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ComputerAutomation

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FLOPPY DISK SUBSYSTEM

USER'S MANUAL

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REVISION HISTORY

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A3	February 1977	Incorporates outstanding change notices (A2-1 and A2-2) and corrects drive cabling description on page H-1.

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INTRODUCTION TO MANUAL

This manual contains information needed to understand and fully utilize the capabilities of the Computer Automation Floppy Disk Subsystem. Also included in the manual is information essential to users who wish to obtain only the controller (interfacing) portion of the system for use in OEM applications.

Knowledge of the Computer Automation Computer Handbook (91-20400-00) is presumed of users of the manual. Relevant software/programming documentation is as follows: Floppy Disk I/O Driver description (96097-00) and Floppy Disk Diagnostic/Formatter description (96096-00).

Section 1 of the manual presents overall mechanical and electrical characteristics and features of the system, and describes diskette characteristics and the data formatting scheme employed. Section 2 contains information needed to operate the system, including the location and function of each operating control and instructions for the insertion and removal of diskettes. Section 3 explains the general programming approach as well as providing descriptions of individual program operations. Section 4 contains installation instructions for both the single chassis disk drive and the dual chassis disk drive configurations of the system.

Appendix A presents programming examples which illustrate the use of the program operations described in section 3. Additional general information relevant to the explanation of programming in section 3 is provided in appendix B. Appendix C lists cables and connector pin assignments. Appendix D contains input power conversion information. Appendices E, F AND H contain instructions for interfacing the Computer Automation Floppy Disk Controller with the Calcomp 140-C, the Pertec FD400, and the Shugart SA800 Floppy Disk Drives, respectively. Appendix G presents information needed by the user who obtains only the Computer Automation Floppy Disk Controller and must implement necessary system functions in his system.

Section 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Computer Automation Floppy Disk Subsystem (Model No. 18566-XX) is a random-access, mass-storage system designed for use with Computer Automation LSI-series computers. It consists of a controller, cables, rack-mount chassis with power supply, one or two floppy disk drives, and software. A basic block diagram of the system is shown in figure 1-1.

The controller is implemented on a standard half-size printed circuit board (7-1/2 x 16-3/4 inches) that plugs into the motherboard of the computer. A 40-pin connector at the rear of the board mates with a cable to the floppy disk drive chassis. The chassis mounts in a standard 19-inch rack and requires 10-1/2 inches of vertical rack space. Its depth is 14-1/2 inches. The chassis contains one or two drive units, a power supply, and a control panel containing separate controls for each drive. If three or four disk drives are desired, a second drive chassis is connected to the first in "daisy chain" fashion.

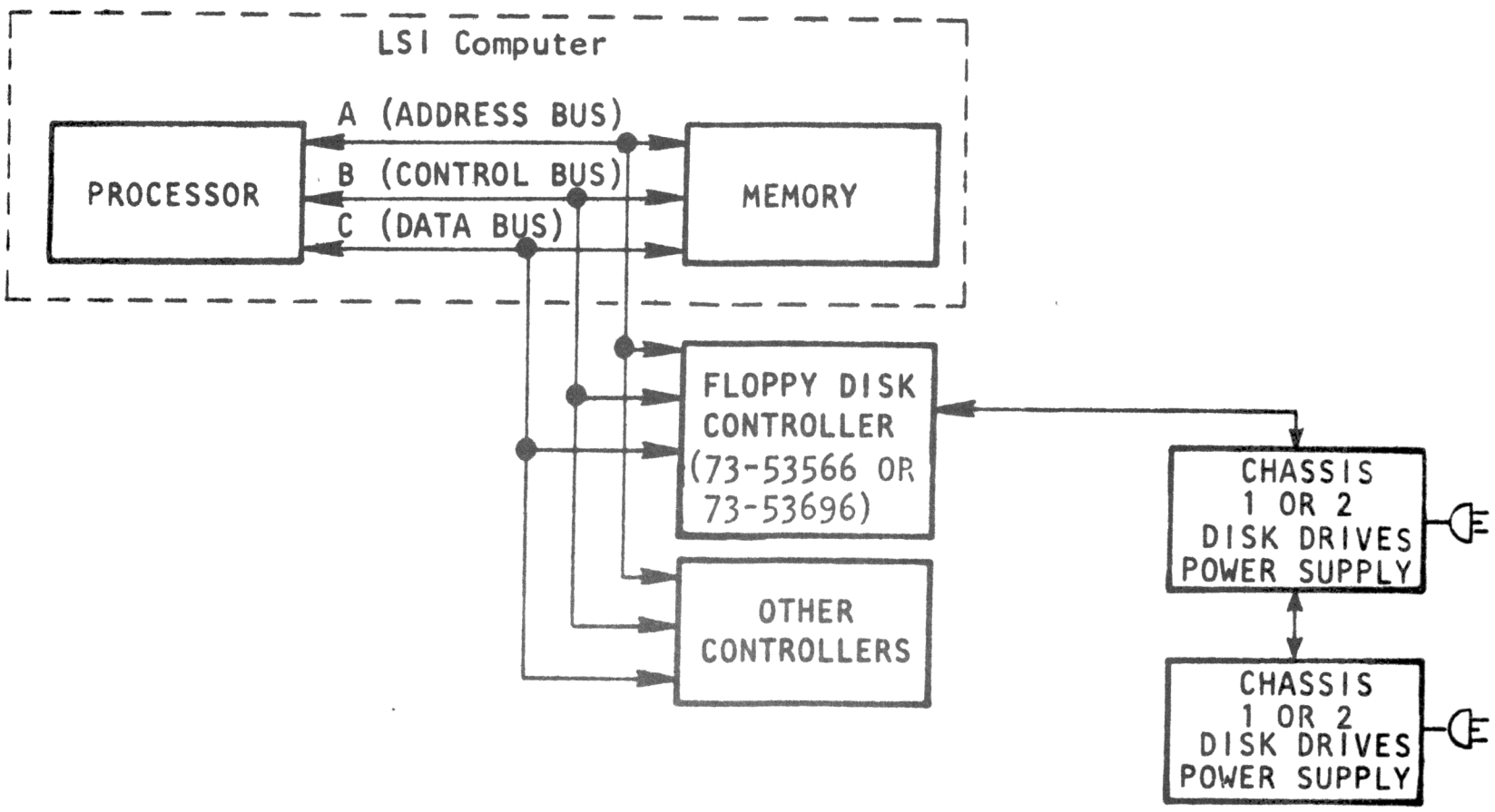


Figure 1-1. Floppy Disk Subsystem Block Diagram

1.2 APPLICATION

The Floppy Disk Subsystem can be employed as a random-access alternative to paper tape and cassette I/O devices at lower cost while affording higher performance. In applications in which longer access times and lower data capacity are acccptable, the system can replace more expensive, large disk systems at considerably lower cost.

1.3 FEATURES

- Direct Memory Access (DMA) data transfer
- Control of up to four floppy disk drives
- IBM diskette and format compatibility
- 250-kHz bit transfer rate (one 16-bit word/64 μs)
- Interrupt termination
- Control block-oriented instructions
- Soft sectoring
- Deleted and non-deleted data formats
- Write protect
- Dialable unit numbers
- Automatic head retraction
- Hardware cyclic redundancy check (CRC)
- Hardware header verification on every sector prior to read or write
- Multi-sector transfers

1.4 SPECIFICATIONS

Access Time	50 ms (minimum) 1004.5 ms (maximum) 10.5 ms cylinder-to-cylinder + 39.5 ms settling time + 0 to 167 ms rotational latency
Transfer Rate	250K bits-per-second
Recording Medium	IBM-compatible diskette
Recording Format	Fully IBM-compatible 242,944 bytes 77 cylinders per diskette 26 sectors per cylinder 128 data bytes per sector
Device Address	Switch selectable
Interrupt Address	Program selectable to any location in memory (except :00). Interrupts to selected address on normal termination, and selected address +2 on abnormal termination.
Size	19" RETMA x 10.5" high x 14.5" deep
Weight	Approximately 55 pounds (rack-mount chassis with power supply and two disk drives)
Power Requirements (max., two drives)	110 Vac/60 Hz @ 3.5 A 220 Vac/60 Hz @ 1.8 A 220 Vac/50 Hz @ 2.2 A 240 Vac/50 Hz @ 2.0 A

Environmental Requirements	Limited by diskette environmental limitations
Humidity	20% to 80% noncondensing
Temperature	60° to 100° F

1.5 DISKETTE CONFIGURATION

The recording medium is a flexible magnetic disk that is 7.8 inches in diameter. The disk is enclosed in a plastic envelope in which it is free to rotate. The package formed by the disk and its enclosing envelope is termed a "diskette". Holes in the envelope provide access for the read/write head and an index for data timing. Reading and writing are accomplished with the head in contact with the diskette. Only one side of the diskette is used.

