correct.

Option 6 - Change Unit Number

It is sometimes necessary to change a unit number in order to resolve a duplicate unit number or to satisfy operating system requirements. This method is a safe and simple way of doing so. WOMBAT prompts for a unit number on the current drive, and then for the new number for that unit.

NOTE: For the change to take effect, the header blocks must be updated using option 4 above.

Option 7 - Display Statistics

Statistics about disk and cache usage are maintained, and recorded on the disk periodically. They are displayed as:

Controller statistics report

# of commands	**xxxx**	
# of reads	**xxxx**	**# of cache hits xxxx (xxx%)**
# of writes	**xxxx**	

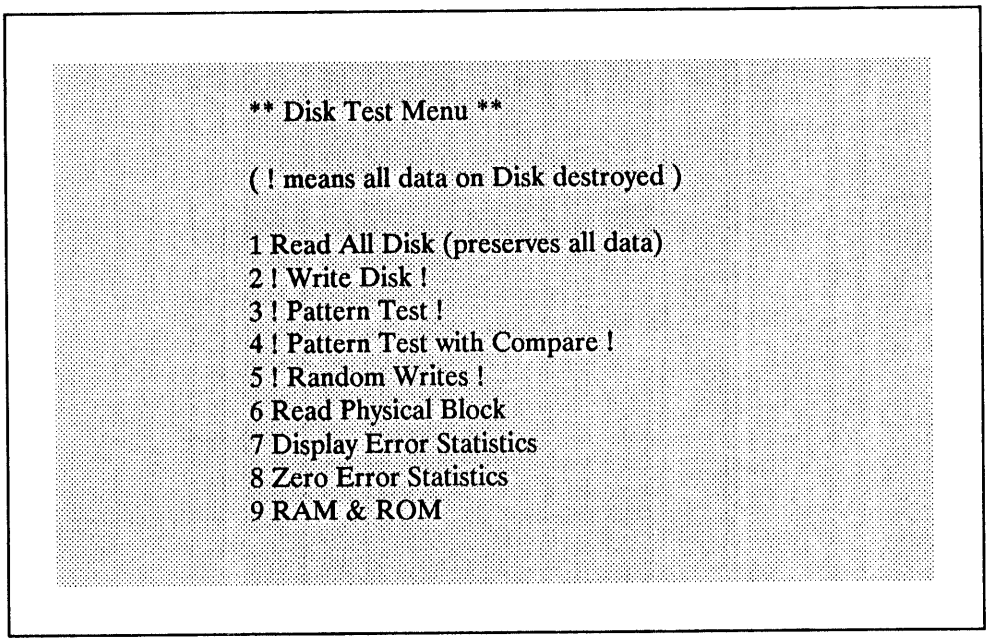
Drive statistics report

Drive #	**Soft errors**	**Re-vectors**	**Blocks replaced**
xxx	xxxx	xxxx	xxxx
Drive #	**Seek distance**	**# of seeks**	**Seek errors**
xxx	xxxx	xxxx	xxxx

Commands is the number of MSCP commands issued.
Re-vectors is the number of accesses to replaced blocks.
Seek distance is the total seek distance, in cylinders.
Blocks replaced is the number of blocks dynamically replaced by the controller during normal operation, rather than through WOMBAT.
Reset Counters is then asked. "Y" will reset them to zero.

3.5 Disk Test Menu Options

A disk can be tested after it has been formatted and before the structure is written to it. Testing does not overwrite the HDR or RCT blocks. The disk structure must be written to the disk before bad blocks can be replaced.



All tests continue indefinitely until aborted by one of the following methods:

1. If an RS232 serial port terminal is attached to the controller, press BREAK.

2. If WOMBAT is running from the Console terminal, type CTRL/C.

When a test is aborted the Test Disk Menu options are returned. If tests are run from an RS232 terminal attached to the controller, beware of system activity on the host computer as Q-bus initializations will cause the disk controller firmware to re-initialize and so leave WOMBAT.

All tests give 10 retries on an error, reporting every error by displaying the block number and an error code.

Option 1 - Read All Disk

This test reports any read errors. Successful operation will be reported in the following format:

```
Pass: 1. Errors: 0.
Pass: 2. Errors: 0.
```

This function does not destroy any information.

Option 2 - Write Disk

This test reports any write errors while writing a test pattern to the whole disk. ALL INFORMATION on the disk, excepting HDR and RCT blocks, is DESTROYED. Errors are displayed in the standard format:

```
Block: 32040   (Error message)
Pass:1. Errors: 1.
Pass:2. Errors: 1.
```

The displayed error count is cumulative until the test is terminated.

Option 3 - Pattern Test

A test pattern is written to each block, including the replacement blocks. WOMBAT does one write and 10 read passes. This test reports any errors in the standard format as shown above.

Option 4 - Pattern Test with Compare

A test pattern is written to each block, including the replacement blocks. WOMBAT does one write and 10 read and verify passes. This test also reports any errors in the standard format as shown above.

Option 5 - Random Writes

This test writes 5000 blocks at random locations in the user area of the disk. It then reads the entire disk to determine if any of the writes caused an error. This test is designed to test the head positioning and selecting logic of the drive.

Option 6 - Read Physical Block

WOMBAT prompts for a block number anywhere on the disk. It then converts that block number into a physical address consisting of cylinder, head, and sector, and displays these values in hex and ASCII. Then it reads that sector and displays a message indicating the success or failure of the read. The same physical block can be re-read by typing \ instead of a block number. The block's replacement block can be read by typing @.

