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# **RIMFIRE 44**

**Product  
Specification**

RIMFIRE 44 Product Specification

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## 1.0 INTRODUCTION

This document describes the operation of the CPC RIMFIRE 44 ANSI Disk/ $\frac{1}{4}$ -inch Cartridge Tape Drive Controller. It provides the information necessary for the user to incorporate the RIMFIRE 44 into a Multibus-based system.

### 1.1 This section contains a generalized overview of the operation of the RIMFIRE 44. Detailed information is contained in later sections.

The CPC RIMFIRE 44 is an intelligent, Multibus-compatible controller, capable of handling up to eight Winchester Disk Drives conforming to ANSI proposal X3T9, and up to four Archive Sidewinder<sup>™</sup> or Cipher Data Quarterback<sup>™</sup> cartridge tape drives (30 ips only). The controller is fully Multibus-compatible, and functions in a 8 or 16 bit system, with 16, 20 or 24 bit addressing, single or multi-processor.

Disk and tape operations are controlled through Parameter Blocks placed in system memory by processors requiring use of the controller. The location of the Parameter Block is programmable for each operation, i.e., the location is passed to the RIMFIRE 44 at the start of each command or chain of commands. Once an operation has begun, no further system intervention is necessary. The RIMFIRE 44 will complete the task or tasks as assigned, and then become available for the next command.

In addition to disk and tape operations, the RIMFIRE 44 can perform several powerful data move and diagnostic functions, and may be used as a general purpose DMA controller. It will also execute user-written 8089 programs. Refer to later sections for details.

The RIMFIRE 44 may be configured at the factory as a RIMFIRE 44D or RIMFIRE 44T. These versions are logic depopulations of the standard controller, and execute only the disk command or tape commands, respectively. The RIMFIRE 44T will accept either 30 ips or 90 ips cartridge tape drives.

## 1.2 FEATURES

- \* Controls up to eight ANSI-compatible Winchester disk drives and four Cipher Data Quarterback<sup>™</sup> or Archive Sidewinder<sup>™</sup> streaming  $\frac{1}{4}$ -inch tape drives.
- \* Automatic on-board disk-to-tape and tape-to-disk data transfers.
- \* Separate 32-bit ECC word on each sector ID and data block.
- \* Programmable for 8 or 16 bit systems.
- \* DMA operation with 24 bit addressing.
- \* Many programmable options including Bus Lock, Linked Commands, Interrupts and ECC/Retry disable.
- \* Flexible Format capability with Auto-interleave option.
- \* Defect mapping with transparent alternate track selection.
- \* Single or Multimaster environments.
- \* Powerful Block Move capability with Search and Translate options.
- \* Executes user-written 8089 programs.
- \* Single 5 VDC operation.



## 2.0 DEFINITION OF TERMS

This section defines the terms used during the detailed description of RIMFIRE 44 operation.

## 2.1 CHANNEL ATTENTION

A Channel Attention is an I/O Write to the Multibus address of the RIMFIRE 44 which is in the system I/O space. It is issued by the system CPU to initiate each RIMFIRE 44 activity. The I/O address may be set by the user via DIP switches on the board. Also selected is the width of the I/O address—8 bits for 8080, Z80 or similar systems, or 16 bits for 8086-type systems. A Channel Attention must never be issued while the RIMFIRE 44 is busy (i.e., Gate Closed).

Since the least significant bit of the I/O address is not selectable, the RIMFIRE 44 occupies two addresses. The Channel Attention is defined as the even address. The odd I/O address is defined as the Software Reset. A write to this address resets the RIMFIRE 44 CPU (see sec. 3.1.1).

## 2.2 GATE

The Gate is a byte of data in the Channel Control Block in system memory. It controls all access to the use of the RIMFIRE 44 by system processors. It is opened (set to 00H) by the RIMFIRE 44 when it is not busy, and closed (set to FFH) by a processor using the RIMFIRE 44. A processor may only close the Gate when it has found the Gate open. In multiprocessing systems, the Gate should only be closed with a test-and-set type instruction.

## 2.3 POINTER

All system memory addresses passed to the RIMFIRE 44 through a Parameter Block must be in the form of a Pointer. Following the Intel 8086 convention, a Pointer consists of two 16 bit words which are combined by the RIMFIRE 44 to form a 20 bit system memory address. The word at the higher address, or Base, is left-shifted by four bits and added to the lower addressed word, or Offset, to obtain the 20-bit result. Refer to the Intel 8086 Family User's Manual for a more detailed discussion of Pointers.

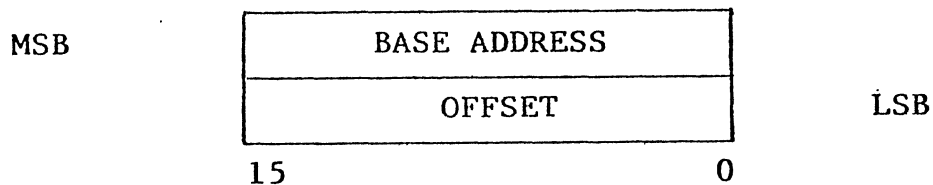


Fig. 2-1. Pointer Value

To accommodate 24-bit addressing, the user may select one of 16 1Mbyte pages. Refer to sec. 4.4 for details.

## 2.4 PARAMETER BLOCK

A Parameter Block is a short block of consecutively addressed data placed in system memory by a processor in preparation for command execution. The Parameter Block contains information the RIMFIRE 44 requires to perform the desired operation. The RIMFIRE 44 command always occupies the first byte of the Parameter Block, which is at the lowest-addressed location.

The Parameter Block is read by the RIMFIRE 44 into local memory when it begins execution, and is rewritten to system memory with appropriate updates just prior to opening the Gate.

### 3.0 DISK ORGANIZATION

Data is written on the disk in addressable blocks called sectors. Each sector address is made up of three components which define a unique position on the disk: Cylinder, Head and Sector. Refer to Fig. 3-1.

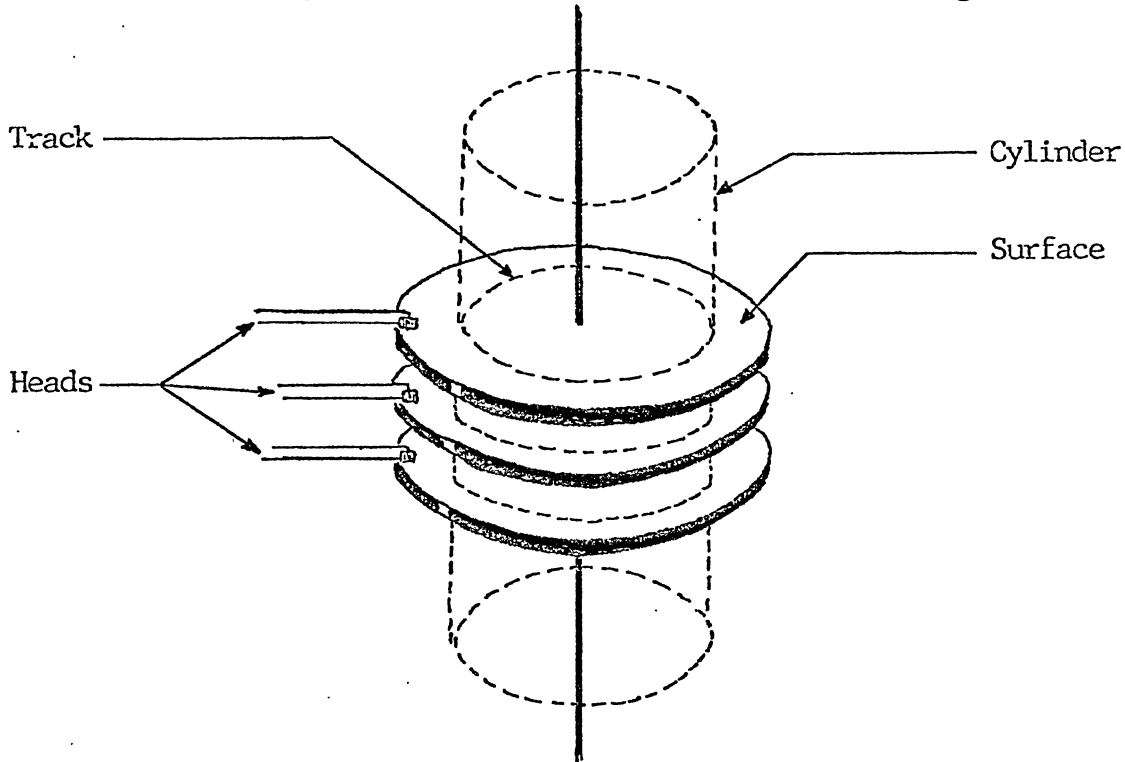


Fig. 3-1. Disk Organization

#### 3.1 TRACK

A Track is one of a number of concentric data paths on a disk surface. If a disk surface has  $N$  tracks, they are numbered from 0 to  $N-1$ , with track 0 being that circular data path with the largest diameter, i.e., furthest from the center. A track is defined by a given cylinder number and head number.

#### 3.2 CYLINDER

A cylinder is the set of all tracks with the same diameter, located on parallel surfaces. Cylinders are numbered in the same manner as tracks.

#### 3.3 HEAD

The Head identifies which surface is to be addressed on a multiple-surface disk, i.e., which track in a given cylinder. Heads are numbered starting with 0.

#### 3.4 SECTOR

Sectors are addressable blocks of data on the disk. Sectors are numbered logically starting from 1 to  $N$  on each track. The first logical sector (sector 1) is always the first physical sector, identified by the occurrence of the Index pulse.

### 3.5 DISK FORMAT

The Disk Format used by the RIMFIRE 44 is shown in Fig. 3-2.

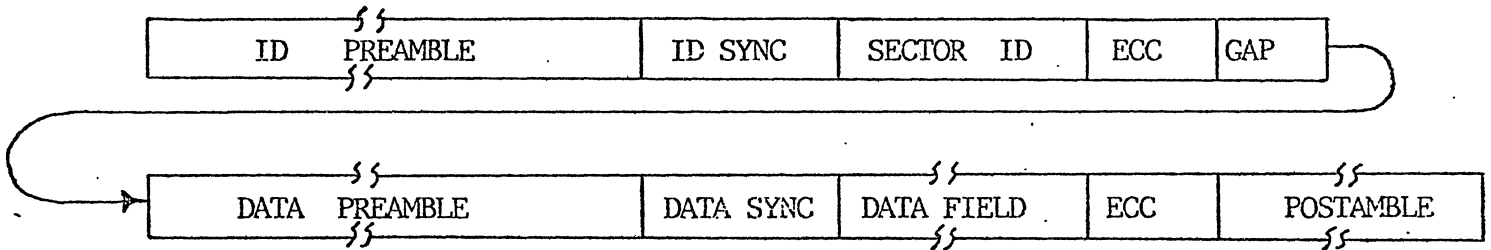


Fig. 3-2. Disk Format

The fields have the following lengths in bytes. Some of the fields vary depending on the drive used. Refer to Appendix G for information regarding specific disk drives.

<u>Field</u>	<u>Length</u>
ID Preamble	- Drive dependent
ID Sync Code (F9H)	- 1 byte
Sector ID	- 6 bytes
Cylinder Upper	
Cylinder Lower	
Sector Upper	
Sector Lower	
Head	
Track type	
ID ECC	- 4 bytes
Gap	- 2 bytes
Data Preamble	- Drive dependent
Data Sync Code (FDH)	- 1 byte
Data Field	- User selectable
Data ECC	- 4 bytes
Postamble	- Drive dependent

The Track Type byte in the sector ID may be one of three hex values.

- AA - Normal track
- C3 - Defective track
- 3C - Assigned alternate

ERROR CORRECTION

The RIMFIRE 44 employs a separate 32-bit ECC word on each sector ID and each data block (Fig. 3.2). This word is used to detect read errors in the sector ID and data fields, and to correct read errors detected in the data field. No attempt is made to correct a detected error in the sector ID field.

Table 3-1 lists the properties of the Error Correction Code used by the RIMFIRE 44.

1. Maximum record length ( $r$ ) =  $1540 \times 8$  bits (including check bits).
2. Correction span = 5 bits.
3. Degree of polynomial = 32.
4. Single burst detection span.
  - = 16 bits for  $r=1540 \times 8$
  - = 19 bits for  $r=526 \times 8$
  - = 20 bits for  $r=270 \times 8$
5. Double burst detection span.
  - = 3 bits for  $r=526 \times 8$
  - = 4 bits for  $r=270 \times 8$
6. Non-detection probability =  $2.3 \text{ E-}10$ .
7. Miscorrection probability --
  - =  $4.59 \text{ E-}5$  for  $r=1540 \times 8$
  - =  $1.57 \text{ E-}5$  for  $r=526 \times 8$
  - =  $8.00 \text{ E-}6$  for  $r=270 \times 8$

Table 3-1. RIMFIRE 44 ECC Properties

## 4.0 FUNCTIONAL DESCRIPTION

This section contains a detailed description of the operation of the RIMFIRE 44.

Operation may be separated into 2 parts: Initialization and Command Execution. All operations are initiated with the issuance of a Channel Attention to the RIMFIRE 44.

### 4.1 INITIALIZATION

Initialization is the procedure through which the RIMFIRE 44 receives the definition of the system environment from the host. The RIMFIRE 44 always executes the Initialization procedure when it receives the first Channel Attention after a board reset (sec. 4.1.1).

After the Channel Attention, the RIMFIRE 44 initializes itself by reading information from three control blocks located in system memory. It is the responsibility of the system to correctly set up these controls blocks prior to issuing the first Channel Attention.