The diskette is divided into cylinders and sectors. A diskette has 77 concentric circular cylinders with the innermost (cylinder 76) having a radius of about 2 inches and the outer cylinder (cylinder 0) having a radius of about 3.6 inches. Each cylinder is divided into 26 sectors for a total of 2002 sectors per diskette. Data is recorded in blocks of up to 64 16-bit words (128 bytes) per sector in the data field of each sector. The diskette is soft sectored--there are no physical sector indicators. Soft sectoring permits the use of non-sequential sector ordering to minimize rotational latency in particular applications.

1.6 DATA FORMAT

The data formatting scheme employed is explained below. This information is necessary to a thorough understanding of program operations described in section 3 of the manual.

1.6.1 Clock/Data Bits

A double frequency encoding technique is used whereby each data bit is preceded by a clock bit (figure 1-2). The space between leading edges of two consecutive clock pulses is defined as a bit cell. The presence of a transition in a bit cell is a logical data one; the absence of a transition is a logical zero. In data bytes, clock pulses are always ones. Logical zero clock pulses are present in bytes used as address marks (described in paragraph 1.6.3.2).

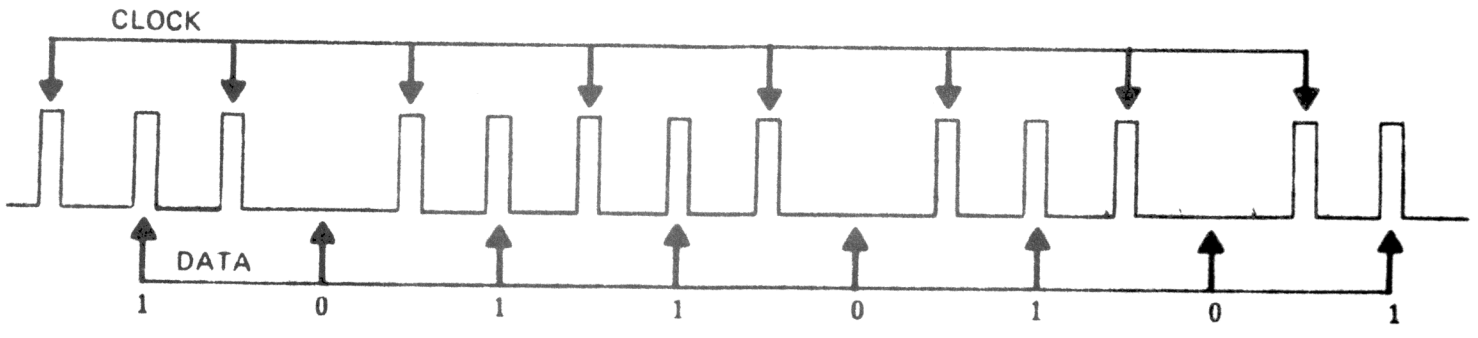


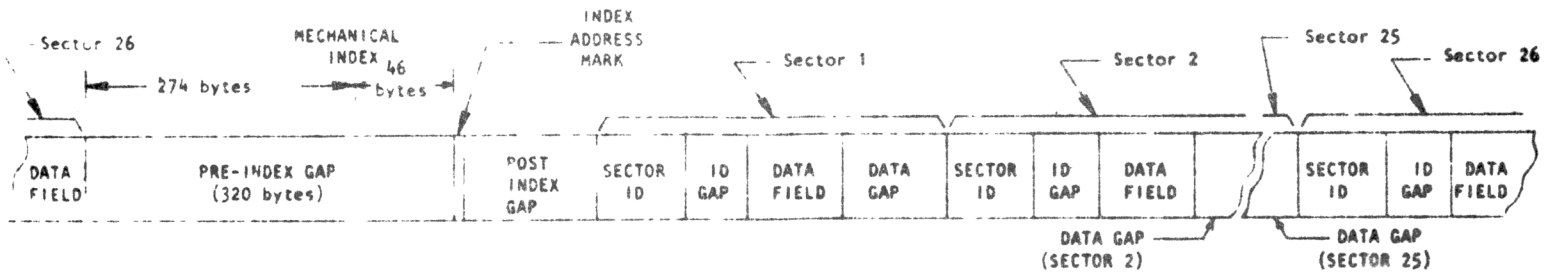
Figure 1-2. Clock/Data Encoding

1.6.2 Byte Transfer

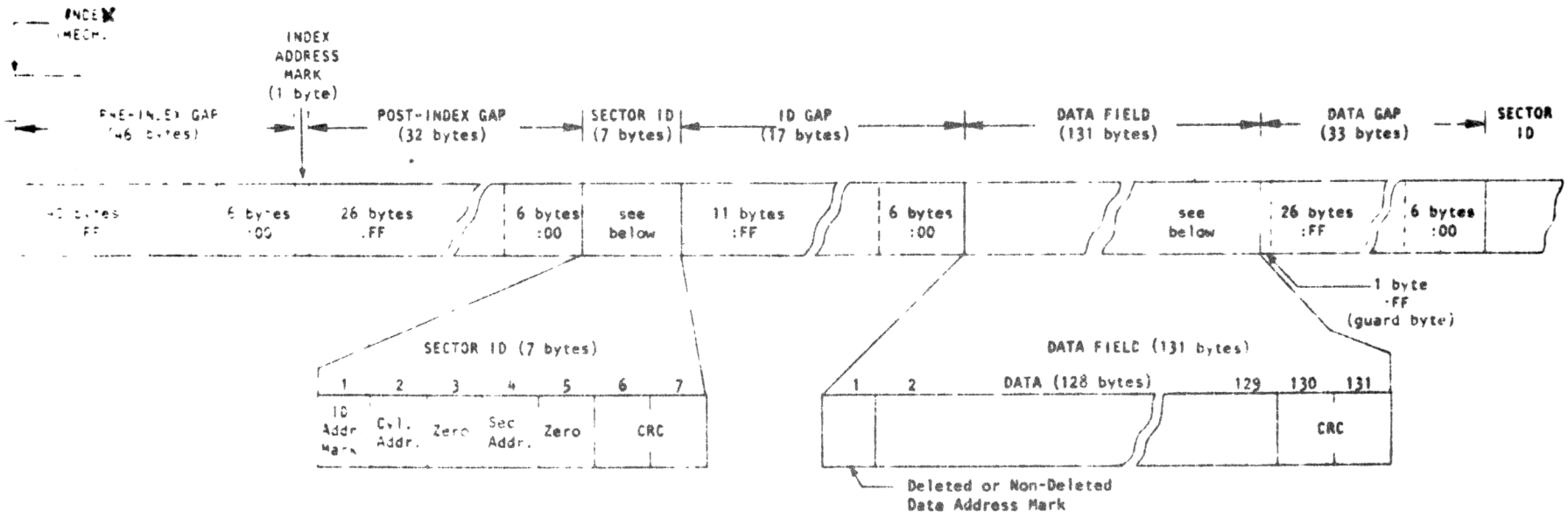
A byte is defined as eight consecutive bit cells. Bit cell 7 is the most significant and bit cell 0 is the least significant. During a read or write operation, the most significant bit cell (7) of the most significant byte is transferred to or from the disk drive first. The least significant bit cell (0) of the least significant byte is transferred last.

1.6.3 Cylinder/Sector

Figure 1-3 illustrates both the format of a cylinder and the format of a typical sector in a cylinder. Following are explanations of the various gaps and address marks.



(a) Cylinder Format



(b) Sector Format

Figure 1-3. Cylinder and Sector Format

1.6.3.1 Gaps

Fields in each sector and each of the 26 sectors within each cylinder are separated by a number of bytes containing all "1" bits and a number of bytes containing all "0" bits. These are called gaps and serve as buffers to enable a field to be updated without affecting adjacent fields. Each gap is described below:

1. Pre-Index Gap

   The pre-index gap is approximately 320 bytes of :FF (all ones) between the last (26th) physical data field on a cylinder and the index address mark (varies with rotational speed when formatted); 46 of the 320 bytes fall between the mechanical

index and the index address mark. This gap may vary in length after the data field in physical sector 26 is updated and because of write frequency and disk drive speed tolerances.

2. Post-Index Gap

The post-index gap is 32 bytes between the index address mark and the ID address mark for physical sector 1. The first 26 bytes of the gap are :FF; the last six bytes are :00 (all zeros). This gap is always 32 bytes and is not affected by updating.

3. ID Gap

The ID gap is 17 bytes between the ID field and the data field. The first 11 bytes of the gap are :FF; the last six bytes are :00. This gap may vary in length after the data field is updated.