Option 7 - Display Error Statistics

Displays the error statistics gathered by any of the above disk testing options in the following format:

```
** Error Statistics **

Block  Number (of errors)
32040          1.
Blocks in error: 1.
```

Option 8 - Zero Error Statistics

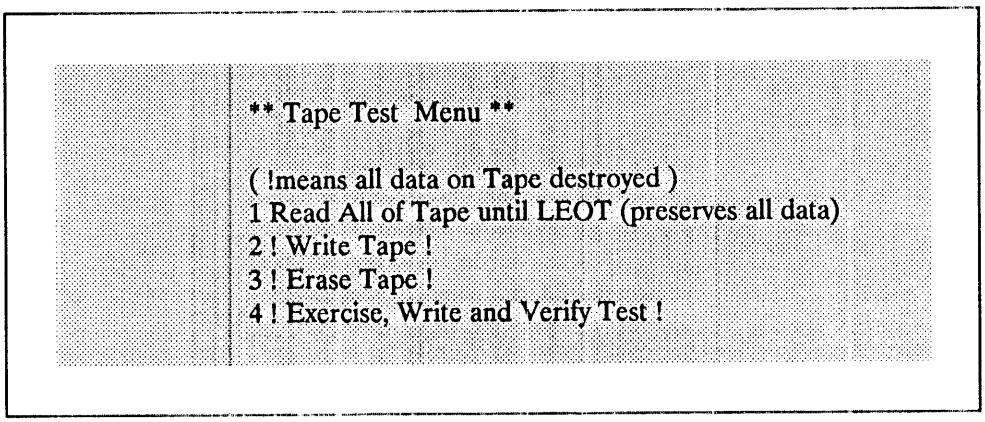
Zeroes the error statistics table & redisplays Test Menu options.

Option 9 - RAM & ROM Option

This test continuously writes test patterns throughout the entire cache and reads them back testing for veracity. A separate part of the test automatically checks that the parity logic is functioning correctly by forcing incorrect parity and checking that an error occurred. The Static RAM is also tested and the code PROM is Check-summed.

3.6 Tape Test Menu Options

A tape can be tested at any time. All tape test automatically perform a rewind at the beginning of each test.



All tests continue indefinitely until aborted by one of the following methods:

1. If an RS232 serial port terminal is attached to the controller, press BREAK.

2. If WOMBAT is running from the Console terminal, type CTRL/C.

When a test is aborted the Test Tape Menu options are returned. If tests are run from an RS232 terminal attached to the controller, beware of system activity on the host computer as Q-bus initializations will cause the disk controller firmware to re-initialize and so leave WOMBAT.

Option 1 - Read Tape

Each test pass will read a tape until an error occurs, logical end of tape (LEOT), physical end of tape (EOT), or until it is aborted. The test will display the length of each record each and any file marks encountered. After a pass is completed, the test will rewind the tape and begin over again until aborted with BREAK or CTRL/C key.

This function does not destroy any information.

Option 2 - Write Tape

Each test pass will write a test data pattern to the tape. All information on the tape will be DESTROYED. The test will display a message every 256 blocks and also write a filemark every 256 blocks. A test pass will terminate at end of tape (EOT). After a test pass is complete the tape will rewind and another test pass will be performed until aborted with a BREAK or CTRL/C key.

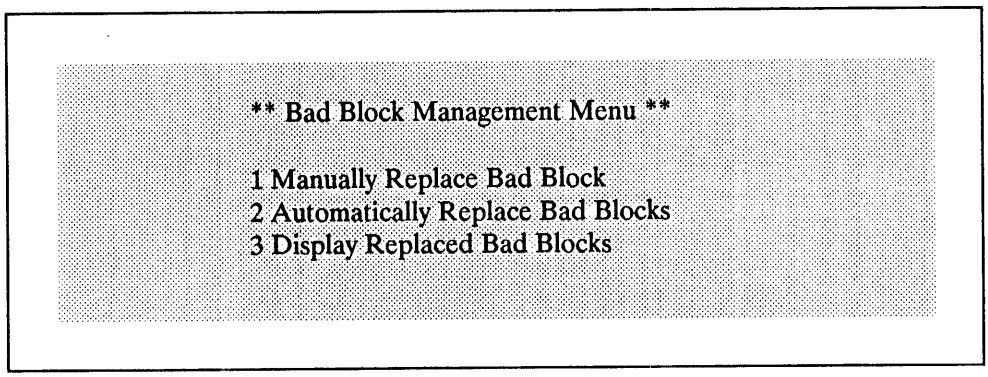
Option 3 - Erase Tape

This function will execute the SCSI tape erase command. It will result in a physical blank tape. This test makes only one pass and can be aborted with a BREAK or CTRL/C key.

Option 4 - Exercise, Write and Verify Test

This function will position write, read and compare a tape. It stimulates the type of tape motion required under most TMSCP programs. A test pass will terminate at end of tape (EOT). After a test pass is complete the tape will rewind and another pass will be performed until aborted with a BREAK or CTRL/C key.

3.7 Bad Block Management Menu Options



Option 1 - Manually Replace Bad Blocks

WOMBAT prompts for a block number within the user area of the disk. Then it marks the specified block as bad and allocates a replacement block for it.

Option 2 - Automatically Replace Bad Blocks

WOMBAT searches the error statistics table, which is compiled by the read, write, and pattern tests, for blocks whose error count exceeds three. Any such blocks are marked as bad on the disk and replacement blocks are allocated for them.