The three control blocks are the System Configuration Pointer, the System Configuration Block and the Channel Control Block. The Initialization process is outlined in Fig. 4-1.

#### 4.1.1 BOARD RESET

The RIMFIRE 44 board-level Reset may be executed through a system reset or software reset. A system reset occurs when the INIT/ line on the Multibus is activated (low) according to bus convention. A software reset occurs when a write to the higher (odd) I/O address of the RIMFIRE 44 is executed by a system processor. The two signals are logically "OR'd" together on the board.

#### 4.1.2 SYSTEM CONFIGURATION POINTER

The 6-byte System Configuration Pointer may begin at any system memory address in the lower 1 Mbyte. The only restriction is that the least significant nibble of the address must be 6H (SCP address = 0XXXX6H). The remaining address bits are set via jumpers on the board.

After the first Channel Attention, the RIMFIRE 44 reads the first byte of the System Configuration Pointer (SYSBUS) to determine the width of the system bus (initially assumed to be 8 bits). A 00H indicates an 8-bit system bus, 01H a 16-bit bus. Byte 2 is not used. Bytes 3-6 comprise a Pointer to the next block, the System Configuration Block. Note that the bus width selected by SYSBUS is the width of the RIMFIRE 44-to-memory bus, and is independent from the system processor type. Most current memory modules will support 16-bit transfers, which would be the most efficient.

After adjusting for physical size, the RIMFIRE 44 continues to the System Configuration Block and reads that information.

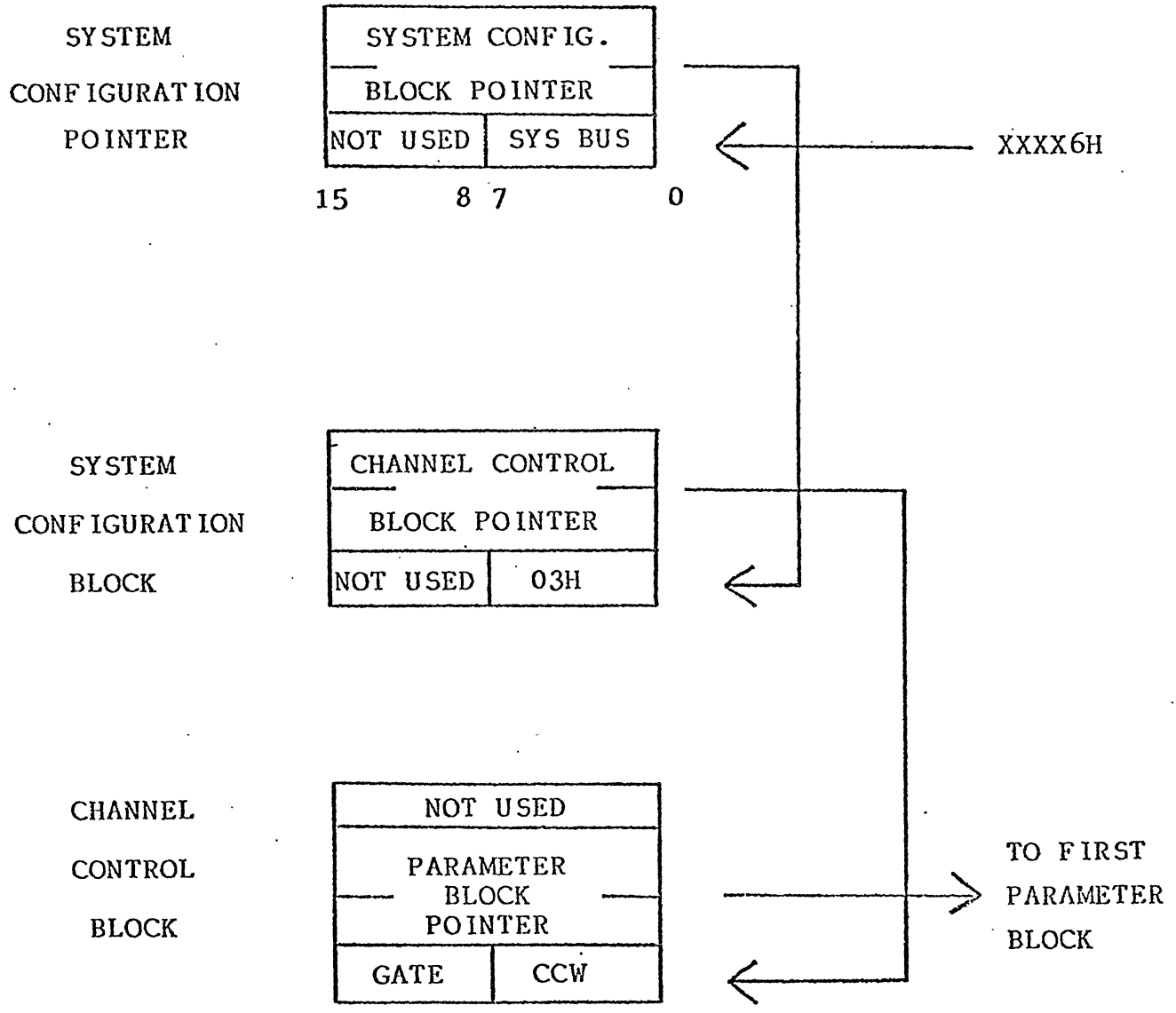


Fig. 4-1. Initialization Sequence

#### 4.1.3 SYSTEM CONFIGURATION BLOCK

The 6 byte System Configuration Block contains one byte whose value is fixed, (03H), an unused byte, and a 4 byte pointer to the last Initialization Block, the Channel Control Block.

After picking up the pointer in this block, the RIMFIRE 44 continues to the last block.

#### 4.1.4 CHANNEL CONTROL BLOCK

The Channel Control Block contains six bytes around which all RIMFIRE 44 operations revolve. Byte 1 is the Channel Control Word (CCW). For all RIMFIRE 44 commands, it must contain either 11H, for normal operation, or 09H, to clear an active non-vectored Multibus interrupt. The CCW may contain other values when executing user-written 8089 programs. Refer to section 4.3 and 4.5 for additional information on the CCW.

Byte 2 is the Gate, which the RIMFIRE 44 uses to signal its readiness to execute a command. Bytes 3-6 (Parameter Block Pointer) form a pointer to the location of the LSB of the first Parameter Block.

During the Initialization process, the only byte used in the Channel Control Block is the Gate. It must be set closed (set to FFH) prior to the Initialization process. When the Initialization process has been completed, the RIMFIRE 44 will open the Gate (set to 00H), indicating it is now ready to execute commands. The location used for the System Configuration Pointer and System Configuration Block, if they are RAM-based, may now be reused as required.

#### 4.2 COMMAND EXECUTION

After the completion of the Initialization process, the RIMFIRE 44 is ready to accept commands, as it now "knows" the programmable locations of the Gate, and of the Parameter Block Pointer. A system processor wishing to execute a command may now do so through the following procedure:

- A. Set up the Parameter Block or Blocks in memory.
- B. Read the Gate location to determine when the RIMFIRE 44 is not busy. When the Gate is open (00), the system processor may take control by setting it closed (FFH). (NOTE: In a multi-processor system, a Test-and-Set type instruction must be used to close the Gate. This is necessary to prevent one processor from reading the Gate between the read and write of the Gate from a second processor).
- C. After closing the Gate, the user sets the pointer in the Channel Control Block to point at its first Parameter Block. It must also set the Channel Control Word, as required.
- D. Issue a Channel Attention to the RIMFIRE 44.



The RIMFIRE 44 will then execute the selected command with no additional system intervention. Upon completion of each command, the RIMFIRE 44 may go on to another Parameter Block, or halt with or without interrupt, depending upon options selected. When it halts, it will open the Gate to signal its readiness to accept another command.

### 4.3 INTERRUPTS

The RIMFIRE 44 may be programmed, through the CONTROL entry in the Parameter Block, to generate an interrupt at the completion of a command (last command only in a linked chain) or if an unrecoverable error occurs. (If such an error occurs during the execution of an intermediate command in a linked chain, the RIMFIRE 44 will search through the chain and act on the interrupt options of the last command).

Interrupts may be of two types--Non-vectored Multibus, or Mailbox interrupts.

#### 4.3.1 NON-VECTORED INTERRUPTS

Non-vectored interrupts occur when the RIMFIRE 44 activates one of the eight Multibus interrupt lines. The interrupt will be asserted at the completion of the command or chain of commands for which an interrupt was enabled immediately prior to the opening of the Gate. The interrupt line will remain active (low level on the Multibus) until cleared.

The interrupt line may be cleared by setting the CCW to 09H and executing another RIMFIRE 44 command. The RIMFIRE 44 will clear the interrupt before it reads the Parameter Block. The Clear Interrupt command may be used here to avoid the time required for a normal Parameter Block sequence, since it requires only a 2-byte command code and halts immediately after clearing the interrupt.

#### 4.3.2 MAILBOX INTERRUPTS

A Mailbox Interrupt occurs when the RIMFIRE 44 sets the contents of a memory location (mailbox) to FFH. The location of the mailbox is stored as a 4-byte pointer in the Interrupt/Link field in the Parameter Block.

### 4.4 PAGING

The RIMFIRE 44 supports 24 bit addressing through a paging technique. When data is to be transferred to or from system memory, the upper four Multibus address bits (ADB 20-23) are set in the Page register on the RIMFIRE 44 board. Thereafter all data operations of that command will take place within the selected 1 Mbyte page. These address bits are selected in the Page entry in the Parameter Block.

All Parameter Blocks and Initialization Blocks must reside in the lower 1 Mbyte.

USER 8089 PROGRAMS

The RIMFIRE 44 will execute user-written 8089 object code, either from system memory or from on-board RAM.

If execution is to begin in system memory, the starting system memory location should be placed as a 4-byte pointer, in place of the first four bytes of the Parameter Block. The remainder of the Parameter Block is not used. The CCW in the Channel Control Block must be set to 13H. A Channel Attention will begin execution.

If the user program is to be executed from on-board RAM, the Block Move should be used to move the code from system memory to RIMFIRE 44 RAM. This RAM occupies local addresses C000H to CFFFH. User programs should start at C100H or above. The starting local address of the user program should be placed in the first 2 bytes of the Parameter Block. The remainder of the Parameter Block is not used. The CCW should be set to 11H. A Channel Attention will begin execution.

## 5.0 DISK COMMAND EXECUTION

When a disk command is executed, the RIMFIRE 44 obtains the information it requires from the Parameter Block. Disk Read and Write commands, for example, require a starting disk address (cylinder, head and sector), a sector count and a starting system memory location. Some fields may or may not be used depending on the command.

## 5.1 DISK PARAMETER BLOCK

The Disk Parameter Block (Fig. 5-1) contains 22 bytes, divided into 11 fields. The Parameter Block pointer must point to the least significant byte of the Parameter Block, i.e., byte 1 of the command field.

The various fields are described in the following sections. Also indicated is whether the field contains information required by the RIMFIRE 44 (Input), status return information from the RIMFIRE 44 (Output) or both (Input/Output). Not all fields are used by all commands.

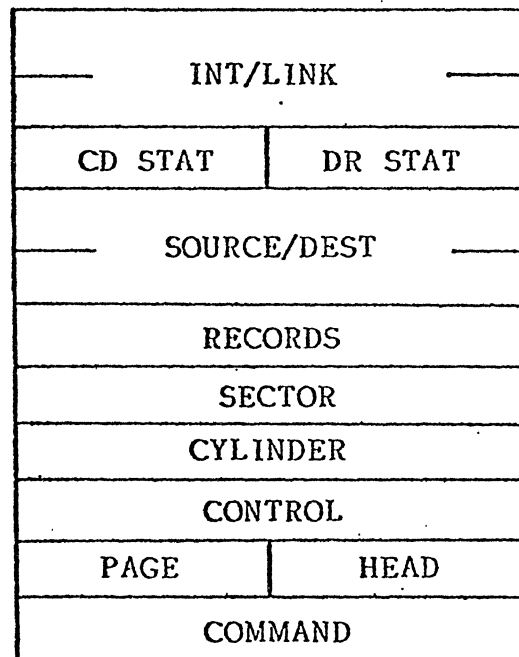


Fig. 5-1. Disk Parameter Block

### 5.1.1 COMMAND (Input)

The command field contains 2 bytes. The upper byte must be 00H for proper operation. Refer to section 9 for the command list.

### 5.1.2 HEAD SELECT (Input/Output)

This field contains the starting head select for disk access commands. The RIMFIRE 44 will accommodate up to 256 heads.

### 5.1.3 PAGE ADDRESS (Input)

The lower nibble of this byte selects the 1 Mbyte page in which this command is to transfer data (ADB 20-23).

### 5.1.4 CONTROL (Input)

The CONTROL field (Fig. 5-2) contains various information used by the RIMFIRE 44 during the execution of disk commands.

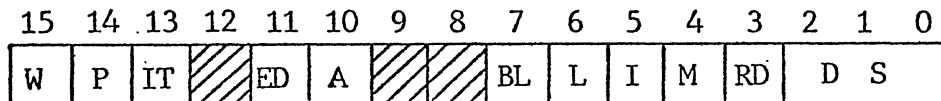


Fig. 5-2. Disk Control Word

- DS - (Disk Select) selects one of eight possible drives.
- RD - (Retry disable) disables all automatic retries when set to 1.
- M - (Mailbox Interrupt) selects non-vectorized interrupts (0) or Mailbox interrupts (1) if the I bit is set.
- I - (Interrupt) causes the RIMFIRE 44 to interrupt on completion of a command or chain of commands.
- L - (Link) informs the RIMFIRE 44 that another Parameter Block follows. The Link and Interrupt options are mutually exclusive, since each uses the Source/Destination field. The Link option takes priority.
- BL - (Bus Lock) causes the RIMFIRE 44 to lock the system bus (1) during DMA transfers to or from system memory.
- A - (Auto-interleave) is used only during a Format or Map Defect command. When set, the RIMFIRE 44 will calculate the logical sector numbering order. Otherwise the user must provide the logical sector order. This bit is also used in conjunction with the Interleave Table bit (see below).
- ED - (ECC Disable) disables the automatic error correction when set to 1.

