Ciprico
Product Specification

RIMFIRE 3200

SERIES
VMEbus
DISK DRIVE CONTROLLERS

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Plymouth, MN 55441
(612) 559-2034

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A. Out of warranty repair will be accomplished expeditiously at a charge of $200.00 flat charge (domestic) plus shipping charges. Enclose a description of the failure whether or not returned products are within warranty period.

B. All products in or out of warranty returned for repair that are found to have no defect will be charged at the out of warranty rate.

C. Shipments arriving at CIPRICO without a Return Authorization (RA) number will not be accepted and will be returned to the customer at his cost regardless of warranty status.

3. RETURN PROCEDURES

A. Upon determining that repair is required the Customer must:

1) Call CIPRICO Customer Support at (612) 559-2034 for a "Return Authorization" (RA) number. Please have available:
   a) The serial number of the board(s)
   b) An open P.O. number for $200.00 per board
   c) The reason for return
   d) If Debit/Rebill is applicable

2) Enclose a detailed description of the failure with the failed unit in a static-shielded protective container.

3) Ship unit to:

CIPRICO INC.
2800 Campus Drive
Suite 110
Plymouth, MN 55441

4) The RA is valid for 30 days after issue. Turn-around time is typically 48 hours in-house.

B. Upon completion of the services required, an invoice will be issued stating charges (when applicable) and work completed. CIPRICO will prepay return shipment (surface) if the item was under warranty.

4. PAYMENT

A. Payment terms are net 30 days from invoice date payable to CIPRICO. Payments must refer to RA number.

B. Send payments to:

CIPRICO INC.
2955 Xenium Lane
Plymouth, MN 55441
ATTN: Accts. Payable

REVISION HISTORY

Number	Rev	Date	Description
21010098	01	04-07-86	Preliminary release
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	06	04-28-87	Preliminary release
	A	08-11-87	"A" product release
21015500	A	11-20-87	Added information to cover models Rimfire 3202, 3210, 3220.

REFERENCE DOCUMENTS

The following documents apply to the Ciprico Rimfire 3200 VMEbus disk drive adaptor.

1. User Manual for applicable disk drive
2. VMEbus Specification Manual, Revision C.1 (Motorola Publication)
3. ANSI SMD Specification
4. CDC SMD Interface Specification
5. CDC SMD-E Interface Specification

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INTRODUCTION

The Ciprico Rimfire 3200 series are intelligent disk drive controllers which operate SMD, SMD-E, or HSMD drives from a single VMEbus slot. They support drive data rates to 24 MHz, and transfer data across the VMEbus at burst rates to 30 Mbytes/second. The Rimfire 3200 series support multiple hosts; they improve system performance and decreases host workload. References to the Rimfire 3200 controller apply to all members of the series unless a specific model number is used.

The Rimfire 3200 controller reduces system overhead and increases the speed of disk operations by means of a number of performance features. Host-controlled feaures include: data caching on read/write operations; automatic read-ahead; and automatic request sorting by disk address (reducing seek times). Reduced-latency reads/writes are performed and single-track operations are combined whenever possible, minimizing disk revolutions. The controller supports fully concurrent two-drive (Rimfire 3201 and Rimfire 3202) or four-drive (Rimfire 3210 and Rimfire 3220) operation, including implied overlap seeks. It generates a variety of disk formats, and provides for inter-track and inter-cylinder skews (spiral formatting).

The Rimfire 3200 controller transfers data to or from any address on the VMEbus. It operates at a burst rate of 30 Mbytes/second with a 30 nS memory response time, and sustains a data throughput between 4 and 7.5 Mbytes/second. It supports transfer widths of 8, 16 or 32 bits and address widths of 16, 24, or 32 bits.

A write to a Channel Attention port alerts the Rimfire 3200 for a command. Commands are issued either singly or in circular lists in host memory. This command list feature (see Section 2) enables up to seven independent hosts to issue disk commands without arbitration for controller time.

Rimfire 3200 hardware is based on the Intel 80186 microprocessor. A National Semiconductor 8466 digital data controller performs disk operations, and a proprietary FIFO gate array performs bus operations. This gate array also swaps bytes and words as required by all 16- and 32-bit processor families (see Section 2 for details). An onboard cache memory consists of 512 Kbytes of dynamic RAM, dedicated solely to disk operations. A separate 64-Kbyte static RAM area is a scratchpad for current operations. Figure 1-1 illustrates Rimfire 3200 architecture.

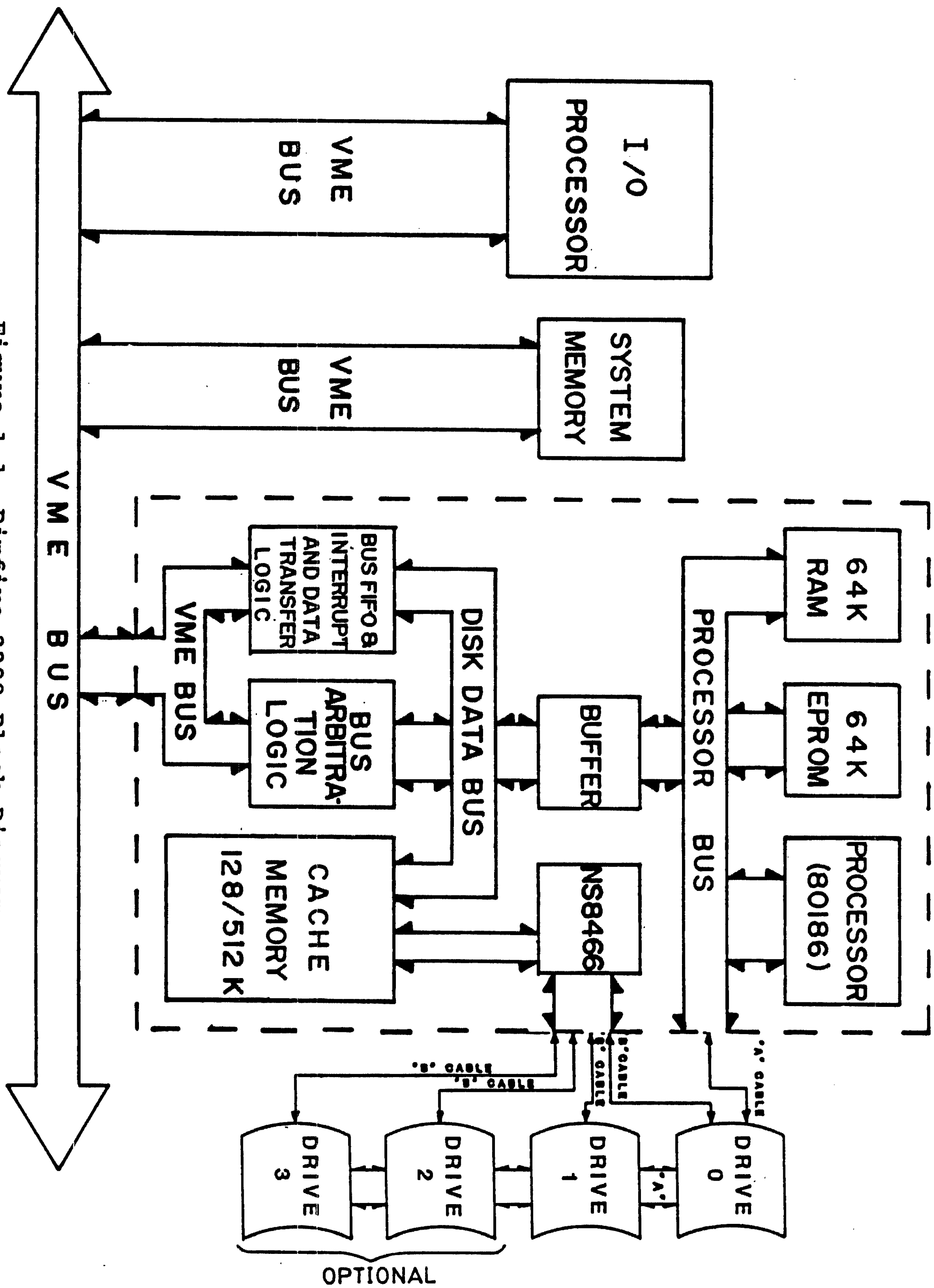


Figure 1-1 Rimfire 3200 Block Diagram

FEATURES

Disk:

- Rimfire 3201 and Rimfire 3202 control 1 to 2 SMD, HSMD, or SMD-E disk drives; Rimfire 3210 and Rimfire 3220 control 1 to 4 disk drives
- Disk data rate to 24 MHz
- Supports removable volume drives
- Sector sizes between 512 and 8192 bytes for all SMD disks: 256 to 8192 byte sectors are supported on drives with data rates of 10 MHz. Any multiple of 16 bytes may be used for sector size.
- Supports Tag 4 and 5, including extended error status
- Implied overlapped seeks used with multiple disk drives

VMEbus:

- Conforms to VMEbus specification revision C.1
- VMEbus burst transfer rate of 20 Mbytes/sec using single transfers, 30 Mbytes/sec using block transfers, both assuming 30 ns. memory response time
- Supports 8, 16 or 32 bit data transfers, 16, 24, or 32 bit address spaces
- No addressing restrictions: any structure may be placed at any address

Host interface:

- Processes host commands without timing restrictions
- Supports up to 7 command lists without timing restrictions or shared memory: usable in multiple-host, multiple-drive, or fault-tolerant applications
- Hardware byte and word swap simplifies support of Intel, National, and AT&T families on VMEbus

Controller features:

- Cache size of 512 Kbytes
- Host control of caching
- Controller simultaneously processes up to 250 host commands
- Command sorting by disk address optimizes disk throughput
- Sector and track mapping, sector slip, onboard defect table optimize access to alternates
- Reduced latency reads and writes: maximum one revolution plus one sector time for most reads/writes to any part of one track
- Multiple reads/writes to a single track are combined, performed in one revolution
- Proprietary 48-bit ECC word
- Spiral formatting
- Concurrent disk-to-cache and cache-to-VMEbus transfers
- Onboard diagnostics with LED status indicators

SECTION 2
OPERATIONAL CHARACTERISTICS

The Rimfire 3200 controller executes commands issued by the host computer. Each command is stored in a 20-byte structure called a **parameter block**. The controller interprets the parameter block and performs the command, then signals command completion and provides error information in a structure called a **status block**, optionally generating a VMEbus interrupt. Certain commands use special block formats, described with their commands in Section 3 of this manual.

STANDARD PARAMETER BLOCK

The 20-byte standard parameter block contains the command and its parameters. It is used to execute all Rimfire 3200 commands. Certain commands define their own parameter block format. These are also 20 bytes long, and are discussed with their commands in Section 3 of this publication.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED		SECTOR COUNT	

Figure 2-1 Rimfire 3200 Standard Parameter Block

IDENTIFIER

The host assigns an **identifier** value to identify the command being executed. The controller places this value in all status blocks the command generated, enabling the host to match status blocks to parameter blocks. The controller does not interpret this field.

COMMAND

This field specifies the command to be executed (see Section 3).

CONTROL

7				0
0	0	0	0	CONTROL GROUP

Figure 2-2 Control Field

CONTROL GROUP - I/O control group for this command (see Initialize I/O Control Group, Section 3)

UNIT

This field (Table 2-1) specifies the SMD drive to which the command applies. Drives 2 and 3 are applicable only to the Rimfire 3210 and 3220 controllers.

Table 2-1 SMD Drive Unit Numbers

0 - Non-disk command
1 - SMD drive 0, main volume
2 - SMD drive 0, second volume
3 - SMD drive 1, main volume
4 - SMD drive 1, second volume
5 - SMD drive 2, main volume
6 - SMD drive 2, second volume
7 - SMD drive 3, main volume
8 - SMD drive 3, second volume

SMD drives with one volume use the unit numbers for main volume. In SMD drives with two volumes, by convention the fixed drive should be the main volume; the removable drive as the second volume. Commands which do not apply to a specific unit must use a unit number field of 0.

ADDRESS MODIFIER

This field contains the VME address modifier used when accessing memory. It is required for all commands which require a VME Memory Address field.

DISK ADDRESS

This field contains the absolute sector number at which to start reading or writing. Disk addresses are referred to by sector number. Cylinder/head/sector addressing is not supported by the RF3200.

VME MEMORY ADDRESS

This field specifies the address to read from or write to. The VME Address Modifier field is required when this field is used.

SECTOR COUNT

This field specifies the number of sectors to be processed by the command.

STATUS BLOCK

All commands return a 12-byte status block, which provides the host with detailed information about command execution. Multiple status blocks may optionally be returned: one for each error, retry or correction. The host specifies the types of conditions that return status blocks by means of the General Options command. Every command returns at least one status block (the last block) with the Command Complete bit set in the Flags field.

The standard status block format is used when returning status from a disk command. This includes the following situations:

- Command complete for an Issue Tag/Read Status command
- Retry and error correction conditions
- Command Complete status blocks, either with errors or with the retry or correction bits set in the Flags byte. In the latter case, disk address and status fields are the values at the time of the last error, not at command completion.

31			0
IDENTIFIER			
VSTATUS	DSTATUS	ERROR	FLAGS
DISK ADDRESS OF ERROR, RETRY, OR CORRECTION			

Figure 2-3 Standard Status Block

IDENTIFIER

This field is copied from the Identifier field of the applicable parameter block. It enables the host to determine which command generated the status block.

FLAGS

This field (Figure 2-4) specifies a variety of status block types and options.

7							0
CC	ERR	RTY	COR	0	0	0	0

Figure 2-4 Flags Byte

COR - Correction required
RTY - Retry required

ERR - 0 = No error
1 = ERROR field shows error
CC - 0 = Command not complete
1 = Command complete

CC bit = 0: Retry/correction status block. In this case, the RTY or the COR bit will be set to 1, signaling a retry or ECC correction. The ERROR field specifies the condition that caused the retry/correction. The rest of the status block lists the address and status of the retry or correction. Retry and correction status blocks are only returned when enabled by the host. Refer to the General Options command for further information.

CC bit = 1: Command complete. If the ERR bit is also set to 1, an error prevented the command from completing correctly: the ERROR field specifies this error. The disk address and disk status fields contain additional error information. The RTY and COR bits specify whether a retry or correction was done any time during command execution.

If the RTY or COR bits are set and the ERR bit is clear, the command completed after one or more retries/corrections. The disk address/status fields contain the location and status associated with the last retry or correction performed, even if it was already reported by a retry/correction status block. See Table 2-2 for examples.

Table 2-2 Examples, Retry/Error Flag Byte Settings

status bits set	meaning
CC	Command completed without errors or retries
CC ERR	Command completed with error, without retries or corrections
CC ERR RTY	Command complete, error occurred after retrying
COR	Correction occurred, status block returns location, command execution continues

ERROR

This field specifies the error, retry or status condition that generated the status block (see Appendix C, Error Codes). If the RTY or COR bits of the FLAGS field are also set, then a retry/correction was done before the error was detected.

DSTATUS

This field (Figure 2-5) returns disk status. It is only returned if a retry, correction, or error occurred.

23							16
0	0	0	WRP	FLT	SER	ONC	RDY

Figure 2-5 Disk Status (DSTATUS) Byte

RDY - Unit ready
ONC - On cylinder
SER - Seek error
FLT - Drive fault
WRP - Write protect

VSTATUS

This field returns vendor-unique extended status from the drive. The host must interpret and act on this status: the controller does not interpret this data, because it depends on the disk drive being used. Vendor-unique status is returned when enabled by the Define SMD Parameters command, or when an Issue Tag/Return Status command is executed.

Figure 2-6 shows the bit ordering of returned vendor status. This corresponds to the bit ordering of Control Data, Fujitsu, and Priam disk drives. Note that the bit names show which status line is returned in each bit: they are NOT the names of the returned fields. Refer to the drive manual to interpret this field.

31							24
SEC	IND	ADM	WRP	FLT	SER	ONC	RDY

Figure 2-6 Vendor Status Byte

RDY - Unit ready
ONC - On cylinder
SER - Seek error
FLT - Drive fault
WRP - Write protect
ADM - Address mark
IND - Index
SEC - Sector

DISK ADDRESS

This field returns the disk address of an error/retry. With ECC corrections, this is the corrected sector. With seek-related errors, this is a sector within the track where the seek was attempted. If all bits in the field are 1 (signifying a value of -1), the current disk location could not be determined. (This field may be ignored with the Status command.)