Option 3 - Display Replaced Bad Blocks

WOMBAT reads the Replacement Control Table and displays the logical block numbers of any blocks recorded there. Some drive vendors do not support this command, but Options 1 and 2 will still work correctly.

3.8 WOMBAT Disk Structure

WOMBAT records the logical structure of the drive on track 0. All of track 0 is reserved for this and other testing purposes. The user area begins at the next block after track 0. This is the same as the number of sectors per track.

All block numbers in WOMBAT are physical block numbers beginning at the first sector of the first head of the first cylinder of the drive, which is defined as block zero. The last block on the drive is block n-1 where n is the total number of blocks on the drive. Therefore, the first block of the user area is not block zero. Its block number is the same as the number of sectors per track, as track 0 on the drive is reserved. Option 4 of the master menu will display both the size and the offset (starting block number) of each unit defined. Using these figures you can determine the exact position and extent of any unit.

3.9 Removable Drives

The SDC-RQD11-SCSI supports removable drives. Jumpers E43&45, E44&46, and E41&42 define how many drives are removable, and they are numbered as drives 0, 1, 2, 3, 4, 5, or 6 respectively. (See section 2.2.6) The SDC-RQD11-SCSI makes certain changes to the way the removable drives operate. The important change is that you may only have one virtual unit on a drive whose media can be removed. That unit must have the same unit number as the physical drive number. The reason for this is that it is necessary to determine the unit number even though the media may be removed. This means that the unit number cannot be recorded on the media for these drives.

3.10 Error Recovery Procedures

During normal operation, the SDC-RQD11-SCSI checks every disk transfer for errors. When an I/O error is detected, the SDC-RQD11-SCSI enters a special error recovery procedure to attempt to provide the host with 'perfect' media.

The first method for recovering the data is through the SCSI drive. Each drive uses various techniques (e.g. ECC Correction, Automatic Bad Block Relocation, Recalibration and Retry) to provide 'perfect' media. The exact technique may vary according to the drive manufacturer.

The second method used to recover the data is simply to try the operation again. If this succeeds, the host is guaranteed to receive good data. This is repeated until a threshold is reached.

If the data is successfully recovered by retrying, then the number of retries necessary is checked. If it exceeds the retry soft error limit then that block is dynamically replaced, on the assumption that it is in the process of gradual failure and will get worse. The known good data is written to the replacement block and the host is notified of success.

If the data cannot be recovered by any of these means then the block is assumed to be bad. The block is dynamically replaced, and an error status will be returned to the host.

3.11 WOMBAT Error Messages

If a check condition status is issued, WOMBAT will perform a SCSI Request Sense Command. The following errors can be displayed:

NO ERRORS	A check condition was issued but no errors were encountered.
RECOVERED ERROR	The target device corrected a media error.
NOT READY	Target unit cannot be accessed. Operator intervention may be requred.
HARD DATA ERROR	Command terminated with a non recovered error condition caused by a media flaw.
HARDWARE ERROR	Indicated a nonrecoverable hardware failure.
INVALID COMMAND	The target received an invalid command.
UNIT ATTENTION	Indicates a SCSI reset has occurred, a removable media has been removed and replaced, or a power failure.
WRITE PROTECT	Indicates that a command attempted to write on a write protected target.

If the target does not issue a check condition status or if the SCSI Request Sense Command fails, the following error messages may be displayed:

REQSEN ERR	Unable to issue Request Sense Command.
AUX ST ERR	Internal SCSI bus failure.
RECON FAIL	A target device failed to reconnect.
E_QBUS	An error occurred while accessing the Q-bus
NO SCSI INTERRUPT	Internal SCSI bus failure

3.12 WOMBAT Self-Diagnostics

Initialization procedures

A common initialization procedure exists for both WOMBAT and the MSCP firmware. It performs:

a RAM integrity test
a ROM checksum
various checks on the disk drive and its structure

The possible results from this procedure are described under Appendix A, SCSI Bus Interface Controller Status.

4. Operating Systems

The following discussion is intended to supplement DEC operating system resources and aims to aid the user of the SDC-RQD11-SCSI in understanding how different operating systems integrate the device. This information will help the user of the controller plan the installation and in choosing the appropriate bus addresses and interrupt vectors for the disk subsystem. For a complete description the DEC system documentation should be consulted.

4.1 Operating Systems Overview

In order to install any new device in a computer, the host operating system must be informed of the device's existence and where to find that device. In DEC operating systems this can be done in one of the following ways:

(a) The device can be manually connected using CONNECT or CONFIGURE statements.

(b) The operating system can be informed about the peripheral device during an interactive SYSGEN.

(c) The operating system can poll the device I/O address space.

Any of these methods will accomplish the desired result. The host system will be alerted to the device's existence, type, address and interrupt vectors.

Method (a) creates a command file that is executed on power-up. Method (b), interactive sysgen, creates a configuration file that the operating system accesses on power-up. Method (c) is referred to as 'autoconfigure'. RT-11 does not use autoconfigure but references standard bus addresses where it expects to find a device. All DEC operating systems try to follow the same set of rules but there are differences. These are discussed next.

MSCP Devices

The SDC-RQD11-SCSI is an MSCP (Mass Storage Control Protocol) type device. All MSCP-type devices contain two registers that are visible to the Q-bus I/O page. They are the Initialization and Polling (IP) register and the Status and Address (SA) register.

Q-bus Addresses

The standard Q-bus address of 17772150 (Octal) is used by all of the operating systems described in this manual as the address of the first controller on the host system. The IP register, CSR address, Q-bus address and the base address all refer to the same register.