IT - (Interleave Table) is used only during a Format command in combination with the Auto-interleave option. It allows the user to examine the calculated sector numbering table without actually formatting. The A and IT bits have the following significance during Format:

<u>IT</u>	<u>A</u>	<u>Result during Format</u>
X	0	Format disk, user supplies sector numbering order.
0	1	Format disk, RIMFIRE 44 calculates sector numbering order based on Interleave value in Records field.
1	1	Bypass Format, but return the calculated sector numbering table, starting at the Source/Destination address.

P - (Protect) may be used to override the automatic alternate track selection feature of the RIMFIRE 44. When set (1), direct access to a track which has been mapped out as defective will be allowed. No access to the alternate track will be made. This bit also allows a direct access to a track which has been assigned as an alternate, which would otherwise result in an error.

W - (Width) selects the logical width of the system bus. "1" indicates 16 bits, "0" indicates 8 bits. Normally this bit would match the bus width selected during initialization (SYSBUS). However, it may be used to force byte transfers on a 16-bit bus. A logical width of 16 bits may not be selected if the physical width is 8 bits.

#### 5.1.5 CYLINDER (Input/Output)

This field specifies the starting cylinder for disk access commands.

#### 5.1.6 SECTOR (Input/Output)

This field specifies the starting logical sector number for disk access commands, where applicable.

#### 5.1.7 RECORDS (Input/Output)

This field specifies the number of sectors to be transferred for a disk Read or Write command. It will also return Sense Byte 1 and 2 for a Disk Status command. See section 5.2 for an explanation of these bits.

#### 5.1.8 SOURCE/DESTINATION (Input)

This 4-byte pointer specifies the starting system memory address for data transfer commands.

### 5.1.9 DISK DRIVE STATUS (Output)

The disk drive General Status byte is returned in this field at the completion of the command (Fig. 5-3). Refer to the appropriate disk user's manual for a detailed explanation of these bits.

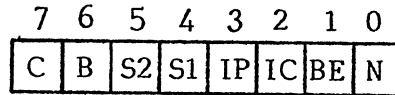


Fig. 5-3. Disk Drive General Status

- N - Not Ready
- BE - Control Bus Error
- IC - Illegal Command
- IP - Illegal Parameter
- S1 - Sense Byte 1
- S2 - Sense Byte 2
- B - Busy
- C - Normal Completion

### 5.1.10 COMMAND STATUS (Output)

These bits reflect the status of the command. (Fig. 5-4).

- E - (Entered) The Parameter Block has been entered by the RIMFIRE 44 and execution has begun.
- C - (Complete) The RIMFIRE 44 has successfully completed the command as outlined in this Parameter Block.
- ERROR - This 6-bit field specifies an error code when a non-recoverable error is encountered. Error codes are listed in Appendix C.

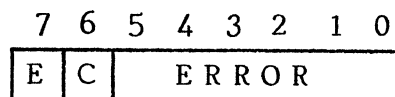


Fig. 5-4. Command Status Field

### 5.1.11 INTERRUPT/LINK (Input)

The Interrupt/Link field is a 4-byte pointer which points to the next Parameter Block if the Link is set, or the Mailbox Interrupt location if the Interrupt and mailbox bits are set. Otherwise it is ignored.

## 5.2 COMPLETION STATUS

When a disk command has completed, the RIMFIRE 44 will update the Parameter Block as required. If the command was a Read or Write, the disk address (cylinder, head and sector) will represent the last sector successfully transferred, plus 1. This facilitates reusing the Parameter Block for sequential operations.

The Records field will be updated for Read and Write commands to reflect the number of sectors which have not yet been transferred. This value will be 0 if the command terminates properly. If a non-recoverable error occurs, this field will help determine the location of the error. This field is also used to return the two Sense Status bytes for a Disk Status command. (Fig. 5-5). Refer to the appropriate disk drive user's manual for a detailed explanation of these bits.

The Command Status and General Status bits will be updated for all disk commands.

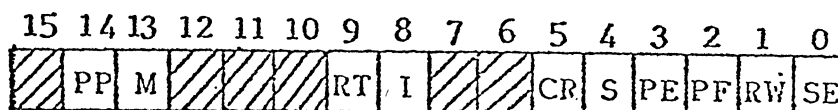


Fig. 5-5. Disk Sense Byte

- SE - Seek Error
- RW - Read/Write Fault
- PF - Power Fault
- PE - Read/Write Permit Error
- S - Speed Error
- CR - Command Reject
- I - Initial State
- RT - Ready Transition
- M - Attribute Table Modified
- PP - Positioned Within Write Protected Area

## 6.0 TAPE COMMAND EXECUTION

Although the RIMFIRE 44 tape interface is intended primarily for automatic disk dump and restore operations, the controller also executes several powerful tape commands. These commands allow the user to position the tape, write filemarks and to stream data to and from the tape drive from an off-board location.

### 6.1 TAPE PARAMETER BLOCK

The Tape Parameter Block (Fig. 6-1) contains 22 bytes, divided into 11 fields.

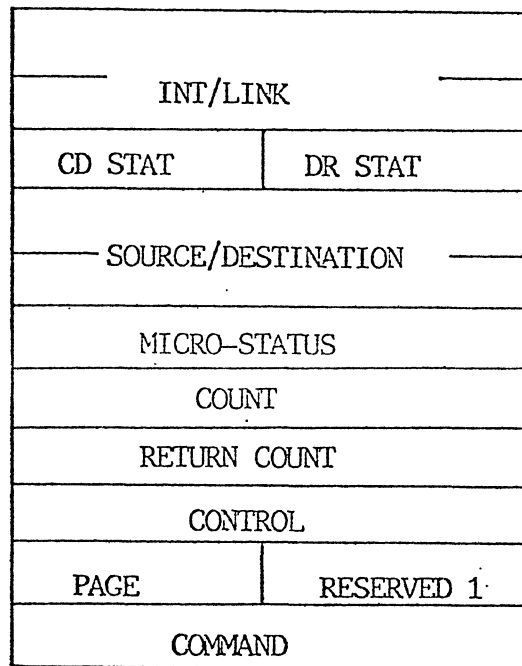


Fig. 6-1. Tape Parameter Block

#### 6.1.1 COMMAND (Input)

The Command field contains 2 bytes. Refer to section 9 for the command list.

#### 6.1.2 RESERVED 1

This field is not used for tape operation.

#### 6.1.3 PAGE ADDRESS (Input)

The lower nibble of this byte selects the 1 Mbyte page in which this command is to transfer data (ADB 20-23).



#### 6.1.4 CONTROL (Input)

The Control field (Fig. 6-2) contains various information used by the RIMFIRE during operation.

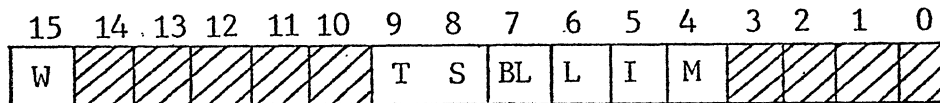


Fig. 6-2. Tape Control Word

M - (Mailbox Interrupts) selects non-vectorred interrupts (0) or Mailbox Interrupts (1), if the I bit is set.

I - (Interrupts) causes the RIMFIRE 44 to interrupt on completion (1).

L - (Link) informs the RIMFIRE 44 that another Parameter Block follows. The Link and Interrupt options are mutually exclusive, since each uses the Source/Destination field. The Link takes Priority.

BL - (Bus Lock) locks the system bus (1) during DMA transfers.

TS - (Tape Select) selects one of four tape drives.

W - (Width) selects the logical width of the systems bus. "1" indicates 16 bits, "0" indicates 8 bits. This bit may be used to force byte transfers on a 16-bit bus. The logical width must not exceed the physical width selected during Initialization.

#### 6.1.5 RETURN COUNT

This field is not used for tape operations.

#### 6.1.6 COUNT (Input/Output)

This field specifies the number of records to be spaced over during the SPACE command. It is counted down by the RIMFIRE 44 and will be zero when the SPACE command completes successfully. If an error occurs during the command, this field will contain the number of records remaining to be spaced.

#### 6.1.7 MICRO-STATUS (Output)

This field returns the tape drive micro-status after every tape command as shown in Fig. 6.3.

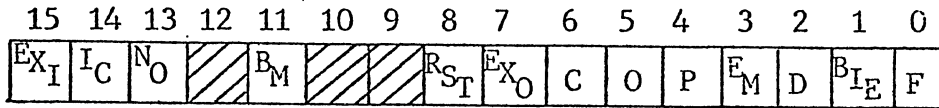


Fig. 6-3. Tape Drive Micro Status

The status bits have the following significance. Refer to the cartridge tape users manual for more detailed information.

- EXO - Exception byte 0
- C - Cartridge not in place
- O - Drive not on line
- P - Write protected
- EM - End of Media
- D - Data Error
- BIE - Block in error not located
- FM - Filemark detected
- EX1 - Exception byte 1
- IC - Illegal command
- ND - No data detected
- R - Eight or more read retries
- BM - Beginning of media
- RST - Reset/Power-up occurs

6.1.8 SOURCE/DESTINATION (Input)

This 4-byte pointer specifies the memory address of the first ring buffer for data transfer operations.

6.1.9 DRIVE STATUS (Output)

This field specifies the status of the tape drive at the completion of the command. (Fig. 6-4)

- R - Drive Ready
- E - Exception is active
- C - Cartridge is in place
- EOT - End of Tape
- F - Filemark detected
- W - Write Protected

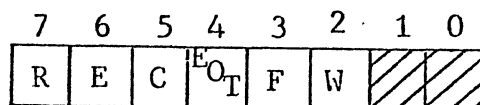


Fig. 6-4 Tape Drive Status

### 6.1.10 COMMAND STATUS (Output)

These bits reflect the status of the command. (Fig. 6-5)

- E - (Entered) The Parameter Block has been entered by the RIMFIRE 44 and execution has begun.
- C - (Complete) The RIMFIRE 44 has successfully completed the command as outlined in this Parameter Block.
- ERROR- This 6-bit field specifies an error code when a non-recoverable error is encountered. Error codes are listed in Appendix C.

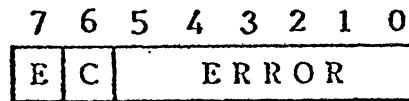


Fig. 6-5 Command Status Field

### 6.1.11 INTERRUPT/LINK (Input)

The Interrupt/Link field is a 4-byte pointer which points to the next Parameter Block if the Link is set, or the Mailbox Interrupt location if the Interrupt and Mailbox bits are set. Otherwise it is ignored.

## 6.2 COMPLETION STATUS

Tape Status and Command Status will be reported at the completion of the command. During a Space command, the Count field will be updated. The rest of the Parameter Block will be unchanged.

## 7.0 BLOCK MOVE EXECUTION

The RIMFIRE 44 can execute a Block Move, or memory-to-memory DMA operation, with many powerful options. The Parameter Block supplies the Source Address and Destination Address, either or both of which may be Local (on the RIMFIRE 44 board) or system memory. The byte count and options are also selected in the Parameter Block.

### 7.1 BLOCK MOVE PARAMETER BLOCK

The Block Move Parameter Block (Fig. 7-1) contains 26 bytes, divided into 12 fields.

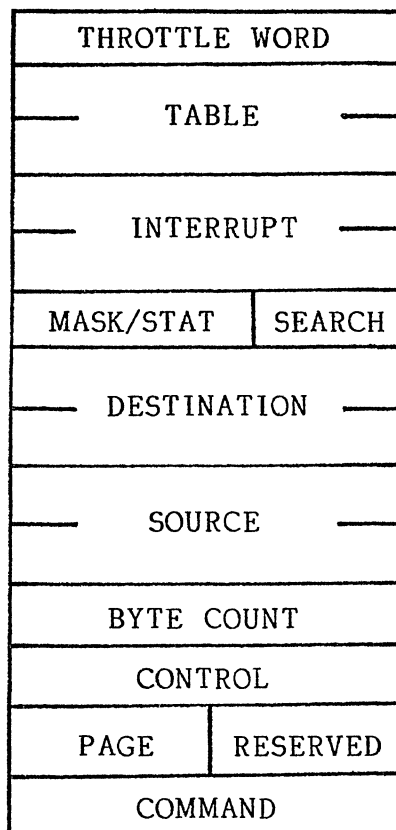


Fig. 7-1. Block Move Parameter Block

#### 7.1.1 COMMAND (Input)

The Command field contains the Block Move command, 80H.

### 7.1.2 RESERVED

This field is not used for the Block Move command.

### 7.1.2 PAGE ADDRESS (Input)

The lower nibble of this byte selects the 1 Mbyte page in which data is to be transferred (ADB 20-23). This applies to system memory addresses only.

### 7.1.4 CONTROL (Input)

The Control field (Fig. 7-2) contains various information used by the RIM-FIRE 44 during a Block Move.