4. Data Gap

The data gap is 33 bytes between the data field and the next ID field and includes a guard byte. The guard byte and the following 26 bytes of the gap are :FF; the last six bytes are :00.

1.6.3.2 Address Marks

Address marks are unique one-byte bit patterns used to identify particular fields and to synchronize deserialization circuitry with the first byte in each field. Address marks are the only bytes in which certain clock bits are zeros. The four types of address marks are shown in figure 1-4 and described below:

1. Index Address Mark

The index address mark is located at the beginning of each cylinder and precedes the first record (sector) by a fixed number of bytes (post-index gap, 32 bytes).

2. ID Address Mark

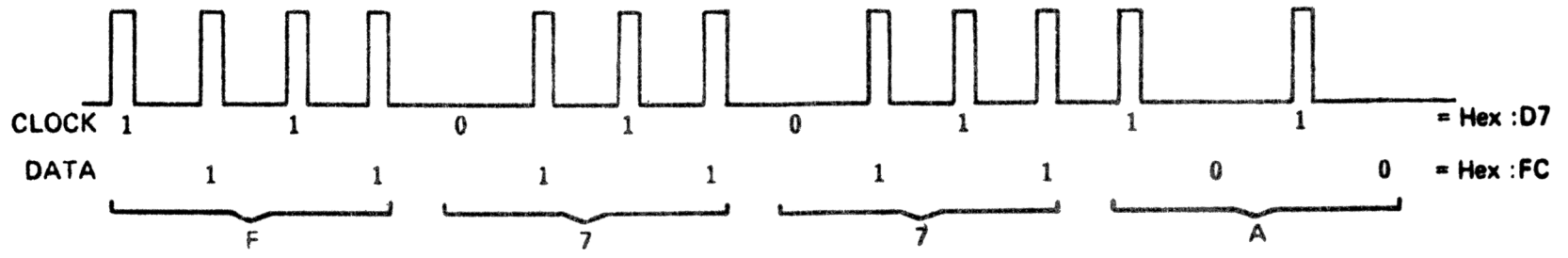
The ID address mark is located at the beginning of each ID field.

3. Data Address Mark

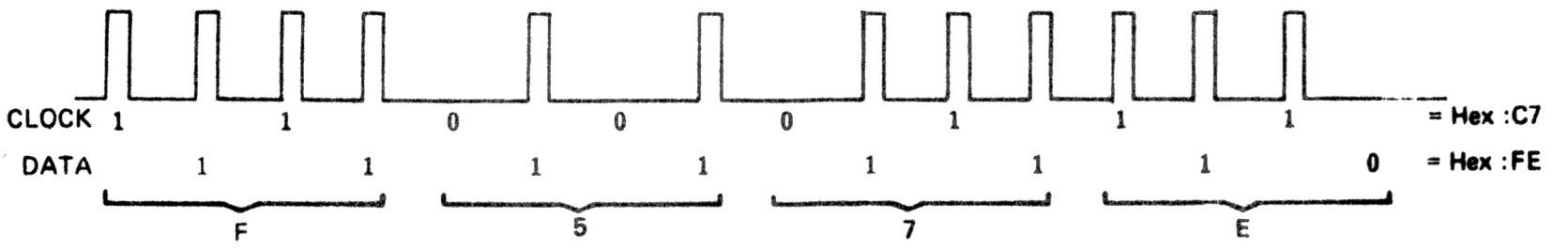
The data address mark is located at the beginning of each non-deleted data field.

4. Deleted Data Address Mark

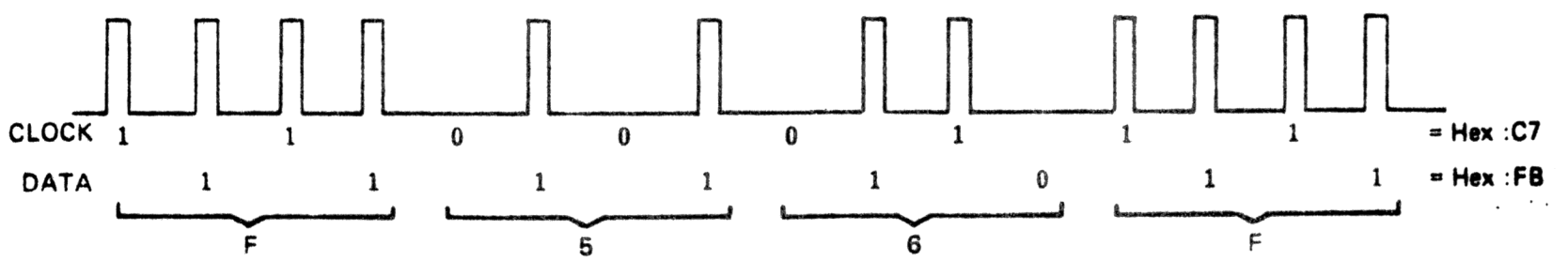
The deleted data address mark is located at the beginning of each deleted data field.



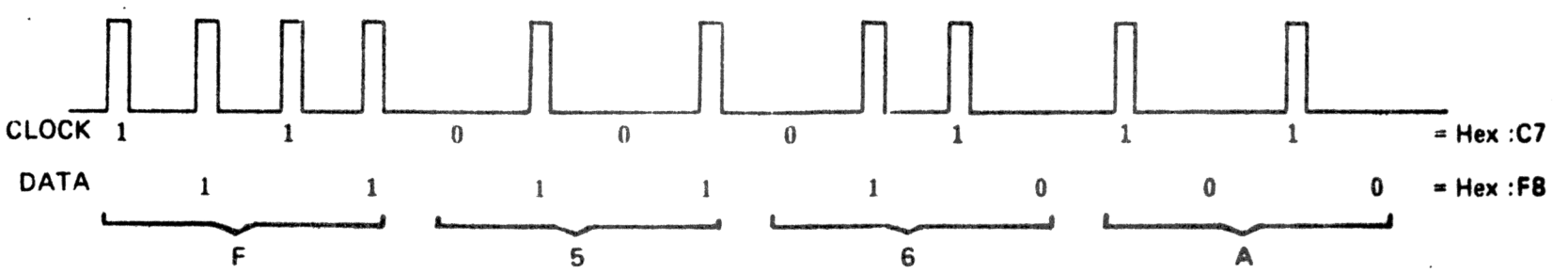
(a) Index Address Mark



(b) ID Address Mark



(c) Data Address Mark



(d) Deleted Data Address Mark

Figure 1-4. Address Marks

1.6.3.3 CRC Bytes

For each ID and data field written on the diskette, a CRC (Cyclic Redundancy Check) word (2 bytes) is added. This word is derived by logically dividing the serial data by a polynomial ($x^{16} + x^{12} + x^5 + 1$) with the remainder becoming the CRC word. When the data is read out, the data plus the CRC word are divided by the same polynomial. If there were no errors, the new remainder is zero.

Section 2

OPERATOR INFORMATION

2.1 INTRODUCTION

This section contains information needed by the Floppy Disk Subsystem operator. The location and function of control panel switches and indicators as well as device address selection and head control switches are given. Procedures for insertion and removal of the diskette are included. Figure 2-1 illustrates the dual disk drive chassis and controller. If the single disk drive chassis is ordered, the single drive is located at the left of the control panel and a diskette storage facility is provided at the right of the control panel.

2.2 CONTROL PANEL

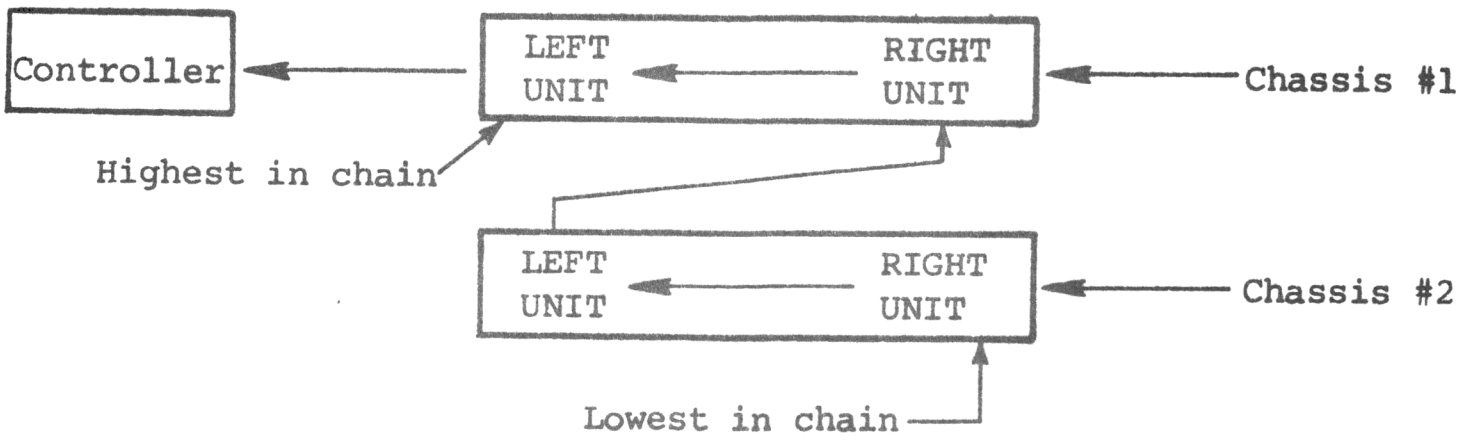
Each disk drive chassis is equipped with a control panel (figure 2-1) used to control certain disk drive functions and to indicate the status of each drive.