Vector Addresses

Many operating systems choose vector addresses automatically. If an operating system requires manual input of vector addresses they are programmed into the controller during the initialization process.

Device Names

Table 4-1 and 4-2 are lists of disk and tape device names for five operating systems. Two controller and device names are given to indicate the numbering scheme.

Table 4-1: Disk Device Names in DEC Operating Systems

OPERATING SYSTEM	CONTROLLER 1st:	CONTROLLER 2nd:	DRIVE 1st:	DRIVE 2nd:
RSTS/E	RU0,	RU1	DU0,	DU1
RSX-11M	---	---	DU0,	DU1
RSX-11M-PLUS	DUA	DUB	DU0,	DU1
RT-11	Port0	Port1	DU0,	DU1
VAX/VMS	PUA,	PUB	DUA0,	DUA1

Table 4-2: Tape Device Names in DEC Operating Systems

OPERATING SYSTEM	CONTROLLER 1st:	CONTROLLER 2nd:	DRIVE 1st:	DRIVE 2nd:
RSTS/E	---	---	MU0,	MU1
RSX-11M	---	---	MU0,	MU1
RSX-11M-PLUS	---	---	MU0,	MU1
RT-11	---	---	MU0,	MU1
VAX/VMS	PTA,	PTB	MUA0,	MUA1

4.2 RT-11 Operating System

Installation of a Single Controller

A single controller is installed at the Q-bus address of 17772150 (Octal) where RT-11 will find and then install the handler for that device. It is not necessary to run sysgen for a single controller. One of the pre-generated monitors provided with the RT-11 distribution kit can be used. To properly implement disk partitioning, the system start-up file (STARTx.COM) must be modified.

Installation of Multiple Controllers

There are two valid methods that can be used to install multiple controllers. Either by modifying the MSCP handler, which is described in the RT-11 Software Support Manual or by performing a SYSGEN. The following procedure describes the SYSGEN technique with user input marked in boldface type.

1. Initiate SYSGEN:

   IND SYSGEN <return>

2. The system will then prompt the user by asking questions. The first concerns the use of a start-up command file when booting.

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

   The start-up file performs two main functions. These specify the additional controller addresses and ensure that disk partitioning is carried out consistently on each bootstrap or power-up.

3. Select the device DU: as the MSCP device when prompted for Disk Options.

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

4. Inform the system of the number of controllers to be installed.

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

   RT-11 refers to individual MSCP controllers on the host as ports. Each port has its own Q-bus and vector addresses.

5. All other devices in the host computer configuration have to be specified. After completing this step, indicate that there are no more devices by entering a period (.).

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

6. Using the SET CSR keyboard command, specify the address of all the MSCP controllers. These must be added to the system start-up file STARTx.COM. The 'x' indicates the monitor to be used - S for single job, F for foreground/background, and X for extended memory. The command file must be edited to include the following statements :

```
SET DU CSR      = 17772150 (DEFAULT)
SET DU CSR2     = 17760334
SET DU VECTOR   = 154 (DEFAULT)
SET DU VEC2     = 160
```

The second device can be at any unused address on the Q-bus I/O page supported by the pin settings on the controller. The vector address can be any unused address in the vector page. No default statements are required.

Disk Partitioning Under RT11

Drives with capacities greater than 65,535 blocks (33.5 Mbytes) cannot be handled by RT-11 unless they are partitioned into smaller segments. Each partition can be smaller than 65,535 blocks if desired but there is a maximum of eight logical devices per physical drive. Each logical drive will be addressed by RT-11 as an independent physical drive.

The assignment names of each logical drive must be placed in the start-up command file to ensure that the drives are partitioned consistently and automatically each time the system is booted. The following is an outline of the procedure used to determine the number of logical drives to be assigned to each physical drive.

1. Decide on the drive configuration to be used. The logical unit number (LUN) and data storage capacity in logical blocks of each logical drive must be known. The controller plug settings must correspond to the bus address selected.

2. The total number of logical disks any physical disk can be partitioned into is calculated by dividing the selected block size of each logical disk into the total capacity of the disk unit. Round the result to the nearest whole number. The last partition can be less than the maximum size selected. This number equals the number of logical disks.

3. STARTx.COM must now be edited to include the logical names of each partition. The format of each statement is:

   SET DUn UNIT=y PART=x PORT=z

   where 'n' is the logical device name, 'y' is the unit number, 'x' is the partition number, and 'z' is the controller number. This must be done for each partition on each drive, including drives that have only one partition.

Sample Disk Partitioning Procedure

The following is an example of the disk partitioning procedure for a drive of 245,412 blocks and a drive of 204,800 blocks. It has been decided to partition the drives into logical units of 65,535 blocks.

(a) $\frac{245{,}412}{65{,}535} = 3.74$ (4 logical units)

(b) $\frac{204{,}800}{65{,}535} = 3.12$ (4 logical units)

Dividing the unit capacities by 65,535 and rounding the result to the nearest whole number gives the number of logical units. If the remainder is very small (under 800 blocks) then it would be advisable to round the figure down rather than up to the next highest number. This may avoid problems with partitions that are too small to be practicable.