EXTENDED PARAMETER BLOCK

This 40-byte structure (Figure 2-7) is used when issuing commands using the type 0 Channel Attention (see "Issuing Commands" in Section 2). This block contains a standard parameter block, status block and interrupt data.

31	0
STANDARD PARAMETER BLOCK	
RESERVED	DONE INTERRUPT
RESERVED	
STATUS BLOCK	

Figure 2-7 Extended Parameter Block

DONE INTERRUPT

The Rimfire 3200 generates VMEbus interrupts when commands complete, or on other host-enabled conditions. This field combines a three-bit interrupt level with an 8-bit Status/ID field (Figure 2-8) to specify which VMEbus interrupt to generate on command completion. It includes a 3-bit interrupt level and an 8-bit Status/ID field. It appears in both the extended parameter block and in the Setup Command List block (see Section 3).

In VMEbus terminology, the RF3200 acts as a D08(0) interrupter. Interrupt requests are removed when the interrupt is acknowledged, making the Rimfire 3200 a Release On Acknowledge-type interrupter.

15						0
0	0	0	0	0	INT. LEVEL	STATUS/ID

Figure 2-8 Interrupt Field (Vector)

STATUS/ID - Specified by the host; placed on data bus during the interrupt acknowledge cycle.

INT. LEVEL - Interrupt level - Clear this area to disable the interrupt.

000 - Interrupt disabled	100 - Interrupt level 4
001 - Interrupt level 1	101 - Interrupt level 5
010 - Interrupt level 2	110 - Interrupt level 6
011 - Interrupt level 3	111 - Interrupt level 7

RES - All reserved bits must be cleared to 0.

ISSUING COMMANDS

All Rimfire 3200 operations are performed by issuing commands to the controller. There are two methods for issuing commands. The first, primarily used for initialization, allows issuing a single parameter block at any address in memory and is referred to as a "Type 0 Channel Attention". The second, used for normal operation, issues commands through a communication area in memory called a "Command List".

SINGLE COMMANDS (TYPE 0 CHANNEL ATTENTION)

This method is used for board initialization and special situations. The first command after a board or system reset must be issued singly, through a type 0 Channel Attention. The steps in issuing this type of command are:

1. Build an extended parameter block in memory (see Figure 2-7).

2. Write the address of the extended parameter block to the address buffer port. This is done using three writes to this address, as shown below. See also Figure 2-10.

   First write: Control flags and address modifier.

   Second write: Most significant 16 bits of address.

   Third write: Least significant 16 bits of address.

3. Write a 0 to the channel attention port, informing the controller that a new command is waiting.

COMMAND LISTS

Command lists (Figure 2-9) are the simplest way to issue multiple commands. A command list is defined by the Setup Command List command (01H). The command list structure consists of two parts. The first is the Parameter Block area, used to issue commands; the second is the Status Block area, used to receive the results of commands.

Each part of the command list is a FIFO, with IN and OUT pointers defining the current start and end of the FIFO. The host places parameter blocks in the Parameter Block area using the rules outlined below, and the controller reads them from here. When commands complete or other status is available, the controller places a status block in the Status Block area, where the host can then interpret it.

The command lists defined in memory are independent of one another: no constraints are placed on the use of the Channel Attention port beyond those defined by the VMEbus specification. A system with more than one host may therefore be supported by a single RF3200, if each host is assigned a separate command list. A startup sequence doing this might have a single host setting up command lists and passing list numbers and addresses to the other hosts, which would issue commands through their individual lists.

NOTE

> The operating system must still ensure that data is properly shared between hosts.

Maximum command list size is 65,536 bytes. For example, if the parameter block and status block lists are of equal size, the maximum list size is 2047 entries. Command list size in bytes is computed by:

$$\text{list size} = 32 + 20P + 12S \text{ bytes}$$

where "P" is the number of parameter blocks in the parameter block area, and "S" is the number of status blocks in the status block area.

31 ... 0
PARAMETER BLOCK IN POINTER
PARAMETER BLOCK OUT POINTER
STATUS BLOCK IN POINTER
STATUS BLOCK OUT POINTER
PARAMETER BLOCK LIST SIZE
STATUS BLOCK LIST SIZE
RESERVED
RESERVED
PARAMETER BLOCK AREA
STATUS BLOCK AREA

Figure 2-9 Command List Data Structure

PARAMETER/STATUS BLOCK IN/OUT POINTER - These four double words contain in and out pointers for the parameter and status block areas. Each pointer is a zero-based index into the appropriate array. Thus a pointer value of 0 is the first entry, 1 the second, 2 the third, etc.

PARAMETER/STATUS BLOCK LIST SIZE - These two double words define the size of the command list, specifying the number of parameter blocks and status blocks respectively.

PARAMETER BLOCK AREA - This is a circular list of parameter blocks, N x 20 bytes long: the host places parameter blocks here and the controller removes them.

STATUS BLOCK AREA - This is a circular list of status blocks, N x 12 bytes long: the controller places blocks here and the host removes them.

The following rules apply to the IN and OUT pointers of each circular list:

1. If IN = OUT, the list is empty.

2. If IN = OUT - 1 (modulo list size), the list is full.

3. To add an entry to the parameter block list:

   - Make sure the list is not full.

   - Write the parameter block at parameter block number IN.

   - Increment IN (modulo list size).

   - Issue a channel attention.

4. To remove an entry from the status block list:

   - Make sure the list is not empty.

   - Read the status block from status block number OUT.

   - Increment OUT (modulo list size).

5. The host must never change the parameter block OUT pointer or the status block IN pointer. Similarly, the RF3200 will never change the parameter block IN pointer or status block OUT pointer.

6. The RF3200 will not update the OUT pointer immediately after a command is read into the board: instead, it waits until it has time. Do not depend on the parameter block OUT pointer to signal that the RF3200 has accepted the command.

HARDWARE INDICATORS

The Rimfire 3200 has a green LED and a red LED on its faceplate. These indicators have a special function in the reset process; refer to the discussion of controller reset later in this section.

Green (busy) LED

The green LED is lit whenever the Rimfire 3200 is executing a command. It is lit when a channel attention is received, and is turned off when the last command is complete.

Red (error) LED

The red LED is lit for one second whenever the RF3200 detects a hard error (not retriable/correctable).

HARDWARE PORTS

The Rimfire 3200 is defined as a 512-byte area in the 16-bit address space. There are four registers in this space (Table 2-3), each on an 8-byte boundary.

Table 2-3 Address Registers

	8 bit	16 or 32 bit	R/W only
Address Buffer Port	--	0H	W
Channel Attention	9H	8H	W
Board Status	--	10H	R
Controller Reset	19H	18H	W

The board responds to either the address modifier 29H (non-privileged 16-bit address space access) or 2DH (privileged 16-bit address space access), depending on the jumper setting (see Appendix D).

ADDRESS BUFFER PORT

This port (Figure 2-10) provides access to a 3-word deep port, 16 bits wide. It is used to write the address of a single parameter block to be executed. It is loaded by executing three writes to the Address Buffer Port address.

15	0	
CONTROL	ADDRESS MOD.	1st write
PB ADDRESS: MSW		2nd write
PB ADDRESS: LSW		3rd write

Figure 2-10 Address Buffer Port

CONTROL - This field (Figure 2-11) specifies transfer widths and byte and/or word swapping status for support of 8086/32032-family processors. The control byte sets transfer width and swap controls once only, during initialization. Set this byte while the board is idle. It takes effect before the parameter block is read in, and applies to all future controller accesses to VME memory.

NOTE

Changing control byte settings while other commands are executing or after a command list has been started will result in undefined actions.

15							8
SET	0	0	0	0	WID	WSW	BSW

Figure 2-11 Control Field, Address Buffer Port

BSW - Byte swap (0 = VME order, 1 = swap bytes)
WSW - Word swap (0 = VME order, 1 = swap words)
WID - Data transfer width (0 = 16 bits, 1 = 32 bits)
SET - Apply Control field

ADDRESS MOD. - Address modifier to use when reading the parameter block.

PB Address - Address of the extended parameter block.

NOTE

Byte and word swap controls must be written as three-word values with VME byte ordering. They are not applied to the address buffer words. The parameter block address is always written as most significant word followed by least significant word.

CHANNEL ATTENTION

This write-only port signals the controller that a command is to be executed. The host writes a number from 0 to 7 into this port. Writing 0 initiates a single command (Type 0 channel attention). Writing 1 through 7 informs the controller that command lists one through seven respectively contain new parameter blocks. The number specifies the command location. Refer to Section 4 for more information.

STATUS PORT

This register (Figure 2-12) returns general controller status.

15 … 8	7 … 5	4	3	2	1	0
RESERVED	LIST	ERR	0	0	RDY	ENT

Figure 2-12 Status Port Register

ENT - This bit determines when a command has been entered (type 0 channel attention). This bit is initially zero. After a type 0 channel attention, it is inverted to 1 to signal that the command was accepted. After a second type 0 channel attention, it is inverted back to 0 to signal that the command was accepted. The bit then inverts each time a type 0 channel attention is accepted.

RDY - This bit is 1 when the Rimfire 3200 is ready to accept commands. If it is 0, the board cannot attempt or execute commands.

ERR - If a memory transfer error is detected while reading parameter blocks or writing status blocks, this bit is set to signal that an error has occurred.

LIST - If ERR is set, this field specifies which command list the transfer error was found on. If 0, a type 0 command could not be transferred. If non-zero, reading or writing the command list given by LIST returned an error.

In each case, the error was a VMEbus error (error code 13H).

Status register on reset:

The status register contains special status on board reset. Its format at this time is shown in Figure 2-13.

15 … 8	7 … 0
BOARD TYPE = X	INTERMEDIATE STATUS

Figure 2-13 Status Register At Board Reset

During the board reset process, the status register goes through the sequence of values shown below:

1. Hardware reset sets status to 0.

2. Immediately after the Rimfire 3200's onboard processor begins executing, it sets the status register to F0H.

3. As each reset step is performed, the status register is decremented by 4 (e.g. ECH, E8H, E4H, etc). During this time the status register is greater than 80H.

4. When the reset process completes, the RDY bit is set in the status register as described above and the board type 0 (signifying a 3200 controller) is placed in the most significant byte of the status register.

NOTE

The board type field is only valid when reset is complete, and before the first channel attention. When a channel attention has been issued, this field has its normal meaning.

If an error is detected during reset, the board status register specifies the error which occurred. Error status values and their associated tests are shown in Table 2-4.

Table 2-4 Error Codes and Associated Tests

00H - The onboard processor is not working, cannot access firmware EPROM, cannot access the short burst FIFO (which holds the status register), or the status register cannot be read over the VMEbus correctly.

04H - Static RAM error. All words of static RAM are written with FFFFH, then 0. This is not an exhaustive test.

08H* - Dynamic RAM error. All words of dynamic RAM are written with FFFFH then 0. This is not an exhaustive test.

0CH - Firmware checksum error. A checksum is done of the odd and even firmware PROMs and must match the expected checksum stored in the PROM.

10H* - Disk sequencer cannot be accessed by onboard processor. This checks that the 8466 disk sequencer can be accessed and that all sequencer read/write registers operate correctly.

14H - Short burst FIFO cannot be accessed by onboard processor. The short burst FIFO is loaded with data, then the data is read back and checked.

18H* - Disk sequencer remote channel test failed. A 342 byte transfer is done from dynamic RAM into the short burst FIFO the reversed. This tests the internal portion of the VMEbus transfer logic.

1CH - Channel Attention register won't clear, cannot be accessed, or the interrupt won't clear.

* When these errors are detected the board still completes the reset process. The red light remains on, SYSFAIL remains asserted, but non-disk commands (e.g. diagnostic) may be issued. This is for factory test purposes and the board will not access disks under these conditions.

CONTROLLER RESET

A write to this port resets the controller. It is identical to a hardware reset. Data associated with this write is ignored.

On reset, red and green LEDs are lit. The green LED is turned off as soon as possible. Initialization and power-on diagnostic checks are performed, taking approximately 5 seconds. On completion, the red LED is turned off and the controller is ready for commands.

The reset process performs a set of diagnostics. A more complete RAM diagnostic may be performed using the Diagnostic/Self-Test command. When an error is detected, the firmware sets the status register to one of the values listed in Table 2-4.

SECTION 3
COMMANDS

NOTE: Only parameter block fields different from those defined in Section 2 are described in this section.

NON-DISK COMMANDS

SETUP COMMAND LIST (01H)

This command (Figure 3-1) starts a command list and specifies its parameters. The host must clear command list IN/OUT pointers and set list size fields before executing this command (see Command List, Figure 2-8).

31 ... 0

IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0		DONE INTERRUPT	
ADDRESS			
RESERVED = 0			LIST #

Figure 3-1 Setup Command List Parameter Block

DONE INTERRUPT - VME interrupt generated after status blocks are added to the list (see Figure 2-8)

ADDRESS - Command list location

LIST NUMBER - Command list number (1 through 7)

STOP COMMAND LIST (02H)

This command (Figure 3-2) stops the controller from accepting listed commands when all pending commands are complete. A Command List Stopped status block (Figure 3-3) is written, and the list number and memory space may be reused.

31 ... 0

IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
RESERVED = 0			
RESERVED = 0			
RESERVED = 0			LIST #

Figure 3-2 Stop Command List Parameter Block

31 ... 0

FFFFFFFFH		
LIST NUMBER	ERROR=0EH	0
0		

Figure 3-3 Command List Stopped Status Block

IDENTIFY (05H)

This command (Figure 3-4) returns a status block (Figure 3-5) which identifies the firmware revision.

31			0
IDENTIFIER			
RESERVED = 0		CONTROL	COMMAND
RESERVED = 0			
RESERVED = 0			
RESERVED = 0			

Figure 3-4   Identify Command Parameter Block

31			0
IDENTIFIER			
FW REV	ENG REV	ERROR	FLAGS
TYPE	DAY	MONTH	YEAR

Figure 3-5   Identify Status Block

ENG REV - Engineering revision level (Ciprico use)

FW REV - Firmware revision level - Last two digits of the even firmware PROM part number

DAY, MONTH, YEAR - Date the firmware was generated

TYPE - Board type (Figure 3-6)

31							24
0	0	0	0	0	0	0	N

Figure 3-6   Type Byte, Identify Status Block

N - Board type: 0 = 2-drive versions (Rimfire 3201, 3202)
1 = 4-drive versions (Rimfire 3210, 3220)

FLAGS - (Figure 3-7) Describes command results: this byte is also part of the Status Block (Figure 2-4).

7							0
CC	ERR	RTY	COR	0	0	0	0

Figure 3-7   Flags Byte, Identify Status Block

COR - Correction required

RTY - Retry required

ERR - 0 = No error
1 = Check ERROR field

CC - 0 = Command not complete
1 = Command complete

BOARD STATISTICS (06H)

This command (Figure 3-8) returns command execution statistics in a data block (Figure 3-9).

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0			
ADDRESS FOR STATISTICS BLOCK			
RESERVED = 0			CLEAR

Figure 3-8 Board Statistics Parameter Block

CLEAR - Controls statistics data: 0 = retain statistics data
non-zero = clear statistics data

Statistics data is returned to system memory starting at the address in the parameter block. Each field (below) refers to the count since either the last reset or the last Statistics command with a non-zero value in the Clear field. Fields for drives 2 and 3 are applicable only to the Rimfire 3210 and 3220 controllers.

31	0	
TOTAL COMMANDS		
NUMBER OF DISK READS		
SECTORS READ FROM DISK		
SECTORS READ FROM CACHE FOR DISK		
NUMBER OF DISK WRITES		
SECTORS WRITTEN TO DISK		
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 0
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 1
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 2
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 3
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	

Figure 3-9 Statistics Data Block

GENERAL OPTIONS (07H)

This command (Figure 3-10) selects the type of status block to be returned, and specifies a variety of global options.

31			0
IDENTIFIER			
THROTTLE	UNIT =0	CONTROL	COMMAND
STATUS BLOCK INTERRUPTS		STATUS BLOCK ENABLES	
RESERVED = 0			
RESERVED = 0			

Figure 3-10 General Options Parameter Block

THROTTLE - (Figure 3-11) Bus throttle and throttle type: controller stays on VMEbus only for Throttle transfers.

31	24
B/T	THROTTLE

B/T - Throttle type - 0 = transfer count 1 = byte count

Figure 3-11 Bus Throttle Word

STATUS BLOCK ENABLE, INTERRUPT - (Figure 3-12) - Selects status block types, interrupt types

15															0
0	0	0	0	0	0	0	0	0	0	0	0	0	IDE	DTE	WDL

Figure 3-12 Status Block Enable/Interrupt Words

WDL - Return "write data loaded" when all data for a write command is in the controller.