2.2.1 POWER Switch/Indicator

This switch, when depressed, applies power to the disk drives and causes the indicator to light. When depressed again, power is removed from the disk drives and the indicator light goes off.

2.2.2 Unit Select Switches

Two rotary switches, RIGHT UNIT and LEFT UNIT, select the logical unit number for each drive in the chassis. Each drive may be assigned a logical unit number of 0, 1, 2 or 3. If two or more of the drives connected to the controller have the same logical unit number, all operations directed to that logical unit number are automatically executed by the drive that is highest (closest to the controller) on the system's "daisy chain", as shown below.



When a chassis contains a single drive, both unit select switches should be set to the same logical unit number to prevent the non-existent right drive from pre-empting any downstream drives in the daisy chain.

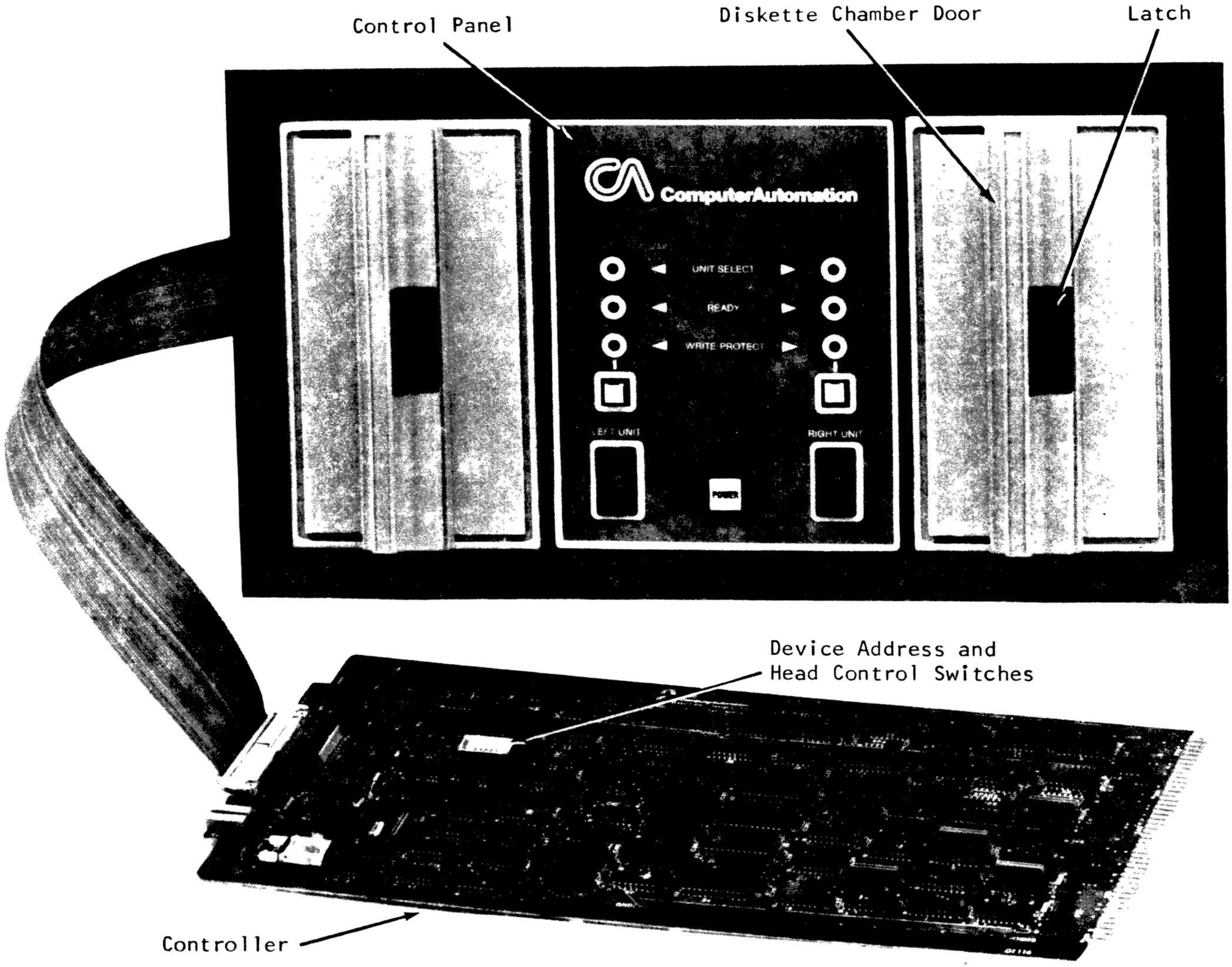


Figure 2-1. Dual Disk Drive Chassis and Controller

2.2.3 UNIT SELECT Indicators

A UNIT SELECT indicator goes on when the drive associated with it (left or right) is selected for operation by the program. It remains on until another drive is selected.

2.2.4 READY Indicators

The READY indicator for each drive goes on when a diskette is properly installed in the corresponding drive and is rotating at the proper speed.

2.2.5 WRITE PROTECT Indicators

The WRITE PROTECT indicator is turned on whenever the drive is write protected or power has been turned on. The drive is automatically write protected whenever a diskette is removed or installed in the drive and remains write protected until the WRITE PROTECT switch is depressed.

2.2.6 WRITE PROTECT Switches

The WRITE PROTECT switch is depressed to remove write protect from the associated drive when the drive is in ready status. The drive can be write protected again by opening the diskette chamber door.

2.3 CONTROL SWITCHES

Eight miniature switches are located on the controller board at the location shown in figure 2-1. Two of these switches, switches 5 and 6, are used to select cylinder-to-cylinder timing, head load timing, and head step direction. Switch 5 must be placed in the ON position and switch 6 in the OFF position. Switch 3, which grounds DMA priority in, should normally be placed in the OFF position.

2.4 DEVICE ADDRESS SELECTION

Five of the miniature switches shown in figure 2-1 are set to assign a device address to the controller. Table 2-1 lists the switch settings and the resulting device address. The controller is initially set to device address :11, as is the associated software. The initial device address setting need only be changed if two controllers are used or if a conflict arises.

2.5 DISKETTE INSERTION AND REMOVAL

To insert the diskette into the disk drive, follow the procedures listed below. Refer to figure 2-2.

1. Apply power to the disk drive.

2. Open the door to the diskette chamber by depressing the latch. The door swings open to the left.

3. Insert the diskette in the orientation shown in figure 2-2. The edge of the diskette having the read/write access slot must be inserted first with the label

on the left side of the diskette. Insert the diskette all the way into the chamber until it strikes the stop.

Table 2-1. Device Address Selection Switch Settings

Device Address	SW8	SW7	SW2	SW1	SW4
:00*	OFF	OFF	OFF	OFF	OFF
:01	OFF	OFF	OFF	OFF	ON
:02	OFF	OFF	OFF	ON	OFF
:03	OFF	OFF	OFF	ON	ON
:04	OFF	OFF	ON	OFF	OFF
:05	OFF	OFF	ON	OFF	ON
:06	OFF	OFF	ON	ON	OFF
:07	OFF	OFF	ON	ON	ON
:08	OFF	ON	OFF	OFF	OFF
:09	OFF	ON	OFF	OFF	ON
:CA	OFF	ON	OFF	ON	OFF
:0B	OFF	ON	OFF	ON	ON
:0C	OFF	ON	ON	OFF	OFF
:0D	OFF	ON	ON	OFF	ON
:0E	OFF	ON	ON	ON	OFF
:0F	OFF	ON	ON	ON	ON
:10	ON	OFF	OFF	OFF	OFF
:11**	ON	OFF	OFF	OFF	ON
:12	ON	OFF	OFF	ON	OFF
:13	ON	OFF	OFF	ON	ON
:14	ON	OFF	ON	OFF	OFF
:15	ON	OFF	ON	OFF	ON
:16	ON	OFF	ON	ON	OFF
:17	ON	OFF	ON	ON	ON
:18	ON	ON	OFF	OFF	OFF
:19	ON	ON	OFF	OFF	ON
:1A	ON	ON	OFF	ON	OFF
:1B	ON	ON	OFF	ON	ON
:1C	ON	ON	ON	OFF	OFF
:1D	ON	ON	ON	OFF	ON
:1E	ON	ON	ON	ON	OFF
:1F	ON	ON	ON	ON	ON

* Do not use; conflicts with console device address.
** Standard device address.