Logical names can then be assigned to the partitions beginning with DU0 on controller unit 0 and modifying the start-up file to include the assignments.

```
SET DU0 UNIT=0 PART=0 PORT=0
SET DU1 UNIT=0 PART=1 PORT=0
SET DU2 UNIT=0 PART=2 PORT=0
SET DU3 UNIT=0 PART=3 PORT=0

SET DU4 UNIT=1 PART=0 PORT=0
SET DU5 UNIT=1 PART=1 PORT=0
SET DU6 UNIT=1 PART=2 PORT=0
SET DU7 UNIT=1 PART=3 PORT=0
```

4.3 RSTS/E Operating Systems (V8.0 and above)

RSTS/E can support two MSCP type controllers. The first is located at the standard Q-bus address (17772150 octal) while the second can be located in floating address space. However, the recommended address for the second controller is 17760334. A controller must be located at the standard Q-bus address to be a bootstrap device.

A program called INIT.SYS scans the system on power-up. INIT.SYS references a user-specified table located in the currently installed monitor. To alter the autoconfigure algorithm, the HARDWARE sub-option of INIT.SYS is used. This modifies the configuration table and allows an MSCP controller to be placed at any address on the I/O page. If a new monitor is installed then the table must be reset.

Controllers are assigned vector addresses and programmed by INIT.SYS during initialization.

Warning: RSTS/E supports disks of a maximum size of 1,048,576 blocks. Larger drives must be broken up into multiple smaller virtual units. At a later date RSTS/E may support larger disks, refer to the RSTS/E Software Dispatch for details.

4.4 RSX-11M Operating Systems (V4.0 and above)

The RSX-11M SYSGEN program is an interactive program that builds a complete and running RSX-11M system for a particular hardware configuration. RSX-11M SYSGEN supports autoconfigure. This program detects MSCP type controllers located at standard Q-bus addresses. Additional controllers must be manually attached to the system according to the procedure outlined below. The procedure is fully outlined in the RSX-11M System Generation and Configuration Guide.

Installing a single controller

A single controller is installed at the standard Q-bus address of 17772150 (Octal). Autoconfigure can then be used to connect peripheral devices.

Installing multiple MSCP controllers

For two controllers manual initialization must be undertaken. The following procedure will connect the devices to the operating system:

1. Invoke SYSGEN.

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

2. Indicate that AUTOCONFIGURE has to be used by answering **Y** (Y) to the following:

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

3. Indicate that the autoconfigure results are not to be overridden. Answer N (no) to the following:

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

   Continue to answer the SET-UP questions as required then continue onto the TARGET CONFIGURATION section. Target configuration defaults for the first group of questions should be accurate because autoconfigure was used.

4. Indicate the number of devices that are installed.
   *Devices: **DU = 2 <return>**
   *Devices: **. <return>**

   Enter the correct value of two. The period (.) terminates the device input operation.

   The questions over the next four sections - HOST CONFIGURATION, EXECUTIVE OPTIONS, TERMINAL DRIVER OPTIONS, and SYSTEM OPTIONS - should be answered appropriately.

5. After answering the above sections it is necessary to define the PERIPHERAL OPTIONS for the controllers on the system. The questions will be asked once for each controller. The abbreviated form of controller "contr" is used.

   The first prompt is for the interrupt vector address, Q-bus address, the number of DU-type disk drives, the number of command rings, and the number of response rings. There is no default value for the number of disk drives.

   ```
   *DU contr 0 [D:154,17772150,,4,4]
   *154,17772150,3,4,4 <return>
   ```

Vector and Q-bus Addresses

The standard vector address for MSCP controllers is 154 (octal). Any unused vector between 300 (octal) and 774 (octal) can be allocated for the second unit.

The standard Q-bus address of 17772150 (octal) is used for the first controller, while the second can be 17760334 (octal) or in floating LSI-11 address space.

Drive Configuration

The following is a list of DEC manufactured drives that are DEC operating system compatible. Non-DEC drives must be compatible with those listed below.

If in doubt consult the manufacturer's specifications to verify compatibility.

```
*RX50
*RD51
*RD52
*RC25
*RA60
*RA80
*RA81
```

Count each RX50 drive as two drives, these contain two 5.25 inch floppy diskettes. The RC25 has both fixed and removable media and should also be counted as two drives.

The configuration of the drives and the logical arrangement (disk partitions) for the disk sub-system is programmed by WOMBAT.

MSCP Ring Buffers

Command and response ring buffers which MSCP establishes in main memory also have to be specified. RSX-11M supports a maximum of eight rings. A value of four will minimize system overhead and is the recommended and default value.

The type of disk drives on each controller must now be specified.

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

For the RQDX1, indicate that there is a RD51 and two RX50 drives. For the SDC-RQD11-EC, indicate that there is one RD51 for each logical disk drive.

RSX-11M must have contiguous unit numbers which must be the same as those reported by the controller during initialization.

WARNING: Versions of RSX-11M prior to 4.2C support disks of a maximum size of 1,044,480 blocks. Larger drives must be broken up into multiple smaller virtual units.

4.5 RSX-11M-PLUS Operating Systems (V2.1 and above)

As with RSX-11M an interactive SYSGEN will build a complete running version of RSX-11M-Plus for a particular hardware configuration. RSX-11M-Plus supports autoconfigure and will detect the first controller located at the standard Q-bus address. Additional controllers must be installed manually.

Installing a Single Controller

A single controller is installed at the standard Q-bus address of 17772150 (octal) using autoconfigure to connect the peripherals. The procedure is fully outlined in the RSX-11M-Plus System Generation and Configuration Guide.

