SDC-RQD11-B

5-1/4″ Winchester
Disk Drive Controller

Manual

Σ *Sigma Information Systems*

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SIGMA INFORMATION SYSTEMS

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1.1   GENERAL DESCRIPTION

The Sigma SDC-RQD11-B is a dual height Qbus interface to ST506 compatible 5-1/4 inch Winchester disk drives.   Implementing DEC's Mass Storage Control Protocol (MSCP), the SDC-RQD11-B couples any size disk to all standard DEC operating systems without software modification. Comprehensive on-board interactive formatting and diagnostic firmware provides engineering support across the range of LSI-11, MicroVAX, and various non-DEC implementations of the Qbus.

ST506 Interface

The Seagate ST506 interface has become the de facto industry standard for 5-1/4 inch Winchester disk drives. Inexpensive, reliable units spanning capacities of 2 to 138 megabyte and access times of 20 to 200 millisecond are now available from 30 to 40 manufacturers, including:

AMPEX	ATASI	CDC	CMI
DISCTRON	EVOTEK	FUJITSU	IMI
MAXTOR	MEMOREX	MICROPOLIS	MINISCRIBE
MITSUBISHI	OLIVETTI	OTARI	PRIAM
RODIME	SEAGATE	SHUGART	TANDON
VERTEX			

Qbus Interface

Originally introduced in 1975 by Digital Equipment Corporation to support the LSI-11 CPU range, the Qbus architecture has evolved in speed and functionality to the point where it now outperforms most small computer bus systems.   The SDC-RQD11-B fully implements all current Qbus enhancements, including block mode transfers and 22-bit addressing, and flexibly supports LSI-11/2, LSI-11/23, LSI-11/73, MicroVAX 1, MicroVAX 2, Motorola 68000 and National 32032 Qbus CPU designs.

Block Mode DMA

When used with block mode memory, the SDC-RQD11-B almost doubles Qbus throughput by interleaving address references with bursts of data, fully conforming with Qbus Block Mode 'DMA protocol.   With non block mode memory, the SDC-RQD11-B reverts automatically to simple DMA.

MSCP Universal Disk Architecture

The SDC-RQD11-B communicates with the software through a simple register pair to memory resident command packets. Disk geometry factors such as sectors, heads and cylinders are invisible to the host computer as the SDC-RQD11-B accepts 32-bit binary block numbers, converting them to physical disk addresses. Disk capacity is inherently communicated back and never assumed by the software, therefore any size disk may be fully accessed without software modification. Supported operating systems include RT-11 version 5, RSX-11M plus version 2.1, TSX-plus version 4, RSTS/E version 8, Micro-VMS and UNIX.

Seek Optimization

Queueing of up to 32 commands is permitted within the SDC-RQD11-B. The optimum order of execution of these packets is dynamically computed to minimize disk head movement and enhance throughput in heavily loaded systems.

Bad Block Replacement

Disk surface defects are detected and flagged by the SDC-RQD11-B during formatting and pattern testing, and redirected to a user-specified reserved area at the end of the disk. During all subsequent operations the SDC-RQD11-B simulates fault-free media through transparent bad block replacement.

Transparent Read Retry

Four Error Correction Code (ECC) bytes are added to each disk sector during write, and verified during read. On miscompare, the SDC-RQD11-B automatically repeats the read operation up to 10 times before attempting ECC correction of the disk data. ECC corrects error bursts up to 11 bits in length, which considerably reduces the number of irrecoverable erros reported to the operating system.

Multi Drive Capability

Two ST506 compatible 5 1/4" winchester disk drives, of any capacity, may be connected to each SDC-RQD11-B controller, and up to three controllers may co-exist in one system. To reduce access time with multiple disk drives, the SDC-RQD11-B will overlap seek by having the drives seek simultaneously.

On-board Bootstrap

A miniature programming plug permits the SDC-RQD11-B to bootstrap on power-up.   The bootstrap can be set to boot to DU, DL, DY or MS, with a default boot to DU0. The bootstrap option can be disabled.

Overlapped Seeks

When two drives are attached to the SDC-RQD11-B controller, and multiple commands are sent to the controller by the host, the seeks of the disk drives will be overlapped by the controller, i.e., if one drive is seeking, an I/O request for the other drive may be issued. If this is a seek, the first drive whose seek finishes will then have its I/O request done.

ECC

The firmware utilizes a 32-bit error correction code (ECC), allowing error bursts of up to 11 bits in one 512 byte clock to be corrected.

Scatter Gather (MicroVAX I)

The SDC-RQD11-B implements scatter-code and will run VMS.

Data Buffer

All data transfers are staged through a single sector buffer to ensure that 'data late' errors will not occur during periods of heavy Qbus traffic. Transfer rate is smoothly adjusted downwards until the bus again becomes available.

Outalk

WOMBAT outloads a communication program from its program ROM into the host memory, which then manages communication between the console and WOMBAT. Communication between WOMBAT and a console terminal enables WOMBAT diagnostics and formatting capability on systems that have the console terminal as an integral part of the CPU (e.g., KDF11-B, KDJ11-B, MicroVAX).

Command Queue Size

The commands queue is requested for both drives. The queue size of the first drive to be put online is used. The first drive to be put online is defined as drive zero.

Head Stepping Rates

Drive head stepping rates can be selected at 3.2us, 16us, and 35us - or from 0.5ms to 6.5ms in 0.5ms increments.

Cylinder Numbers

The SDC-RQD11-B supports disks with up to 2048 cylinders with 15 as the maximum number of heads.

Controls and Indicators

At the rear edge of the circuit board is a red LED indicator to signal Board Failure and a green LED to signal Access in Progress. An output is provided for off-board indication of Access, and inputs are provided for two optional Write Protect switches.

WOMBAT Utilities

WOMBAT is a set of interactive formatting, diagnostic and debug utilities totally contained within the SDC-RQD11-B firmware. An on board serial connection is provided for communication with an ASCII terminal, permitting disk formatting and maintenance operations to be carried out with no other hardware present.

No external software, media, or program loading device is required in maintenance of the SDC-RQD11-B or its attached disk drive.

WOMBAT Formatter

WOMBAT initalizes a fresh disk drive by writing sector addresses   and zero   data   blocks through the entire recording surface. On invoking the formatter, the user is prompted at the terminal to supply parameters such as numbers of cylinders, heads and sectors, sector interleave factor, bad block replacement capacity, positioner step rate, and shipping zone cylinder.   This data is stored twice in reserved areas of track zero during the format process, and retrieved by a simple homeseek-read sequence at each power-up.   No special PROMs or switch settings are required to fully characterize the connected disk drive.

WOMBAT Self-diagnostics

On bootstrap, the SDC-RQD11-B is prompted by the operating system to enter a comprehensive series of controller and disk confidence tests. On failure, a red on board LED is illuminated to highlight the faulty module.

WOMBAT Interactive Diagnostics

Terminal oriented engineering utilities contained within the WOMBAT firmware include a down-line loader, an ODT-style firmware debugger, a TECO-like disk control and manipulation language, a continuous read/write/seek exerciser, a disk surface pattern tester, and a bad block replacement routine.