DTE - Return data error retries/corrections including soft read error, ECC correction.

IDE - Return ID/interface error retries including seek errors, drive faults, ID CRC errors, sync errors.

These options are disabled on initialization.

INITIALIZE I/O CONTROL GROUP (08H)

This command (Figure 3-13) specifies caching and data recovery options. Up to 16 I/O control groups may be defined and selected. The I/O group is listed in the IOCG field.

31			0
IDENTIFIER			
RESERVED=0	UNIT	IOCG	COMMAND
CACHE CONTROL		READ-AHEAD	RECOVERY
RESERVED = 0		D RETRY	ND RETRY
RESERVED = 0			

Figure 3-13 Initialize I/O Control Group Parameter Block

IOCG - (lower four bits) Assigns value between 1 and 15 to the I/O Control Group initialized in this command: this value may be used with other commands to enhance system performance. Group 0 in I/O Control Group is preassigned and cannot be changed by the host. Table 3-1 describes Group 0.

Table 3-1 I/O Control Group 0

Retry Count	3
Ignore ECC	Off
Disable Correction	Off
Extended Recovery	Off
Search Cache	On
Cache Read Data	On
Cache Write Data	Off
Read-Ahead Length	255
Read-Ahead Priority	Off
Read Ahead Cross Track	On
Read Ahead Cross Cylinder	Off
Sort Reads	On
Sort Writes	Off
Non-Data Retry Count	3
Data Retry Count	11

READ-AHEAD - Number of sectors to read beyond the end of a read request (see CACHE CONTROL, below).

RECOVERY - (Figure 3-14) Sets data recovery options.

7							0
0	0	0	0	0	EXT	COR	IGE

Figure 3-14 Recovery Byte, IOCG Parameter Block

IGE - Ignore ECC

COR - Disable error correction (reread data until retry count expires)

EXT - Apply track and data separator offsets to recover marginal data

CACHE CONTROL - (Figure 3-15)

31															16
0	0	0	0	0	0	RCC	RCT	ZLI	0	SWT	SRD	CWT	RAH	CRD	SEA

Figure 3-15 Cache Control Word, IOCG Parameter Block

SEA - 0 = Read directly from disk
1 = Search cache for read data

CRD - 0 = Disable caching of read data
1 = Cache read data

RAH - 0 = Abort current read-ahead on new disk request
1 = Complete read-ahead before next disk request

CWD - 0 = Disable caching of write data
1 = Cache write data

SRD - 0 = Execute reads in order received
1 = Execute reads in optimal order

SWT - 0 = Execute writes in order received
1 = Execute writes in optimal order

ZLI - 0 = Zero latency operations performed (multiple sector reads/writes may be done out of order, enhancing speed)
1 = Zero latency inhibited (reads/writes performed in order on disk)

RCT - 1 = Read ahead will cross tracks
0 = Do not read ahead beyond end of track

RCC - 1 = Read ahead will cross cylinder (NOTE: RCC functions only when RCT bit is set)
0 = Do not read ahead beyond end of cylinder

DATA RETRY COUNT (D RETRY) - (Table 3-2) Number of times an operation is retried: used if CRC, ECC or sync byte errors are detected. If extended recovery is enabled, this field specifies the recovery type. Different track and data offsets are performed until either the data is recovered or the retry count expires.

Table 3-2 Data Retry Count Sequence

Retry	Action
1	Re-seek the track
2	Recalibrate the drive and re-seek
3-11	Retry track and data offsets

NON-DATA RETRY COUNT (ND RETRY) - Number of times an operation not involving data recovery is retried: used for interface and seek errors, or with data errors during non-read operations (i.e. Write, Format).

DIAGNOSTIC/SELF TEST (09H)

This command (Figure 3-16) enables diagnostic tests. Test type and test data are specified in the parameter block. No other commands are executed during testing.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0			TEST TYPE
VME MEMORY ADDRESS			
RESERVED = 0			AREA

Figure 3-16 Diagnostic/Self-Test Parameter Block

UNIT - Clear this field and all reserved fields to 0.

TEST TYPE - Tests performed by the RF3200:

Board hardware tests:
- 01H - Test scratchpad RAM
- 02H - Test cache RAM
- 04H - Checksum firmware PROM
- 7FH - All the above tests

Cache data retention tests:
- 80H - Load cache memory area
- 81H - Read cache memory area

Other tests:
- 08H - Test non-memory board hardware

Board hardware tests

Cache and scratchpad RAM are tested for memory faults, and firmware PROM checksum tests check for corrupted data. Error information is returned to the status block, including the error code.

Cache data retention tests

Data is loaded into and read from cache RAM: data retention is checked. The cache area is marked so that it cannot be overwritten, except as noted below. Cache areas are 4 Kbyte segments within cache memory; data retention tests are performed in units of 4 Kbytes. Valid cache area values are 0 - 127 for a 512 Kbyte cache. Transfer errors are not indicated.

NOTE

> When testing cache areas 0, 16, 32, 48, 64, 80, 96, and 112, use the Read Cache Memory command to read data. The controller uses part of these areas as a scratch pad, corrupting retained data. Do not perform the cache memory diagnostic (test type 02 above) while retained data is loaded, because errors will be returned on subsequent Read Cache Memory commands.

Returned diagnostic information

Memory error information is returned in a status block (Figure 3-17).

31			0
IDENTIFIER			
PASS #	AREA	ERROR	FLAGS
EXPECTED	FOUND	ADDRESS	

Figure 3-17 Memory Diagnostic Status Block

ERROR - See "DIAGNOSTIC ERROR CODES" section, Appendix C of this manual.

AREA - The portion of memory at fault.
- 0 - Scratchpad memory
- 1-8 - Cache memory (first through eighth 64 K bank)
- 255 - Error in the PROM checksum

PASS # - The memory test pass that found the error.
PROM checksum errors: 0 = even PROM checksum incorrect
1 = odd PROM checksum incorrect

ADDRESS - The address of the faulty byte within the 64 K area described above (not applicable to PROM checksum tests)

EXPECTED - The value written into the byte, expected to have been read out of it (not applicable to PROM checksum tests)

FOUND - The value actually found in the erroneous byte (not applicable to PROM checksum tests)

CONTROLLER SETUP COMMANDS

CONFIGURE DISK (10H)

This command (Figure 3-18) passes drive characteristics to the RF3200. Configuration data in this parameter block is used by all other disk commands. This must be the first command issued: if not, error 04H (Drive Not Configured) is returned. Cylinders/Disk and Heads/Cylinder fields must be non-zero. Bytes/Sector must be 256 or greater, and a multiple of 16.

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
BYTES/SECTOR		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	BASE HEAD
RESERVED = 0			FLAGS

Figure 3-18 Configure Disk Parameter Block

CYLINDERS/DISK - Number of cylinders on the disk

BYTES/SECTOR - Number of bytes/sector (multiple of 16, between 256 and 8192)

HEADS/CYL - Number of heads/cylinder

BASE HEAD - Physical head number of the first head for this volume. Clear to 0 for single volume disks.

SCT/TRK - Number of data sectors/track (complete sectors only). NOTE: If this field is 0 or 255, the RF3200 will count the number of sectors actually on the disk, and compute the number of data sectors to use. The formula is:

SCT/TRK = number of sectors on disk
minus number of spare sectors
minus length of short sector (SSP)

Alternatively,

Physical sectors/track = SCT/TRK
plus number of spare sectors
plus length of short sector (SSP)

SPARES - Number of spare sectors to reserve per track for sector slip defect mapping

FLAGS - (Figure 3-19) Additional drive characteristics.

7							0
0	0	0	0	0	0	EAD	SSP

Figure 3-19 Flags Byte, Configure Disk Parameter Block

SSP - 1 = Short sector present as last sector of each track (too short for data)

EAD - Extended addressing
0 = Use 11th cylinder bit addressing (Tag 4 line)
1 = Use SMD-E addressing. Tag 2 is used for overflow cylinder bits.

DEFINE SMD PARAMETERS (11H)

This optional command (Figure 3-20) specifies extra configuration parameters.

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
INTERLEAVE	HEAD SKEW	CYL SKEW	RESERVED=0
DATA RECOVERY		ID P SIZE	DATA P SIZE
RESERVED = 0			

Figure 3-20 Define SMD Parameters Block

INTERLEAVE, HEAD SKEW, CYLINDER SKEW - Permissible range: 0 to sectors/track minus 1. If skews = 255, do not change the current value. See DISK FORMAT, Section 4 for more information.

DATA P SIZE, ID P SIZE - Default preamble sizes are large enough for all drives: clear these fields to use the default (23 bytes). For drives which use a different preamble, set these parameters to the number of bytes in each preamble.

DATA RECOVERY - (Figure 3-21) Controls reading of vendor-unique status when an error occurs. During error recovery, the controller issues a tag number with data bits set to the Data Bus value. Input data lines are read and returned in the status block reporting the error.

31–29	28–26	25–15
TAG #	0	DATA BUS VALUE

Figure 3-21 Data Recovery Field, Define SMD Parameters Block

Data Bus Value - The value to place on the SMD data lines before issuing the selected tag.

Tag # - A value from 4 to 6 for tags 4, 5 and 6 (or 0 for no tags). Tag 6 means that both tags 4 and 5 are on.

RETURN CONFIGURATION (12H)

This command (Figure 3-22) returns a data structure (Figure 3-23) containing SMD drive configuration at the address in the parameter block. It includes data passed by the Configure Disk and Define SMD Parameters commands.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0			
VME MEMORY ADDRESS			
RESERVED = 0		SECTOR COUNT	

Figure 3-22 Return Configuration Parameter Block

31			0
BYTES/SECTOR		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	BASE HEAD
0			FLAGS
NUMBER OF SECTORS PER DISK			
INTERLEAVE	HEAD SKEW	CYL SKEW	0
DATA RECOVERY		ID P SIZE	DATA P SIZE
0			
0			

Figure 3-23 Return Configuration Data Block

This command may be used independently of the drive setup code. For example, a format or defect mapping program might ask the controller for the configured drive parameters, rather than prompting the user for them.

Use this command in a multi-host system to enable one processor to determine the characteristics of a disk configured by another processor.

INTERROGATE DISK (13H)

This command (Figure 3-24) determines the characteristics of an SMD disk. The information returned is as follows:

- cylinders/disk
- heads/cylinder
- physical sectors/track
- data sectors/track
- number of spare sectors
- final short sector present

31			0
IDENTIFIER			
MODIFIER	UNIT	IOCG	COMMAND
RESERVED = 0			
VME MEMORY ADDRESS			
RESERVED = 0			

Figure 3-24 Interrogate Parameter Block

Information is returned in a data block (Figure 3-25) pointed to by the VME memory address. If a value cannot be determined, zero is returned.

31			0
0		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	0
0		P SCT/TRK	FLAGS

Figure 3-25 Returned Interrogate Data Block

CYLINDERS/DISK - the number of cylinders on the disk.

HEADS/CYL - the number of heads per cylinder

SCT/TRK - the number of data sectors per track (formatted disk only)

SPARES - The number of spare sectors on each track (formatted disk only)

P SCT/TRK - the number of physical sectors per track

FLAGS - Configuration flags:

7							0
0	0	0	0	0	0	0	SSP

Figure 3-26 Flags Byte, Interrogate Data Block

SSP = 1 if final short sector present (formatted disk only)

To use the Interrogate command, first configure the disk. The Bytes/Sector, Base Head, and Extended Addressing flags must be set correctly. Cylinders/Disk and Heads/Cylinder may be set to any non-zero value. Sectors/Track, # spares, and Short Sector Present should be set to zero.

After the drive is configured, execute the Interrogate command. The returned data block gives the disk geometry which the controller was able to determine. Note that the Base Head and Extended Addressing Flag must be set correctly for Interrogate to work.

Tests performed by Interrogate are:

Cylinders/disk: The controller seeks to increasing cylinder numbers until an error is detected. The controller first seeks in increments of 128 tracks until a seek error is found, then starts over with the last good cylinder, seeking every cylinder until a seek error is found. If a drive has exactly 1024 cylinders, interrogate cannot determine the number of cylinders (since the drive never returns a seek error) and returns zero.

Heads/cylinder: The controller selects each head in sequence and checks for a drive fault or seek error. If this test fails (an error is never returned), then the controller attempts a read ID after selecting each head until a CRC error is returned or the head number wraps.

Normally, disks do not report errors for invalid head selection. Therefore, heads/cylinder normally cannot be determined on an unformatted disk. On a formatted disk, the value returned will typically be the number of heads previously formatted rather than the physical number.

Physical sectors/track: The controller counts the number of sector pulses between index pulses. The number of sector pulses plus one equals the number of physical sectors/track. The number of physical sectors/track is the sum of the number of data sectors/track, number of spare sectors, and the final short sector, if any.

Data sectors/track, number of spares, final short sector: The controller reads a track of IDs from the disk and examines the type of each header to determine these parameters.

DATA TRANSFER COMMANDS

READ (18H)

This command (Figure 3-27) reads data from the disk starting at the sector number in the parameter block, and transfers it to system memory starting at the location in the Source/Destination Pointer field. The Sector Count field determines the number of sectors to be read. If an error occurs, the host cannot assume that any sectors have been read.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0		SECTOR COUNT	

Figure 3-27 Read/Write (Standard) Parameter Block

WRITE (19H)

This command (Figure 3-27) writes data from system memory starting at the location in the Source/Destination Pointer field to the disk starting at the sector number in the parameter block. The Sector Count field determines the number of sectors to be written. If an error occurs, the host cannot assume that any sectors have been written.

SCATTER READ (1AH)

This command reads data from the disk and scatters it into a number of noncontiguous areas in system memory. A standard status block is returned. The Source/Destination Pointer field contains a scatter/gather header address. The header(s) are linked in a list held in system memory. Place the number of descriptors (length/address blocks) in the chain into the appropriate field of the parameter block (Figure 3-28).

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
SOURCE/DESTINATION			
RESERVED = 0		# DESCRIPTORS	

Figure 3-28 Scatter/Gather Parameter Block

The board reads in the list of headers before starting the command. The number of descriptors is the smaller of either the specified number or the number actually found. The maximum permissible number of descriptors is 255. For greatest efficiency, use the minimum number of descriptors possible.

Each scatter/gather header (Figure 3-29) contains eight scatter/gather descriptors, each of which contains the address and length in bytes of as many as eight data fields. A descriptor with a length field of zero means that the rest of the header is ignored.

The Length field is the least significant 24 bits of a 32-bit field. The most significant eight bits are reserved, and must be cleared to zero. Data lengths must be even numbers, greater than or equal to 4 bytes. The Next SG Header field contains the address of the next scatter/gather header. If this field is set to -1 (FFFFFFFFH), this is the end of the chain.

If the Address Modifier field is zeroed, the Address Modifier from the main command is used.

31	0
NEXT SG HEADER	
ADDR MOD 1	DATA LENGTH 1
DATA ADDRESS 1	
ADDR MOD 2	DATA LENGTH 2
DATA ADDRESS 2	
(descriptors 3 through 6)	
ADDR MOD 7	DATA LENGTH 7
DATA ADDRESS 7	
ADDR MOD 8	DATA LENGTH 8
DATA ADDRESS 8	

Figure 3-29 Scatter/Gather Header Format

GATHER WRITE (1BH)

This command (Figure 3-28) is analogous to Scatter Read, except that data is transferred from memory and written to the disk. If data length is not a multiple of sector size, the remainder of the last sector is filled with the format fill pattern specified in the Board Options command. The same parameter block and Scatter/Gather header formats are used as the Scatter Read block.

DISK FORMATTING COMMANDS

FORMAT TRACKS (20H)

This command (Figure 3-30) formats the disk according to data from the Configure and Define SMD Parameters commands. Formatting starts at the sector number in the parameter block, which points to the beginning of a track: it continues for the number of sectors in the Sector Count field. If the Sector Count field is 0, formatting continues to the end of the disk. The number of sectors must divide evenly into the number of sectors/track. If formatting fails, the status block shows the error location.

VERIFY (21H)

This command (Figure 3-30) reads the disk to determine whether errors exist. Verification begins with the sector number in the parameter block, and continues for the specified sector count. Errors are reported in the status block. If the Sector Count field is 0, verification continues to the end of the disk.