Installing Multiple Controllers

To add the SDC-RQD11-SCSI to the system configuration use the Add a Device option of SYSGEN or do a complete SYSGEN. The Add a Device procedure is described below:

1. Invoke SYSGEN

   SET/UIC = [200,200] <return>

2. Answer N (no) to the following questions to indicate that only a subset of the SYSGEN procedure is wanted:

   *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. Indicate that a specific module of SYSGEN is required by answering Y (yes) to the following :

   * SU150 Do you want to do any individual sections
   of SYSGEN? [Y/N D:Y]: **Y <return>**

4. Select the Add a Device option of SYSGEN by typing the letter H.

   *SU160 Which sections would you like to do?
   [S R:0.-15.]: **H <return>**

   SYSGEN now asks questions about the type and number of controllers to be installed in the system. There is one question for each controller supported. Type 0 (zero) until the prompt for UDA-type devices appears.

5. Specify the number of MSCP devices when asked by typing :

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

6. Give the total number of drives on each controller installed on the system.

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

   The following is a list of DEC manufactured drives that are DEC operating compatible. Non-DEC drives must be compatible with those listed below. If in doubt consult the manufacturer's specifications to verify compatibility.

   *RX50
   *RD51
   *RD52
   *RC25
   *RA60
   *RA80
   *RA81

   Count each RX50 drive as two drives, these contain two 5.25 inch floppy disks. The RC25 has both fixed and removable media and should also be counted as two drives.

   The configuration of the drives and the logical arrangement (disk partitions) for the disk sub-system is programmed by WOMBAT.

7. SYSGEN then asks the user to specify controllers for each drive.

   *CP3044 To which DU controller is DU0:
   connected? [S R:1-1]: **A <return>**

   This question is repeated until the number of MSCP drives has been exhausted. RSX-11M-Plus must have contiguous unit numbers and be the same as those reported by the controller during initialization or errors will occur. Use A as the primary and B as the alternate controller.

8. Enter the Vector Address for each controller.

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

The standard vector address for MSCP controllers is 154 (octal). Any unused vector between 300 (octal) and 774 (octal) can be allocated for the second unit.

9. Enter the CSR address for each controller.

```
*CP3076 What is its CSR address?
        [O R:1.-8. D:4.] 4 <return>
```

The standard CSR address 17772150 (octal) is used for the first controller, while the second can be 17772154 (octal) or in floating CSR address space.

10. 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>
```

RSX-11M-Plus supports a maximum of eight command rings. A value of four will minimize system overhead and is the recommended and default value.

11. 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>
```

RSX-11M-Plus supports a maximum of eight response rings. A value of four will minimize system overhead and is the recommended and default value.

WARNING: Versions of RSX--M Plus prior to 3.0C support disks of a maximum size of 1,044,480 blocks. Larger drives must be broken up into multiple smaller virtual units.

4.6 MicroVAX/MicroVMS Operating System

The first SDC-RQD11-SCSI controller is located at the standard bus address of 17772150 (Octal) and the second in floating address space. The MicroVMS SYSGEN utility can determine the Q-bus and interrupt vector addresses for any of the I/O devices installed on the bus. MicroVAX/MicroVMS must be running in order to use this utility. The Q-bus and interrupt vector addresses can be determined manually if access to a running system is not possible.

Using MicroVAX/MicroVMS SYSGEN

The following is an outline of the MicroVMS SYSGEN procedure to determine Q-bus and Interrupt vector addresses. This procedure requires system manager privileges.

1. Log in and run the SYSGEN utility.

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

   The SYSGEN> prompt indicates that the program is ready.

2. Obtain a list of the devices currently installed on the MicroVAX Q-bus by typing:

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

   and get:

   Name: PUA Units: 1 Nexus: 0 CSR: 772150 Vector1: 154 Vector2: 000
   Name: TXA Units: 1 Nexus: 0 CSR: 760500*Vector1: 310*Vector2: 000

   *Indicates a floating vector or address.

   Sysgen lists the devices already installed on the Q-bus by logical name. Devices with floating bus and vector addresses should be noted if it is intended to re-install them with the SDC-RQD11-SCSI controller. Floating bus addresses will be larger than 760000 (octal). Floating interrupt vectors will be larger than 300 (octal).

3. Execute the configure command. This will determine the Q-bus and Vector addresses that autoconfigure will expect for each device type.

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

   Specify the devices to be installed on the bus by typing their Q-bus names. Under MicroVAX/MicroVMS the device name for MSCP-type controllers is **UDA.**

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

   The device name is separated from the number of devices by a comma. The number of devices is specified in decimal.

   Devices with floating addresses or vectors are not affected by devices with fixed addresses or vectors. Only devices with floating addresses or vectors need be specified.

4. When all the devices have been specified enter a control-Z.

   DEVICE> CTRL-Z

The addresses and vectors of the devices entered will be listed in the following manner:

Device: UDA Name: PUA CSR: 772150 Vector: 154 Support: yes
Device: UDA Name: PUB CSR: 760334* Vector: 300* Support: yes
Device: DHV11 Name: TXA CSR: 760500* Vector: 310* Support: yes

*Denotes floating bus and interrupt vector addresses. Floating CSR addresses must be programmed into the SDC-RQD11-SCSI by selecting the correct pin configuration on the PCB.

5. If an address other than that selected for the SDC-RQD11-SCSI by CONFIGURE command is desired, CONNECT statements must be entered into the SYSCONIF.COM file. SYSCONIF.COM can only be accessed through the system manager's account SYS$MANAGER. The correct syntax is given in the DEC MicroVMS SYSGEN documentation.