4. Close the chamber door.

The drive READY indicator turns on when the diskette reaches full speed (in approximately two seconds).

To remove the diskette from the chamber, it is necessary only to open the diskette chamber door and remove the diskette.

CAUTION If the door is opened while the computer is transferring data, an error will occur.

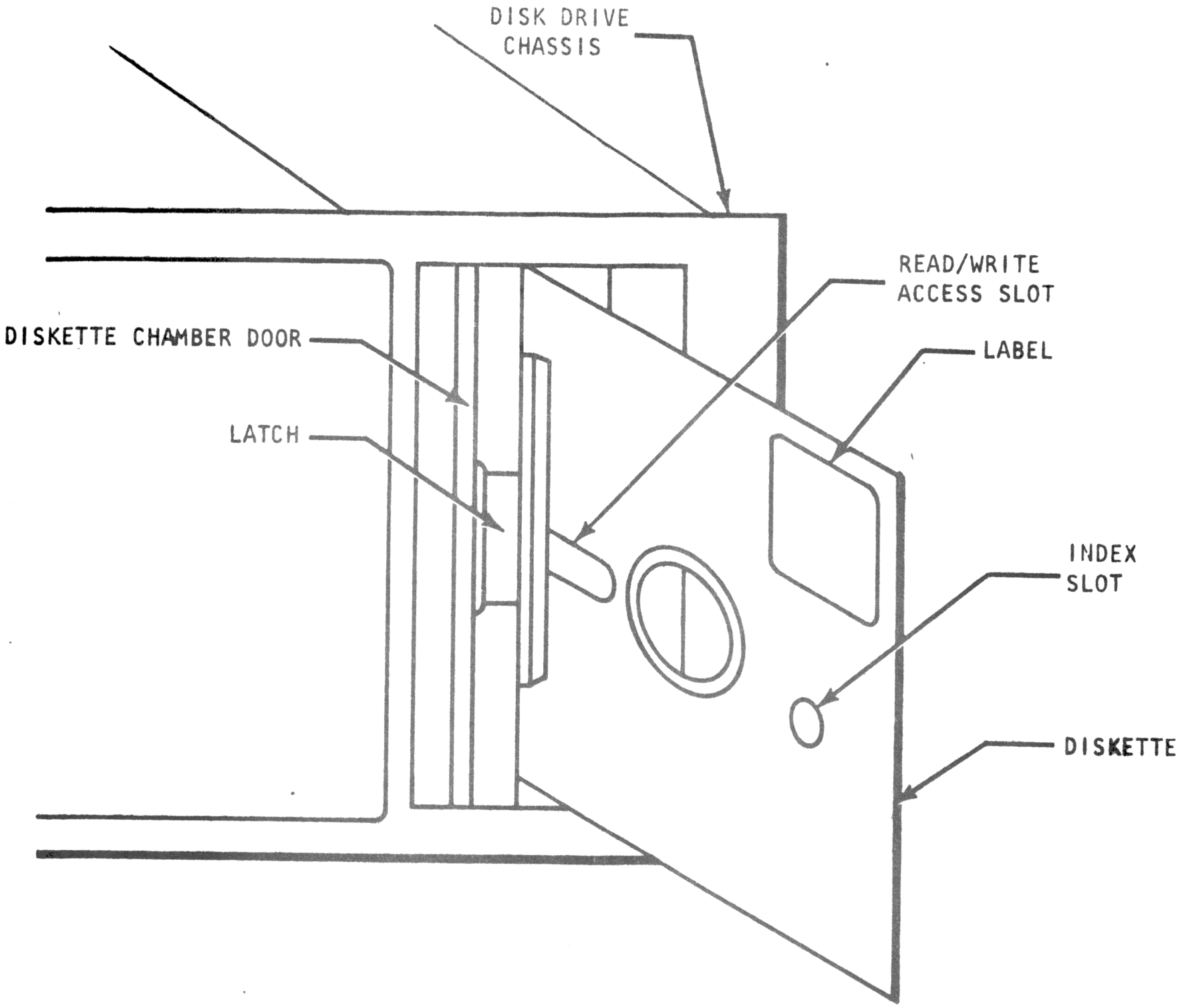


Figure 2-2. Diskette Insertion

CAUTION

The operational life and reliability of the diskette may be reduced if the precautions listed below are not heeded. Note that the diskette, which consists of a flexible magnetic disk enclosed within a plastic envelope, is provided with a protective jacket for use when the diskette is not in service.

1. Remove the diskette from its protective jacket only when preparing the diskette for service.

2. Use only a felt-tipped pen to record information on the protective jacket.

3. Do not write on the plastic envelope of the diskette; instead, prepare a label with the desired information, then attach the label to the envelope.

4. Allow no debris to fall on the diskette to prevent diskette and read/write head contamination.

5. Do not touch or attempt to clean exposed magnetic disk surfaces.

6. Prevent exposure of the diskette to heat and direct sunlight.

7. Keep the diskette away from magnetic fields and ferromagnetic materials to prevent the destruction of data.

Section 3

PROGRAMMING

3.1 INTRODUCTION

To simplify the software required for communication with the controller, a "control block" approach has been taken. As a result, only four I/O instructions are used with the controller:

1. Sense for controller installed.
2. Sense for controller not busy.
3. Initialize the controller.
4. Output the memory address of a control block which completely describes the operation to be performed.

The resultant program is much like making a call to a conventional I/O driver subroutine; however, the equivalent functions are implemented in the hardware. All other communication with the controller is via Direct Memory Access (DMA).

The controller may be programmed using sense response or interrupt techniques to determine when an operation is completed. Normally, interrupt programming is used as this reduces the processor overhead. The interrupt addresses are programmable. Therefore, the controller may be instructed to interrupt to any location in memory (except :00). The controller distinguishes between normal and abnormal operation termination and interrupts to two separate locations accordingly.

In all cases, the controller writes a two-word termination block back to memory which reports the results of the operation.

3.2 INSTRUCTIONS

3.2.1 Sense Instructions

To determine if a floppy disk controller is present in a system, a sense instruction with device address :11 (standard device address for Floppy Disk Subsystem) and function code 4 is executed:

```
SEN :11,4
```

A true response (a Skip) indicates that the controller is present.

To determine if the controller is idle and ready to accept a new command, a sense instruction with function code 0 is executed:

```
SEN :11,0
```

A true response indicates that the controller is idle and ready to accept a command. A false response indicates the controller is busy executing a previous command.

Sense commands with function code 1-3 or 5-7 are reserved.

3.2.2 Select Instructions

The floppy disk controller is initialized by issuing a Select or Select and Present command with a device address of :11 and a function code of 4 (register contents are ignored for Select and Present instructions, SEA and SEX):

```
SEA :11,4          (contents of A register ignored)
```

Operations are terminated, the unit number is set to zero and the controller will not interrupt the computer or transfer the termination block to memory. The controller is also initialized by a reset from the console or when the hardware power-down or power-up sequence is taking place in the processor. Software initialization is normally required only to abort an operation prior to completion.

Select commands with function code 0-3 or 5-7 are reserved.

3.2.3 Output Instructions

An output instruction (OTA or OTX) with function code zero:

```
OTA :11,0
```

outputs the memory address of the first word of the control block and initiates the action defined by the control block. The controller must be in the "idle" state. (Instruction WRA or WRX can be used to output the command when the controller enters the "idle" state.)

Output instructions with function code 1-7 are reserved.

The control block address format is as follows:



Bits 0-14 indicate the starting address of the first word of the control block. The address rolls over at 32K. Upon receipt of this instruction, the floppy disk controller enters the "busy" state, fetches the control block from memory using DMA, and initiates the action defined by the control block. Once an operation is started by an output instruction, further output instructions are ignored until the controller again enters the "idle" state.

3.2.4 Input Instructions

There are no input instructions associated with the controller. All function codes are reserved and should not be executed by the software.