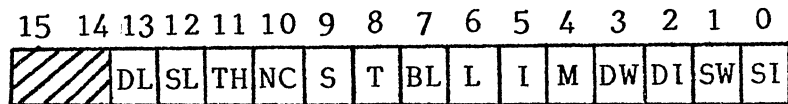


Fig. 7-2. Block Move Control Word

- SI - (Source I/O) specifies that the source address of the Block Move increments after each transaction (0) or remains constant (1).
- SW - (Source Width) specifies the logical width of the source as 8 bits (0) or 16 bits (1). The logical bus width cannot exceed the physical width as specified during Initialization.
- DI - (Destination I/O) same as SI for the destination address.
- DW - (Destination Width) same as SW for the destination address.
- M, I, L and Bl are the same as for the tape or disk.
- T - (Translate) selects (1) the translate option. This causes each byte from the source to be translated from a look-up table before being moved to the destination. When this option is selected, all transfers must be 8 bits.
- S - (Search) causes (1) the RIMFIRE 44 to check each byte against a Search Byte during transfer, and stop on a compare (or non-compare). Before the compare is made, each byte is first masked with a Mask Byte, so that only desired bits are checked. When this option is selected, all transfers must be 8 bits.
- NC - (Non-Compare) causes (1) a Search operation to stop when a non-compare is encountered. If it is not set, a Search operation will stop on compare.

- TH - (Throttle) causes (1) the RIMFIRE 44 to inject a delay between each byte or word transferred. The length of the delay is specified in the Parameter Block. This option is used to prevent the RIMFIRE 44 from monopolizing the bus during a non-critical operation.
- SL - (Source Local) indicates (1) that the source is a 16 bit Local address, i.e., on the RIMFIRE 44 board, or a 20 bit system memory address (0) specified as a 4-byte pointer.
- DL - (Destination Local) indicates (1) that the destination address is a 16 bit Local address, i.e., on the RIMFIRE 44 board, or a 20 bit system memory address (0) specified as a 4-byte pointer.

7.1.5 BYTE COUNT (Input/Output)

This field specifies the number of bytes to be transferred. If a Search is active, the Block Move will terminate on a compare, if it occurs before all bytes have been transferred. This field will contain the number of bytes remaining at the completion of the command, normally zero.

7.1.6 SOURCE (Input)

This field contains a 4-byte pointer to the starting local or system memory location from which data is to be moved (2 bytes only) if the Source is local).

7.1.7 DESTINATION (Input)

This field contains a 4-byte pointer to the starting local or system memory location to which data is to be moved (2 bytes only if the destination is local).

7.1.8 SEARCH (Input)

This field contains the compare byte used during Search operations.

7.1.9 MASK/STAT (Input/Output)

This field serves a dual purpose. At the start of the command it contains an 8-bit value to which each byte is masked before being compared, during a Search operation. After completion of the command, this byte contains status information as shown in Fig. 7-3.

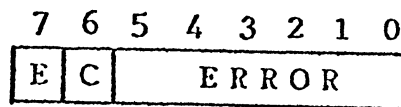


Fig. 7-3. Block Move Status

The E, C, and ERROR fields are the same as for the tape or disk except that a code of 20H indicates that a match was found during a Search.

#### 7.1.10 INTERRUPT (Input)

The Interrupt field specifies the location of the Mailbox Interrupt, if enabled.

#### 7.1.11 TABLE (Input)

This 4-byte pointer specifies the starting system memory address of a 256-byte look-up table. If the Translate option is selected during a Block Move, each source byte is used as an index into this table. The entry at that location is then moved to the destination.

#### 7.1.12 THROTTLE WORD (Input)

If the Throttle bit is set in the Control Word, the RIMFIRE 44 uses this entry to determine the length of delay between each byte or word transferred. This 16-bit number is counted down to 0000 before each transfer, at the rate of about 100 micro-seconds per count.

#### 7.2 COMPLETION STATUS (Output)

Besides the Mask/Status field, the only other field to be updated is the Byte Count field. At the end of the command, this field will contain the number of bytes to be transferred. After a successful command completion, this field will be 0.



## 8.0 DUMP/RESTORE EXECUTION

The Dump and Restor commands obtain a starting and ending disk address (cylinder, head and sector) from the Parameter Block, and transfer data between the disk and tape until all sectors have been moved. Onboard RAM is used to buffer all data.

Data is transferred in logical sector order. Since the tape drive requires data to be divided into 512 byte blockettes, the blocking and deblocking is done automatically by the RIMFIRE 44.

If a Dump or Restore command requires more than one tape cartridge, the Resume command can be used to continue the operation on a new cartridge when the EOT is detected.

The Dump and Restor commands proceed at a tape speed of 30 ips.

## 8.1 DUMP/RESTORE PARAMETER BLOCK

The Dump and Restore Parameter Blocks are identical except for the Command field, and contain 30 bytes in 13 fields (Fig. 8-1).

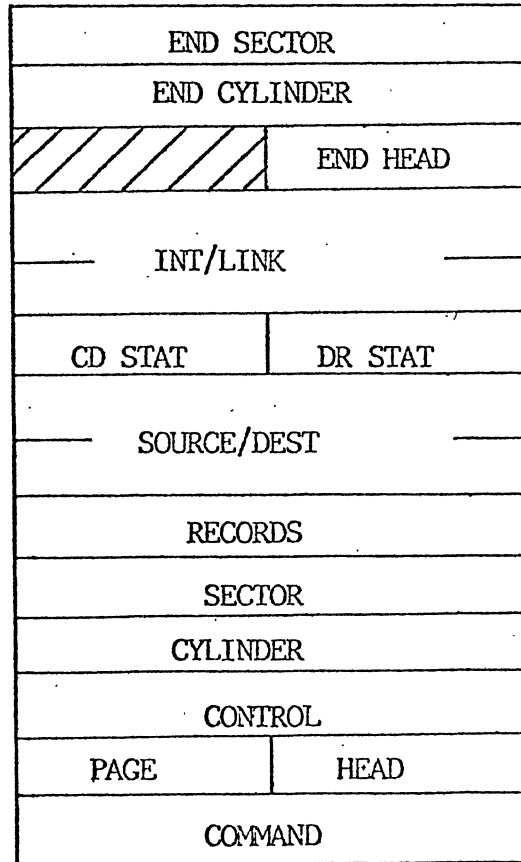


Fig. 8-1. Dump/Restore Parameter Block

### 8.1.1 COMMAND (Input)

This field contains the Dump or Restore command code.

### 8.1.2 HEAD SELECT (Input/Output)

This field contains the head select of the first logical sector to be transferred. It will be updated to the current disk location when the command completes.

### 8.1.3 PAGE ADDRESS

This field is not used for the Dump or-Restore commands.

### 8.1.4 CONTROL (Input)

The Control field (Fig. 8-2) contains various information used by the RIMFIRE 44 during the execution of Dump and Restore commands.

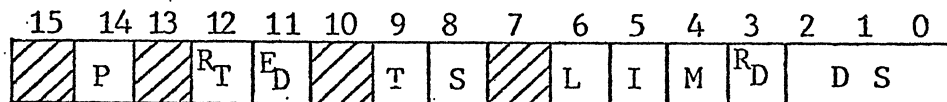


Fig. 8-2. Dump/Restore Control Word

- DS - (Disk Select) selects one of eight disk drives.
- RD - (Retry Disable) disables all automatic tape and disk retries when set to 1.
- M - (Mailbox Interrupts) selects non-vectored interrupts (0) or Mailbox interrupts (1) if the I bit is set.
- I - (Interrupt) causes the RIMFIRE 44 to interrupt on completion of a command or chain of commands.
- L - (Link) informs the RIMFIRE 44 that another Parameter Block follows. The Link and Interrupt options are mutually exclusive, since each uses the Source/Destination field. The Link option takes priority.
- TS - (Tape Select) selects one of four tape drives.
- ED - (ECC Disable) disables the automatic disk error correction when set to 1.
- RT - (Retension) causes the tape drive to retension the tape prior to a Dump, Restore, or Resume.
- P - (Protect) overrides the automatic alternate track selection feature of the RIMFIRE 44. When set (1), a disk access to a track which has been mapped out as defective will attempt to access that track. No seek will be made to an alternate track.

8.1.5 CYLINDER (Input/Output)

This field specifies the cylinder number of the last logical sector to be transferred. It will be updated to the current disk location when the command completes.

8.1.6 SECTOR (Input/Output)

This field specifies the number of the last logical sector to be transferred. It will be updated when the command completes.

8.1.7 RECORDS

This field is not used during the Dump or Restore commands.

8.1.8 SOURCE/DESTINATION

This field is not used during the Dump or Restore commands.

8.1.9 DRIVE STATUS (Output)

At the completion of the Dump or Restore, this field will contain the disk drive status (Sec. 5.1.9) if the command terminates successfully, or if a disk error occurs. If a tape error occurs, this field will return the tape drive status (Sec. 6.1.9).

8.1.10 COMMAND STATUS (Output)

These bits reflect the status of the command (Fig. 8-4).

E - (Entered) The Parameter Block has been entered by the RIMFIRE 44 and execution has begun.

C - (Complete) The RIMFIRE 44 has successfully completed the command as outlined in this Parameter Block.

ERROR - This 6-bit field specifies an error code when a non-recoverable error is encountered. Error codes are listed in Appendix C.

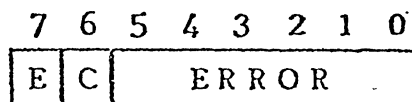


Fig. 8-4. Command Status Field

8.1.11 INTERRUPT/LINK (Input)

The Interrupt/Link field is a 4-byte pointer which points to the next Parameter Block if the Link is set, or the Mailbox Interrupt location if the Interrupt and Mailbox bits are set. Otherwise it is ignored.

#### 8.1.12 END HEAD (Input)

This field specifies the head select of the last logical sector to be transferred.

#### 8.1.13 END CYLINDER (Input)

This field specifies the cylinder number of the last logical sector to be transferred.

#### 8.1.14 END SECTOR (Input)

This field specifies the number of the last logical sector to be transferred.

### 8.2 COMPLETION

The Dump/Restore Parameter Block will be updated at the completion of the command to contain the disk address (cylinder, head and sector) of the last logical sector to have been transferred successfully, plus 1.

A Dump or Restore command will be suspended if the tape EOT is detected before all the data is transferred. If this occurs the Resume command will continue the operation on a subsequent cartridge. The disk address returned at this point represents the current location of the disk, but not the exact amount of data on the tape. This occurs because the RIMFIRE 44 RAM is used to FIFO data and may contain valid data when the command is suspended.

## 9.0 RIMFIRE 44 COMMANDS

The RIMFIRE 44 executes 35 commands in six categories. Refer to sections 5, 6, and 7 for a description of the contents and significance of the Parameter Block fields. The Command Code (in hex) follows each command. The Configure command (00H) must be the first command executed, or an error will result.

### 9.1 DISK DRIVE CONTROL

These commands transfer control and status information between the RIMFIRE 44 and the disk drives, and perform other non-data functions such as positioning or status.

#### 9.1.1 CONFIGURE (00)

This command initializes the RIMFIRE 44 and allows it to process all other commands. In addition, the controller executes a short on-board diagnostic. A 64-byte Disk Record, whose location is specified by the Source/Destination pointer, is read from system memory during this command. The form of the Disk Record is shown in Fig. 9-1.

The Disk Record entries are hex numbers and have the following significance:

- Heads/Cylinder - The highest numbered head select, starting with 0. An entry of 02H indicates 3 heads per cylinder.
- Drive Type - This byte indicates the disk drive type. Refer to Appendix G for a listing of drive types.
- Sectors/Track - The highest numbered sector on a track, starting with 1. An entry of 0042H indicates 42H sectors per track (66 decimal).
- Cylinders/Disk - The highest numbered cylinder, starting with 0000. An entry of 022FH indicates 0230H cylinders per disk (560 decimal).
- Bytes/Sector - The number of data bytes in one sector. An entry of 0100H indicates 256 (decimal) bytes per sector.

The user must form the Disk Record prior to the execution of the Configure command. The Disk Record allows for 8 disks, each disk requiring 8 bytes. The entire Disk Record must occupy real memory locations, although only those entries which correspond to physical drives need contain meaningful data.

The Disk Record is stored by the RIMFIRE 44 in its own memory. Whenever a subsequent disk command is executed, the RIMFIRE 44 examines the Disk Select bits in the Parameter Block of that command, and selects the corresponding disk parameters from its copy of the Disk Record. In this way the RIMFIRE 44 can support up to 8 disks with completely different characteristics and formatting.

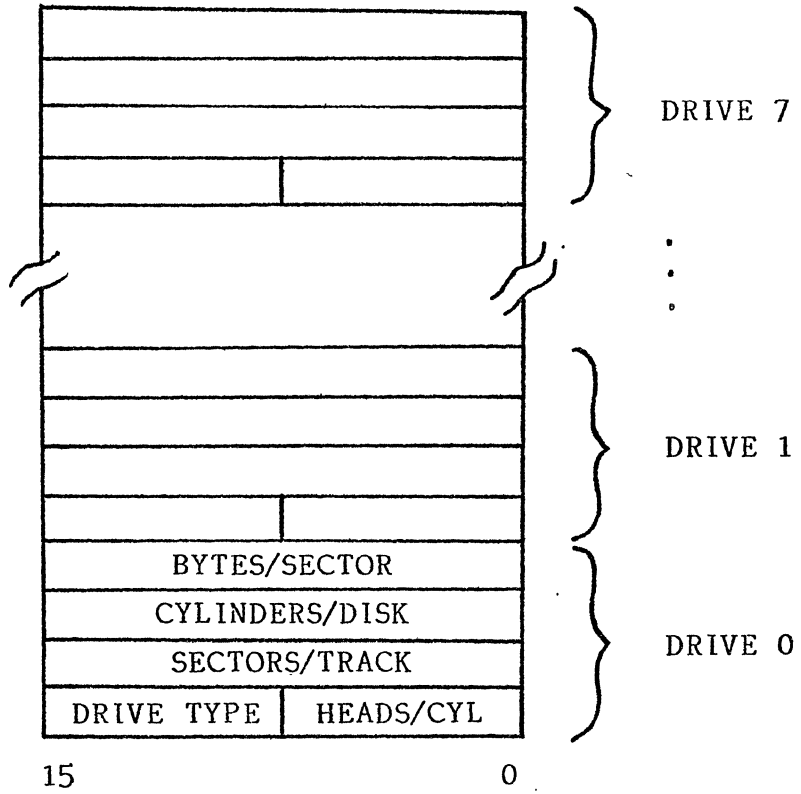


Fig. 9-1. Disk Record

9.1.11 DISK MICRO (A4)

This command may be used to execute any current or future ANSI disk command. This desired command code is specified in the lower byte of the Records field. If the command requires a parameter to be sent, it is specified in the upper byte of the Records field. If the command returns a parameter, it will be returned in this location.