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
DISK ADDRESS			
RESERVED = 0			
SECTOR COUNT			

Figure 3-30 Format/Verify Parameter Block

DEFECT HANDLING COMMANDS

READ DRIVE DEFECT DATA (25H)

This command (Figure 3-31) reads manufacturer defect data from a single track, in the format common to CDC, Fujitsu, Pertec, and Priam (Figure 3-32). NOTE: The above format may vary between manufacturers. Consult the appropriate disk drive manual for the exact format.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0			

Figure 3-31 Read Drive Defect Data Parameter Block

The command seeks to the track pointed to by the disk address in the parameter block. After the seek, track defect information is returned to the host. If the MSB (D field) of the second word is set, the track is defective.

15		0
00H		19H (CONSTANT)
D	CYLINDER NUMBER	
HEAD NUMBER		00H
POSITION 1		
LENGTH 1		
POSITION 2		
LENGTH 2		
POSITION 3		
LENGTH 3		
POSITION 4		
LENGTH 4		
00H		F0H (CONSTANT)

Figure 3-32 Read Defect Data Block

DISK DEFECT HANDLING

The Rimfire 3200 provides three methods for handling disk defects within the controller. These are the Map Track, Map Sector and Slip Sector commands, described below. These commands enable the controller to preserve disk data when marking defective disk locations. The Data Recovery field in the Defect Handling commands parameter block (Figure 3-33) provides three data recovery options to be used with these commands (Table 3-3).

<table>
<tr><td>31</td><td></td><td></td><td>0</td></tr>
<tr><td colspan="4">IDENTIFIER</td></tr>
<tr><td>RESERVED=0</td><td>UNIT</td><td>CONTROL</td><td>COMMAND</td></tr>
<tr><td colspan="4">DEFECTIVE TRACK/SECTOR ADDRESS</td></tr>
<tr><td colspan="4">ALTERNATE TRACK/SECTOR ADDRESS</td></tr>
<tr><td colspan="2">RESERVED = 0</td><td colspan="2">DATA RECOVERY</td></tr>
</table>

Figure 3-33 Defect Handling Commands Parameter Block

RECOVERY - (Table 3-3) The data recovery procedure to be applied to the track/sector to be mapped/slipped.

Table 3-3 Data Recovery Options

Value	Meaning
0	Do not recover old data. Use when mapping a disk after formatting. Old data is not retained, and data may be lost which is not within the track/sector being mapped.
1	Read old data, abort command if error occurs. ECC correction is applied as specified in the applicable I/O Control Group.
2	Read old data, continue if error occurs. All old data is kept. If an uncorrectable ECC error is detected, uncorrected data is retained. If a different error is detected, the data of that sector is lost. This option retains as much data as possible. The I/O control group should enable ECC correction, extended recovery, and use a retry count of at least 11.

SLIP SECTOR (22H)

This command (Figure 3-33) marks the sector listed in the disk address field of the parameter block as defective. This and all later sectors are moved toward the end of the track; one spare is used as the last sector. To select an alternate, the controller first tries to slip the sector, then maps it to the end of the disk. If the sector was slipped, the address of the main sector is returned as the alternate address. Therefore if the defective sector is identical to the alternate, the sector was slipped, not mapped. If there are no spares on the track, an error is reported, and Map Track or Map Sector must be used to replace the defective sector.

MAP SECTOR (23H)

This command (Figure 3-33) maps a defective sector to an alternate location, selected either by the host or by the controller. To select this alternate, the controller starts at the end of the disk and searches toward track zero until it finds an available track. The address of this alternate is returned in the disk address field of the standard status block. Set the Alternate Number field to -1 (all bits set to 1) for automatic alternate selection.

MAP TRACK (24H)

This command (Figure 3-33) maps a defective track to another track, selected by the host or the controller. A value of -1 (all bits set to 1) in the Alternate field causes the controller to automatically select the alternate. To do this, it starts at the end of the disk and searches toward track zero until it finds an available track. The address of the alternate is returned in the disk address field of the standard status block.

ADDITIONAL DISK COMMANDS

READ ID (2BH)

This command (Figure 3-34) returns the first disk ID it encounters to the location in the Source/Destination Pointer field, in the format illustrated in Figure 3-35.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0			

Figure 3-34 Read ID Command Parameter Block

If the Disk Address field has a valid sector number, the controller seeks to the track containing that sector and returns the first ID it finds. If the disk address field is -1 (all bits set to 1), the controller returns the next sector ID it encounters without attempting any seeks. See Figure 4-1 (Rimfire 3200 Sector Format).

15	0
CYLINDER	
SECTOR	HEAD
ALTERNATE SECTOR NO.	FLAG

Figure 3-35 Disk ID Field

READ TRACK OF IDs (2CH)

This command (Figure 3-36) reads an entire track of IDs from the disk. If the Disk Address field has a valid sector number, the controller seeks to that track. If the Disk Address field is -1 (all bits set to 1), the controller reads the track of IDs at the selected cylinder and head, starting at the index pulse. This returns all IDs on the track to system memory, starting at the address in the Source/Destination Pointer field, and using the format found in Figure 3-35.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0			

Figure 3-36 Read Track of IDs Parameter Block

REZERO DISK (2DH)

This command (Figure 3-37) returns the read/write heads to cylinder 0. The drive number should be listed in the Unit field. Rezeroing either unit (fixed or removable) of a single unit rezeroes both logical units.

31			0
RESERVED = 0			
RESERVED=0	UNIT	CONTROL	COMMAND
DISK ADDRESS (SEEK ONLY)			
RESERVED = 0			
RESERVED = 0			

Figure 3-37 Rezero Disk/Seek Parameter Block

SEEK (2EH)

This command (Figure 3-37) causes the drive to seek to the head and cylinder containing the sector number listed in the parameter block. As in the Rezero Disk command, the fixed and removable parts of a unit are linked for seeks. This is a diagnostic command.

READ LONG (29H)

This command (Figure 3-38) reads the data bytes and six ECC bytes of the sector listed in the Sector Count field and places them in the buffer listed in the Source/Destination Pointer field. This command operates on one sector at a time. It may be used in conjunction with the Write Long command to check the error correcting algorithm.

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0			

Figure 3-38 Read Long/Write Long Command Parameter Block

WRITE LONG (2AH)

This command (Figure 3-38) writes a quantity of data and six ECC bytes of a sector to the disk. The Source/Destination Pointer points to the data. The Sector Count number is the starting address on the disk. The six bytes following the data are written to the disk as ECC bytes. The byte count must be the number of bytes/sector plus six. This command operates on one sector at a time. It may be used in conjunction with the Read Long command to check the error correcting algorithm.

ISSUE TAG/RETURN STATUS (14H)

This command (Figure 3-39) returns drive status and (optionally) data from one of the SMD extended tags (4, 5 or 6). The drive need not be configured to use this command. Data is returned in a standard status block (Figure 2-3) using Drive Status and Vendor Status fields. Use this command for vendor-unique drive functions. The host must perform all data interpretation.

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
RESERVED = 0		DATA TO SEND	
RESERVED = 0		TAG NUMBER	
RESERVED = 0			

Figure 3-39 Issue Tag Parameter Block

TAG NUMBER - Permissible values are 4, 5, and 6, corresponding to turning on tag 4, tag 5, or tag 6 (both tags 4 and 5 on at the same time). If this field is zero, extended tag data is not returned.

DATA TO SEND - The value on the data lines when the extended tag is issued. An extended tag is issued in the following way:

- Place the "data to send" value in the SMD data lines.
- Turn on the specified tag.
- Wait 1 ms. for drive diagnostics to begin (only certain drives).
- Read the SMD data lines and return the data.

SET PICK AND HOLD (30H)

This command (Figure 3-40) applies only to the four-drive versions of the Rimfire 3200 controller series. It activates the PICK and HOLD lines on the SMD interface, starting the spindle motors of all drives connected to the controller.

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
RESERVED = 0			
RESERVED = 0			
RESERVED = 0			

Figure 3-40 Pick and Hold Parameter Block

A valid unit number must be specified; however, it is ignored by the controller, since the Pick and Hold lines apply to all drives connected to the controller.

CLEAR PICK AND HOLD (31H)

This command (Figure 3-40) disables the PICK and HOLD lines on the SMD interface, stopping the spindle motors of all drives connected to the controller. It is identical to the Set Pick and Hold command in all other ways, and applies only to the four-drive versions of the Rimfire 3200 series of controllers. These commands are accepted by the 2-drive versions for compatibility, but do nothing.

SECTION 4
FUNCTIONAL DESCRIPTION

DRIVE NUMBERING (UNIT NUMBER)

Each disk drive is identified by a unit number, as shown in Table 4-1.

Table 4-1 Drive Numbering (unit numbers)

1	Physical unit 1, main volume
2	Physical unit 1, alternate volume
3	Physical unit 2, main volume
4	Physical unit 2, alternate volume
5	Physical unit 3, main volume
6	Physical unit 3, alternate volume
7	Physical unit 4, main volume
8	Physical unit 4, alternate volume

Most drives are single-volume, so unit numbers 1, 3, 5, and 7 should be used. When a drive has both fixed and removable volumes, the controller distinguishes them by different unit numbers and treats them as two independent disks.

With two-volume disks, the fixed volume should be the main volume, and the removable disk should be the alternate. This ordering is conventional for SMD disks.

The drive distinguishes the volumes by head number. The "logical head number" is the head number within a volume, and is used to compute block numbers. The physical head number is the actual head number within the drive. Table 4-2 illustrates this principle.

Table 4-2 Example, Physical/Logical Head Numbering

If disk drive heads are:

Volume 0: 6 heads starting with head 0
Volume 1: 2 heads starting with head 6

Physical head numbers translate to logical head numbers shown below:

Physical Head	Volume #	Head #
0	0	0
1	0	1
2	0	2
3	0	3

Physical Head	Volume #	Head #
4	0	4
5	0	5
6	1	0
7	1	1

LOGICAL FORMAT

The host addresses disk drives using a 32-bit absolute sector number. Sector 0 is the first sector on the disk.

PHYSICAL FORMAT

The disk is physically addressed by cylinder, head and sector number. The host sector number is converted to cylinder/head/sector format when a command is executed. Sector number is used to report disk errors.

Logical sector number = sector + spt(head + hpc(cylinder))

where:
- sector is the sector number
- head is the logical head number
- cylinder is the cylinder number
- spt is the number of sectors per track
- hpc is the number of heads per cylinder

All numbers begin with zero: the start of the disk is physical cylinder 0, head 0, sector 0.

DISK FORMAT

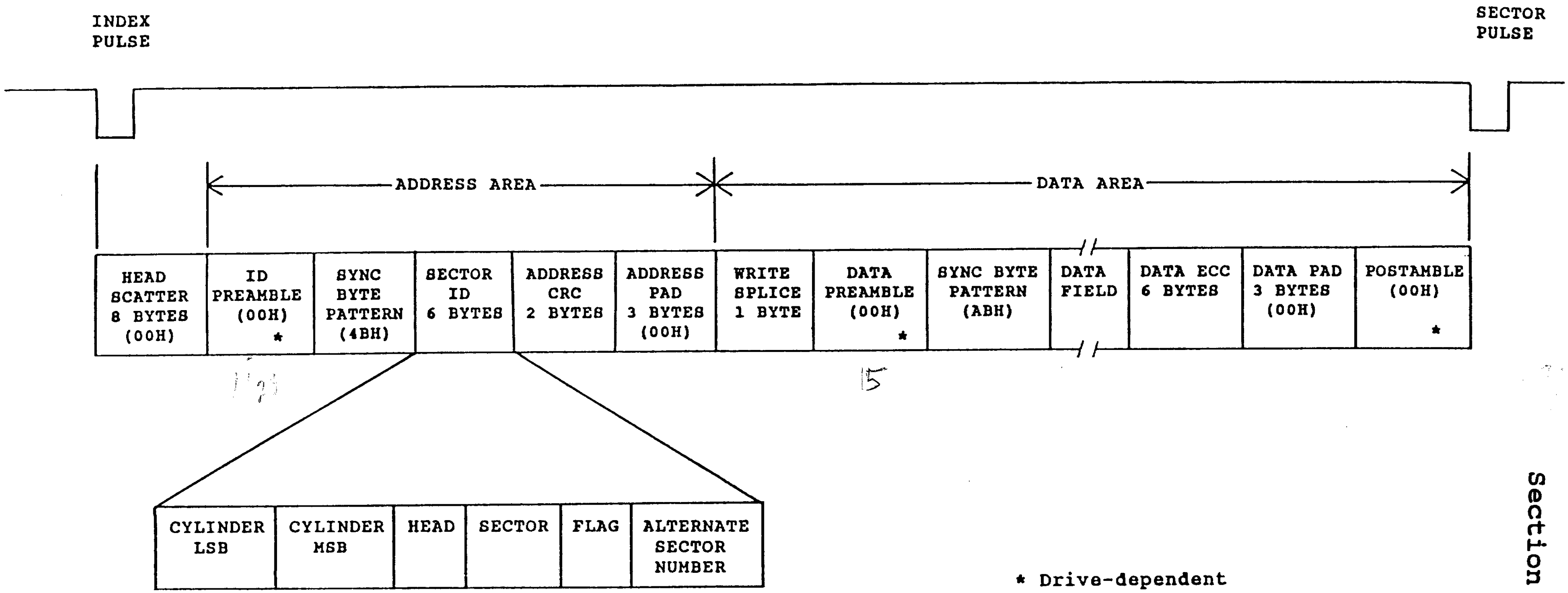
The RF3200 supports the hard-sectored SMD format (Figure 4-1). A hard-sectored disk drive provides pulses which define sectors to the controller. The number of sector pulses on each track is determined by switches on the drive.

The "read gate delay" is specified by the drive manufacturer as a time to wait after the sector/index pulse before reading the sector header. It is sometimes called a "head scatter gap" or "post-index delay".

Rimfire 3200 sector format is illustrated in Figure 4-1.

ID Preamble and Data Preamble fields default to 23 bytes, a value large enough for all existing drives. Minimum preamble length is specific to each drive. The Postamble field is the remainder of the physical sector: the user must ensure that it is long enough.

The controller uses the sector ID to verify the location on the disk. The sector ID also contains defect mapping information (address of alternate tracks and sectors). The READ ID command description (Section 3) tells how this data is returned to system memory.



NOTE: Default for preamble fields is 23 bytes, unless this value is set by the host. Postamble length is determined by the unformatted sector size set by switches on the drive.

Figure 4-1 Rimfire 3200 Sector Format

Sector ID fields are defined as follows:

Cylinder and Head

These fields refer to the current cylinder and head. In a defective track or sector, these fields contain the address of the alternate track or sector. In an alternate track or sector, they point to the address of the defective track/sector.

Sector

This field refers to the unique number for normal sectors. Special numbers identify particular sector types, as shown in Table 4-3:

Table 4-3 Sector Types

FDH: Short (non-data) sector
FEH: Spare sector available for slipping
FFH: Slipped sector (flagged defective by Slip Sector command)

Flag

This flag (Table 4-4) identifies the sector and track type.

Table 4-4 Flag Values

AAH - Normal track - May contain defective or alternate sectors as well as normal sectors.

3CH - Defective track - A track which automatically causes its alternate to be accessed.

C3H - Alternate track - A track pointed to by a defective track, which takes its place. It may contain spare sectors to be slipped, but may not contain defective or alternate sectors.

33H - Bad track - An alternate track which was reassigned, for example, by issuing a Map Track command to map the same track twice. This track may not be accessed.

5AH - Defective sector - A sector which automatically causes its assigned alternate to be accessed.

A5H - Alternate sector - A sector which is pointed to by a defective sector: it takes its place. An alternate sector may contain spare tracks to be mapped.

35H - Bad sector - An alternate sector which was reassigned, for example, by issuing a Map Sector command to map the same sector twice. This type of sector may not be accessed at all.

Alternate Sector Number

The alternate sector number identifies the sector type and specifies the alternate sector address. For normal sectors, this field is FFH. In a mapped defective sector, this field contains the alternate sector number. In an alternate sector, this field contains the defective sector number. In a bad sector (the old alternate for a sector which has been re-mapped) this field contains the current sector number. Table 4-5 lists sector ID fields.