3.2.5 Command Summary

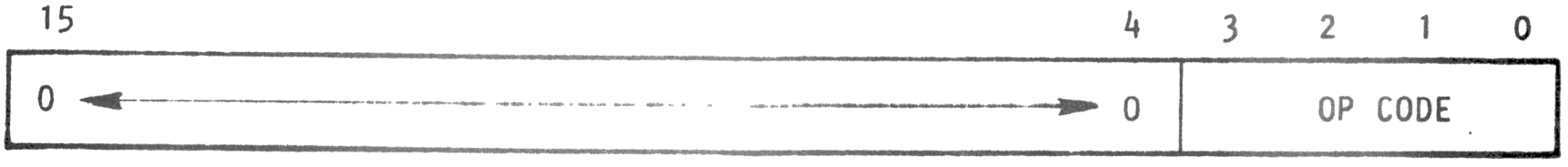
Function Code	Sense	Input	Output	Select
0	Controller Idle	*	Control Block Memory Address	*
1	*	*	*	*
2	*	*	*	*
3	*	*	*	*
4	Controller Present	*	*	Initialize Controller
5	*	*	*	*
6	*	*	*	*
7	*	*	*	*
* = Reserved				

3.3 CONTROL BLOCK

Specific operations to be performed are defined in a control block consisting of eight control words entered into memory at consecutive locations. Upon receiving an output command with the control block starting address, the controller reads each of the eight words from memory and begins executing the operation defined by the block. Prior to executing the output command, the software must set up the control block as shown below in consecutive memory locations.

Control Word 0 - Op Code
1 - Unit Number
2 - Cylinder Address
3 - Relative Seek Count
4 - Sector Number
5 - Word Count
6 - Memory Address
7 - Interrupt Enable and Address

3.3.1 Word 0 - Op Code



The four least significant bits of this word define the operation to be performed. Bits 4 through 15 must be set to zero.

Bit				Operation
3	2	1	0	
0	0	0	0	No-Op
0	0	0	1	Format
0	0	1	0	Write Non-Deleted Data
0	0	1	1	Write Deleted Data
0	1	0	0	Read Non-Deleted Data Only
0	1	0	1	Read Deleted Data Only
0	1	1	0	Read Regardless
0	1	1	1	Read All Data
1	0	0	0	Verify
1	0	0	1	Seek Only (Restore)
1	0	1	0	Reserved
1	0	1	1	↕
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	Reserved

All operations are performed within a single cylinder. All operations, except No-Op, perform a seek based on the relative seek count before the specified operation. The seek is verified for all operations, except Format and Read Regardless, by comparing both the cylinder and ID CRC written on the diskette to the cylinder in the control block and the recomputed ID CRC. All data operations are multi-sector if the word count is sufficient and sectors are processed in logical order.

3.3.1.1 No-Op

Used primarily to obtain the status of a particular unit. The No-Op selects the unit defined by word 1 of the control block, writes the termination block into memory, and interrupts if enabled.

3.3.1.2 Format

Formatting begins when the mechanical index (see paragraph 1.6.3) is encountered. Data is then transferred from memory until the word count equals zero. Then the controller writes ":FF's" until the mechanical index is encountered again. In a Format operation, the word count becomes a byte count and must be equal to 4960. The software must provide all data and clock patterns necessary as described in paragraph 1.6, without the first byte after the mechanical index and the pre-index gap between the last data field and the mechanical index. A word is transferred from memory for each byte to be written on the diskette. The word is made up of eight clock bits interspersed with eight data bits. For example, the first word accessed from memory is :FFFF for a clock pattern of :FF and a data pattern of :FF. The index address mark is stored in memory as :F77A for a clock pattern of :D7 and a data pattern of :FC (as illustrated in figure 1-4a). The unit must not be write protected.

The following indicates memory contents for one cylinder:

	No. of Bytes	Memory Content	
	39	:FFFF	39 bytes of :FF
	6	:AAAA	6 bytes of :00
	1	:F77A	Index address mark
Repeated 26 Times	26	:FFFF	26 bytes of :FF
	6	:AAAA	6 bytes of :00
	1	:F57E	ID address mark
	1	:AAAA +	cylinder number in odd bits
	1	:AAAA	1 byte of :00
	1	:AAAA +	sector number in odd bits
	1	:AAAA	1 byte of :00
	1	:AAAA +	first byte of ID CRC in odd bits
	1	:AAAA +	second byte of ID CRC in odd bits
	11	:FFFF	11 bytes of :FF
	6	:AAAA	6 bytes of :00
	1	:F56F	Non-deleted or deleted data address mark
	128	:FEBB	128 bytes of :E5 (may be any desired pattern)
	1	:BBFB	Data CRC based on non-deleted data address mark and all :E5 data field; uses same polynomial as ID CRC.
	1	:AFAA	
	1	:FFFF	1 byte of :FF

Calculation of CRC is described in paragraph A.3 of appendix A

3.3.1.3 Write Non-Deleted Data

Data is written from memory to the diskette with a Non-Deleted Data address mark when: (1) a valid comparison is made between the cylinder and sector defined in the control block and an ID field written on the diskette and (2) the recalculated ID CRC compares with the CRC written on the diskette. The operation continues until the word count reaches zero or the end-of-cylinder is reached. Data written in this manner is skipped over during a Read Deleted Data operation. The unit must not be write protected; otherwise, the operation aborts and sets an error bit in the status word.

3.3.1.4 Write Deleted Data

Similar to write Non-Deleted Data, except that the data field is preceded by a Deleted Data address mark. Data written in this manner is skipped over during a Read Non-Deleted Data operation. It may be retrieved using a Read Deleted Data or Read All Data operation.

3.3.1.5 Read Non-Deleted Data Only

Data is read from the diskette to memory when: (1) a valid comparison is made between the cylinder and sector defined in the control block and the ID field written on the diskette, (2) the recalculated ID CRC compares with the CRC written on the diskette, and (3) the data field is preceded by a Non-Deleted Data address mark.

If the data field is preceded by a Deleted Data address mark, the data field is skipped over and the word count is not altered. The sector register is incremented when a valid ID and CRC comparison is made so that sectors containing Deleted Data

and sectors containing Non-Deleted Data may be interspersed, but only the sectors containing Non-Deleted Data are read.

The operation continues until the word count equals zero or the end-of-cylinder is reached.

3.3.1.6 Read Deleted Data Only

Similar to Read Non-Deleted Data Only, except that only sectors preceded by a Deleted Data address mark are read.

3.3.1.7 Read Regardless

The Read Regardless operation is provided for the following purposes:

1. To access ID field for diagnostics and error recovery.
2. To access ID CRC for diagnostics.
3. To access data CRC for diagnostics.
4. To recover data if an ID field is in error.

Starting at the first ID encountered, as many words are transferred as are specified by the word count as follows:

1st Word	Cylinder and Sector
2nd Word	ID CRC
Next 64 Words	Data field associated with first and second words
67th Word	Data CRC
68th Word	Cylinder and Sector of next physical sector.
etc.	

The operation continues until the word count equals zero, a sync error is detected, or an Initialize is executed. In the case of a large word count, the operation does not terminate on reaching the end-of-cylinder, but instead wraps around and continues until the word count expires, or a sync or rate error occurs.

3.3.1.8 Read All Data

Combination of Read Deleted Data and Read Non-Deleted Data operations. No sectors are skipped.

3.3.1.9 Read Verify

Recomputes CRC character on data beginning when a valid comparison is made between the contents of the track-sector register and an ID field written on the diskette, and compares the recomputed CRC character to the one written on the diskette. Read Verify does not skip deleted records. The operation terminates when the word count equals zero or the end-of-cylinder is reached. No data is transferred to memory.

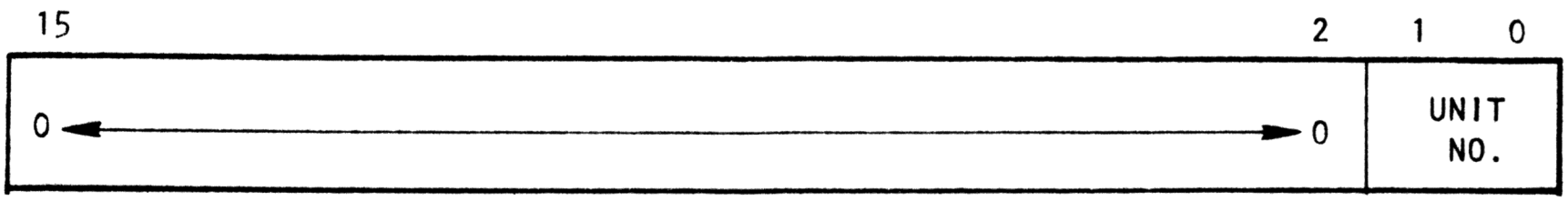
3.3.1.10 Seek Only

The Seek Only operation causes the controller to move the read/write head as determined by the relative seek count (see paragraph 3.3.4).

The Seek Only operation may be used as a restore operation by setting the relative seek count to -80 (decimal). As the head will not step beyond cylinder zero, a relative seek count of -80 will ensure that the head is on cylinder zero at the completion of the seek, regardless of its initial cylinder address.