1.2   SDC-RQD11-B CONTROLLER SPECIFICATIONS

Bus interface:	DEC Qbus
Transfer mode:	Block mode DMA
Memory address capacity:	4 megabyte (22-bit)
Software emulation:	DEC Mass Storage Control Protocol
Command buffer capacity:	Up to 32 MSCP commands
Data buffer capacity:	512 bytes (one sector)
CSR address:	172150, 160334, and 160340 plug selectable
Interrupt vector:	Software selectable
Interrupt priority:	Level 4 through 7 plug selectable
Qbus loads:	1 DC, 2 AC
Drive interface:	Seagate ST506
Access time overhead:	3 mS (plus drive access time)
Single block transfer rate:	625 Kbyte/sec
Full track transfer rate:	260 Kbyte/sec (depends upon sector interleave factor)
32-bit Error Correction Code:	ECC allows error bursts of up to 11 bits in one 512 byte clock to be corrected

Automatic bootstrap: 173000, plug selectable

Disk connectors: One 34-pin control, two 20-pin data

Power requirement: 5 volt 2.6 amp typical

Physical: 226mm x 132mm dual height module

On-board LED indicators: RED - board failure
                                  GREEN - disk access in progress

Output: Disk access in progress

TTL inputs: Write Protect Drive 0 switch
                                  Write Protect Drive 1 switch

2.1   INTRODUCTION

Figure 2-1 shows the locations of connectors and jumpers that are used to configure the SDC-RQD11B.
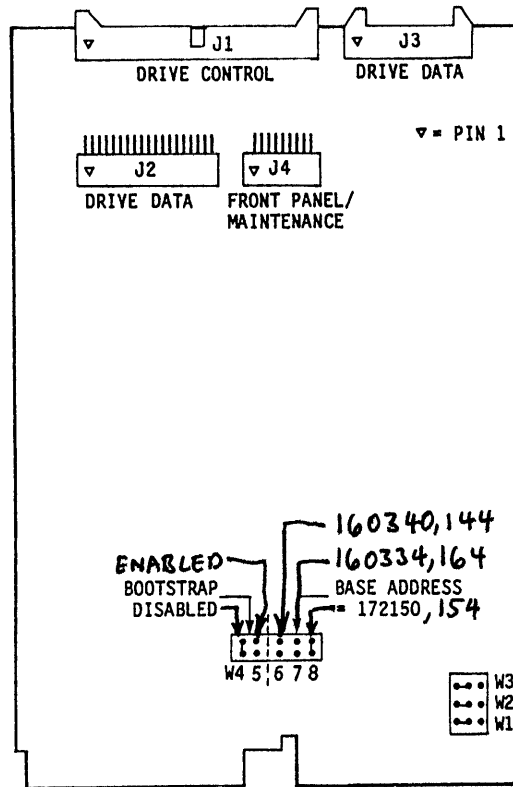
FIGURE 2-1:   CONNECTOR AND JUMPER LOCATIONS

2.2   ST506 INTERFACE CONNECTIONS

2.2.1   34-pin Control Connector (J1)

Function	Pin	Function	Pin	
*SEEK COMPLETE	8	*DRIVE SELECT 1	26	* = ACTIVE LOW
*TRACK 0	10	*DRIVE SELECT 2	28	
*WRITE FAULT	12	*DRIVE SELECT 3	30	
*INDEX	20	*DRIVE SELECT 4	32	
*READY	22	*HEAD SELECT 0	14	
*WRITE GATE	6	*HEAD SELECT 1	18	
*STEP	24	*HEAD SELECT 2	4	
*DIRECTION IN	34	*HEAD SELECT 3	2	
RESERVED	16			
GROUND	1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33			

2.2.2   20-pin Data Connector (J2 and J3)

Function	Pin	Function	Pin
*DRIVE SELECTED	1	+MFM READ DATA	17
+MFM WRITE DATA	13	-MFM READ DATA	18
-MFM WRITE DATA	14	RESERVED	3,5,7,9
GROUND	2,4,6,8,10,11,12,15,16,19,20		

* = ACTIVE LOW

2.3   JUMPER PLUG SETTINGS

Miniature movable configuration plugs permit easy selection of base
address, automatic bootstrap select, and interrupt priority.

2.3.1   Base (CSR) Address

Configuration Plugs W6, W7, W8 define the CSR address for LSI-11,
MicroVAX I, and MicroVAX 2 systems as shown below.

BASE ADDRESS (HEX)	CPU	W6	W7	W8			VECTOR
17772150	LSI	OUT	OUT	IN	)	STANDARD	~~254~~ 154
303FF468	MICROVAX I	OUT	OUT	IN	)	ADDRESS	
20001468	MICROVAX II	OUT	OUT	IN	)		
17760334	LSI	OUT	IN	OUT	)	FIRST	~~164~~ 164
303FE0DC	MICROVAX I	OUT	IN	OUT	)	ALTERNATE	
2000000DC	MICROVAX II	OUT	IN	OUT	)	ADDRESS	
17760340	LSI	IN	OUT	OUT	)	SECOND	144
303FE0E0	MICROVAX I	IN	OUT	OUT	)	ALTERNATE	
2000000E0	MICROVAX II	IN	OUT	OUT	)	ADDRESS	

2.3.2   Automatic Bootstrap Select (LSI-11 Only)

For LSI-11 processors only, jumper W5 installation provides an on-board
bootstrap. If jumper W4 is installed the bootstrap function is disabled.

W4	W5	
OUT	IN	On board bootstrap enabled at addresses 173000 and 773002
IN	OUT	On board bootstrap disabled

When the LSI-11 is powered up the message "SRQD11 Boot V4.3" is
displayed, which indicates the bootstrap program has been loaded. If no
key is struck "Booting from DU0" is displayed. However, the user can
boot DL, DU, DY and MS devices via the console terminal.

1. If the user strikes any key within two seconds after power-up (or after "SRQD11 Boot V4.3" is displayed) the controller prompts with:

>

2. The operator may then key in a device (DU,DL,DY,MS) according to the following syntax rules:

>DEVICE [Controller Number] [Unit Number] :

where [ ] = options below. If no options are specified defaults = A, 0.

```
        *DEVICE    [Controller Number] [Unit Number]

          DU           [A,B,C]            [0-7]:
          DL                              [0-7]:
          DY                              [0-1]:
          MS          [A,B,C,D]:
```

Examples: DU1:   second drive on the first DU controller
             DUB2:   third drive on the second DU controller
             DY1:   second RX02 floppy disk drive

3. If any error occurs, a message is printed and the boot re-prompts for the proper options.

*The CSR addresses for the bootstrap device are:

Device	Address	Device	Address
CONSOLE	177560	MSA:	172520
DU:	172150	MSB:	172524
DUA:	172150	MSC:	172530
DUB:	160334	MSD:	172534
DUC:	160340	DL:	174400
MS:	172520	DY:	177170

2.3.3   Interrupt Priority

Configuration plugs W1, W2, and W3 define the interrupt priority as shown below.

```
Priority Level 4    Priority Level 5    Priority Level 6    Priority Level 7

 W3 o---o  o         W3 o---o   o        W3 o---o   o        W3 o    o---o
 W2 o---o  o         W2 o---o   o        W2 o   o---o        W2 o    o---o
 W1 o---o  o         W1 o   o---o        W1 o---o   o        W1 o---o   o
```

2.4   SDC-RQD11-B OPTIONAL ACCESSORIES

Optional accessories include:

        Drive Signal and Control Cable Set
        RS232 Maintenance Terminal Adaptor (DLV11J Compatible)
        Front Panel Connector

2.4.1   Drive Signal & Control Cable Set

Both the drive signal and control cables consist of a flat or twisted
pair cable joining a displacement-type flat cable socket at the
controller end, and a displacement-type flat cable PC edge connector at
the drive end. The drive controller cable and connector are 34-pin types,
and the signal cable and sockets are 20-pin. Both cables have a maximum
length of 20 feet. Drive/controller cabling is shown in Figure 2-2.