9.1.12 REZERO DISK (A8)

Clear the selected disk interface and issue a seek to track zero.

## 9.2 TAPE DRIVE CONTROL

These commands transfer control and status information between the RIM-FIRE 44 and the tape drives and perform other non-data functions such as positioning or status.

### 9.2.1 TAPE STATUS (28)

The status of the selected drive is returned in the Drive Status byte, and the micro-status is returned in the micro-status word in the Parameter Block.

### 9.2.2 REWIND (34)

The tape is rewound to load point.

### 9.2.3 RETENSION (38)

This command retensions the tape on the selected drive.

### 9.2.4 REPORT ERROR COUNTERS (3C)

This command reports the four 16-bit statistical error counters in the drive and clears them to zero. These counters are moved to system memory starting at the location specified by the Source/Destination field in the Parameter Block. They are stored as shown in Fig. 9-3. The four counters are:

- RDECTR - Read Data Error Counter
- RURCTR - Read Underrun Counter
- WDECTR - Write Data Error Counter
- WURCTR - Write Underrun Counter

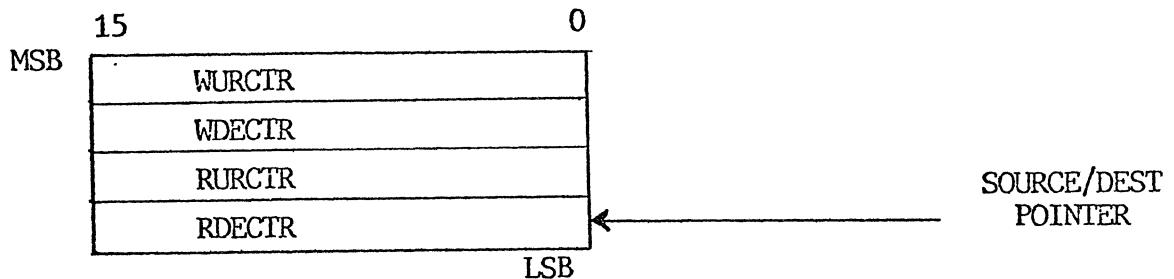


Fig. 9-3. Tape Drive Error Counters

This command can be used to maintain a statistical history on a tape drive or on a particular cartridge.



### 9.1.2 DISK DRIVE STATUS (04)

This command returns three bytes of disk status information. The first byte, returned with all disk commands, is the General Status byte as described in section of 5.1.9. Sense Byte 1 is returned in the lower byte of the Records field, and Sense Byte 2 is returned in the upper byte. These bytes are shown in Fig. 5-5.

### 9.1.3 LOAD (18)

This command issues a "Spin-up" directive to the drive if required to start rotation.

### 9.1.4 UNLOAD (1C)

This command issues a seek to track 0 and a "Spin-down" directive if required to stop rotation.

### 9.1.5 DISK RESET (6C)

This command issues a Reset directive to the disk drive.

### 9.1.6 SEEK (78)

This command selects the head specified in the Parameter Block, and then initiates a Seek operation to the specified track. This command is useful for overlapping Seeks.

### 9.1.7 READ ID (7C)

This command reads the 6-byte ID of the first sector encountered on the current head and cylinder. Note that no Seek is implied, and the head and cylinder entries in the Parameter Block are ignored.

### 9.1.8 INTERROGATE (88)

This command is used to read a portion or all of the Attribute Table of the disk drive. The RIMFIRE 44 will read a specified number of attributes, starting with a specified attribute number. The command will terminate when all desired attributes are read, or if the drive does not support the attribute requested. In such cases the RIMFIRE 44 will return an "Illegal Command" error code.

The attributes read by the RIMFIRE 44 are placed in system memory starting at the Source/Destination address. The number of attributes requested and the starting attribute number are specified in the Records field as shown in Fig. 9-2. All entries are in hex.

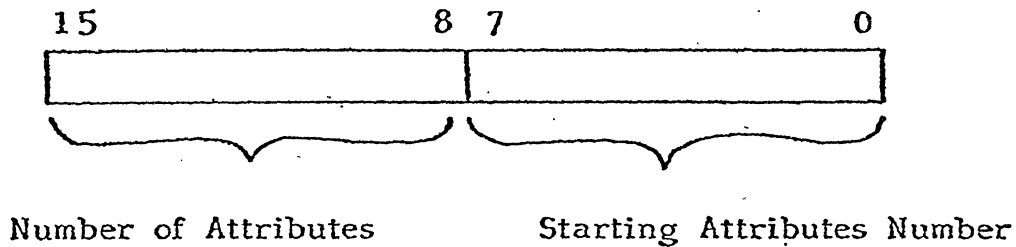


Fig. 9-2. Records Field for Interrogate Command

### 9.1.9 TEST INTERFACE (8C)

This command tests the RIMFIRE 44-to-disk interface, by writing a byte to the drive and then reading it back. The user selects the byte to be written by placing it in the lower byte of the Records field. The RIMFIRE 44 will return the byte read in the upper byte of the Records field. The user may then compare the two bytes.

### 9.1.10 READ WRITE PERMIT (98)

This command will examine the Records field bit by bit, starting with bit 0 and executes the function corresponding to the first bit set for the designated drive.

<u>Bit</u>	<u>Function</u>
0	Write enable the drive.
1	Write disable the drive.
2	Load write permit.
3	Load read permit.
4	Report write permit.
5	Report read permit

The cylinder address for loading and reporting read and write permit will be passed in the cylinder location in the Parameter Block.

9.2.5 WRITE FILEMARK (40)

A filemark is written on the tape.

9.2.6 SPACE FILEMARK (48)

This command spaces forward one filemark for each count in the Count field.

9.2.7 ERASE TAPE (50)

This command erases the tape.

9.2.8 DRIVE RESET (90)

This command resets the selected tape drive. This command must be executed after a power-on, and when a new cartridge is inserted.

## 9.3 DISK DATA TRANSFER

These commands transfer data between system memory and the selected disk.

### 9.3.1 DISK READ (10)

This command transfers one or more sectors of data from the disk to system memory. The first sector transferred is the logical sector specified by the Cylinder, Head and Sector entries in the Parameter Block. Thereafter, sectors are transferred in logical order, with ascending sector number, head select and cylinder respectively. A multiple sector transfer may cross head and cylinder boundaries. The number of sectors to be transferred is specified in the Records entry. The starting system memory location is specified as a pointer in the Source/Destination field.

### 9.3.2 DISK WRITE (14)

This command transfers one or more sectors of data from system memory to the disk. The first sector transferred is the logical sector specified by the Cylinder, Head and Sector entries in the Parameter Block. Thereafter, sectors are transferred in logical order, with ascending sector number, head select and cylinder respectively. A multiple sector transfer may cross head and cylinder boundaries. The number of sectors to be transferred is specified in the Records entry. The starting system memory location is specified as a pointer in the Source/Destination field.

### 9.3.3 FORMAT (24)

This command formats the disk. The format variables (i.e., bytes/sector, cylinders/disk) are supplied during a previously executed Configure command. The Format starts at the track and head as specified in the Parameter Block, and continues to the programmable end of the disk. Note that the programmable end of the disk is defined by the Configure command, and need not be the physical end. This allows portions of the disk to be formatted with different sector sizes, if desired.

The RIMFIRE 44 requires the user to select the type of inter-leaving, i.e., the order in which the physical sectors are assigned logical numbers. One of two interleave options may be chosen, Auto-interleave or user-supplied. If the Auto-interleave bit in the Control Word is set during the Format, the RIMFIRE 44 will assign the logical sector numbers based on the selected interleave schedule. This interleave number must be entered in the Records field. This option is limited to disks having 255 sectors or less per track.

If the Auto-interleave bit is not set, the RIMFIRE 44 will read the sector numbering table from system memory, starting at the address specified in the Source/Destination field. The user must create this table, and insure that it contains an entry for each sector and that no numbers are skipped. Each entry in the sector numbering table is a byte for disks with 255 or less sectors per track, and a word (16 bits) for those disks with 256 sectors per track or more.

The Format command may also be used to examine the interleave table created by the RIMFIRE 44 without actually formatting any tracks. See section 5.1.4 for details.

Refer to the RIMFIRE 44 Application Note for Format examples.

#### 9.3.4 MAP DEFECT (84)

This command is used to inform the RIMFIRE 44 that the track specified in the Parameter Block has a defect and should be mapped out. The RIMFIRE 44 will then mark the track as defective by reformatting the track with the Defective Track ID (sec. 3.5). An alternate track is assigned from the end of the disk, i.e., the highest numbered cylinder and head combination which has not been assigned as an alternate. This track is also reformatted with the Alternate Track ID (sec. 3.5).

When a defective track is accessed during normal operation, the RIMFIRE 44 will automatically access the alternate track, transparent to the user. The cylinder and head of the alternate track are contained in all IDs of the defective track.

Since the Map Defect command includes the reformatting of two tracks, one of the two methods of interleave selection must be used (i.e., Auto-interleave or user-supplied table). Refer to section 9.3.3 for details.

Alternate track selection may be overridden by setting the "P" bit in the Control Word for Disk Read or Write commands.

#### 9.3.5 READ LONG (AC)

This command is similar to the normal Disk Read except that it reads and returns to system memory the data in each specified sector plus the four bytes of Error Correction Code. It does not check the data for faults. This command may be used in conjunction with the Write Long command to verify the ECC logic. (sec.9.3.7).

#### 9.3.6 WRITE LONG (BO)

This command transfers a data buffer from system memory to the disk which is four bytes longer than the configured sector length, in place of the normal sector length plus the 4-byte ECC word. This command may be used in conjunction with the Read Long command to verify the ECC logic. (sec. 9.3.7).

#### 9.3.7 ECC VERIFICATION

To verify the ECC, the following procedure may be used:

- \*Write a known pattern in the test sector
- \*Read Long to system memory
- \*Modify up to 5 consecutive bits of the pattern
- \*Write Long back to the disk
- \*Read the sector normally and verify the data

TAPE DATA TRANSFER COMMANDS

Tape Data Transfer commands transfer data between the tape and system memory. These commands are "stand-alone" tape operations in that the data is supplied or accepted by the user through the system memory. As such, they are distinctly different from the Dump and Restore commands, in that they allow the user to dump or retrieve data from an off-board device. Such a device could be a medium to high speed peripherals such as a  $\frac{1}{2}$  inch magnetic tape or another disk. In any case, the system must supply data at a rate of at least 30 Kbps (30 ips) or 90 Kbps (90 ips) to keep the drive streaming. The RIMFIRE 44 uses ring buffers to simplify this requirement.

#### 9.4.1 RING BUFFER WRITE (74)

This command transfers data from system memory to the tape in a continuous manner using a ring buffer technique (Fig. 9-3). Ring buffers are used to allow the user to provide a continuous source of data to the tape, which is necessary to maintain streaming operation.

The Ring Buffer Write requires one or more data blocks in system memory. Each block contains an 8-byte header (Fig 9-4) and a data area of variable length. The header contains several handshake bits, a byte count and a pointer to the next block.

When the RIMFIRE 44 begins a Ring Buffer Write command, it proceeds to the first block and waits at the Block Gate until the Ready bit is set by the system. When this occurs, and no faults are present, it writes the data from the data area in the block to the tape. The RIMFIRE 44 then proceeds to the next block and repeats the same process, continuing until it enters a block with the "Last Block" bit set. When this occurs the RIMFIRE 44 will write this data to the tape, write a filemark and exit the command in the normal fashion.

The Ring Buffer Write command provides an easy method for the user to "stay ahead" of the RIMFIRE 44 in supplying the data which is to be written onto the tape. Conceptually, the RIMFIRE 44 "chases" the Primary device (supplying the data) around the ring buffers, emptying each data block as it is filled by the system, until it arrives at the last block. Having a block filled with data whenever the RIMFIRE 44 requests it is necessary if the tape is to be kept streaming. A temporary interruption, which causes the RIMFIRE 44 to wait at the Block Gate for the buffer to be filled, may cause the tape drive to stop and reposition. However, when data does become available the tape will start again.

The Ring Buffer Write command can terminate in two other ways. If the system software detects an error in the device supplying data (Primary device) while filling a block, it should set the Primary Device Error bit in the Block Gate. When the RIMFIRE 44 enters that block it will check this bit and halt without writing the data to the tape. If the RIMFIRE 44 detects an unrecoverable tape error while writing to the tape, it will set the Tape Error bit in the Block Gate and halt.

#### 9.4.2 RING BUFFER READ (70)

This command is similar to the Ring Buffer Write, except that the RIMFIRE 44 "leads the chase" around the ring buffers, filling each data block for the system to empty. The system must empty each block fast enough such that it is available to the RIMFIRE 44 when it arrives, or a repositioning cycle on the tape will occur. In such cases the sequence will start again as soon as the data buffer is made available by the system.