After power-up, the head position may be on a (non-formatted) cylinder beyond cylinder zero. It is therefore advisable to initially perform a positive seek of 2 to move the head into the formatted portion of the diskette, then to perform a restore operation.

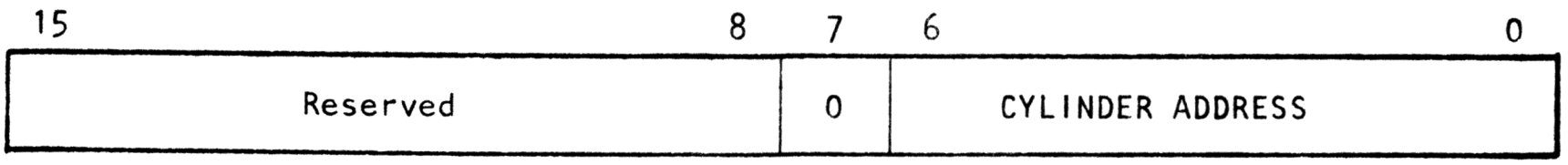
3.3.2 Word 1 - Unit Number



The floppy disk drive unit number on which the selected operation is to be performed is specified by bits 0 and 1 of control word 1. Bits 2 through 15 must be zero.

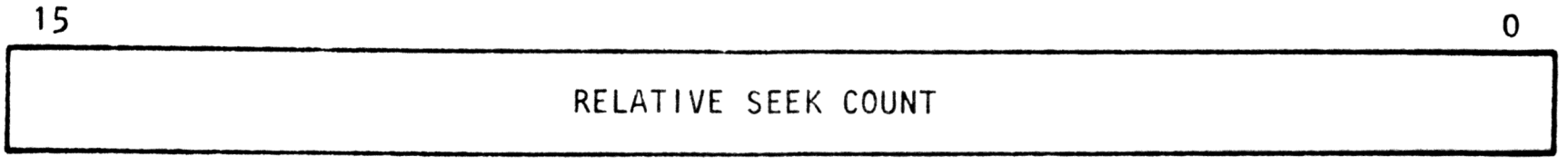
Bit		Unit Number
1	0	
0	0	0
0	1	1
1	0	2
1	1	3

3.3.3 Word 2 - Cylinder Address



Bits 0-6 contain the cylinder number on which this operation is to be performed. Bit 7 must be zero. The cylinder number ranges from 0 to 76. Bits 8 through 15 are reserved.

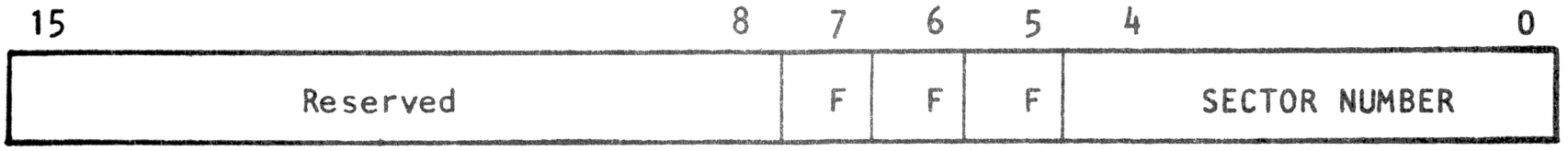
3.3.4 Word 3 - Relative Seek Count



All 16 bits of word 3 are used to indicate the relative seek count. The relative seek count defines the number of consecutive cylinders over which the head must traverse in a seek operation to arrive at a desired cylinder. The number is signed to indicate direction of travel, + (positive, non-zero number) specifying movement

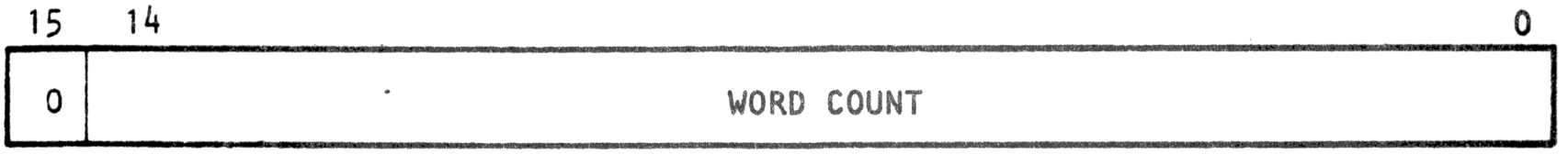
from a lower numbered cylinder to a higher numbered cylinder and - (negative, two's complement number) specifying movement from a higher numbered cylinder to a lower numbered cylinder. Thus, if the head is currently positioned at cylinder 9 and it is necessary to next position the head at cylinder 3, the relative seek count must be -6; if the head is currently positioned at cylinder 11 and it is necessary to next position the head at cylinder 18, the relative seek count must be +7. (The cylinder address (control word 2) simply defines the number of the cylinder at which the current operation is to be performed.)

3.3.5 Word 4 - Sector Number



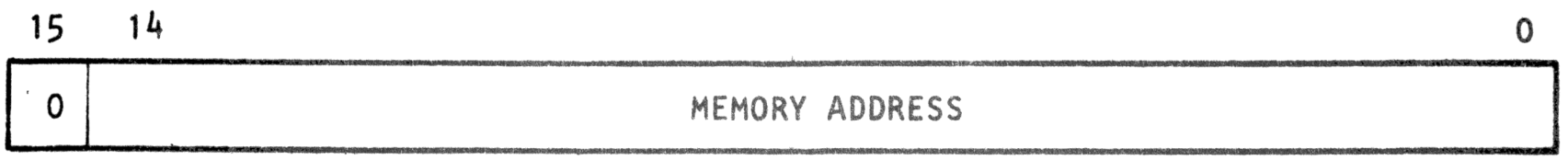
Bits 0-4 contain the sector number where the operation is to begin. The sector number ranges from 1 to 26. Bits 5-7 may be used as flag bits in a non-IBM compatible mode in which case these bits must be inserted at format time also; they must be set to zero for IBM compatibility. Bits 8 through 15 are reserved. Note that the flag bits are the only variation from IBM format. Sector size and the number of sectors must remain the same.

3.3.6 Word 5 - Word Count



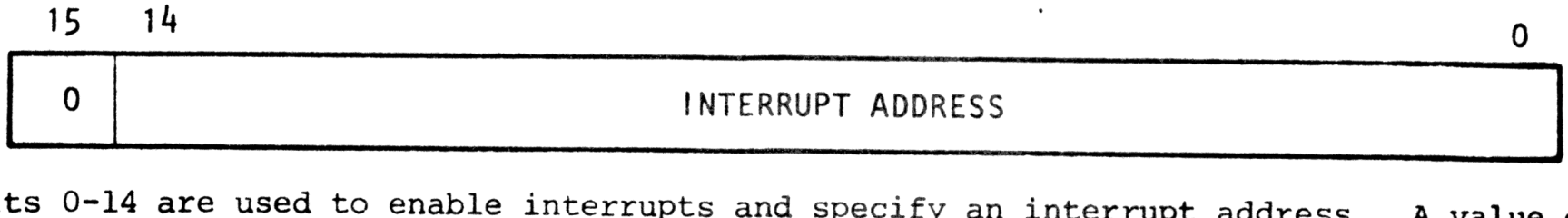
Bits 0-14 of word 5 contain the number of words to be transferred during the operation. Bit 15 must be zero.

3.3.7 Word 6 - Memory Address



Bits 0-14 contain the memory address of the location where the data transfer is to begin. The address rolls over at 32K.

3.3.8 Word 7 - Interrupt Enable and Address



Bits 0-14 are used to enable interrupts and specify an interrupt address. A value of zero disables interrupts, while a value of other than zero enables interrupts and specifies the address for an errorless return. If an error occurs, the interrupt will occur at the specified address plus two. Bit 15 must be zero.

(See appendix B for additional control block information.)

3.4 TERMINATION BLOCK

When an operation is terminated either successfully or due to an error, a two-word termination block is written into memory immediately following the control block. The two words are valid only when the controller goes idle following an operation that has not been initialized.

Word No.

0 ↕ 7	Control Block (8 words)
8	No. of Words Processed
9	Status

} Termination Block

3.4.1 Word 8 - Number of Words Processed

The number of words processed will be a positive number less than or equal to the word count (word 5, control block).

If the operation was a Format, Write Non-deleted Data, or Write Deleted Data, the number will equal the number of words transferred from memory to the diskette.

If the operation was a Read Non-deleted Data, Read Deleted Data, or Read All Data, the number will equal the number of words transferred from the diskette to memory.