<p align="center">NOTE</p>

        Drive cabling has no effect on the unit number. The unit
        number must be set on the drive itself. Although the
        controller allows only drive physically configured as zero
        or one, WOMBAT can logically configure any drive as a unit
        number in the range 0-255.
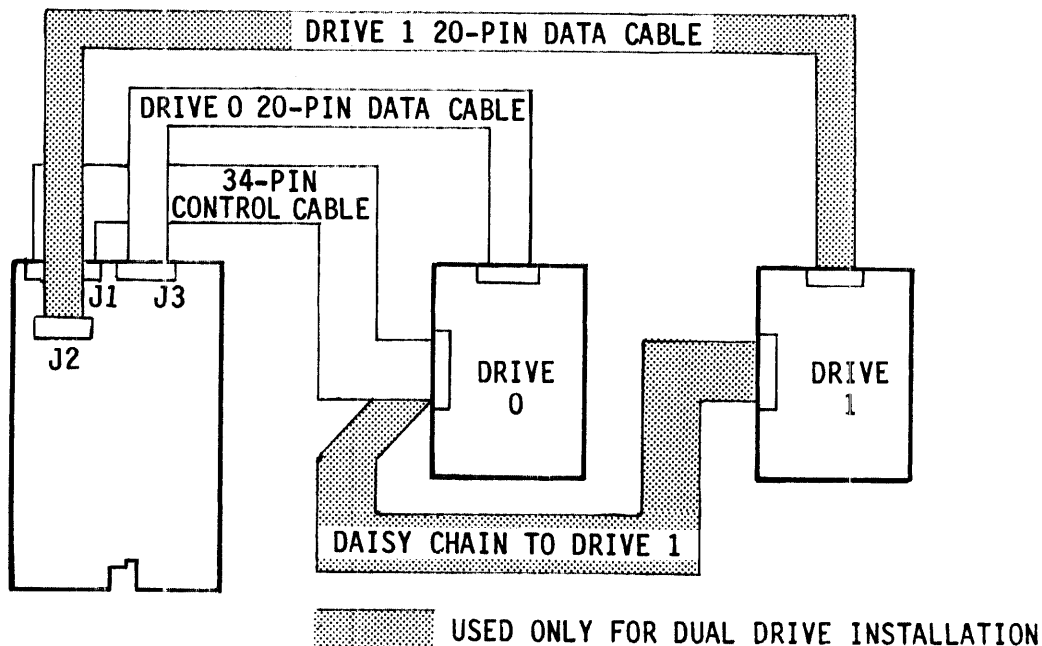
FIGURE 2-2: DRIVE/CONTROLLER CABLING

2.4.2   Maintenance Terminal/Front Panel Adaptor

WOMBAT (see Chapter 4) can communicate either through the computer system console or the front panel/maintenance connector. If pin 7 on this connector is grounded, the latter will be the case.

The communication format is:

        ASCII RS232
        9600 Baud
        8 Data Bits
        1 Stop Bit
        No Parity.

The RS232 maintenance terminal adaptor allows simple connection to a standard computer terminal. It consists of a 10-pin flat cable with a DB25S connector on one end and a 10-pin displacement-type flat cable socket on the other. (See Table 2-1).

Notice that if normal disk access is attempted with this cable connected to a terminal, garbage will appear on the terminal due to the shared RS232 Output/Access Light Function. This is normal.

TABLE 2-1: RS232 MAINTENANCE TERMINAL ADAPTOR (DLV11J COMPATIBLE)

10-pin Connector Pins	DB25S Pins	Function
7	7	RS232 Enable
8	2	RS232 Input
3	3	RS232 Output
2,4,5,6,9	7	Ground

If required, a front panel can be connected to J3, the front panel/maintenance connector. The functions supported are write-protect switch and access light. See Table 2-2.

TABLE 2-2: 10-PIN FRONT PANEL CONNECTOR

PIN	FRONT PANEL FUNCTION
*7	Write-protect switch input. Connecting this input to ground will write-protect drive 1. Has an on-board 1K ohm pull-up.
8	Write-protect switch input. Connecting this input to ground will write-protect drive 0. Has an on-board 10K ohm pull-up.
3	Access Light. This output can be used to drive an Access Light. When active, this will indicate drive 0 or drive 1 is being accessed. The levels are:

> Access: -5V through 1.5K ohm
> No Access: +3.5V @ 5 ma max.

2,4,5,6,9   Ground.

*RS232 MAINTENANCE TERMINAL ADAPTER. When pin 7 of J4 is grounded and a terminal is connected   to this connector, WOMBAT will communicate to this terminal when WOMBAT is invoked.   This connector is DLV11-J compatible.

NOTE

If both switches are closed the controller assumes a front panel or maintenance   cable is connected and ignores the switch functions - that is the drive will be "on-line" and "write-enabled". Keep switches open for WOMBAT.

3.1   OVERVIEW OF MSCP

Mass storage control protocol (MSCP) is the message-oriented set of rules by which the SDC-RQD11-B controller module communicates with the host system. This protocol allows the host to simply send message requests for reads or writes to the controller and receive response messages back from the controller. The host does not concern itself with details such as device type, media geometry, media format, or error recovery.

All software and hardware functions are partitioned into two independent layers (host and controller), where changes can be made within one layer without affecting the other. Within this framework, commands and data are transmitted from one layer to the other, through the controller, in the form of message packets

In the host layer, the computer runs users' applications programs that make demands on the mass storage (disk) medium. The controller layer's various functions ensure that the host layer is able to read or write data, without error, at its own speed, and when it wishes. The disk layer receives the data, stores it as long as necessary, and makes it available to the controller on command.

The host layer uses two layers of software to accomplish input/output operations. The first sub-layer includes a mass-storage class driver which constructs the message packets in order to perform I/O functions, such as reading and writing, and on the same level, a diagnostics and utilities class driver which constructs message packets in the diagnostics and utilities protocol. The other sub-layer is the controller driver which passes the message packets along the bus between the host and controller.

The controller layer includes routines that receive messages from or transmit messages to the host. Its other functions concern the disk, which include controlling head motion, accepting commands from the controller, reporting status to the controller, and reading and writing.

The mass-storage class driver handles all message exchange between the operating system and any mass-storage device of a specific class, which means that any size disk may be fully accessed without software modification. The disk drive itself contains a parameter table of all of its own characteristics, such as geometry and retry counts for error handling. At system startup, this information is passed to the controller so that it may manage operation of that particular disk configuration.
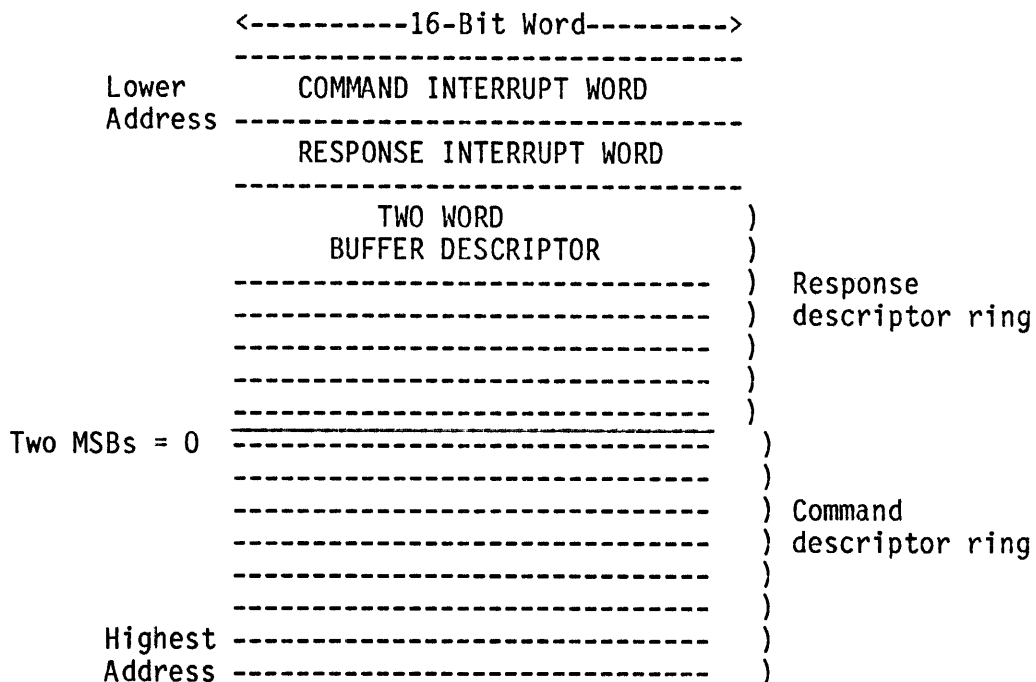
In addition to relieving the host-resident driver of disk-specific data, the controller and disk together provide the host with "clean" data. This implies data for which all necessary error detection, correction, and recovery have already been done. The disk drive handles some positioner errors entirely by itself and performs certain error-recovery operations under direction of the controller.