   The STARTUP.COM or UVSTART.COM command files in the main system account, SYS$SYSTEM must not be altered.

4.7 Autoconfigure

Autoconfigure is a utility program that finds and identifies I/O devices in the I/O page of system memory. Most devices have a fixed bus address reserved for them. When the computer is bootstrapped autoconfigure polls those addresses - specifically the console status register (CSR) which is usually the first register of the block.

A block of addresses is reserved when a device is detected. The size of the block is determined by the number of registers the device uses. Autoconfigure then looks to the next CSR address space for that same type of device. If there are no other devices of that type autoconfigure looks to the next valid CSR address. Autoconfigure expects an eight byte block to be reserved for each device not installed in the system. An empty block tells autoconfigure to look to the next valid address space.

Devices with no fixed address are assigned addresses from floating CSR address space. This may be necessary if there are several of the same device in the system. Floating address space is in the vicinity of 76000 to 763776 of the bus I/O page. Devices can also have floating interrupt vector addresses. Floating CSR and interrupt vectors must be assigned in specific sequences depending on the rank of the device (see Table 4-2). The presence or absence of floating bus and interrupt vector address devices will affect the assignment of addresses to other floating vector devices.

Table 4-3: SYSGEN Device Ranking

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 treated as two DZ11s.

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

[3] The first two devices of this type have fixed addresses while extra devices have floating addresses.

An eight byte gap must also be reserved in floating address space for each device type not currently installed in the system. This gap must start on the proper boundary. See Table 4.6 for an example of gap placement.

A device's CSR address is determined on word boundaries according to the number of bus accessible registers the device has. The relationship of word boundaries and device registers is set out in Table 4-3. Autoconfigure only inspects for a device type at one of the possible device boundaries. For instance, autoconfigure will not look for a DMZ32 which has 16 registers at an address that ends in 20.

Table 4-4: Device Registers and 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

Vector Addresses and Autoconfiguration

Devices are assigned vector addresses in order of rank commencing at 300 (octal) up to 777 (octal). Extra devices of the same type are assigned consecutive vector addresses according to the number of vectors required and starting boundaries for each device type. Table 4-4 shows the order of assignment.

The boundaries in the modulus column indicate where vector addresses are assigned. If the modulus is 10 the first vector address for that device must end with a zero (XX0). If the modulus is 4 the first vector must end with either a zero or four (XX0,XX4).

Vector addresses can only end on an address of four or zero i.e. modulo 4 boundaries (XX0, XX4). If a device has two vectors the first must start on a modulo 10 boundary. Using 350 as a starting point the vectors will be 350 and 354.

Table 4-5: Floating Vector Address Device Priority Ranking

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

continued on next page...

Table 4-5: Floating Vector Address Device Priority Ranking

Rank	Device	Number of Vectors	Octal Modulus
25	DWUN	2	10
26	DMC11	2	10
26	DMR11	2	10
27	DZ11/DZS11/DZV11	2	10
27	DZ32	2	10
28	KMC11	2	10
29	LPP11	2	10
30	VMV21	2	10
31	VMV31	2	10
32	VTV01	2	10
33	DWR70	2	10
34	RL11/RLV11[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] KL11 or DL11 have fixed vectors when used as a console.

[2] The first device has a fixed vector all subsequent device of the same type have a floating vector.

[3] ML11 is a Mass Bus device which connects to the Q-bus or Unibus via a bus adaptor.

System Configuration Example

An example of a system configuration is shown in Table 4-5. The configuration includes both fixed and floating addresses and vectors.

Table 4-6: CSR and Vector Address Example

CONTROLLER	VECTOR	CSR
1 UDA50	154	772150
1 DZ11	300	760100
1 UDA50	310	760334
2 DHV11	320	760520
	330	760520

Table 4-6 shows the computed CSR addresses and gaps for floating devices.

Table 4-7: Floating CSR Address Assignment

	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	760330
	DEUNA	Gap	760340
----->	UDA50 (SDC-RQD11-SCSI)		772334[1]
----->	UDA50 (SDC-RQD11-SCSI)		760354
		Gap	760360
	DMF32	Gap	760400
		Gap	760440
	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] indicates a fixed address device

Notes

5. Q-bus Interface

All data, address and control information transfers between the processor and disk controller are carried out over the Q-bus. The SDC-RQD11-SCSI supports all current Q-bus functions including block mode DMA, 22 bit addressing, 4-level position independent interrupt structure, all LSI-11 CPU's and MicroVAX II.

The Q-bus consists of 42 bidirectional and 2 unidirectional signal lines wired into the backplane assembly. These are grouped into the following categories:

- Sixteen multiplexed data/address lines - BDAL:00
- Two multiplexed address/parity lines - BDAL:16
- Four extended address lines - BDAL:18
- Six data transfer control lines - BBS7L, BDINL, BDOUTL, BRPLYL, BSYNCL, BWTBTL
- Six system control lines - BHALTL, BREFL, BEVNTL, BINITL, BDCOKL, BPOKL
- Ten interrupt control and direct memory access control lines - BIAKOL, BIAKIL, BIRQ4L, BIRQ5L, BIRQ6L, BIRQ7L, BDMGOL, BDMRL, BSACKL, BDMGIL

Communication is asynchronous, allowing devices with differing data rates to share the bus. A strict master/slave protocol avoids the need for synchronizing clock pulses by implementing handshaking and other control signals between I/O devices.