The Ring Buffer Read command will continue until it encounters the last block, which is the normal method of termination. It will also stop if it detects an unrecoverable tape error, a Primary Device Error, or a filemark. In these cases the appropriate error code will be set in the Parameter Block.

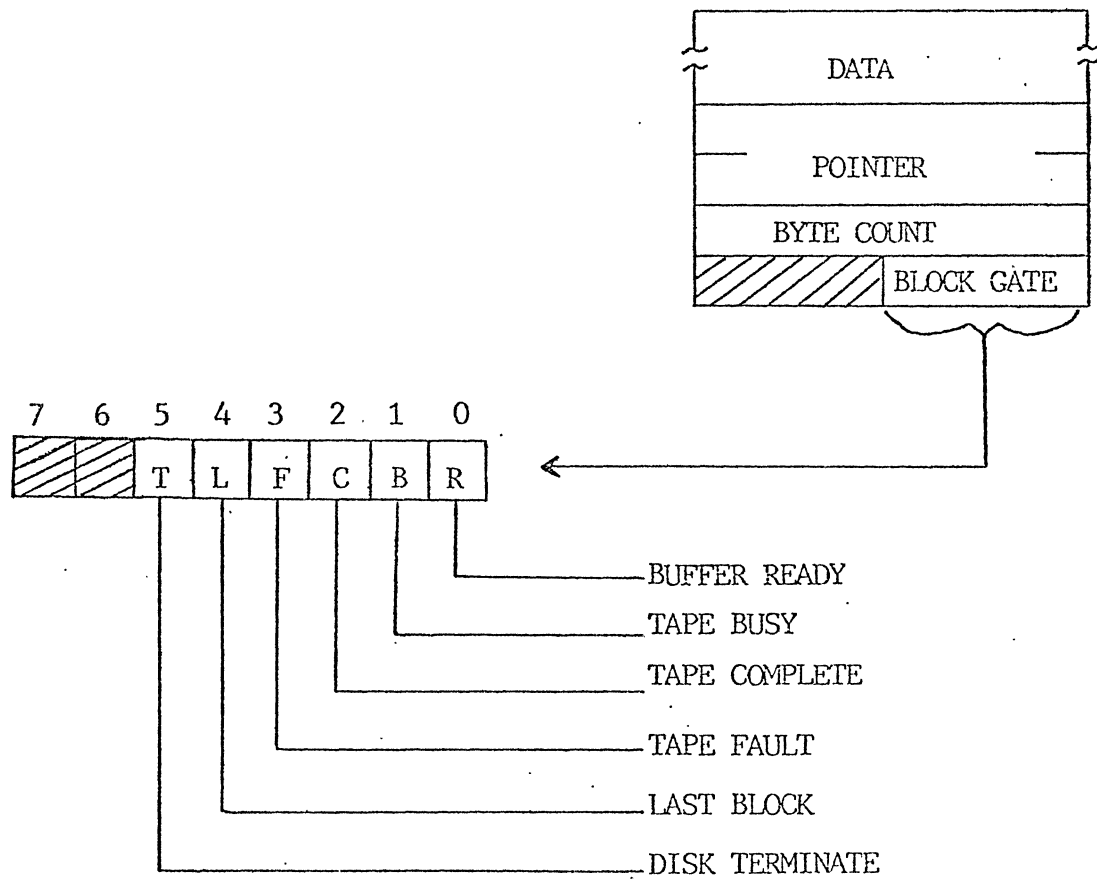


Fig. 9-3. RIMFIRE 44 Ring Buffers

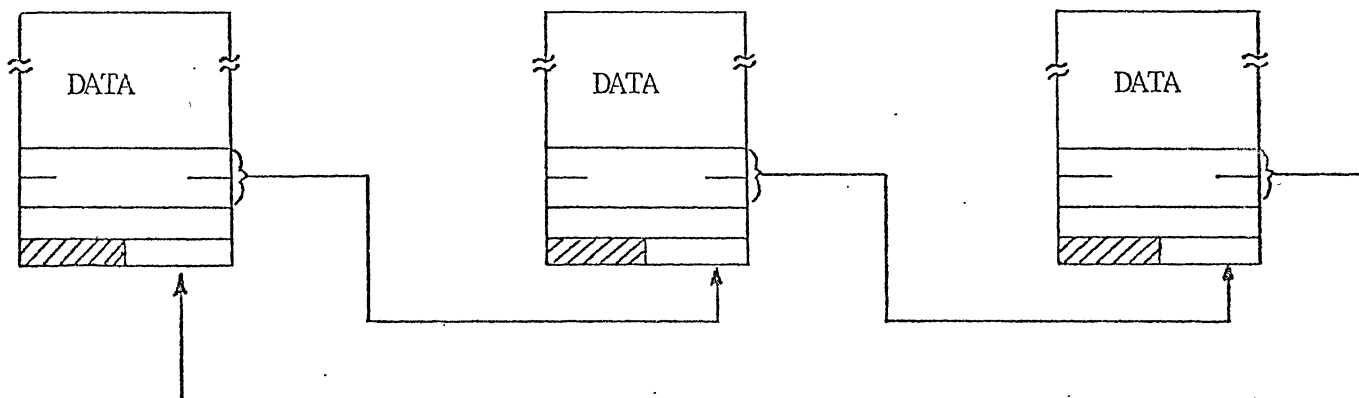


Fig. 9-4. Ring Buffer Header



## 9.5 COMBINATION COMMANDS

These commands transfer data between the disk and the tape in logical sector order. Data is read from and written to the tape such that 30 ips streaming operation is maintained.

### 9.5.1 DUMP (54)

This command transfers data from the disk to the tape in logical sector order. The command obtains a starting and ending disk address (cylinder, head and sector) and transfers data until it has transferred the last sector, or until an unrecoverable error is encountered. It then writes a filemark to indicate the end of the record. If the EOT is encountered, the tape will be rewound to Load Point, and the Parameter Block updated to indicate the address of the next sector to be read.

### 9.5.2 RESTORE (58)

This command transfers data from the tape to the disk, in logical sector order using the starting and ending disk locations in the Parameter Block.

### 9.5.3 RESUME (68)

This command continues a Dump or Restore operation on a fresh cartridge, when the previous cartridge has been filled.

When a Dump or Restore detects the EOT, it will return a "Suspended" error to the system. The proper response is to remove the cartridge, insert a new cartridge, and execute a RESUME. This is done by inserting the command code in the Parameter Block and issuing a Channel Attention. The rest of the Parameter Block is not used.

No other command should be executed after a "Suspended" condition except the Resume.

## 9.6 SPECIALS

These commands do not involve the tape or disk, and may be executed with the drives unconnected.

### 9.6.1 NOP/ID

This command executes the mechanics of normal Parameter Block operation, and returns the RIMFIRE 44 Board ID (40H) in place of the General Status byte in the Parameter Block.

### 9.6.2 DIAGNOSTIC (5C)

This command executes a controller diagnostic.

### 9.6.3 BLOCK MOVE (80)

This command moves data, up to 65K bytes, between two memory locations. Either location may be local (on the RIMFIRE 44 board) or system memory, and may be constant or incrementing.

Several operations may be performed on the data during the move, as outlined in Sec. 7.1.4.

The Block Move provides a powerful tool for any Multibus system. Some example usages are:

- \* Extended Memory--Since the RIMFIRE 44 can address 16M bytes (24 address bits), it can be used in conjunction with a compatible memory board to provide access to memory not normally accessible to system processors.
- \* User 8089 programs--The Block Move may be used to download a user-written 8089 program from system memory to the RIMFIRE 44 for execution (See sec. 3.6).

### 9.6.4 CLEAR INT (9C)

This command requires no Parameter Block except for the 2-byte command field. It will immediately halt after clearing an active interrupt, if the CCW Word in the Channel Control Block has been set to 09H. This command is a useful tool to quickly remove an active interrupt without the time involved in a full Parameter Block command.

## APPENDIX A - SPECIFICATIONS

Physical:	Height 6.75 in. Length 12.00 in.									
Electrical:	Voltage +5v +5% Current (A) <table><thead><tr><th></th><th>Typ</th><th>Max</th></tr></thead><tbody><tr><td>RIMFIRE 44</td><td>2.5</td><td>3.5</td></tr><tr><td>RIMFIRE 44D</td><td>2.0</td><td>3.0</td></tr></tbody></table>		Typ	Max	RIMFIRE 44	2.5	3.5	RIMFIRE 44D	2.0	3.0
	Typ	Max								
RIMFIRE 44	2.5	3.5								
RIMFIRE 44D	2.0	3.0								
Capacity:	8 disk drives 4 tape drives									
Transfer Rate:	Tape - Tape speed Disk - Disk interface - 1.25 Mbps Multibus interface - 675 Kbps (8 bit system) - 1.25 Mbps (16 bit system)									
Environmental:	0° - 55° ambient (°C)									
Bus interface:	Fully Intel Multibus compatible									
Mating Connectors:	J1, J2 -3M No. 3425 or equivalent P1 -Viking No. 2VH43/1AV5 or equivalent									

## APPENDICES

## APPENDIX B - CABLES

The RIMFIRE 44 requires two 50-pin flat cables, one to the disk drive and one to the tape drive. Standard cable length is 10 feet. Daisy-chain cables are available on a custom-order basis.

CPC P/N	Function
81011001	RIMFIRE 44 J2 to disk drive
81011031	RIMFIRE 44 J1 to tape drive

## APPENDIX C - ERROR CODES

This section lists the codes for unrecoverable errors detected by the RIMFIRE 44 during execution of a command. The code is returned in the Command Status byte, bits 0-6.

Code	Description
00	This command executed successfully with no unrecoverable error and no retries.
01	This command executed successfully with no unrecoverable error, but required at least one retry or error correction during the execution.
02	An error was detected in the data field which could not be corrected by retry (if enabled) or error correction (if enabled).
03	An error was detected in the ID field which could not be corrected by retry (if enabled).
04	A seek error occurred, because of a Seek Error status from the disk, or because the target was beyond the logical or physical end of the disk.
05	A verify error occurred when the RIMFIRE 44 read an ID after a seek. To correctly verify, the cylinder and head of the first ID encountered after a seek must match the target cylinder and head.
06	The disk was not ready when a disk command was begun.
07	The desired logical sector number could not be located on this track.
08	The RIMFIRE 44 could not locate an ID sync mark between sectors or pulses during a read or write, or the data sync mark between sector pulses during a write.
09	An unexpected End-of-Tape mark was encountered during a tape write operation.
0A	An unrecoverable data error was detected during a tape read, or during an automatic read-after-write.
0B	A Resume command was issued when a Dump/Restore Suspended condition did not exist.
0C	An illegal command was attempted.
0D	A diagnostic command was attempted without having the diagnostic jumper installed.
0E	A checksum error in the PROM-resident firmware was detected.
0F	A time-out condition occurred between the tape drive and the RIMFIRE 44.
10	The selected tape drive is not ready or is busy with another command.
11	The disk or tape was write-protected when a write command was begun.
12	The ID sync code could not be located during a disk read ID operation.
13	One or more of the parameters in a Dump/Restore Parameter Block was in error. This occurs if the ending disk address is not greater than the starting disk address, or if the starting or ending sector number is zero.
14	A Block Move command was linked to from another command. Block Move must be the first command in a chain.

15 An unexpected EOF (Filemark) was detected during a tape read.  
16 A direct access was attempted to a track on the disk which had  
been assigned as an alternate.  
17 A Dump or Restore command was suspended because the EOT (Dump)  
or EOF (Restore) was detected. A new cartridge must be inserted  
and a Resume command given.  
18 No Tape drive.  
19 An illegal parameter was specified. Possible error conditions  
include:  
- Zero record count for disk read or write.  
- Zero record count for tape space.  
- Auto-interleave selected during a disk format with greater than  
255 sectors per track.  
1A A disk drive error exists which prevented execution of a disk write.  
Check sense Byte 1 to identify the error.  
1B Not used.  
1C The disk interface is busy, i.e., the drive and RIMFIRE 44 cannot  
communicate temporarily.  
1D The disk is busy executing a command.  
1E An illegal disk parameter, selected during a previously executed  
Configure command, was detected during a disk command. Such par-  
ameters include BPS(bytes/sector), HPC(heads/cylinder), SPT(sectors/  
track) or CPD (cylinders/disk).  
1F The selected disk drive is down, inoperable or not connected.  
20 A match was found during a Block Move command using the Search  
option.  
21 A Ring Buffer Read or Write was terminated early by the primary  
device.  
22 There is no cartridge in the selected tape drive.  
23 An unexpected exception error occurred in the tape drive.  
24 The micro status received from the tape drive was not expected.  
25 A time-out occurred with the handshaking signals between the RIM-  
FIRE 44 and the tape drive.  
26 A system memory time-out occurred.  
27 No data was detected during a tape read.  
28 A failure occurred during the execution of the micro diagnostic.  
29 Not used.  
2A Not used.  
2B An unidentifiable hardware error occurred.  
2C A RIMFIRE 44 command other than a Configure was attempted as the  
first command after reset.  
2D The RIMFIRE 44 was unable to write a disk ID during a Format or  
Map Defect command.

## APPENDIX D - JUMPERS

This section describes the setting of jumpers and DIP switches on the RIMFIRE 44 board. Factory settings are indicated with an asterisk.

1. Jumpers 1-10 (Read Gate Delay Counter)

These jumpers are factory set and are used by the RIMFIRE 44 sequencer.

2. Jumpers 13, 14 (Bus Time-out)

These jumpers enable or disable the system bus time-out.