3.2   CONTROLLER COMMUNICATIONS

The host designates an area of memory to be used as a communications area. This area is made up of two sections:

1. The header area containing interrupt identification words.

2. A variable-length section containing the response (receive) and command (send) rings, organized into ring buffers.

The following diagram shows the format of the memory communications area.

```
                  <-----------16-Bit Word--------->
                  ---------------------------------
  Lower              COMMAND INTERRUPT WORD
  Address         ---------------------------------
                     RESPONSE INTERRUPT WORD

                  ---------------------------------
                        TWO WORD                  )
                     BUFFER DESCRIPTOR            )
                  -------------------------------  )
                  -------------------------------  ) Response
                  -------------------------------  ) descriptor ring
                  -------------------------------  )
                  -------------------------------  )
Two MSBs = 0      ===============================  )
                  -------------------------------  )
                  -------------------------------  ) Command
                  -------------------------------  ) descriptor ring
                  -------------------------------  )
                  -------------------------------  )
  Highest         -------------------------------  )
  Address         -------------------------------  )
```

3.2.1   Command and Response Rings

Command and response rings are each organized into a ring of 32-bit descriptors. The length of each ring is determined by the relative speeds with which the host and controller generate and process messages. The host sets the ring lengths at initialization time.

Descriptor Format:

```
   15  14  13  12  11  10  09  08  07  06  05  04  03  02  01  00
   -----------------------------------------------------------------
    L   L   L   L   L   L   L   L   L   L   L   L   L   L   L   Z
   -----------------------------------------------------------------
    0   F   <           Reserved            >   H   H   H   H   H   H
   -----------------------------------------------------------------
```

Code Description

 Z   Is zero, as envelope address (text+0) is word-aligned. The
      controller will always assume that Bit 00 is set to zero.

 L   Low-order envelope address.

 H   High-order envelope address.

 F   Flag bit.

      When the controller returns ownership to the host it sets F=1 to
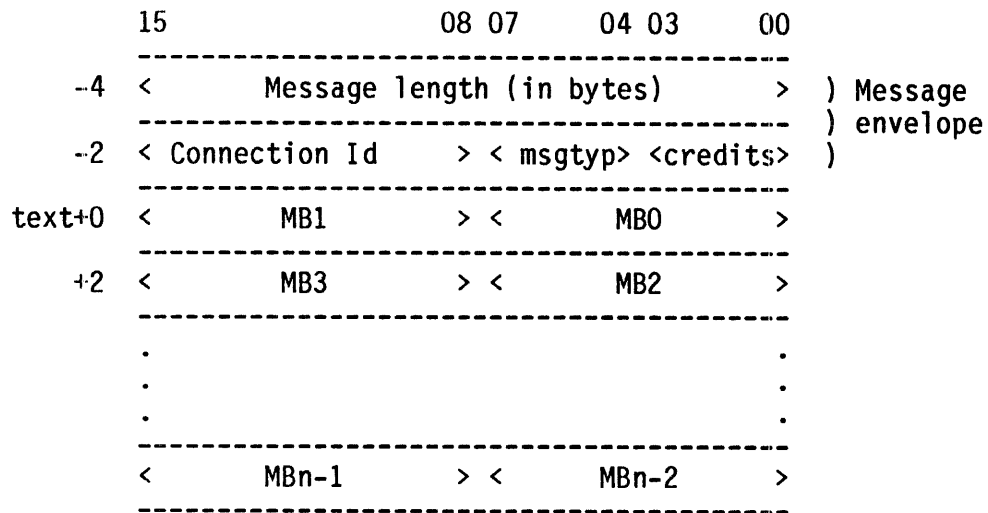   indicate that it has completed action on the descriptor.

      When the controller acquires ownership of a descriptor from the
      host, F=1 indicates that the host is requesting a ring transition
      interrupt. If F=0, the host is not requesting a ring transition
      interrupt. The interrupt will occur only if this descriptor causes
      a ring transition and if transition interrupts were enabled during
      initialization.

      The controller always sets F=1 when returning a descriptor to the
      host, so if a host wishes to override ring transition interrupts it
      must always clear F when passing ownership of a descriptor to the
      controller.

 0   Ownership bit. Set to 0 if owned by the host or 1 if owned by the
      controller. Interlocks the descriptor against premature access by
      either party.

3.2.2   Message Packets

The command or response descriptor points to word (text+0) of a 16-bit
word-aligned message envelope formatted as follows:

```
          15                      08 07      04 03        00
          ----------------------------------------------------
    -4   <           Message length (in bytes)        >   ) Message
          ----------------------------------------------------  ) envelope
    -2   < Connection Id      > < msgtyp> <credits>   )
          ----------------------------------------------------
text+0   <        MB1         > <           MB0        >
          ----------------------------------------------------
    +2   <        MB3         > <           MB2        >
          ----------------------------------------------------
                    .                        .
                    .                        .
                    .                        .
          ----------------------------------------------------
         <        MBn-1       > <          MBn-2       >
          ----------------------------------------------------
```

Word   Envelope Contents

0   Message length, in bytes.

For commands, this length is equal to the size of the command (in bytes), beginning with [text+0].

For responses, the host sets the length equal to the size of the response buffer (in bytes), beginning with <text+0>. Before actual transmission of a response, the controller reads the field length in the message envelope. If the controller's response is longer than the response buffer, the controller will fragment its response into as many response buffers as necessary.

The controller sets the resulting value into the message length field. The host must therefore keep re-initializing the value of this field for each proposed response. If a controller's responses are less than or equal to 60 bytes, then the controller need not check the size of the response slot.

1   Connection Id

Identifies the connection serving as a source of, or destination for, the message in question.

2   Message Type

The following response ring message types are implemented:

```
        MSGMNT      Maintenance packet (diagnostic)
        MSGCRD      Credit notice (ignored)
        MSGDAT      Datagram packet.
        MSGSEQ      Sequential packet
```

3   Credit field

Gives a credit value (usually one) associated with the message. This mask, in response packets, is added to the controller's credit field to give the number of commands-in-progress. So while Word 1 is always 1 for the command ring, this is not the case for response rings.

3.3   MESSAGE TRANSMISSION

3.3.1   Command Transmission

When the ownership bit (O) of a command ring descriptor is equal to 1, it means that the host has filled the descriptor and is releasing it to the controller. When the ownership bit (O) resets to zero, it means that the controller has emptied the command ring descriptor and is returning ownership of the descriptor to the host.

To ensure that the controller sees every command, the host must read the IP register whenever it inserts a command in the command ring. This forces the controller to poll the command if it was not already accessing the command ring.

3.3.2   Response Transmission

When the ownership bit (O) of a response ring descriptor is equal to zero, it means that the controller has filled the descriptor and is releasing it to the host. When the ownership bit (O) sets to 1 it means that the host has emptied the response ring descriptor and is returning ownership of the descriptor to the controller. Just as the controller must poll for commands, so must the host poll for responses.

3.3.3   Interrupts

The transmission of a message will result in a host interrupt from the controller under the following circumstances.

1. During the initialization process (open a 'connection').

2. When the command ring buffer transitions from 'full' to 'not full'. This interrupt means that the host may place another command in the command ring.

3. When the response ring buffer transitions from 'empty' to 'not empty'. This interrupt means that there is a response for the host to process.

4. When a fatal controller error is detected and an interrupt can be generated. These are:

   Failure to become Qbus master for data transfer
   Failure to become Qbus master for interrupt
   Failure to access I/O page registers or communication area
   Qbus parity error detected.

3.4   DATA TRANSMISSION

In the command ring, the descriptor points to a command packet. Within the command packet is a buffer descriptor which contains a pointer and a byte or word count. The buffer descriptor points to the data buffer which holds data transfers. The data is moved by the controller into or out of the buffer as DMA transfers to/from Qbus addresses.

3.5   INITIALIZATION

The purpose of initialization is to identify the parameters of the host-resident communications region to the controller, provide a confidence check of controller integrity, and bring the controller online to the host.

3.5.1   Initialization Process

This paragraph describes the activity within the SA register during an initialization process. This is dependent on whether SA is being read or written.

By moving 4000 into IP, the controller initializes and passes back the 'step' response in SA. Then, the initialization parameters are written into SA. There are 4 words of initialization, and the controller must reflect each step by the appropriate step response, which is also * returned in SA.

3.5.2   Initialization Paramters

Word   Contents

   0   Command and Response ring sizes, interrupt enable and vector.

       The host writes into SA the lengths of the rings, whether interrupts are to be armed, and if so, the address of the interrupt vector. The controller then runs a complete internal integrity check and signals either success or failure.