Table 4-5 Types of Sector IDs

TYPE	HEAD + CYLINDER	SECTOR	FLAG	A SECTOR
Normal track	current	current	AAH	FFH
Defective track	alternate	current	3CH	FFH
Alternate track	defective	current	C3H	FFH
Bad track	current	current	33H	FFH
Slipped sector	current	FFH	---	FFH
Spare sector	current	FEH	---	FFH
Short sector (SMD only)	current	FDH	---	FFH
Defective sector	alternate	current	5AH	alternate
Alternate sector	defective	current	A5H	defective
Bad sector	current	current	35H	sector

DEFECT MAPPING

The RF3200 supports one of three methods of handling defects, depending on the defect type (following):

1. An error in a sector ID field. A Sector Not Found or CRC error is returned. Because the ID field cannot be read correctly, the associated sector cannot be accessed. Track mapping should be used in this case.

2. A correctable data error. This error is smaller than the 15-bit correction span of the ECC algorithm. However, a performance penalty is incurred.

3. An uncorrectable data error. This cannot be corrected by the ECC algorithm. An ECC Error or Data Sync Not Found error is returned.

TRACK MAPPING

When access is attempted to a defective track, the RF3200 automatically accesses (maps) its alternate. Track mapping adds alternate track seek time to total operation time, incurring a slight penalty in performance. Use this technique when a sector ID error is detected or when there are many sectors with ECC errors on a given track.

SECTOR MAPPING

When access is attempted to a defective sector, the RF3200 automatically accesses (maps) its alternate. This method takes the most time of all defect handling methods: two disk revolutions are lost with the alternate sector seek and the seek back to the original track. However, this technique requires the smallest amount of disk space.

SECTOR SLIPPING

Sector slipping reassigns a single sector on the same track. This technique does not degrade performance, but requires spare sectors on each track. Normally there is one spare sector, because there is rarely more than one error per track. The spare should be the last physical sector of a track, regardless of head skew. When a defective sector is slipped, its physical position is marked as defective, and all sectors after it are moved toward the end of the track.

Table 4-6 illustrates this process. In each case, a track of 12 logical sectors and 2 spare sectors is slipped. The order in which they are slipped is significant.

Table 4-6 Slip Sector Examples

Before	1	2	3	4	5	6	7	8	9	10	11	12	U	U
Slip 4	1	2	3	D	4	5	6	7	8	9	10	11	12	U
Slip 8	1	2	3	D	4	5	6	7	D	8	9	10	11	12
Before	5	6	7	8	9	10	11	12	1	2	3	4	U	U
Slip 4	5	6	7	8	9	10	11	12	1	2	3	D	4	U
Slip 8	5	6	7	D	8	9	10	11	12	1	2	D	3	4

DEFECT MAPPING RESTRICTIONS

Use track mapping if defective sector ID fields exist. An occasional CRC retry occurs when the RF3200 reads an ID for the alternate track address. Sector mapping/slipping may be used if all sector ID fields on the track are without fault.

INTERACTION BETWEEN DEFECT MAPPING TECHNIQUES

Defect mapping techniques may be used together, with certain restrictions. The host may ignore a particular defect, because the RF3200 automatically maps its logical address to a physical address. The following rules apply:

1. Verify: If an alternate sector or track is directly accessed, Verify checks it directly, rather than returning a "direct access to alternate" error. Thus a verify may be executed on a full disk without regard to defect mapping.

2. Remapping of Tracks and Sectors: Defect mapping is performed in relation to the logical disk address. Track/sector remapping is allowed; the defective track/sector is remapped to a new alternate and the old alternate is left inaccessible.

3. Slip Sector on Mapped Tracks: If a Slip Sector is performed on a track which has been mapped, the corresponding sector of the alternate is slipped.

4. Slip Sector and Map Sector: A mapped alternate sector may not be slipped. A defective mapped sector must be reassigned to a new alternate by using another Map Sector command. If a Slip Sector command is performed on a non-mapped sector of a track containing mapped sectors, it succeeds, and all defective sector markings are left in the same physical location on the track.

5. Map Sector and Map Track: A Map Sector command may not be used on a mapped track. The track must be remapped instead. A Map Track may be performed on a track containing defective sectors; the sectors are reassigned to the alternate track.

ADDITIONAL NOTES

Alternate track and sector formats of the RF3200 enable the disk to be verified. All defective tracks should be pointed to by exactly one alternate, and alternates pointed to by exactly one defective track. This format supports a disk verification routine which reads the sector IDs of a full disk, returns the defect map and detects any format inconsistencies.

INTERLEAVE

The RF3200 identifies data within a track by its logical sector number. The interleave factor specifies the number of physical sectors between logical sectors: it is used when the host cannot keep up with the disk drive transfer rate. Interleave is specified in the Configure command: it applies only if a Format command is to be executed. Interleave 1 is the default. See Table 4-7.

Table 4-7 Interleave Factors 1 - 3

Physical Sectors	0	1	2	3	4	5	6	7	8	9	10	. . . .
Logical Sector Numbers												
Interleave Factor = 1	0	1	2	3	4	5	6	7	8	9	10	. . . .
Interleave Factor = 2	0	x	1	x	2	x	3	x	4	x	5	. . . .
Interleave Factor = 3	0	x	x	1	x	x	2	x	x	3	x	. . . .

SKEW

The skew factor changes the position of logical sector 0 relative to the start of the track. Positioning sector 0 to be read/written immediately after a head/cylinder change saves a disk revolution. Head and cylinder skew are defined in the Define SMD Parameters command: they apply if a Format Tracks command is to be executed. The first logical sector of a track is shifted by the skew factor from the previous track. If the disk is already formatted, this field may be cleared. If no skew (skew 0) is specified, logical sector 0 is the first sector after the drive index pulse (see Table 4-8).

Table 4-8 Example, Head Skew (Skew Factor 1)

Physical Sectors:	0	1	2	3	4	5	6	. . .	n-1
Logical Sectors:									
Head 0	0	1	2	3	4	5	6	. . .	n-1
Head 1	n-1	0	1	2	3	4	5	. . .	n-2
Head 2	n-2	n-1	0	1	2	3	4	. . .	n-3

HEAD SKEW

Head skew is the amount sectors are shifted on a single cylinder. Because head switch times are typically a few microseconds, this factor depends on RF3200 overhead. See Table 4-9.

Table 4-9 Typical Skew Factors

Skew	Drive Type
2	10 MHz drives
3	15 MHz drives
5	20 MHz drives
6	24 MHz drives

Certain drives have a head switch time as long as 3 ms., due to the use of an embedded servo between data tracks. In these cases, head skew is computed from the head switch time specified by the manufacturer.

CYLINDER SKEW

Cylinder skew is the amount sectors are shifted between the last head of one cylinder and head 0 of the next cylinder. Permissible range is 8 to 30. Because cylinder skews are larger than head skews, they save only one-half to three-quarters revolution (head skews save a full revolution). For drives with more than 16 heads, cylinder skew must also allow for head group select time.

SKEW CALCULATION

This example uses a drive with:

- 10 heads
- Negligible head switch time
- 5 ms. single cylinder seek time
- 1 ms. head/cylinder switch firmware overhead
- 32 sectors/track
- 3600 RPM disk spin rate
- Sector time of 16.7 ms./32 = 0.53 ms.

To compute head skew, convert total head switch time (drive head switch plus firmware overhead) to a number of sector times. Here, total head switch time is 0.5 ms., slightly less than the sector time (0.53 ms.). Therefore a head skew of two or three enables head boundaries to be crossed without loss of disk revolutions.

To compute cylinder skew, divide cylinder seek time (plus overhead) by sector time, rounding upward. For a 5 ms. seek time plus 1 ms. overhead, the time is (6/0.53), or 12 after rounding, making a cylinder skew of 12 appropriate.

INTERFACE-UNIQUE FEATURES

SMD INTERFACE HANDLING

Final Short Sector

SMD disks often have an extra short sector at the end of each track, when the unformatted bytes per sector figure does not divide evenly into the bytes per track figure. The end sector must be large enough to hold a sector ID. Its minimum size is:

20 bytes + ID Preamble length + Postamble length
(typically 40 to 80 bytes)

If this sector is too short for data, it is ignored.

Extended Cylinder Addressing (SMD-E/Tag 4)

The original SMD specification allows 1024 cylinders on a drive (10 data bits). Newer disk drives with more than 1024 cylinders must address extra cylinders either by using the Tag 2 command to specify high order address bits along with head number (Control Data), or by using the Tag 4 line as the high order (11th) cylinder bit when issuing a seek command (Priam).

ECC ERROR CORRECTION

The RF3200 uses a 48-bit ECC word on each data block to detect and correct read errors in the sector data field. Error bursts less than or equal to 15 bits are corrected. Single error bursts shorter than or equal to the single burst detection span are detected without miscorrection. Double bursts where neither burst is longer than the double burst detection span are detected without miscorrection.

If an error burst exceeds the correction/detection capability of the ECC code, the decoder may change the wrong locations, increasing the number of errors. Miscorrection probability for the RF3200 is approximately one in 8 million.

Correction and detection spans are measured in consecutive bits. Table 4-10 illustrates the error detection span.

Table 4-10 Error Detection Span

Sector Size (bytes)	Single Burst Detection Span (bits)	Double Burst Detection Span (bits)
128	19	4
130 - 256	24	4
258 - 512	24	4
514 - 1024	24	4
1026 - 2048	25	3
2050 - 4096	25	2
4098 - 8192	23	-
8194 - 16384	23	-
16386 - 32768	23	-

RETRY PROCEDURES

The RF3200 performs retries to recover from data, header, and SMD interface errors. The number of retries attempted depends on either the data retry count (used when attempting to read data from the disk) or the non-data retry count (used for control and write operations).

GENERAL RETRY PROCEDURES (data and header errors)

For reads, the operation is retried to the data retry count. Each retry reseeks to the desired track. The second retry re-zeroes the drive before reseeking. If extended data recovery is enabled, track and data offsets are used to recover the data.

For writes, the operation is retried to the nondata retry count. All retries reseek to the desired track, and the second retry re-zeroes the drive.

NOTE

> Extended data recovery features require that sectors in error be mapped elsewhere, rewritten, or the track reformatted.

DATA ERROR HANDLING

Two types of error can occur when reading data:

Data sync not found: Standard data retry procedures are performed.

ECC errors: The RF3200 attempts to correct the error by rereading the sector for the ECC syndrome bytes. If correctable, data is returned. If not, the read is retried to the data retry limit using standard retry procedures, attempting to correct data with each read.

HEADER ERROR HANDLING

Header errors include ID sync not found, ID CRC error, header miscompare/misseek, and sector not found. These errors are retried using the procedures outlined above.

SMD INTERFACE ERROR HANDLING

The following errors may occur in the SMD interface:

Drive not ready - This error means the drive is not spinning or there is an uncorrectable fault in the drive. There are no retries.

Drive fault - Most drive fault conditions are related to write operations, commonly from selecting a nonexistent head. The controller does the following:

1. Issue a "clear fault" command to the drive.

2. Wait 20 ms. for the fault clear to take effect.

3. Retry the operation to the nondata retry count.

Seek error - This error means that a seek was attempted to a nonexistent track. Some drives return a seek error when selecting a nonexistent head. The RF3200 rezeroes the drive and retries the operation to the nondata retry count.

COMMAND QUEUEING

The RF3200 accepts multiple commands and processes them as quickly as possible. As they are read into the board, commands are placed in queues corresponding to each drive. For maximum performance, the host should send all commands to the RF3200 as they are generated.

MULTIPLE DRIVE HANDLING

The Rimfire 3200 normally maintains a queue of operations for each drive, keeping both drives busy. Commands operate independently: seeks and long commands are automatically overlapped between drives. If a full disk format is issued to one drive, the other may still be accessed with reduced performance. A long read/write to one drive does not lock out the other. A typical sequence of drive operations is:

1. Initiate seeks to both drives.
2. Drive 1 (example) completes its seek.
3. The read/write is performed to drive 1.
4. Another seek to drive 1 is issued.
5. The RF3200 determines if the second drive is done seeking. If so, the read/write is processed. If not, it waits for the next seek to finish before continuing.

SORTING DISK REQUESTS

The RF3200 can sort reads and/or writes to a drive. Command sorting should normally be enabled, because it reduces average seek times to increase throughput. However, certain data bases require that operations be done in the order issued; disable sorting in these cases. Multiple operations to the same disk location are done in the correct order, regardless of sorting options. Requests are sorted into ascending disk order by cylinder number, head number within a cylinder, then sector within a single track.

Sorting causes commands to complete out of order, but does not prevent command completion. If a command at a high cylinder number is delayed too long, new commands will be performed, which may be sorted after the delayed command.

Nonsorted commands are executed after all previous commands, then subsequent commands are sorted. This ensures that the sorting process changes only command order.

COMBINING DISK REQUESTS

After disk operations are sorted, they are combined if possible. Disk request combination is automatic and invisible to the host. If a command writes sectors 0 - 7 of a track, the next command writes sectors 8 - 15. These operations normally require two disk revolutions, because the RF3200 requires a short time to set up the second command. Combining disk requests completes the commands to be done in one revolution.

Adjacent disk requests are combined in one operation. Data for all combined commands is read/written in one disk revolution rather than two or more (no retries). This allows sequential data to be read/written at almost disk data rates, even when sent to the controller as short commands.

CACHING

The RF3200 uses a 512 Kbyte cache memory to buffer data to and from the disk. Part of the cache is used to prevent lost disk revolutions: the rest of the cache holds disk data previously read.

Three types of data may be cached:

1. Data from previous reads. This data is most useful if the same sector will be reread within a short time.

2. Read-ahead. The next few sectors after the end of a read are cached in anticipation of another request for those sectors. This is useful when performing sequential file accesses.

3. Data from previous writes. This data is most useful if the host is likely to write then reread the same sector within a short period of time.

The host determines caching specifications by setting the cache control bits in the I/O Control groups. The RF3200 caches data on a sector-by-sector basis. When the cache fills, its oldest data is the next to be deleted.

The cache interacts with uncached read and write operations. An uncached write removes cached data for the sectors written, ensuring that the cache always contains current data. Because multiple operations to the same sectors are always done in order, the cache always contains the correct data.

The cache is accessed through a hash table, which provides fast (100 microsecond) cache search time over a 512K area.

READ AHEAD

Read ahead is the process of continuing a read and storing the data in the cache, assuming that another read will require this data.

The read ahead length determines the distance to read ahead. Select zero read ahead when disk reads will not be sequential. Specify a read ahead length for the controller to read the specified number of sectors or to the end of the current track, whichever comes first.

Read ahead priority can either be forced (set) or background (not set). If set, the read ahead is done whether or not another operation is ready. (High priority should be used only if data is certain to be read by a later command.) If priority is not set, a pending disk operation stops the read ahead. If an operation becomes ready during a read ahead, the read ahead is stopped early, data already read is kept, and the new operation is started.

REDUCED LATENCY OPERATIONS

The RF3200 uses a zero-latency technique to expedite reads and writes, as follows:

1. At the start of the operation, read the current disk ID.
2. Add one to the sector number, wrapping back to zero if necessary. Use this sector as the first to read/write, if within the range of the current operation. If not, start with the first sector.
3. Read/write consecutive sector numbers to the disk. When the last number is reached, wrap back to the first sector desired.

The RF3200 performs zero-latency reads for operations over four sectors and zero-latency writes for operations over four sectors but less than full tracks. This means that long reads/writes take no more than one disk revolution plus one sector time. Read-ahead length is included in reduced-latency reads, enabling reads-ahead to complete with no effect on performance.

The RF3200 consolidates disk operations wherever possible. If several writes are made to sequential sectors, they are combined and performed as a single write.

I/O CONTROL GROUPS (IOCGs)

Disk reads/writes are controlled by I/O Control Groups, which specify caching, data recovery, and retry count options. The host tunes RF3200 performance by specifying a different I/O Control Group for each command.

As many as sixteen I/O Control Groups may be initialized at once. Control Group 0 is set by the RF3200, and may not be changed. The host defines Groups 1 through 15. I/O Control Groups may be changed at any time, except while disk I/O commands are in progress.

USE OF I/O CONTROL GROUPS

Caching Control

Controller performance may be improved by setting appropriate caching specifications with I/O control groups. For example, because read-ahead and caching are not effective when applied to the swap partition in a UNIX system, disabling these functions for swap partition accesses improves performance.

Because accesses to file system control structures (e.g. UNIX inodes) are not likely to be sequential, disabling read-ahead for file system structures improves performance.

Data Recovery

Applications such as digitized images are not seriously disturbed by small data errors. An I/O Control Group which ignores data errors may be used to access data, eliminating the time needed for error correction. However, data errors may be checked when information requiring error correction is accessed.