Jumper 13-14	Time-out enabled.
* No jumper	Time-out disabled.

3. Jumpers 15-17 (I/O Address Bus Width)

These jumpers select the width of the I/O address Bus.

* 8-bit width	- Jumper 15-16
16-bit width	- Jumper 15-17

4. Jumpers 18-22 (Maintenance)

These jumpers are used at the factory to allow the insertion of the CPC 8089 Emulator into the CPU socket.

Maintenance Mode	- Jumper 19-21, 20-22
* Normal Mode	- Jumper 18-19, 20-21

5. Jumpers 23, 26 (BPRO/)

These jumpers are set according to the type of bus priority used on the Multibus.

* Serial priority	- Jumper 23-26
Parallel priority	- No Jumper



## 6. Jumpers 24, 25, 27-30 (Bus Arbitration)

These jumpers control the conditions under which the RIMFIRE 44 surrenders control of the Multibus during a transfer sequence. Jumpers 24, 25, 27 allow CBRQ/ to be jumpered low (24-25) or to the Multibus (24-27). Jumpers 28-30 allow the ANYRQST input on the 8289 Bus Arbiter to be jumpered high (28-29) or low (29-30). Four configurations are possible.

Mode	Jumper	Description
1	(24-27) (29-30)	The RIMFIRE 44 will surrender the bus to a higher priority master, when that master activates CBRQ/.
2	(24-27) (28-29)	The RIMFIRE 44 will surrender the bus to a higher or lower priority master, when that master activates CBRQ/.
* 3	(24-25) (28-29)	The RIMFIRE 44 will surrender the bus after each transfer cycle.
4	(24-25) (29-30)	The RIMFIRE 44 will surrender the bus to a higher priority master after every cycle.

## 7. Jumpers 31-50 (Initialization Address)

These jumpers allow the user to select the upper 16 bits of the 20-bit System Configuration Pointer address (see sec. 3.1.2). This address is normally set once to the optimum location for a particular system and not changed thereafter.

The address is set in two groups of eight bits. Each group is set in a similar fashion. Each group contains 10 pins - 8 pins corresponding to address bits, one pin to a pull-up, and one to ground. Those address bits which are to be active are daisy chained to the pull-up, and those which are to be inactive are daisy-chained to the ground.

The pins have the following significance.

31 - Ground	41 - Ground
32 - A4	42 - A12
33 - A5	43 - A13
34 - A6	44 - A14
35 - A7	45 - A15
36 - A8	46 - A16
37 - A9	47 - A17
38 - A10	48 - A18
39 - A11	49 - A19
40 - Pull-up	50 - Pull-up

As an example, Fig. D-1 indicates the connections necessary to set the address to 0AAAA6H. (The lowest nibble is not selectable and must be 6H).

\* Factory setting is 00FFF6H, unless requested otherwise.

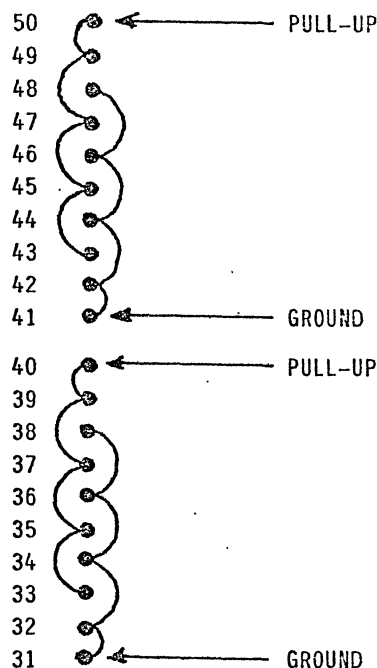


Fig. D-1. Initialization Address

8. DIP switch (Channel Attention, Bus Width)

The two DIP switches are used to select the Channel Attention address (15 bits), and the width of the system data bus (8 or 16 bits). A bit will be decoded as a "1" (active) if the corresponding switch is set off or open.

As an example, Fig. D-2 shows the switch settings for a Channel Attention Address of AAAAH-AAAABH, using a 16-bit data bus. (The RIM-FIRE 44 occupies two I/O addresses, since AO is not decoded).

\* Factory setting is AAH, 8-bit I/O address and 16-bit data bus, unless requested otherwise.

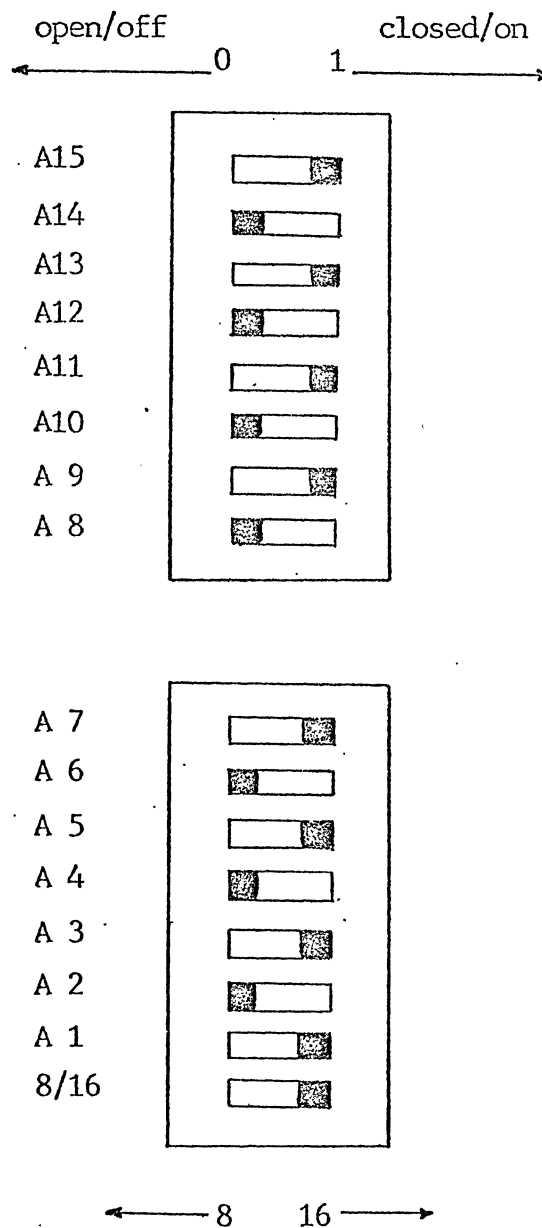


Fig. D-2. Channel Attention Address AAAAH.

9. Jumper INT, I0-17 (Interrupts)

These jumpers select the non-vectored interrupt priority level by connecting the INT pin to the appropriate level (I0 = Interrupt 0, I7 = Interrupt 7).

\* Factory setting is Interrupt level 7.

APPENDIX E - CONNECTOR PIN-OUTS

J1 - TAPE DRIVE

Signal Pin	Ground Pin	Signal Name
2	1	Spare
4	3	Spare
6	5	Spare
8	7	Spare
10	9	Spare
12	11	Host Bus 7
14	13	Host Bus 6
16	15	Host Bus 5
18	17	Host Bus 4
20	19	Host Bus 3
22	21	Host Bus 2
24	23	Host Bus 1
26	25	Host Bus 0
28	27	On Line
30	29	Request
32	31	Reset
34	33	Transfer
36	35	Acknowledge
38	37	Ready
40	39	Exception
42	41	Direction
44	43	Spare
46	45	Spare
48	47	Spare
50	49	Spare

## J2 - DISK DRIVE

Signal Pin	Ground Pin	Signal Name
1	10	Ground
		Control Bus
2	10	Bit 0, Select/Attn. Device 0
3	10	Bit 1, Select/Attn. Device 1
4	10	Bit 2, Select/Attn. Device 2
5	10	Bit 3, Select/Attn. Device 3
6	10	Bit 4, Select/Attn. Device 4
7	10	Bit 5, Select/Attn. Device 5
8	10	Bit 6, Select/Attn. Device 6
9	10	Bit 7, Select/Attn. Device 7
11	12	Not used
13	14	Select Out/Attn. In Strobe
15	16	Command Request
17	18	Parameter Request
19	20	Bus Direction Out
21	22	Port Enable
23	24	Address Mark Control
25	26	Read Gate
27	28	Write Gate
29	30	Bus Acknowledge
31	32	Index
33	34	Sector/Address Mark Detected
35	36	Attention
37	36	Busy
39	38	Read Data+
40	38	Read Data -
42	41	Read/Reference Clock+
43	41	Read/Reference Clock-
45	44	Write Clock+
46	44	Write Clock-
48	47	Write Data +
49	47	Write Data-
	50	Ground

## APPENDIX F - COMMAND CODES

This section lists the hex codes for all RIMFIRE 44 commands.

### Group 1. Disk Drive Control

- 00-Configure
- 04-Disk Drive Status
- 18-Load
- 1C-Unload
- 6C-Disk Drive Reset
- 78-Seek
- 7C-Read ID
- 88-Interrogate
- 8C-Test I/F
- 98-Read/Write Permit
- A4-Disk Micro
- A8-Rezero the Disk

### Group II. Tape Drive Control

- 28-Tape Drive Status
- 34-Rewind
- 38-Retension
- 3C-Report Error Counters
- 40-Write Filemark
- 48-Space
- 50-Erase Tape
- 90-Tape Drive Reset

### Group III. Disk Data Transfer

- 10-Disk Read
- 14-Disk Write
- 24-Format
- 84-Map Defect
- AC-Read Long
- BO-Write Long

### Group IV. Tape Data Transfer Commands

- 70-Ring Buffer Read
- 74-Ring Buffer Write

### Group V. Combination

- 54-Dump
- 58-Restore
- 68-Resume

### Group VI. Specials

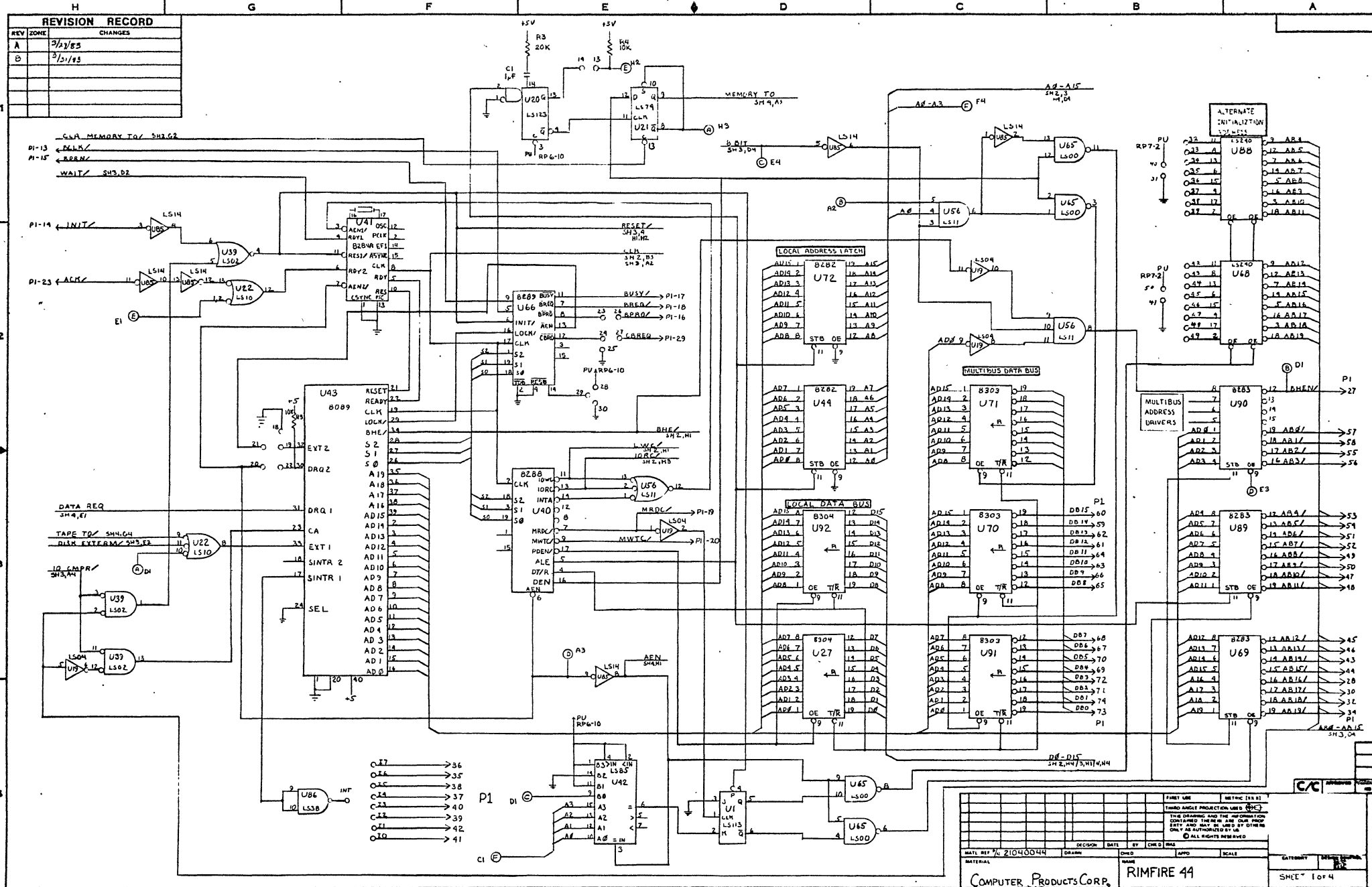
- 20-NOP/I.D.
- 5C-Diagnostic
- 80-Block Move
- 9C-Clear Interrupt