1   Low order address of communications area, ie., ring buffer address.

The host reads an echo of the ring lengths from SA, and then writes into SA the low-order portion of the ring base address.

2   High order address of communications area, bits 0-14.

The interrupt vector address and the master interrupt arming signal are echoed in SA. The host then writes the high order portion of the ring base address to SA along with a signal that conditionally triggers an immediate test of the polling functions of the controller.

3   Burst transfer control, last failure flag, and the 'GO' bit.

The controller tests the ability of the Qbus to perform DMA transfers. If successful, the controller zeros the entire communications area, and then signals the host that initialization is complete.

3.6   REGISTERS

The programmable registers contained on the SDC-RQD11-B are the Initialize and Poll register (IP) and the Status and Address register (SA).

3.6.1   Initialize and Poll Register (IP)

The host begins the initialization sequence by either issuing a bus initialize or by using the IP initialize operation. Any write to that address will cause an initialization of the controller. When read while the controller is operating, it causes the controller to initiate polling. While DEC's controller always performs an initialization when the IP register is written to, the SDC-RQD11-B responds to the following initialization words :

```
-----------------------------------------------------------------------
        CPU          Word (octal)    Function

     LSI-11 only        *250         Call WOMBAT

     LSI-11 only         251         Call DEBUG (if implemented)

     LSI-11 only         252         Read block zero into host computer
                                     memory at location zero
                                     (simple boot procedure)

 LSI-11 & MicroVAX    Anything else  Initialization
-----------------------------------------------------------------------
```
*See Section 4.3 for invoking WOMBAT on MicroVAX CPUs.

3.6.2   Status and Address Register (SA)

The SA register consists of a set of two registers, the SA read register and the SA write register.

When read by the host during initialization, it communicates data and error information relating to the initialization process. When written by the host during initialization, it communicates certain host-specific parameters to the controller. When read by the host during normal operation, it communicates status information including fatal errors detected by the controller.

3.7   MSCP COMMANDS

The following commands are supported by the SDC-RQD11-B controller.

Command	Function
Access	Reads data from the specified unit.
Abort	Guarantees that referenced MSCP command will complete within the controller timeout period.
Available	If specified unit is on-line, returns it to the unit-available state. If specified unit is currently in the unit-available state, this command has no affect.
Compare Host Data	Reads data from the disk and compares it with the data in the host buffer.
Erase	Writes zeros to the specified logical blocks on the unit. (No data is accessed from the host).
Get Command Status	Reports the status of a specified command wtih a number that reflects the command's progress.
Get Unit Status	Reports on the status of a specified unit.
On Line	Places the specified unit on line, if possible.
Read	Reads data starting from the specified logical block on the disk, into host memory.
Set Controller Char	Sets host-settable controller characteristics.
Set Unit Char	Sets host-settable unit characteristics.
Write	Writes data starting at the specified logical block on the disk, from the host memory.

3.8   <u>ERROR HANDLING</u>

High data integrity is achieved by the controller through error code and
correction (ECC) and transparent bad block replacement. A read operation
is performed up to 10 times before a hardware error is reported to the
operating system.

MSCP Status Code Messages

Command Aborted   The current command was aborted before it could
                           be completed normally.

Compare Error   While performing a Compare command, a
                           discrepancy was found while comparing the disk
                           data to the host data.

Controller Error   The SDC-RQD11-B controller detected an internal
                           error, but is able to continue processing its
                           outstanding commands.

Data Error   Data could not be read or written due to CRC
                           errors, "Header Not Found", or due to a sector
                           being read whose forced error bit was set.

Drive Error   A drive-related error was detected (such as a
                           seek failure).

Media Format Error   Indicates that the media mounted on the unit
                           was incorrectly formatted.

Host Buffer Access Error   Reports bus timeouts and parity errors during
                           data transfers. (Applies only to the data
                           portion of an MSCP command).

Invalid Command   The SDC-RQD11-B controller found some field in
                           the command to be in error.

Success   The command was successfully completed.

Unit Available   The SDC-SRQD11-B controller is not on line, but
                           it can accept an On Line command from the host.

Unit Offline   The SDC-SRQD11-B controller is not on line, and
                           it cannot be brought on line.

Write Protected   A Write or Erase command was attempted to a
                           unit that is logically write-protected.

3.9   FATAL CONTROLLER ERROR

If a fatal error is detected when the controller is initialized, the error LED is lit, and the fatal error status set in the SA register.

ERROR CODES (octal)	DESCRIPTION
100004	RAM test failure
100005	ROM checksum failure
100011	No drive
100100	Disk unformatted
100101	Disk unstructured
100103	No RCT table
100103	No FCE table

A full description may be found under Section 4.5 : WOMBAT ERROR messages.

4.1   INTRODUCTION TO WOMBAT UTILITIES

WOMBAT utilities provide a controller resident means of formatting, testing and maintaining the drive and controller sub-system.

Interactive communication with WOMBAT may be achieved by connecting a 9600-baud terminal to the SDC-RQD11-B as described in Chapter 2.

When no terminal is connected directly to the SDC-RQD11-B, the WOMBAT communication program will automatically search for and use the console terminal at address 177560 on the Qbus.

4.2   OUTALK

When the WOMBAT code is deposited into the SDC-RQD11B base address (250 octal for LSI CPUs and AC hex for MicroVAX CPUs shown above), WOMBAT outloads a communication program from its program ROM into its host's memory. When this program executes, it manages communication between the console and WOMBAT. Communication between WOMBAT and a console terminal enables WOMBAT diagnostics and formatting capability on systems that have the console terminal as an integral part of the CPU (e.g., KDF11-B, KDJ11-B, MicroVAX).

NOTE

The second and third base address
conform to the MicroVMS
software requirements.

4.3   STARTING UP WOMBAT

WOMBAT is invoked by depositing a special data pattern into the SDC-RQD11-B control and status register. WOMBAT may be started by depositing a WOMBAT code into the IP register via console ODT.

WOMBAT on LSI processors is invoked by:

```
--------------------------------------------------------------------
KEYBOARD  SYSTEM      KEYBOARD
ENTRY     RESPONSE    ENTRY       COMMENTS

CSR*      000000      250 <RET>   ;ask WOMBAT to load the communication
                                  ;program into memory.

R7/       XXXXXX      2000 <RET>  ;set up program start address

RS/       000000      340 <RET>   ;set PSW to block interrupts

P <RET>                           ;start program without the bus reset
                                  ;that a micro ODT "G" would cause.
--------------------------------------------------------------------
```

WOMBAT on a MicroVAX I processor is invoked by:

```
--------------------------------------------------------------------
SYSTEM    KEYBOARD
PROMPT    ENTRY                   COMMENTS

>>>       D/P/W CSR* AC <RET>     ;ask WOMBAT to load the communication
                                  program into memory

>>>       S 400 <RET>            ;start the program
--------------------------------------------------------------------
```

WOMBAT on a MicroVAX II processor is invoked by:

```
--------------------------------------------------------------------
SYSTEM    KEYBOARD
PROMPT    ENTRY                      COMMENTS

>>>       D/P/W 20001F40 20 <RET>    ;enable Q bus access to memory

>>>       D/L 20088008 80000002 <RET> ;set up the appropriate Q  bus  map
                                       ;entry

>>>       D/W CSR* AC <RET>           ;ask WOMBAT to load the  ;communi-
                                       ;cations program into memory

>>>       S 400 <RET>                 ;start the program
--------------------------------------------------------------------
```

When P (LSI-11) or S 400 (MicroVAX) is entered WOMBAT should start and
appear on the console terminal.

*Enter CSR address defined in Section 2.3.1.

<u>NOTE</u>

For all CPUs, WOMBAT can be stopped
by re-booting the system.