INTERRUPT GENERATION

The RF3200 generates VME interrupts when status information is ready for the host. The host selects the interrupt level and the Status/ID returned during the interrupt acknowledge cycle.

TYPE 0 COMMAND INTERRUPTS

When a command is initiated by a type 0 channel attention, one interrupt is generated on completion. An error interrupt is generated if an uncorrectable error occurred during command execution; otherwise the no error interrupt is generated.

COMMAND LIST INTERRUPTS

When status blocks are written to a command list and a block is programmed for an interrupt, an interrupt is generated. Command complete status blocks always generate an interrupt; other status block interrupts must be enabled by the General Options command. With Command Completion or Write Data Loaded status blocks, the No Error interrupt is generated. If a status block signals an error or retry, the Error interrupt is generated.

With multiple status blocks, only one interrupt is generated, though several commands may have completed. The interrupt signals that the command list needs attention: the host must not assume that only one command has completed.

BYTE AND WORD ORDERING

The RF3200 adapts itself to the byte and word ordering of the host, which depends on the processor interface to the bus. On the VMEbus, MSB is at the lowest address (Table 4-11).

Table 4-11 VMEbus (Motorola) Byte Ordering

Address	Data
0	Bits 24 - 31
1	Bits 16 - 23
2	Bits 8 - 15
3	Bits 0 - 7

The Intel 8086 and National 32000 series place LSB at the lowest address and MSB at the highest address (Table 4-12).

Table 4-12 Intel/National Byte Ordering

Address	Data
0	Bits 0 - 7
1	Bits 8 - 15
2	Bits 16 - 23
3	Bits 24 - 31

Byte swapping is used for word (16 bit) values: byte and word swapping apply to double word (32 bit) values. Parameter blocks are treated as double word structures, and other data is treated as word-based.

For Intel ordering, read the data in this manual from right to left (byte 0 at the right end and byte 3 at the left end). For VMEbus ordering, read data from left to right (byte 0 at the left end, byte 3 at the right end).

APPENDICES

APPENDIX A
SPECIFICATIONS

Physical:	Rimfire 3201:	Double height VME (160mm x 233.35mm)
	Rimfire 3202:	Double height VME
	Rimfire 3210:	Double height VME plus daughter bd.
	Rimfire 3220:	Triple height, full depth VME card (400mm x 366.66mm)
Electrical:		+ 5 vdc @ 5.0 A typical - 12 vdc @ 0.5 A typical
Capacity:	Rimfire 3201, 3202:	2 SMD-E or SMD hard disk drives
	Rimfire 3210, 3220:	4 SMD-E or SMD hard disk drives
Transfer Rate:		Disk data rate to 24 MHz
Environmental:		0 - 55 degrees Celsius ambient temperature
Bus Interface:		VMEbus Standard Revision C

NOTE

For trouble-free operation of the Rimfire 3200 board, a cooling air flow of at least 200 linear feet per minute must be maintained over the board's surface. Consult Ciprico for additional information on the operating environment.

NOTE

When applying power, the main system should be powered up before the drives. When powering down, the drives should be turned off first, then the remainder of the system.

APPENDIX B
CABLES AND CONNECTIONS

The Rimfire 3200 series of controllers may be connected to SMD or SMD-E disk drives in several ways.

1. **(Rimfire 3201 controller only)** VMEbus connector P2 on the board may be connected to a single disk drive, configured as drive 0. Ciprico supplies four different cables for this use:

Ciprico P/N	Length	Function
81010021	40"	P2 to drive (SMD Tag 4 used)
81010022	10'	P2 to drive (SMD Tag 4 used)
81010031	40"	P2 to drive (SMD Tag 5 used)
81010032	10'	P2 to drive (SMD Tag 5 used)

The cables listed above have two connectors at the disk drive end, enabling their attachment to the A and B connections of the disk drive.

NOTE

This mode of connection requires that the Tag 4/5 jumpers on the board be properly set. Refer to Appendix D.

2. **(Rimfire 3201, Rimfire 3202 controllers)** J1, J2, and J3 on the board may be connected to two disk drives, configured as drives 0 and 1. J1 is attached to the A cable connector of drive 0, which is daisy-chained to drive 1. J2 and J3 are attached directly to the B cable connectors of drives 0 and 1, respectively.

(Rimfire 3220 controller) J1 is attached to the A cable, and J2 through J5 are connected to the B cable connectors of drives 0 through 3.

(Rimfire 3210 controller) J2 is attached to the A cable, and J3 through J6 are connected to the B cable connectors of drives 0 through 3.

Ciprico supplies cables for this use:

Ciprico P/N	Length	Function
81015001	10'	A cable (daisy chain)
81015002	20'	A cable (daisy chain)
81015011	10'	B cable to drive
81015012	20'	B cable to drive

NOTE

If this mode of connection is used, care must be taken in guiding the cables between the boards on the VMEbus.

3. **(Rimfire 3201 only)** The Ciprico Rimfire 3200 Faceplate Connector (p.n. 83100007) may be used, enabling rapid connection of all cables through the front of the VMEbus rack. The faceplate connector is mounted next to the Rimfire 3201 in the rack, and is attached to J1, J2 and J3 of the Rimfire 3201. Its function is to bring the J1, J2 and J3 connectors to the front of the rack. The cables listed under 2. (above) may be used with the faceplate connector.

The Rimfire 3210 controller consists of two boards: the main board and the expansion connector assembly board. The main board is plugged directly into the VMEbus. The smaller board is attached to P2 of the main board in one of three ways:

1. Directly to the main board at the backplane (right-angle connector)
2. Directly to the main board at the backplane (straight connector)
3. Remote mounting (cable connection to the main board)

APPENDIX C
ERROR CODES

CODE	ERROR
01H	Invalid command The host issued an invalid command number.
02H	Bad unit number specified The host specified a unit number greater than eight.
03H	Bad unit type for this command The host specified a unit number which is not valid for the command used.
04H	Drive not configured The host attempted to access a disk drive for which a Configure command has not been executed.
05H	Memory transfer alignment error A memory transfer was attempted with either an odd system memory address or an odd length. All memory addresses and transfer lengths must be an even number of bytes.
06H	Bad logical sector number specified The host specified a logical sector number larger than the disk size when accessing a disk drive. Correct the sector size to be less than or equal to the disk size.
07H	Bad number of sectors specified The requested operation exceeds the size of the disk (for example, asking to read 5 sectors starting with the last sector on the disk).
08H	Bad track starting sector Commands which operate on track-wide structures (i.e. Format) must specify a logical sector number which is a multiple of the number of sectors per track. The sector number specified was not a multiple of the number of sectors per track.

09H Bad number of sectors for track-wide operation

Commands which operate on tracks (i.e. Format) must specify a sector count which is a multiple of the number of sectors per track. The sector count specified in the parameter block was not a multiple of the number of sectors per track.

0AH Bad tag number, Issue Tag/Return Status

The tag number specified in the Issue Tag/Return Status command was not one of 4, 5 or 6.

0BH Field not zero

A Reserved field in the parameter block is non-zero. In order to ensure expandability, the Rimfire 3200 requires that Reserved fields be set to zero.

0CH Bad number of scatter/gather headers specified

In a Scatter Read or Gather Write command, the number of headers was either 0 or greater than 255. This field should be corrected before the command is reissued.

0DH Bad length of scatter/gather table

A Scatter/Gather Descriptor Table entry was found to have a length of less than 4 bytes. The table should be corrected and the command reissued.

0EH Command list stopped

The controller has finished all processing on this command list. This is the last status block returned to a command list after it is stopped. It reports a status, not an error.

0FH Bad command list size field

The size of one of the circular buffers in a command list is less than 2 elements long, or the command list is greater than 65,535 bytes long.

10H Bad command list number specified

The command list number specified in a Start Command List or Stop Command List command is not between 1 and 7.

11H Command list cannot be started/stopped

If this error is returned from a Start Command List command, the specified command list is already active, and therefore cannot be started. If this error is returned from a Stop Command List command, the specified command list is not active, and therefore cannot be stopped.

12H Software bus timeout error

No activity was seen on the VMEbus, and the memory transfer timed out.

13H VMEbus error

A VMEbus access error was detected during a memory access. Causes for this condition include:

1. Invalid memory address: The specified address does not point to read memory.
2. Invalid address modifier
3. Quad byte (32 bit) transfer attempted with memory which does not support quad byte accesses.
4. Improper jumpering of the bus request/bus grant lines of the RF 3200 board.
5. Improper jumpering of the VMEbus backplane bus request/bus grant lines.

14H Drive won't select/not present

The specified SMD disk drive will not return "Selected" status on the B cable. This error will be returned if:

1. The disk drive is not plugged into the Rimfire 3200.
2. The disk drive is not turned on.
3. The disk drive B cable is plugged into the wrong drive connector.
4. The disk drive is not set to the proper unit number.

15H Drive not ready

The READY line from the specified SMD drive is not active. The READY line signifies that the drive spindle motor is up to speed, and the drive is ready to read or write. This error is only reported for commands requiring a spinning drive.

1CH Drive reported seek error

The drive detected an error during the seek process, or an attempt was made to seek to an invalid cylinder.

1EH Fault detected

A fault condition occurred in the drive. It indicates either a broken drive, an error in the Rimfire 3200, or a drive which is not fully compatible with the Rimfire 3200.

23H Sector too short/overrun error

A sector pulse was detected before the end of a sector. Possible causes for this error include:

1. The drive was configured for more bytes per sector than are physically available.

2. An unstable read or reference clock from the drive.

3. A noisy cable connection to the drive.

4. A hardware problem in the drive or controller.

24H Data error, no correction done

Data read from the drive is in error. As a retry, this was a soft error which did not recur when the controller reread the data. As a command error, the controller encountered a data error on the disk, for which correction was not attempted. When this error is returned, error correction was not attempted.

25H ID sync error (sector not found)

The Rimfire 3200 cannot find the desired sector on the disk. This may be caused by an error in the sector ID for the desired sector, or by an unformatted disk or disk formatted for a different number of sectors per track.

26H Header CRC error

A CRC error was detected while reading the header of the desired sector. It implies an error in the sector ID of the sector being read or written.

27H No data synchronization error

Possible causes for this error include:

1. A data error exists and the sector should be mapped

2. The disk is unformatted, or formatted for a different number of sectors per track.

3. The data preamble of the desired sector is too short.

28H Seek timeout

A seek or rezero did not complete within three seconds. This error normally means the drive is not operating correctly.

29H SMD data operation timeout

The drive is not returning read/reference clock pulses, or the drive is not returning index pulses.

2AH SMD misseek/direct access to an alternate

This error is returned when any of the following occurs:

1. An attempt was made to directly read an alternate track or alternate sector. Alternate tracks and sectors must be accessed via the defective track or sector which points to this alternate.

2. The disk drive performed a seek to the wrong track without detecting the error. The controller detects this via a bad sector ID value.

3. The disk format is corrupted, so that a defective track does not point to the proper alternate track. In this situation the invalid track or sector must be reformatted.

Most errors relating to invalid track IDs are classed under this error number. When retried, the retry process starts with the original sector being searched for. This ensures that all seek-related errors during defective track/sector processing are properly retried.

2BH Error reading SMD sector ID

A soft error occurred while reading a sector ID but the CRC was correct. This error will normally be seen only as a retry, since it implies the ID was re-read without error.

2CH Direct access to bad track or sector

An attempt was made to directly access a track or sector marked as bad. Possible causes for this error include:

1. The host attempted to access the wrong sector.

2. The disk format is corrupted. The proper tracks or sectors should be reformatted.

2DH ECC correction performed

This error number is only returned when a successful ECC error correction is done. It specifies that an error occurred which the ECC algorithm corrected.

2EH ECC correction failed

A data error could not be corrected using the ECC algorithm. As a retry, it means that the ECC algorithm could not correct the error and the data is being reread. As a command error, it means the data errors are beyond the correction span of the ECC algorithm. This error may also be returned if the disk was written with a different number of bytes per sector than the value currently configured.

2FH Sectors per track don't match disk setting

During format or mapping commands, the controller found that the number of physical sectors per track on the disk drive was different from the value found by the Configure command. To correct, reconfigure the drive with the correct number of sectors per track.

31H Drive write-protected

The drive cannot be written to because the write-protect switch or jumper is active.

32H Sectors/track field bad

The Sectors/Track field is zero or greater than 200.

33H Bytes per sector field bad

The Bytes/Sector field is less than 256, greater than 8192, or not a multiple of 16 bytes.

The requested track size (bytes/sector and sectors/ track) is larger than the physical drive capacity. Either request a smaller sector size or fewer sectors per track.

34H Preamble too long

One of the drive preambles exceeds permissible limits. Use the Return Configuration command to determine the various field sizes. When using the Define SMD Parameters command, the Rimfire 3200 preamble limitations are:

1. ID preamble length must be less than or equal to 54 bytes.

2. Data preamble length must be less than or equal to 62 bytes.

37H Configuration parameter inconsistent

One of the fields in the Configure or Define SMD Parameters commands is inconsistent. Such a condition might be: the interleave or skew factor is greater than or equal to the number of sectors per track; the number of cylinders per disk or heads per cylinder are 0; there is an invalid tag number in the data recovery field.

39H Attempt to initialize I/O Control Group 0

An attempt was made to change I/O Control Group 0. This I/O Control Group may not be changed.

3AH Bad source in defect mapping command

This error is generated by the Slip Sector, Map Track, and Map Sector commands. It signifies a problem with the sector or track to be flagged as defective, such as:

1. A Slip Sector command was attempted on an alternate or bad track.

2. A Map Track command was attempted on a track containing alternate sectors or on an alternate or bad track.

3. A Map Sector command was attempted on an alternate or bad track, on a mapped track, or on an alternate or bad sector.

3BH Bad destination in defect mapping command

This error is generated by the Map Track and Map Sector commands. It signifies a problem with the alternate address to be mapped to. It will only occur if the host selects the alternate location.

1. For a Map Track command, the alternate address is not a normal track. It is already flagged as an alternate, defective or bad track; or it contains alternate, defective, or bad sectors.

2. For a Map Sector command, the alternate address is not a normal sector. It is part of an alternate, defective, or bad track; or it is already an alternate, defective, or bad sector.

3CH No spares left on track

This error is generated by the Slip Sector command. It may mean:

1. The drive is configured without spare sectors

2. The track does not contain any more unused sectors. A Map Track or Map Sector command must be used to map the defect.

3DH Bad recovery field in defect mapping command

The value in the Recovery field in a Slip Sector, Map Track, or Map Sector command is invalid. This must be set to a valid recovery value and the command reexecuted.

DIAGNOSTIC ERROR CODES

60H Cache memory diagnostic error

This error will be returned if, during a cache memory test, a byte read from cache differed from the pattern previously written to that location. This is a controller hardware error.

61H Static RAM error

This error indicates that a byte read from the controller's scratchpad RAM differed from the pattern originally written. This is a controller hardware error.

62H PROM checksum error

This error is returned if the firmware EPROMs in the controller have been damaged, or were not successfully programmed. Controller firmware must be replaced for correct operation.

63H Error - undefined diagnostic specified

This error indicates that the diagnostic command set a bit in the Diagnostic Type field that did not correspond to a valid diagnostic test. This command may be reattempted after correcting the Diagnostic Type field in the parameter block.

APPENDIX D
JUMPER SETTINGS

Figures D-1, D-2, and D-3 illustrate the positions of the jumpers on the various Rimfire 3200 controller boards. Figure D-4 illustrates their settings. These jumpers determine the following parameters:

1. Board Address - These jumpers determine the address of the controller within the system. They correspond to Bits 9 - 15 of the board starting address (in = 0, out = 1). Factory setting: EE00H (all jumpers ~~inserted~~, except jumper in 12 position) ~~out~~ This is in conflict w/ itself.