5.1 Interrupts

Interrupt priority for the SDC-RQD11-SCSI is switch selectable on the PCB. The recommended priority setting is five. In order to service LSI-11 and LSI-11/2 CPU's the SDC-RQD11-SCSI automatically outputs level four interrupts despite switch priority selections.

Interrupts suspend program execution while the processor starts the device service routine at a vector address input from the requesting device.

Interrupts are serviced according to device priority. Device priority can be determined in two ways. These are termed 'Position Defined' and 'Distributed' arbitration. Positioned Defined arbitration gives priority to those devices which are electrically closest to the processor. Distributed arbitration implements priority according to the priority levels set on the device hardware. When devices with equal priority generate an interrupt, the processor gives preference to the device which is electrically closest. A previous bus transaction must have been completed before another can be commenced.

The interrupt protocol has three phases:

1. Interrupt Request Phase. The interrupt enable bit in the status register is set and interrupt request lines are asserted according to priority settings.

2. Interrupt Acknowledge and Priority Arbitration Phase. The processor detects the request and checks if any other device with higher priority is requesting an interrupt. If there are no devices with higher priority seeking an interrupt the processor acknowledges the interrupt.

3. Interrupt Vector Transfer Phase. The device outputs vector address bits to the processor which then enters the device service routine.

5.2 Direct Memory Access

The SDC-RQD11-SCSI supports both normal and block mode Direct Memory Access (DMA). During a DMA transfer the processor passes mastership of the bus to the controller.

During block mode DMA transfer the SDC-RQD11-SCSI has a four microsecond delay after every 16 words to service any pending interrupt or DMA requests from other devices. The SDC-RQD11-SCSI also detects DMA requests from other devices and will implement a 'DMA Throttle' after eight words. This prevents data loss from other DMA devices which may also share the Q-bus.

The SDC-RQD11-SCSI interleaves address references with bursts of data during DMA. Because the starting memory address is asserted only once every sixteen data words so data throughput is almost doubled.

DMA protocol consists of three phases:

1. Bus Mastership Acquisition Phase. The SDC-RQD11-SCSI requests control of the bus. The processor arbitrates the request then initiates the transfer of bus mastership.

2. Data Transfer Phase. The processor provides the controller with the following information utilizing MSCP - block number on the disk, the number of bytes to transfer, and address in main memory, and if the operation is a read or write.

3. Bus Mastership Relinquish Phase. Bus mastership is relinquished after completing or aborting the data transfer cycle.

For a detailed description of the Q-bus the appropriate DEC manual should be consulted.

Notes

Appendix A. WD33C93 SCSI Bus Interface Controller Status

CODE (HEX)	DEFINITION
Successful Completion Interrupt	
0	Reset by command or power-up
10	A Reselect Command completed successfully
11	A Select Command completed successfully
13	A Receive, Send, Reselect-And-Transfer, or Wait-For Select-And-Receive Command completed successfully (ATN is not asserted)
14	A Receive, Send, Reselect-And-Transfer, or Wait-For Select-And-Receive Command completed successfully (ATN is asserted)
15	A Translate Address Command completed successfully
16	A Select-And-Transfer Command completed successfully
18	Transfer Command (Bus phase: Data out to target)
19	Transfer Command (Bus phase: Data in from target)
1A	Transfer Command (Bus phase: Command to target)
1B	Transfer Command (Bus phase: Status from target)
1E	Transfer Command (Bus phase: Message out to target)
1F	Transfer Command (Bus phase: Message in from target)
Pause or Aborted Interrupt	
20	A Transfer Command (Message-in phase) has paused with ACK asserted
21	A Save Data Pointers message was received during a Select-And-Transfer Command
22	A Select or Reselect Command was aborted
23	A Receive or Send Command has halted or was aborted (ATN is not asserted)
24	A Receive or Send Command has halted or was aborted (ATN is asserted)
28	Transfer Command was aborted (Bus phase: Data in from target)
29	Transfer Command was aborted (Bus phase: Data out to target)
2A	Transfer Command was aborted (Bus phase: Command to target)
2B	Transfer Command was aborted (Bus phase: Status from target)
2E	Transfer Command was aborted (Bus phase: Message out to target)
2F	Transfer Command was aborted (Bus phase: Message in from target)

Terminated Interrupt

40	An invalid command was issued
41	An unexpected disconnect caused a command to terminate
42	A time-out occurred during a Select or Reselect Command
43	A Parity Error caused a command to terminate (ATN is not asserted)
44	A Parity Error caused a command to terminate (ATN is asserted)
45	The Logical Address exceeded the disk boundaries
46	The wrong Target device reselected the WD33C92/3-SBIC
47	An incorrect message, status, or command byte was received
48	Unexpected information phase was requested (Bus phase: Data out to target)
49	Unexpected information phase was requested (Bus phase: Data in from target)
4A	Unexpected information phase was requested (Bus phase: Command to target)
4B	Unexpected information phase was requested (Bus phase: Status from target)
4E	Unexpected information phase was requested (Bus phase: Message out to target)
4F	Unexpected information phase was requested (Bus phase: Message in from target)

Service Required Interrupt

80	The WD33C92/3-SBIC has been reselected
82	The WD33C92/3-SBIC has been selected (ATN is not asserted)
83	The WD33C92/3-SBIC has been selected (ATN is asserted)
84	The ATN signal has been asserted
85	A Disconnect has occurred
88	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Data out to target)
89	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Data in from target)
8A	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Command to target)
8B	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Status from target)
8E	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Message out to target)
8F	The REQ signal has been asserted following connection and the information phase type should be examined (Bus phase: Message in from target)