When WOMBAT is invoked it will immediately try to determine how many disk
drives are connected to the SDC-RQD11-B. The following will be displayed
on the terminal:


```
**WOMBAT Version 4.X**
Drive 0: [READY/NO DRIVE]
DRIVE 1: [READY/NO DRIVE]
SELECT DRIVE [0-1]
```


Upon selecting a drive, WOMBAT will immediately try to read the disk and
assess if it has a valid structure. The structure incorporates such
factors as the number of cylinders, number of heads, and other details
relating to the disk. This information is always written on the first
two sectors of the first track of the disk, which makes this area and the
remainder of track zero permanently unavailable to the user. Once the
disk is structured, WOMBAT can access this information without having to
know anything about the disk.   When a disk does not have a valid
structure a warning message is displayed:

* Warning - disk is not formatted
* Warning - disk has no valid structure

You cannot perform any function with WOMBAT until the disk has first been
structured (refer section 4.4.1).   A previously structured disk will
automatically return the Master Menu when WOMBAT is invoked.

4.4   SETTING UP THE DISK STRUCTURE

When you attach a disk drive to the controller, you must go through the
process of setting up the disk structure, and then finally writing that
structure on to the disk. You do this by:

1. Creating the disk structure.

2. Formatting the disk (the structure is still in the SDC-RQD11-B
   memory).

3. Testing the disk drive, if you are unsure how reliable it is. At this
   stage you may still write to the disk as the   structure is still
   in the SDC-RQD11-B memory.

4. If the disk drive is not suspect and does not have errors on blocks
   zero or one, write the disk structure to it. If the disk has errors
   on blocks zero or one, you cannot attach and use it with the
   SDC-RQD11-B controller.

5. If necessary, do bad block management.

When you have set up the disk structure, then formatted and written the
structure to disk, you may let the host operating system use the disk.

The instructions for these procedures and the other available options,
are described in the next paragraphs. For consistency and clarity, each
option is described within its Menu set.

4.5   WOMBAT MENU OPTIONS

You communicate with WOMBAT by selecting the required option from the
master menu set which is given below :

*** Master Menu ***

        1 Structure Disk
        2 Test Disk
        3 Manage Bad Blocks
        4 Initialize Controller
        5 Position Head On Shipping Zone

Select an option by typing 'option number' followed by a carriage return
(RETURN). Options 4 and 5 are single function options, while accessing
options 1, 2 or 3 will provide you with a further sub-menu of options as
detailed below.

To return to the Master Menu while in a sub-menu, enter RETURN at an
option prompt.

*** Option 1 : Disk Structure Menu ***

     1 Create Disk Structure
     2 Format Disk
     3 Write Disk Structure
     4 Update HDR blocks
     5 Display Disk Structure

*** Option 2 : Test Disk Menu ***
     (! Means all data on disk destroyed)

     1 Read all Disk (preserves all data)
     2 ! Write Disk !
     3 ! Pattern Test !
     4 ! Random Writes !
     5 ECC Validation (preserves all data)
     6 Display Error Statistics
     7 Zero Error Statistics

*** Option 3 : Bad Block Management Menu ***

     1 Manually Replace Bad Block
     2 Automatically Replace Bad Block from Error Statistics
     3 Display Replaced Bad Blocks

*** Option 4 : Initialize Controller ***

This forces the controller to perform its initialization functions: RAM
clear and test, ROM test, and checks on the disk and its structure.
Initialization also allows selection of a new drive.

WARNING

Error Statistics Table cleared.

*** Option 5 : Position Head on Shipping Zone ***

When this option is selected, the head is positioned on the default
shipping zone cylinder number which is 340 unless an alternate zone is
provided by the manufacturer (see drive data sheet).   This provides a
safeguard for data areas on the disk.

When the head is positioned on the specified zone, the following message
is displayed:

Disk Heads now on SHIPPING zone!
This disk drive may now be safely removed.

4.4.1   Disk Structure Menu

Create Disk structure

When you attach a new disk drive to the SDC-RQD11-B controller, this option MUST be the FIRST selected as you cannot do anything else until the disk structure is specified.

WOMBAT has a completely 'soft' disk structure.   That is, it assumes nothing about the various disk parameters: cylinders, heads, and other pertinent factors. This option allows these parameters to be specified.

WOMBAT first displays its name and version.   This is used as an identifier when the disk structure is read to ensure that the various routines accessing the disk agree about the structure format.   The warning message simply highlights the fact that the disk is not structured.

If a disk drive has been previously structured, WOMBAT displays -

   *Disk Characteristics *
   Created by: WOMBAT Version

You may override any characteristic with different data, or press RETURN to accept the current parameter and display the next line.

If you incorrectly type in any one of the 10 parameters, simply press the RETURN key enough times to bypass the remaining parameter fields, until the 'Disk Structure Menu' is returned.   Select this option again and enter the correct data.

Example of a Disk's Structure

The following example is representative of a particular 20 Mbyte disk drive.   You would enter the correct figures relevant to your disk. All numeric values are decimals unless otherwise stated. Do not enter the decimal point to signify a decimal number as this is automatically returned by WOMBAT.

All figures shown in the righthand column are entered at the keyboard.

```
-----------SYSTEM PROMPTS--------------              EXAMPLE
DESCRIPTION                    DEFAULTS              ENTRIES

Size, Cylinders:              [0.]?                 306
Heads:                        [0.]?                 8
Sectors per Track:[17-18]     [18.]?                *<RET>
Interleave Factor:[2-6]       [0.]?                 2
Replacement Cylinders:        [0.]?                 6
Head Step Rate:               [15.]?                0
Seek Optimiaation:    0-None 1-Nearest 2-Elevator 3-Forward
Command Queue Size:[1-32]     [8.]?                 *<RET>
Optimization Strategy:[0-3]   [0.]?                 1
Fairness Count:[1-255]        [25.]?                *<RET>
Shipping Zone Cylinder:       [340.]?               *<RET>
Media Type:(AAAnn)            [WCCxx.]?             WCC31
Removable Media               [Y/N]                 N
Serial Number:(Octal)         [0]?                  *<RET>
Unit Number                   [0.]                  *<RET>
```

*A <RET> retains the default value.

SYSTEM READBACK MESSAGE:

USR area: 43038 blocks

'RETRN' to continue: (Returns the Disk Structure Menu)

Field Descriptions

The drive's data sheet is required for reference as WOMBAT needs to know some of the specifications. It is important that the details are accurately transcribed to ensure that WOMBAT runs effectively. Please refer to Appendix A at the end of this manual for a table of typical disk structure parameters used by other manufacturers. Please realize that WOMBAT trusts you. Entering nonsensical data will result in chaos. Press the RETURN key after each entry and the next prompt will be displayed.

Size, Cylinders   The total (decimal) number of cylinders on the disk. You will find this information on the drive data sheet.

Heads   The number of read/write data heads (other than servo heads) that the drive has, as stated on the data sheet.

Sectors per Track

The number of 512-byte sectors (17 or 18). You can determine this figure from information available on the data sheet. If the rotational speed (rpm) is specified as 3,600 +/- 0.1% (or less) then enter 18. Some drives may specify 1.0%. In these cases it is mandatory to use 17 because of the risk of sector overlap. If a number other than 17 or 18 is entered, WOMBAT displays '?Invalid' and repeats the prompt.

Interleave Factor [2-6]

The SDC-RQD11-B cannot directly transfer data between the Qbus memory and the disk. It must stage it via local RAM. Therefore an interleave factor of at least two is needed for the sectors on a track to get maximum transfer rate during a single revolution. The process involves the controller renaming the physical sector addresses. Some guidelines are:

Factor 2 Suitable for fast memory with block mode capability, including DEC MSV11-PK, MSV11-PL.

Factor 3 Necessary for slower, non block mode memory.

Factor 4/5/6 The rest of these were provided in case some application code could benefit.

CAUTION: You must match the interleave factor to the memory speed. A too low interleave factor will cause the disk to run much more slowly.

If an invalid interleave factor is entered, WOMBAT will display '? Invalid' and repeat the prompt.

Replacement Cylinders

This allocates room for the bad block replacement table. Allow at least 6 cylinders. When a structure is created on a formatted disk, the allocation is made as follows:

2 tracks for RCT (Replacement Control Table)
1 track for WRK (Controller work area)
1 track for FCE (Forced error table)
remainder for BAD (Bad block replacement area)

If you do not allow enough space serious problems may occur.