APPENDIX G - DISK DRIVE TYPES

<u>Type</u>	<u>Overhead Bytes</u>	<u>Manufacturer</u>	<u>Model/Series</u>
00	46	3M	8500
		SLI	CHEYENNE
		KENNEDY (BASF)	6170
		PRIAM	ALL
01	110	3M	8400
02	80	IMI	7700



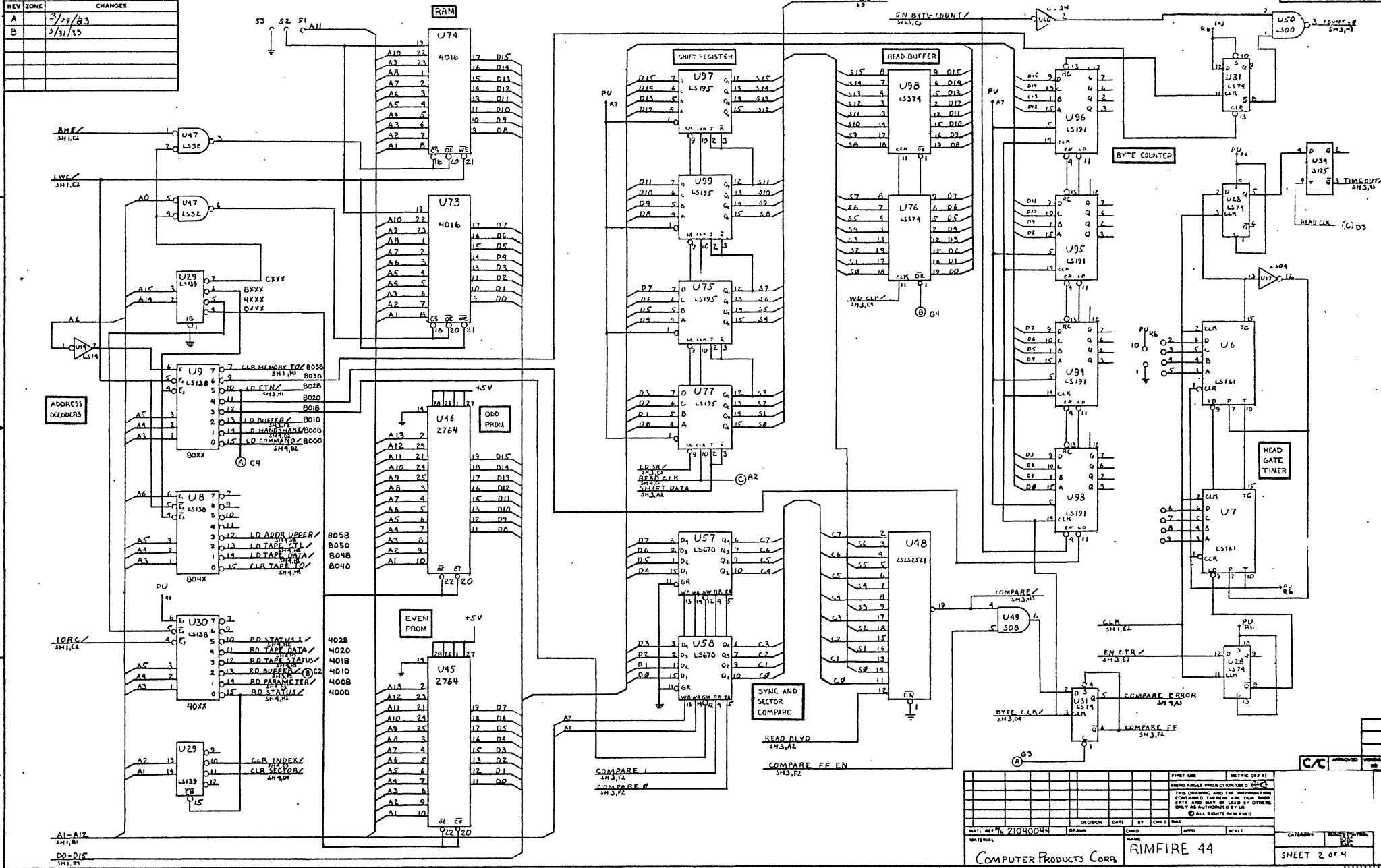
REV	ZONE	CHANGES
A		3/13/53
B		3/21/53



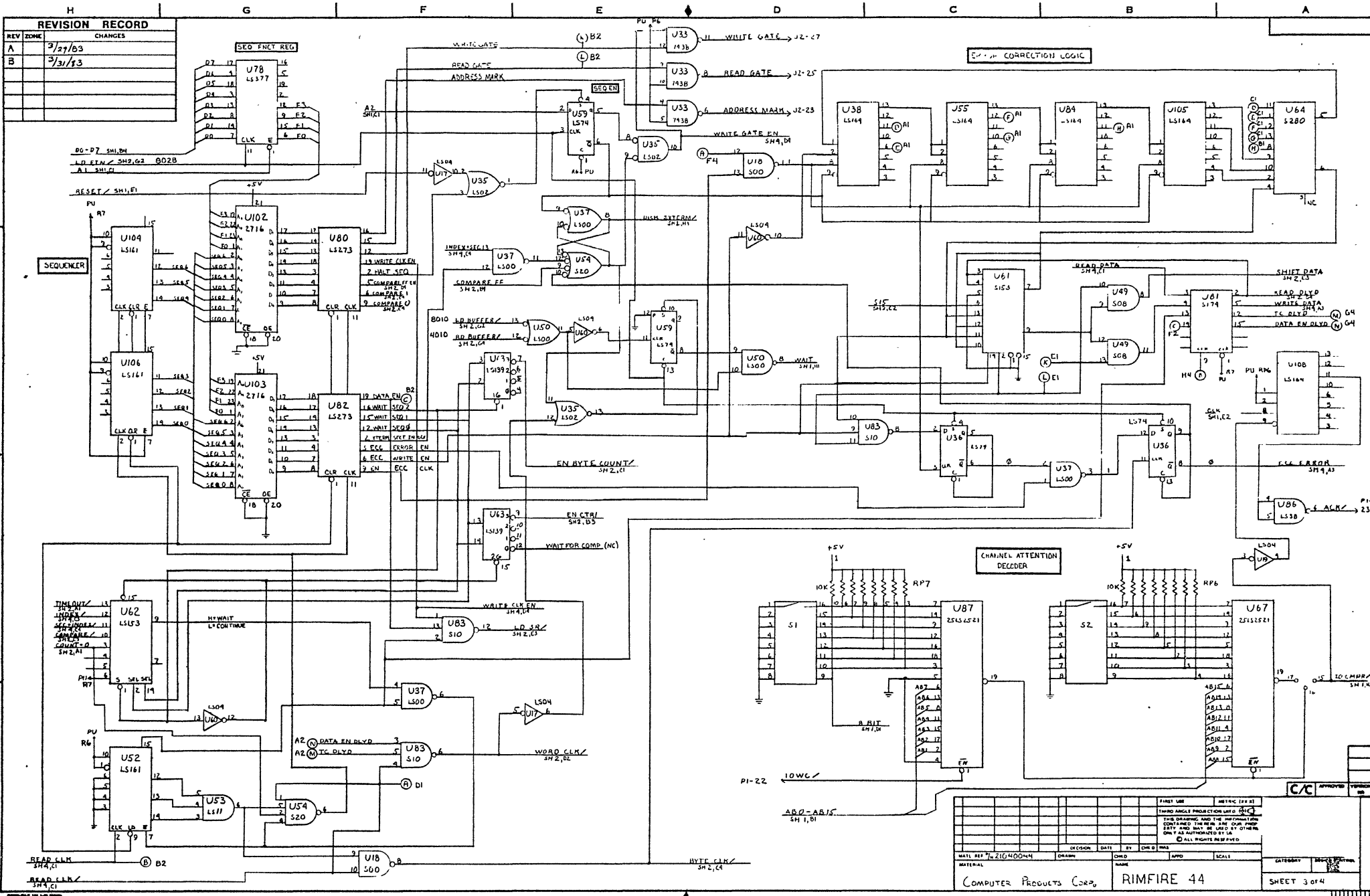
DATE	REV	NO	DESCRIPTION	BY	CHKD	DATE	SCALE	CALCULATED	DATE

COMPUTER PRODUCTS CORP. RIMFIRE 44 SHEET 1 of 4

REVISION RECORD		
REV	ZONE	CHANGES
A		3/29/83
B		3/31/83



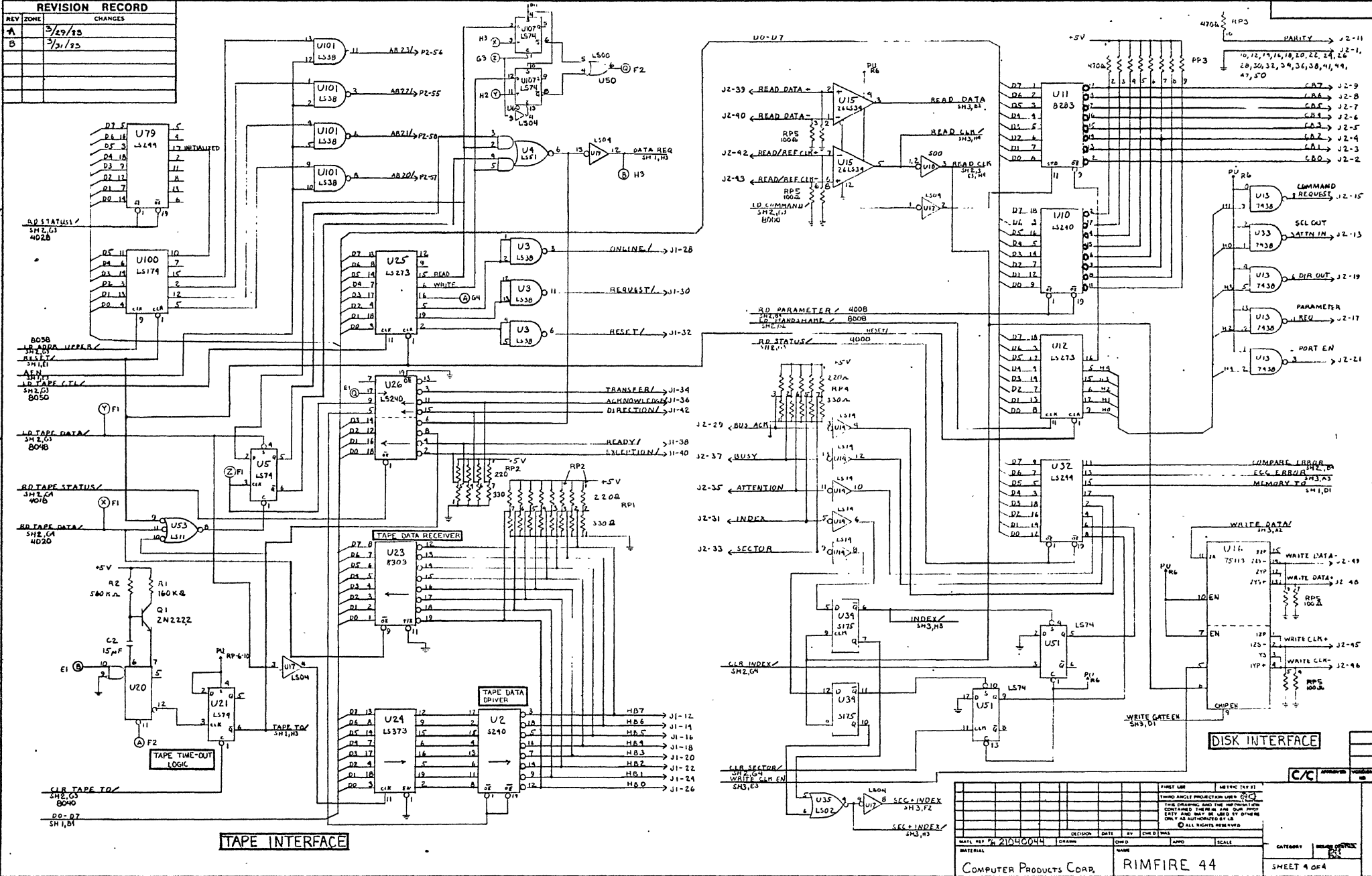
FIRST NAME		METHIC 159 81	
THIRD ANGLE PROJECTION LINE 0 0 0 0			
THIS DRAWING AND THE INFORMATION CONTAINED THEREIN ARE THE PROPERTY OF COMPUTER PRODUCTS CORP. AND MAY BE USED BY OTHERS ONLY AS AUTHORIZED BY US.			
© ALL RIGHTS RESERVED			
MATL REF NO	21040044	DESIGN	DATE
DRAWN		CHKD	
MATERIAL		APPRO	
COMPUTER PRODUCTS CORP.		RIMFIRE 44	
SHEET 2 OF 4		C/C APPROVED	



REVISION RECORD	
REV	CHANGES
A	3/27/83
B	3/31/83

DRAWN				DATE				BY				CHECKED				APPROVED				SCALE											
MATERIAL				QUANTITY				DATE				BY				SCALE															
COMPUTER PRODUCTS CORP.																RIMFIRE 44															
SHEET 3 OF 4																															

REVISION RECORD		
REV	ZONE	CHANGES
A	3/27/73	
B	3/31/73	



TAPE INTERFACE

DISK INTERFACE

MATERIAL		DESIGN		DATE		BY		CHK'D		APP'D		SCALE		CATEGORY		ISSUE	
MATERIAL NO. 21040044		DESIGN NO.		DATE		BY		CHK'D		APP'D		SCALE		CATEGORY		ISSUE	
<p>COMPUTER PRODUCTS CORP. RIMFIRE 44 SHEET 4 OF 4</p>																	