2. Address Modifier - This jumper selects one of two alternative VMEbus Address Modifiers. In = Address Modifier code 29 (short non-privileged access). Out = Address Modifier code 2D (short supervisory access). Factory setting: jumper out (code 2D)

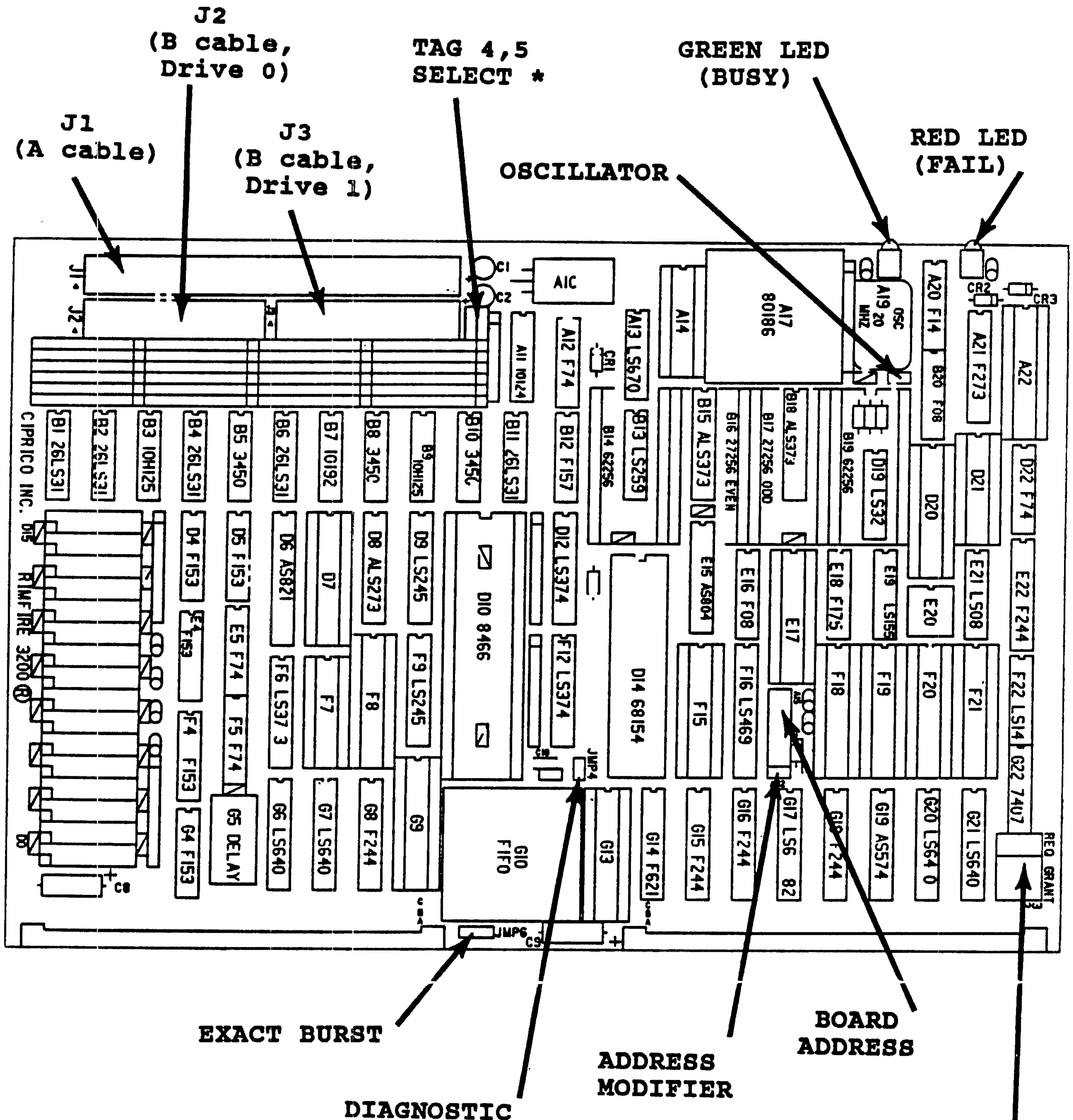
3. Bus Request/Grant In/Out 0-3 - This group of jumpers indicates the level at which the Rimfire 3200 controller requests the VMEbus, and determines bus grant passing. Refer to the VMEbus Specification manual for Bus Request and Bus Grant In/Out information. Factory setting: Level 3 (see Figure D-4)

4. Tag 4, 5 Select - This jumper enables the user to use the drive-dependent SMD and SMD-E Tag 4 and 5 functions. This jumper only applies to the Rimfire 3201 model, and only if the board is controlling a single drive attached at the P1 edge connector. Factory setting: not used (no jumper)

5. Diagnostic - This jumper enables Ciprico personnel, or the user of the board, to run diagnostic tests on the board. In = board self tests. Out = board runs normally. Factory setting: out (normal operation)

6. Exact Burst - This jumper inhibits VMEbus DMA operations until the board is ready to transfer a burst of at least 32 data bytes (except any remaining bytes of a transfer that was not a multiple of 32 bytes). In = transfer exact burst. Out = board starts VMEbus DMA burst when ready to transfer data, for greatest system throughput. Factory setting: out (normal operation).

7. Oscillator - This jumper is for factory use only.



* Tag 4/Tag 5 Select jumper is used only on the Rimfire 3201 controller.

Figure D-1 Rimfire 3201/Rimfire 3202 Board Diagram

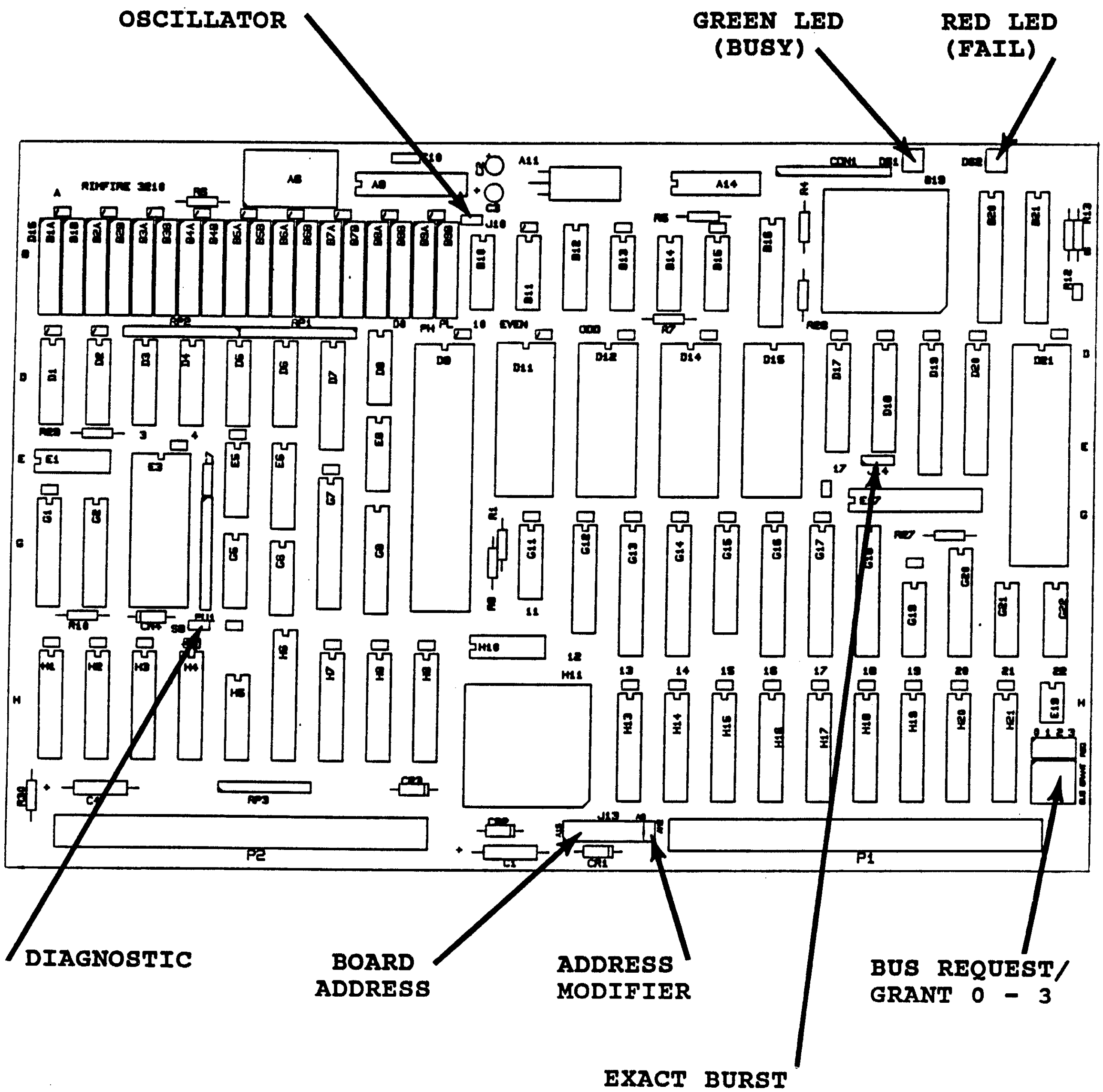


Figure D-2 Rimfire 3210 Board Diagram

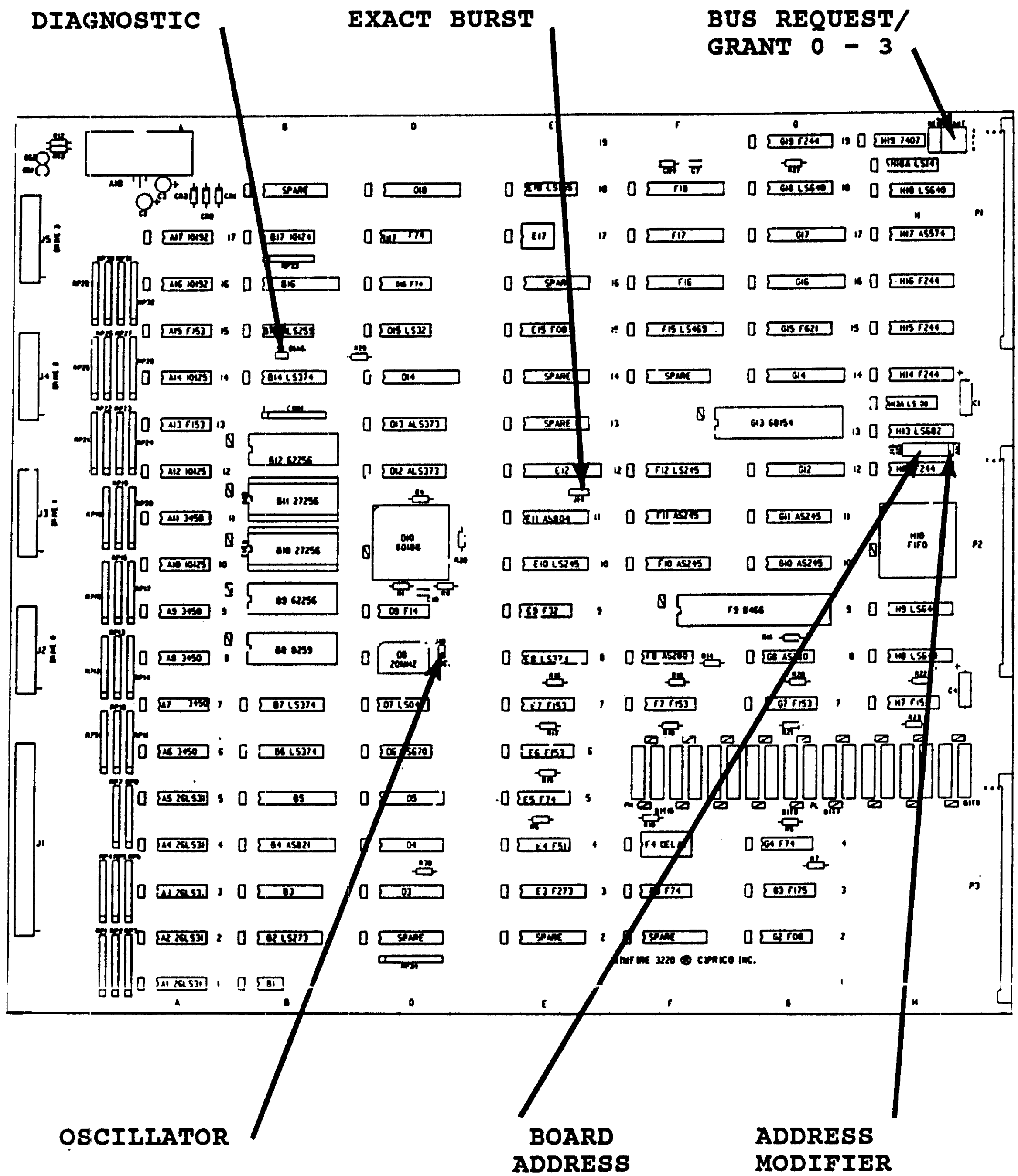
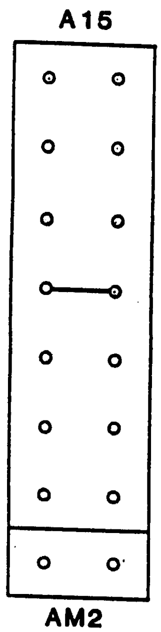


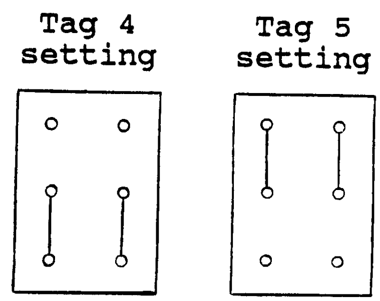
Figure D-3 Rimfire 3220 Board Diagram



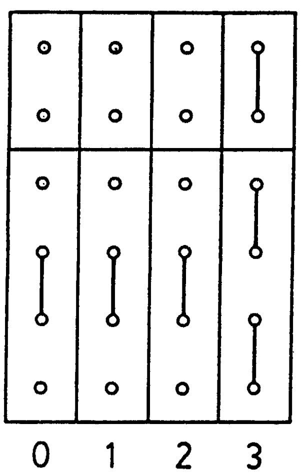
Board Address jumpers:
correspond to Bits 9-15
of board starting address
(in = 0, out = 1)

Example: EE00

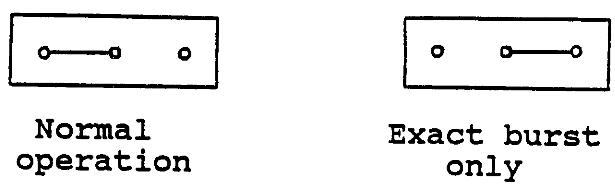
Address Modifier jumper:
in = AM code 29
(short non-privileged access)
out = AM code 2D
(short supervisory access)



Tag 4/5 Select jumpers
(3201 only, if P2 in use)



Bus Request/Bus Grant jumpers:
(level 3 shown)



Exact Burst jumper

NOTE: Board orientation as shown in Figure D-1.

Figure D-4 Rimfire 3200 Series Jumper Settings

APPENDIX E
CONNECTOR PINOUTS

Table E-1 VMEbus J1/P1 Pin Assignments

VME Pin	Row A	Row B	Row C
1	D00	BBSY	D08
2	D01	BCLR	D09
3	D02	ACFAIL	D10
4	D03	BG0IN	D11
5	D04	BG0OUT	D12
6	D05	BG1IN	D13
7	D06	BG1OUT	D14
8	D07	BG2IN	D15
9	GND	BG2OUT	GND
10	SYSCLK	BG3IN	SYSFAIL
11	GND	BG3OUT	BERR
12	DS1	BR0	SYSRESET
13	DS0	BR1	LWORD
14	WRITE	BR2	AM5
15	GND	BR3	A23
16	DTACK	AM0	A22
17	GND	AM1	A21
18	AS	AM2	A20
19	GND	AM3	A19
20	IACK	GND	A18
21	IACKIN	SERCLK(1)	A17
22	IACKOUT	SERDAT(1)	A16
23	AM4	GND	A15
24	A07	IRQ7	A14
25	A06	IRQ6	A13
26	A05	IRQ5	A12
27	A04	IRQ4	A11
28	A03	IRQ3	A10
29	A02	IRQ2	A09
30	A01	IRQ1	A08
31	-12V	+5V STDBY	+12V
32	+5V	+5V	+5V

Table E-2 VMEbus J2/P2 Pin Assignments

VME Pin	Row A	Row B	Row C
1	User-defined	+5 V	User-defined
2	User-defined	GND	User-defined
3	User-defined	Res.	User-defined
4	User-defined	A24	User-defined
5	User-defined	A25	User-defined
6	User-defined	A26	User-defined
7	User-defined	A27	User-defined
8	User-defined	A28	User-defined
9	User-defined	A29	User-defined
10	User-defined	A30	User-defined
11	User-defined	A31	User-defined
12	User-defined	GND	User-defined
13	User-defined	+5V	User-defined
14	User-defined	D16	User-defined
15	User-defined	D17	User-defined
16	User-defined	D18	User-defined
17	User-defined	D19	User-defined
18	User-defined	D20	User-defined
19	User-defined	D21	User-defined
20	User-defined	D22	User-defined
21	User-defined	D23	User-defined
22	User-defined	GND	User-defined
23	User-defined	D24	User-defined
24	User-defined	D25	User-defined
25	User-defined	D26	User-defined
26	User-defined	D27	User-defined
27	User-defined	D28	User-defined
28	User-defined	D29	User-defined
29	User-defined	D30	User-defined
30	User-defined	D31	User-defined
31	User-defined	GND	User-defined
32	User-defined	+5V	User-defined

APPENDIX F
NEC BIT ORDERING

Disk drives manufactured by NEC use the following bit ordering for the vendor-unique status byte in the Status Block returned by the controller after every command (see Section 2 of this manual). The host must convert the order returned by the Rimfire 3200 into the NEC order before interpreting status from NEC drives.