Head Step Rate

Specify the rate at which the disk heads can step. Zero is default, and is used for all disks with buffered stepper motor or voice coil head positioners.

| | Time between |
Rate	Stepping Pulses
0	35us
1	0.5ms
2	1.0ms
3	1.5ms
4	2.0ms
5	2.5ms
6	3.0ms
7	3.5ms
8	4.0ms
9	4.5ms
10	5.0ms
11	5.5ms
12	6.0ms
13	6.5ms
14	3.2us
15	16us

WOMBAT defaults to rate 15. However, rate 14 (3.2us) is recommended as the rate for MAXTOR drives to get the fastest seek rates.

Command Queue Size

The MSCP protocol allows the controller to stack a number of commands; this parameter allows you to specify the size of the command stack.

Please realize that the larger the stack, the more overhead the disk controller incurs when it scans it; also that some operating systems (RSX-11M-Plus 2.1B is a good example) have a maximum limit for the size of the stack. The default size (8.) is a good compromise, and acceptable to most operating systems.

Optimization Strategy

The seek optimization strategy can be either:

       0-None
       1-Nearest
       2-Elevator
       3-Forward

This is a user preference feature. WOMBAT displays '? Invalid' if the number entered is out of range, and repeats the prompt.

Explanation :

None

No optimization done. First request found executed.

Warning : This may not be the next sequential request.

Near

Nearest cylinder strategy selects the request that is closest to the current cylinder.

Elevator

This processes requests like an elevator - as it moves in one direction along the disk until it reaches the last request in that direction. This means that "Elevator" favours the centre of the disk, as it passes it twice as often as the periphery.

Forward

This processes requests from the lowest cylinder number to the highest; like "Elevator" except in only one direction. This is the generally recommended strategy for most purposes, and will yield an approximately 2:1 improvement in apparent performance in random access applications.

Note that optimization is only effective if the host operating system supports multiple accesses. RT-11, TSX-Plus, and RSX-11M normally do not without provision of special device handlers.

Fairness Count

The fairness count relates to disk commands. A reasonable count for normal use would be around 25. If the number entered is not within the range 1 - 255, WOMBAT displays the message 'Number too large', and the cursor moves to the next line. Enter a valid number.

This count determines the number of times an I/O request will be passed over by seek optimization before it is executed. Every time a request is passed over its fairness count is decremented. When that count reaches zero that request will be selected, no matter what optimization strategy is in effect.

This count has no effect if no optimization is selected.

Shipping Zone Cylinder   WOMBAT is setup to use cylinder 340, being
                             standard for a number of disk drives. Refer to
                             the Appendix to ensure that this is appropriate
                             for your type of drive.

Media Type   This field allows the media type to be
                             specified. The MSCP protocol returns - as part
                             of unit status when a "Get Unit Status" command
                             is issued - a 5 character media type.

                             As a default, WOMBAT sets up "WCCnnn", where
                             nnn is the size of the drive in megabytes. To
                             change this, enter 1 to 3 alphabetic characters
                             and 2 digits, e.g. RD52, to emulate DEC's 31MB
                             Winchester.

                             This field is displayed by some operating
                             systems when you enquire about the type of
                             drive. For example, RSX-11M-PLUS responds to a
                             "DEV DU:" command with :
                             "DUO: Public Mounted Loaded Label = RSX11MPBL15
                             Type = WCC31"

Serial Number   The MSCP protocol returns - as part of its
                             response when an "on-line" command is issued -
                             a 32-bit volume serial number. WOMBAT defaults
                             this field to zero.

                             To change this, enter, in octal, the desired
                             serial number.

                             This field is used, for example, by
                             RSX-11M-PLUS, when you initialize a disk with
                             the "INI DU:" command. It sets up the volume
                             serial number.

Unit Number   The unit number will default to the drive
                             number of the selected drive.

WOMBAT will then compute and report the user area on the disk. The user
area (USR area) is defined as the size, in blocks, of the user area on
the disk, as reported to the host operating system.

NB: The user area is the ONLY portion of the disk that the host operating
system can see.

Format Disk

The disk structure is now set up in the SDC-SRQD11-B controller's local
memory. Before the structure can be written out to disk, the disk must be
formatted.

Formatting destroys ALL INFORMATION on the disk, and this includes previous bad block allocations recorded in the Replacement Control Table. Take note that if a disk is restructured and not reformatted, then previously allocated bad block numbers could create an error when the structure is written to disk. The error message 'Disk Error Writing Disk Structure at NNNNN' would be displayed. NNNNN represents a bad block number allocated prior to the last formatting procedure.

When you select this option WOMBAT displays:

> *** Warning: all information on this disk will be destroyed, including any bad block mapping.
> Is this what you want to do [Y/N]?

Ensure that you do in fact want to format the disk and enter Y. If you enter N, the Disk Structure menu is returned.

While the disk is being formatted WOMBAT displays the mapped cylinder counter which commences from zero and increments by 64, thus showing you when the formatting operation is nearing completion. The final cylinder number (the parameter you entered when structuring the disk) is not displayed, and when formatting is complete the message '* Disk Formatted *' is displayed and the Disk Structure menu is returned.

Write Disk Structure

When you set up the disk structure, it is only recorded in the controller's local memory. This option writes the structure on the disk, where it is read by either the controller program or WOMBAT, to set up the disk parameters. Once this procedure is complete the host operating system may use the disk. If an override structure is written to disk and the disk has not been reformatted, an error could occur if there were blocks previously marked as bad (refer "BAD BLOCK MANAGEMENT MENU")

No information is displayed during the write process and when finished, the Disk Structure menu is returned.

Update HDR Blocks

This option allows you to just update the Disk Structure as recorded in the HDR blocks. If you, in the "Create Disk Structure" option, have ONLY altered any of the following parameters:

> Command Queue Size
> Optimization Strategy
> Fairness Count
> Shipping Zone Cylinder
> Media Type
> Serial Number
> Unit Number,

you may update the HDR blocks to include these changed parameters without destroying any data on the disk. A good example of this is if you are testing various disk optimization strategies.

WARNING

Do not alter any other parameter and try to use this
option; you must "Write Disk Structure" to update all the
disk structures in this case.

No information is displayed during the update process, and when finished, the Disk Structure Menu is returned.

Display Disk Structure

This is an optional sequence which may be used at any time to review parameters entered during a 'Create Disk Structure' procedure.

4.4.2   Test Disk Menu

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.

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

1. If an ASCII terminal is attached to the controller, press BREAK.

2. If WOMBAT is running from the Console terminal, type CTRL/C.   To abort, multiple CTRL/C may have to be entered rapidly.

When a test is aborted the Test Disk menu options are returned. If tests are run from an ASCII terminal attached to the controller, beware of system activity on the host computer as Qbus 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. The codes are defined as follows:

BB   Bad Block; block marked as bad.

ID   Id error; sector header cannot be found on disk.

CRC   Cyclic redundancy error; miscompare of the 16-bit cyclic redundancy word on a write or read verification sequence.

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.

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   020 ID
        Pass:1. Errors: 1.
        Pass:2. Errors: 1.

Displayed error count is cumulative until the test is terminated.

Pattern Test

This test writes a worst case pattern to each block along with the block number.   It does one write and 10 read and compare passes, where it checks that it is reading the right block and that the data pattern is correct.   This test reports any errors in the standard format as shown above.

Random Writes

As for Pattern test on USR area of disk, then performs 5000 random writes, reporting every 1000 writes for timing purposes. Finally it does a check of all data on the disk again. This test reports:

        Initializing Disk ...
        #5000 Random Writes
        1000.
        2000.

ECC Check

Enables ECC logic to be checked. This writes blocks with both correctable and uncorrectable ECC errors, thus verifying the ECC operation. This test is non-destructive of data on the disk.

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.

Zero Error Statistics

Zeroes the error statistics table & redisplays Test Menu options.

4.4.3   Bad Block Management Menu

Bad blocks are replaced by marking them as bad on the disk (by flagging them as "BAD" in the sector header), and recording the block number in the Replacement Control Table, pointing at a replacement block in the BAD area of the disk.

When the disk structure is written, a zeroed replacement table is written to the RCT. Therefore, any bad blocks on the disk will exist without a replacement block so that any testing of the disk will then report them as "BAD" blocks (BB).

Bad block management cannot be done until the structure has been written to the disk.