Rimfire 3200 order is:

MSB							LSB
SEC	IND	ADM	WRP	DRF	SER	ONC	UNR

UNR - Unit ready
ONC - On cylinder
SER - Seek error
DRF - Drive fault
WRP - Write protect
ADM - Address mark
IND - Index
SEC - Sector

NEC order is:

MSB							LSB
WRP	ADM	UNR	ONC	SER	DRF	SEC	IND

IND - Index
SEC - Sector
DRF - Drive fault
SER - Seek error
ONC - On cylinder
UNR - Unit ready
ADM - Address mark
WRP - Write protect

APPENDIX G
QUICK REFERENCE

COMMANDS

NON-DISK COMMANDS

Setup Command List	1
Stop Command List	2
Identify	5
Board Statistics	6
General Options	7
Initialize I/O Ctrl Grp	8
Diagnostic/Self-Test	9

CONTROLLER SETUP COMMANDS

Configure Disk	10
Define SMD Parameters	11
Return Configuration	12
Interrogate Disk	13

DATA TRANSFER COMMANDS

Read	18
Write	19
Scatter Read	1A
Gather Write	1B

DISK FORMATTING COMMANDS

Format Tracks	20
Verify	21

DEFECT MAPPING COMMANDS

Read Drive Defect Data	25
Slip Sector	22
Map Sector	23
Map Track	24

ADDITIONAL DISK COMMANDS

Read ID	2B
Read Track of IDs	2C
Rezero Disk	2D
Seek	2E
Read Long	29
Write Long	2A
Issue Tag/Return Status	14
Set Pick and Hold	30
Clear Pick and Hold	31

STANDARD PARAMETER BLOCK

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
DISK ADDRESS			
VME MEMORY ADDRESS			
RESERVED = 0		SECTOR COUNT	

Control Field

7				0
0	0	0	0	CONTROL GROUP

CONTROL GROUP - Defines I/O control group (see Initialize I/O Control Group command)

STANDARD STATUS BLOCK

31			0
IDENTIFIER			
VSTATUS	DSTATUS	ERROR	FLAGS
DISK ADDRESS OF ERROR, RETRY, OR CORRECTION			

DSTATUS (Disk Status) Byte

23							16
0	0	0	WRP	FLT	SER	ONC	RDY

RDY - Unit ready
ONC - On cylinder
SER - Seek error
FLT - Drive fault
WRP - Write protect

Flags Byte

7							0
CC	ERR	RTY	COR	0	0	0	0

COR - Correction required
RTY - Retry required
ERR - 0 = No error
1 = ERROR field shows error
CC - 0 = Command not complete
1 = Command complete

EXTENDED PARAMETER BLOCK

31	0
STANDARD PARAMETER BLOCK	
RESERVED = 0	DONE INTERRUPT
RESERVED = 0	
STATUS BLOCK	

INTERRUPT FIELD

15						0
0	0	0	0	0	INT. LEVEL	STATUS/ID

STATUS/ID - See VMEbus standard

INT. LEVEL - 000 - Interrupt disabled
001 - Interrupt level 1
010 - Interrupt level 2
011 - Interrupt level 3
100 - Interrupt level 4
101 - Interrupt level 5
110 - Interrupt level 6
111 - Interrupt level 7

RES. - All reserved bits are cleared to 0.

ADDRESS REGISTERS

	8 bit	16 or 32 bit	R/W only
Address Buffer Port	--	0H	W
Channel Attention	9H	8H	W
Board Status	--	10H	R
Controller Reset	19H	18H	W

ADDRESS BUFFER PORT

15	0	
CONTROL	ADDRESS MOD.	1st write
PB ADDRESS: MSW		2nd write
PB ADDRESS: LSW		3rd write

Control Byte

15							8
SET	0	0	0	0	WID	WSW	BSW

BSW - Byte swap control - 0 = natural VME ordering
1 = swap bytes
WSW - Word swap control - 0 = natural VME ordering
1 = swap words
WID - Data transfer width - 0 = 16-bit 1 = 32-bit
SET - 0 = Ignore control field 1 = Apply control field

STATUS PORT REGISTER

15–8	7	6	5	4	3	2	1	0
RESERVED = 0	LIST			ERR	0	0	RDY	ENT

ENT - 1 = Command entered
RDY - 0 = Powerup, board reset
1 = Board initialized, ready for commands
ERR - 1 = Error during read/write
LIST - Specifies which command list is in error (if ERR set):
if 0, type 0 command could not be transferred.

COMMAND LIST DATA STRUCTURE

31	0
PARAMETER BLOCK IN POINTER	
PARAMETER BLOCK OUT POINTER	
STATUS BLOCK IN POINTER	
STATUS BLOCK OUT POINTER	
PARAMETER BLOCK LIST SIZE	
STATUS BLOCK LIST SIZE	
RESERVED = 0	
RESERVED = 0	
PARAMETER BLOCK AREA	
STATUS BLOCK AREA	

SETUP COMMAND LIST PARAMETER BLOCK

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0		DONE INTERRUPT	
ADDRESS			
RESERVED = 0			LIST #

STOP COMMAND LIST PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
RESERVED = 0			
RESERVED = 0			
RESERVED = 0			LIST #

COMMAND LIST STOPPED STATUS BLOCK

31			0
FFFFFFFFH			
LIST NUMBER		ERROR=0EH	0
0			

IDENTIFY STATUS BLOCK

31			0
IDENTIFIER			
FW REV	ENG REV	ERROR	FLAGS
TYPE	DAY	MONTH	YEAR

FW REV - Firmware revision level - Last two digits of the even firmware PROM
ENG REV - Engineering revision level (Ciprico use only)
DAY, MONTH, YEAR - The date when the firmware was generated
TYPE - Board type (0 = two-drive, 1 = four-drive version)

Flags Byte

7							0
CC	ERR	RTY	COR	0	0	0	0

COR - Correction required
ERR - 0 = No error
1 = Check ERROR field

RTY - Retry required
CC - 0 = Command not complete
1 = Command complete

BOARD STATISTICS PARAMETER BLOCK

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0			
ADDRESS FOR STATISTICS BLOCK			
RESERVED = 0			CLEAR

CLEAR - If zero, board retains statistics data
If non-zero, board clears statistics data

STATISTICS DATA BLOCK

31	0	
TOTAL COMMANDS		
NUMBER OF DISK READS		
SECTORS READ FROM DISK		
SECTORS READ FROM CACHE FOR DISK		
NUMBER OF DISK WRITES		
SECTORS WRITTEN TO DISK		
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 0
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	
SEEK ERRORS	SMD INTERFACE ERRORS	DRIVE 1
ECC CORRECTIONS	NON-ECC DATA ERRORS	
ALTERNATE TRACK SEEKS	ECC CORRECTIONS FAIL.	
CONTINUED FOR DRIVES 2 AND 3		

GENERAL OPTIONS PARAMETER BLOCK

31			0
IDENTIFIER			
THROTTLE	UNIT =0	CONTROL	COMMAND
STATUS BLOCK INTERRUPTS		STATUS BLOCK ENABLES	
RESERVED = 0			
RESERVED = 0			

Status Block Enable/Interrupt Words

15															0
0	0	0	0	0	0	0	0	0	0	0	0	0	IDE	DTE	WDL

WDL - Return "write data loaded"
DTE - Return retries and corrections
IDE - Return ID/interface retries

INITIALIZE I/O CONTROL GROUP PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	IOCG	COMMAND
CACHE CONTROL		READ-AHEAD	RECOVERY
RESERVED = 0		D RETRY	ND RETRY
RESERVED = 0			

Recovery Byte

0	0	0	0	0	EXT	COR	IGE

IGE - Ignore ECC
COR - Disable Correction
EXT - Extended Recovery

Cache Control Word

31															16
0	0	0	0	0	0	RCC	RCT	ZLI	0	SWT	SRD	CWT	RAP	CRD	SEA

SEA - Search Cache
CRD - Cache Read Data
RAP - Read Ahead Priority
CWT - Cache Write Data

SRD - Sort Reads
SWT - Sort Writes
ZLI - Zero Latency Inhibit
RCT - Read Ahead crosses tracks
RCC - Read Ahead crosses cylinders

DIAGNOSTIC/SELF-TEST PARAMETER BLOCK

31			0
IDENTIFIER			
ADDR MOD	UNIT	CONTROL	COMMAND
RESERVED = 0			TEST TYPE
VME MEMORY ADDRESS			
RESERVED = 0			AREA

Test Type byte

01H - Test scratchpad RAM
02H - Test cache RAM
04H - Checksum firmware PROM
7FH - All the above tests
80H - Load cache memory area
81H - Read cache memory area
08H - Test non-memory board hardware

MEMORY DIAGNOSTIC STATUS BLOCK

31			0
IDENTIFIER			
PASS #	AREA	ERROR	FLAGS
EXPECTED	FOUND	ADDRESS	

Area byte

0 - Scratchpad memory
1-8 - 512 Kbyte cache memory (first through eighth 64K bank)
255 - Error in PROM checksum

Error byte

60H - Cache memory diagnostic error
61H - Static RAM error
62H - PROM checksum error
63H - Undefined diagnostic

CONFIGURE DISK PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
BYTES/SECTOR		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	BASE HEAD
RESERVED = 0			FLAGS

Flags Byte

7							0
0	0	0	0	0	0	EAD	SSP

SSP - Short sector present
EAD - Extended addressing

DEFINE SMD PARAMETERS BLOCK

31 ... 0

IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
INTERLEAVE	HEAD SKEW	CYL SKEW	RESERVED=0
DATA RECOVERY		ID P SIZE	DATA P SIZE
RESERVED = 0			

Data Recovery Field

31 29	28 26	25 15
TAG #	0	DATA BUS VALUE

RETURN CONFIGURATION DATA BLOCK

31 ... 0

BYTES/SECTOR		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	BASE HEAD
0			FLAGS
NUMBER OF LOGICAL BLOCKS (SECTORS) PER DISK			
INTERLEAVE	HEAD SKEW	CYL SKEW	0
DATA RECOVERY		ID P SIZE	DATA P SIZE
0			
0			

INTERROGATE DISK PARAMETER BLOCK

31 ... 0

IDENTIFIER			
MODIFIER	UNIT	IOCG	COMMAND
RESERVED = 0			
VME MEMORY ADDRESS			
RESERVED = 0			

RETURNED INTERROGATE DATA BLOCK

31 ... 0

RESERVED = 0		CYLINDERS/DISK	
# SPARES	SCT/TRK	HEADS/CYL	RESERVED=0
RESERVED = 0		P SCT/TRK	FLAGS

Flags Byte

7							0
0	0	0	0	0	0	0	SSP

SSP - Short sector present

SCATTER/GATHER HEADER FORMAT

(used by Scatter Read, Gather Write commands)

31	0
NEXT SG HEADER	
RESERVED=0	DATA LENGTH 1
DATA ADDRESS 1	
RESERVED=0	DATA LENGTH 2
DATA ADDRESS 2	
(descriptors 3 through 6)	
RESERVED=0	DATA LENGTH 7
DATA ADDRESS 7	
RESERVED=0	DATA LENGTH 8
DATA ADDRESS 8	

FORMAT/VERIFY PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
DISK ADDRESS			
RESERVED = 0			
SECTOR COUNT			

READ DEFECT DATA BLOCK

15	0
00H	19H (CONSTANT)
D | CYLINDER NUMBER	
HEAD NUMBER	00H
POSITION 1	
LENGTH 1	
POSITION 2	
LENGTH 2	
POSITION 3	
LENGTH 3	
POSITION 4	
LENGTH 4	
00H	F0H (CONSTANT)

DEFECT HANDLING COMMANDS PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
DEFECTIVE TRACK/SECTOR ADDRESS			
ALTERNATE TRACK/SECTOR ADDRESS			
RESERVED = 0		DATA RECOVERY	

Recovery Field Values

00H	Do not recover old data
01H	Read old data, abort command if an error occurs
02H	Read old data, continue if an error occurs

DISK ID FIELD

(returned by Read ID command)

15	0
CYLINDER	
SECTOR	HEAD
ALTERNATE SECTOR #	FLAG

ISSUE TAG PARAMETER BLOCK

31			0
IDENTIFIER			
RESERVED=0	UNIT	CONTROL	COMMAND
RESERVED = 0		DATA TO SEND	
RESERVED = 0		TAG NUMBER	
RESERVED = 0			

ERROR CODES

01H	Invalid command
02H	Bad unit number specified
03H	Bad unit type for this command
04H	Drive not configured
05H	Memory transfer alignment error
06H	Bad logical sector number specified
07H	Bad number of sectors specified
08H	Bad track starting sector
09H	Bad number of sectors for track-wide operation
0AH	Bad tag number, Issue Tag/Return Status
0BH	Field not zero
0CH	Bad number of scatter/gather headers specified
0DH	Bad length of scatter/gather table
0EH	Command list stopped
0FH	Bad command list size field
10H	Bad command list number specified
11H	Command list cannot be started/stopped
12H	Software bus timeout error
13H	VMEbus error
14H	Drive won't select/not present
15H	Drive not ready
1CH	Drive reported seek error
1EH	Fault detected
23H	Sector too short/overrun error
24H	Data ECC error, no correction done
25H	ID sync error (sector not found)
26H	Header CRC error
27H	No data synchronization error
28H	Seek timeout
29H	SMD data operation timeout
2AH	SMD misseek/bad disk format
2BH	Error reading SMD sector ID
2CH	Direct access to bad track or sector
2DH	ECC correction performed
2EH	ECC correction failed
2FH	Sectors per track don't match disk setting
31H	Drive write-protected
32H	Sectors/track field bad or greater than allowed
33H	Bytes per sector field bad
34H	Preamble too long
37H	Configuration parameter inconsistent
39H	Attempt to initialize I/O control group 0
3AH	Bad source in defect mapping command
3BH	Bad destination in defect mapping command
3CH	No spares left on track
3DH	Bad recovery field in defect mapping command
60H	Cache memory diagnostic error
61H	Static RAM error
62H	PROM checksum error
63H	Error-undefined diagnostic specified

APPENDIX H
RF3200 INSTALLATION INTO SUN 3 SYSTEMS

This appendix discusses the user/third party requirements for installing the Rimfire 3200 into VME-based Sun-3/XXX systems.

The items needed to integrate the RF3200 are:

1. Ciprico VME Controller

2. Ciprico Rimfire 3200 UNIX BSD 4.2 Software Driver (supplied by Ciprico)

3. Sun Dual Width to Triple Width VME adapter card (Sun part no. 3/160-160). This adapter card is not required if the Rimfire 3220 controller is used.

NOTE: Contact Ciprico Support Engineering for information on obtaining the Sun adapter card.

If a Rimfire 3200 model other than the Rimfire 3220 controller board is used, remove the VME faceplate from the Ciprico controller before installation. In all models, install jumpers on the Ciprico board for these conditions (refer to Appendix E of this manual for jumpering information):

Bus Grant In/Out 3
Bus Request 3
Board Address 0x2000

The two lower jumpers of the specific card slot location of the board must be removed from the Sun 3 back panel (Bus Grant 3 and IACK).

Using the Sun SYSTEM MANAGER'S MANUAL, link the Ciprico software driver into the system's UNIX kernel. Upon completion, the selected peripheral should be ready for access.

If there are still problems or questions concerning this information, Ciprico Support Engineering is available at the following phone number for assistance: (612) 559-2034.

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