Manually Replace Bad Block

This option prompts operator entry of an arbitrary block to be replaced as "bad".

If you enter a block number that is higher than the total number of blocks available, or enter an illegal non-numeric block number, then WOMBAT displays the error message '* Failed *'.

Automatically Replace Bad Block from Error Statistics

This option replaces all bad blocks discovered during any or all of the
three   tests,   subsequently   displayed   in   the   'Display Error Scan
Statistics' function. Any block with 10 or more errors will be marked as
bad and replaced with a block in the BAD area.

Display Replaced Bad Blocks

Displays all blocks in the Replacement Control Table and gives the total
number of blocks replaced.

4.6   WOMBAT ERROR MESSAGES

No Drive

Initialization tried to read the disk structure and failed.   Check   that
the disk is connected correctly to the controller.

Disk Unstructured

Initialization can read the disk but cannot identify either copy of the
data in the header blocks.

Cannot read RCT Table

Cannot read either copy of the RCT Table because of disk   errors   or   the
structure is not as expected.

Format error at block

An error was encountered while trying to format the disk at the specified
block number. Since this is the first thing you do to a disk, it normally
means that either the disk is not working at all, or the disk is not
connected properly (e.g. wrong cables) to the controller. If the message
occurs at other times the disk drive is probably very sick, or
intermittent.

No Disk structure

An attempt has been made to display a disk structure on a disk that has
not been structured.

Cannot replace this block

The block number entered is not within the bounds of the user area of the disk.

No RCT Table

Initialization could read neither of the two copies it keeps of the RCT (Replacement Control Table). Though you will destroy all information about replaced bad blocks, try writing the disk structure again. If errors persist in the RCT area, you may have to move the RCT to another cylinder on the disk. If the writing of the disk structure is successful this time, you can recover any replaced bad blocks by just performing a read test, which will bring up any unreplaced bad blocks as hard (10 retries) BB (Bad Block) errors. You may then replace them by using the "Automatically Replace Bad Blocks From Error Statistics" option.

No FCE Table

Initialization cannot locate the "Forced Error Table". Comments for "No RCT Table" apply.

RCT error

WOMBAT found the answer invalid when it computed the address of the RCT on disk. Check and respecify the bad block replacement table size in cylinders.

Disk error writing Disk structure at: (block)

For some reason, WOMBAT cannot write the structure details on to the disk. Test the disk thoroughly with the "Test Disk" menu. If that works properly, move the RCT and try again. If it still fails, you may have a bad disk or controller. Try component swapping.

Command Timeout

When all commands are executed, a counter is started to stop them "hanging". This counter has expired. If this is the first time the disk has been used, is the disk connected properly? Are the cables correct? Is there power to the disk? If the disk has a select light, is it on? Try powering off and on. Try component (disk and controller) swapping.

Fatal - Respecify Structure

An error has been detected in the disk structure specified; check and re-enter.

4.7   WOMBAT SELF-DIAGNOSTICS

A common initialization procedure exists for both WOMBAT and the MSCP firmware. It performs : a RAM integrity test, a ROM checksum, and various checks on the disk drive and its structure

The errors which can result from this are described under Section 3.9 Fatal Controller Errors.

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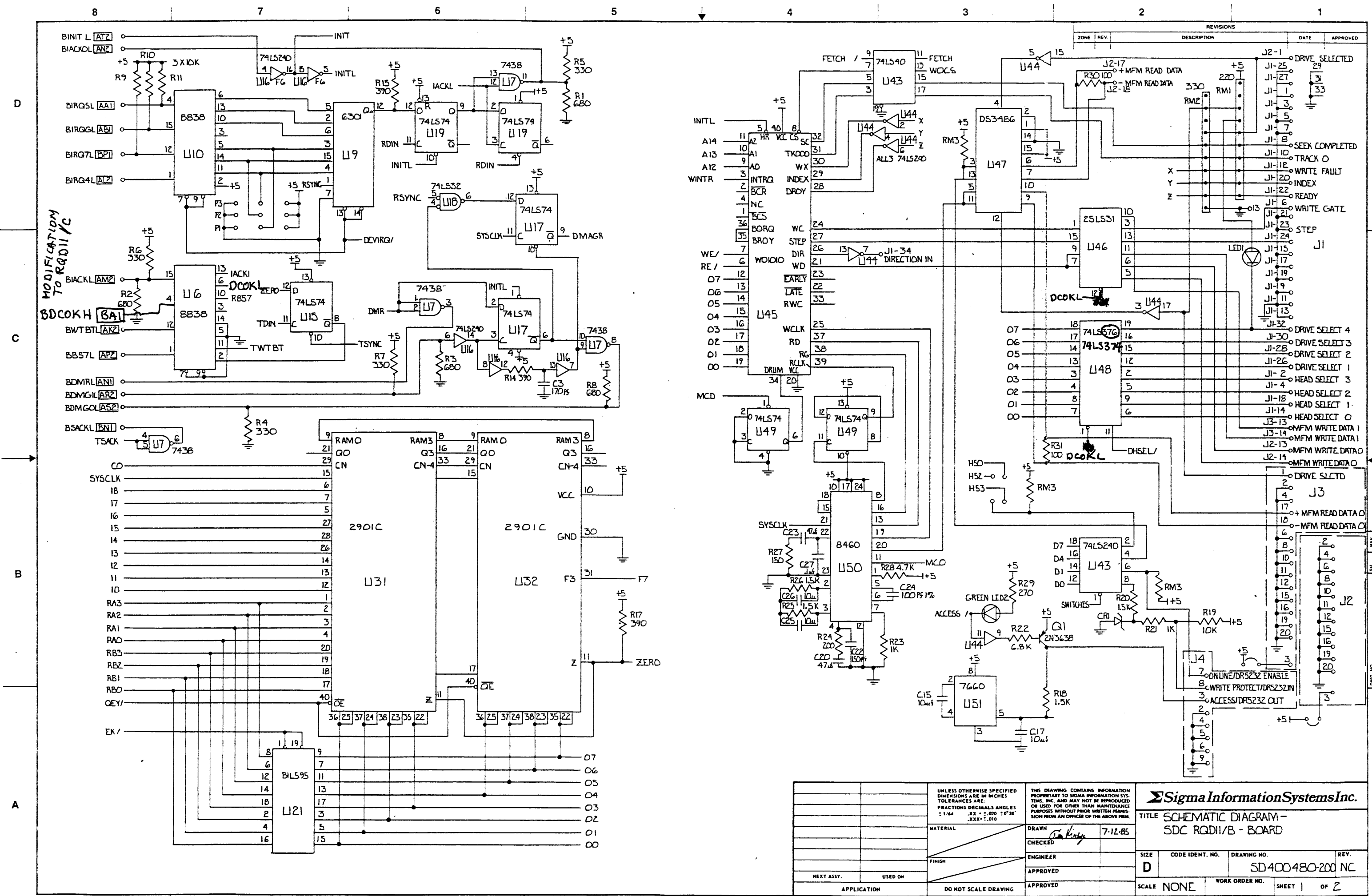DEC, MSCP, LSI11, MicroVAX, RT-11, RSX-11M plus, RSTS/E, Micro VMS, and Qbus are trademarks of Digital Equipment Corporation.
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WOMBAT is a trademark of Webster Computer Corporation.

Appendix A

Table of Typical Disk Structure Parameters

MANUFACTURER	MODEL	NO. CYL.	NO. HEADS	NO. SECTS	REPL. CYL.	STEP RATE	SHIPPING CYL.
CDC	9415-5 WREN	697	5	17	7	0	-
HITACHI	DK503-2	306	4	17	6	0	320
MAXTOR	XT-1140	918	15	18	8	0	-
MINISCRIBE	3012	612	2	17	12	0	656
OTARI	D526	306	8	18	6	0	340
PRIAM	504	755	11	17	10	0	-
TANDON	TM503	306	6	17	6	0	-
RODIME	204	320	8	18	4	0	340
VERTEX	V170	987	7	18	7	0	-

SCHEMATIC DIAGRAM - SDC RQD11/B - BOARD

Sigma Information Systems Inc.

SIZE D   DRAWING NO. SD400480-200   REV. NC

SCALE NONE   SHEET 1 OF 2