If the operation is a Read Verify, the number is equal to the number of words successfully verified if a data CRC error did not occur. If a data CRC error occurred, then the number of words successfully verified will equal N x 64 where N is a positive integer such that N x 64 < number of words processed; i.e., the number of words in the good sectors.

If the operation is a Read Regardless, the number equals the number of words transferred from the diskette to memory, including cylinder/sector, ID CRC, and data CRC words.

If the operation is a Seek Only or a No-Op, the number is zero.

3.4.2 Word 9 - Status

Word 9 is a 16-bit word indicating the state of the controller upon termination of the operation. Bits 0-7 of word 9 indicate the reason for an error interrupt or unsuccessful termination. Bits 8 and 9 indicate the type of data encountered during all read operations and do not cause an error return. Bit 10 (Done) is set when the controller has completed as much of the specified operation as it can, even if an error occurred. The controller does not clear this bit in memory when a new operation is started. Bit 15 indicates that the selected unit is write protected but does not cause an error by itself.

Bit	Definition
0	Selected units not ready: diskette not installed or up to speed.
1	DMA rate error or attempted access to non-existent memory.
2	End-of-cylinder reached and words processed not equal to word count.
3	Attempted to write on a write-protected unit.
4	No ID compare.
5	ID CRC error.
6	Data CRC error.
7	Sync error. If set with bit 4, could not find an ID sync within one full revolution of diskette. If set without bit 4 being set, could not find a data sync following a valid ID comparison.
8	Non-deleted data encountered
9	Deleted data encountered
10	Done - operation completed
11	Cylinder zero - selected drive on cylinder zero (not valid in the power-up case where cylinder is less than zero)
12-14	Reserved
15	Selected unit write-protected.

(See appendix A for programming examples employing the operations described in section 3.)

Section 4

HARDWARE INSTALLATION

4.1 INTRODUCTION

This section contains information needed to install the Floppy Disk Subsystem, in both the one and two chassis configurations.

4.2 SYSTEM INSTALLATION

System installation requires installation of a floppy disk controller and one or two disk drive chassis to form a one- or two-drive system or a three- or four-drive system, respectively. It is recommended that not more than two chassis be connected to a controller. Controller installation and installation of the single chassis and dual chassis disk drive systems are described below. (Appendix C lists cables and connector pin assignments.)

4.2.1 Controller Installation

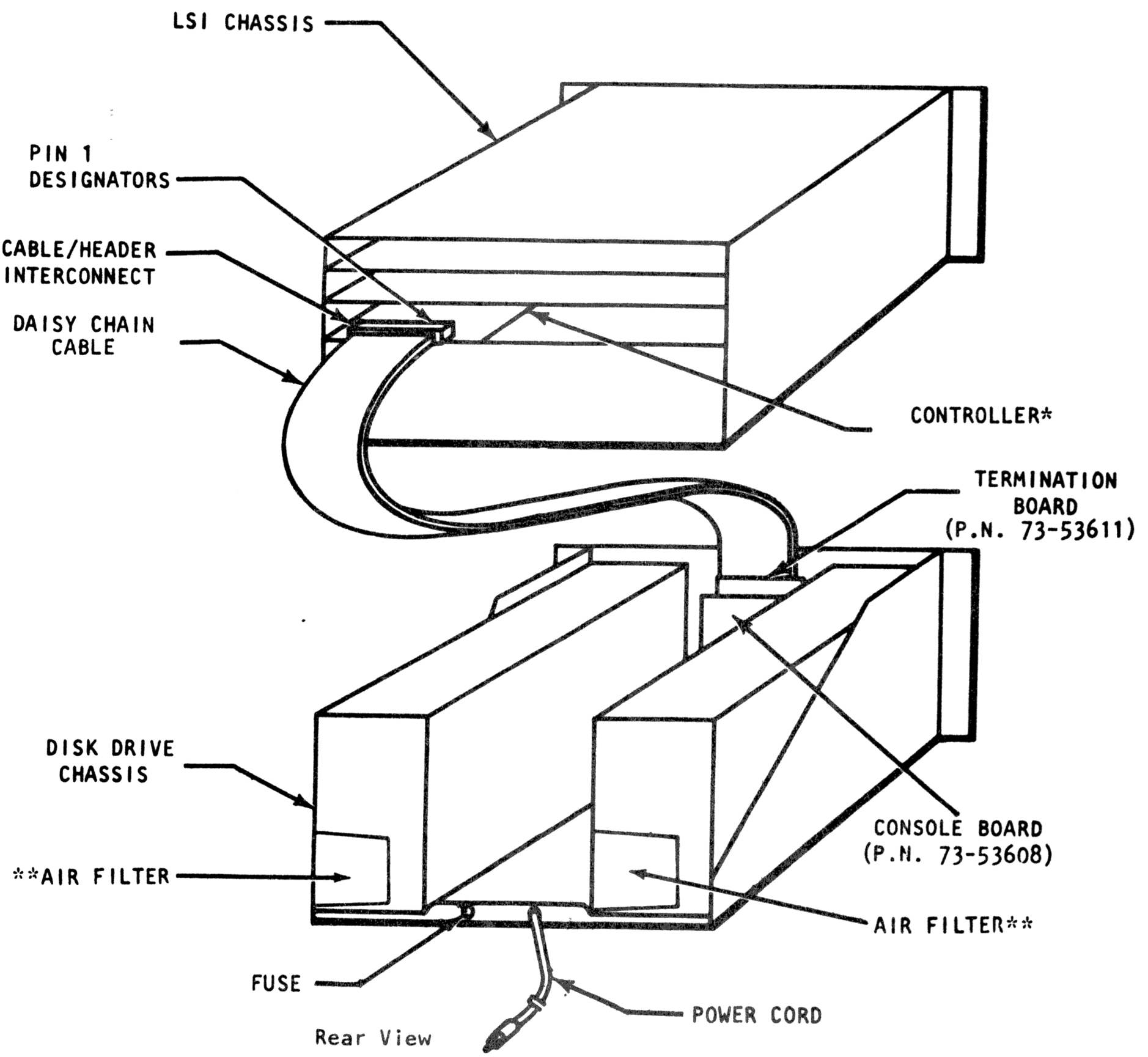
The installation of the floppy disk controller (73-53566 or 73-53696) must accommodate the requirements of both the DMA and the interrupt priority chains. The controller half-card must therefore be installed in a left-side slot in the computer motherboard (as viewed from the rear), or in any location of a half-width card cage or ALPHA LSI-3/05, and there must be no open card slots between the controller and the processor. In some cases, it may be necessary to install a filler card to maintain the continuity of the priority chains. The controller's physical position in the computer motherboard determines its interrupt priority relative to other controllers. A priority chain is strung throughout the motherboard connectors. A controller higher in the chain (closer to the processor) has higher priority than controllers lower in the chain. Interrupt priority is explained in detail in section 2 of the Computer Handbook (91-20400-00).

4.2.2 Single Chassis Drive Installation

The floppy disk drive chassis, as well as the computer itself, is designed to mount in a standard 19-inch RETMA rack. After installing the chassis in the rack, make the interconnections as follows (see figure 4-1):

1. Connect the supplied flat ribbon cable hardwired from the disk drive chassis to the rear-edge connector of the controller. Observe proper polarity of the cable connector and the mating connector on the controller by making sure that the pin 1 designators on the two connectors are aligned. (Pin 1 designator locations are indicated in figure 4-1.)

2. Plug a termination board (73-53611) into the header (upper edge connector) on the console board (backside of the control panel on the disk drive chassis).



*Controller must be installed on left side of chassis when viewed from the rear.

**Calcomp Drive only.

Figure 4-1. Single Chassis Drive System Installation

3. Connect the computer chassis and the disk drive chassis to an ac power outlet.

The system is now ready for operation.

4.2.3 Dual Chassis Drive Installation

When using three or four disk drives (two chassis), install as follows (see figure 4-2):

1. Install computer chassis and both disk drive chassis in the proper position in the rack.

2. Connect the supplied ribbon cable from the first disk drive chassis to the rear-edge connector of the controller. Observe proper polarity of the cable connector and the mating connector on the controller by making sure that the pin 1 designators on the two connectors are aligned. (Pin 1 designator locations are indicated in figure 4-2.)

3. Connect the ribbon cable from the second disk drive chassis to the header on the console board of the first disk drive chassis (backside of the control panel). Observe proper polarity of the cable connector and the mating connector on the header by making sure that the pin 1 designators on the two connectors are aligned. (Pin 1 designator locations are indicated in figure 4-2.)

4. Install a termination board (73-53611) into the header on the console board of the second disk drive chassis.

5. Connect the computer chassis and both disk drive chassis to an ac power outlet.

The system is now ready for operation.

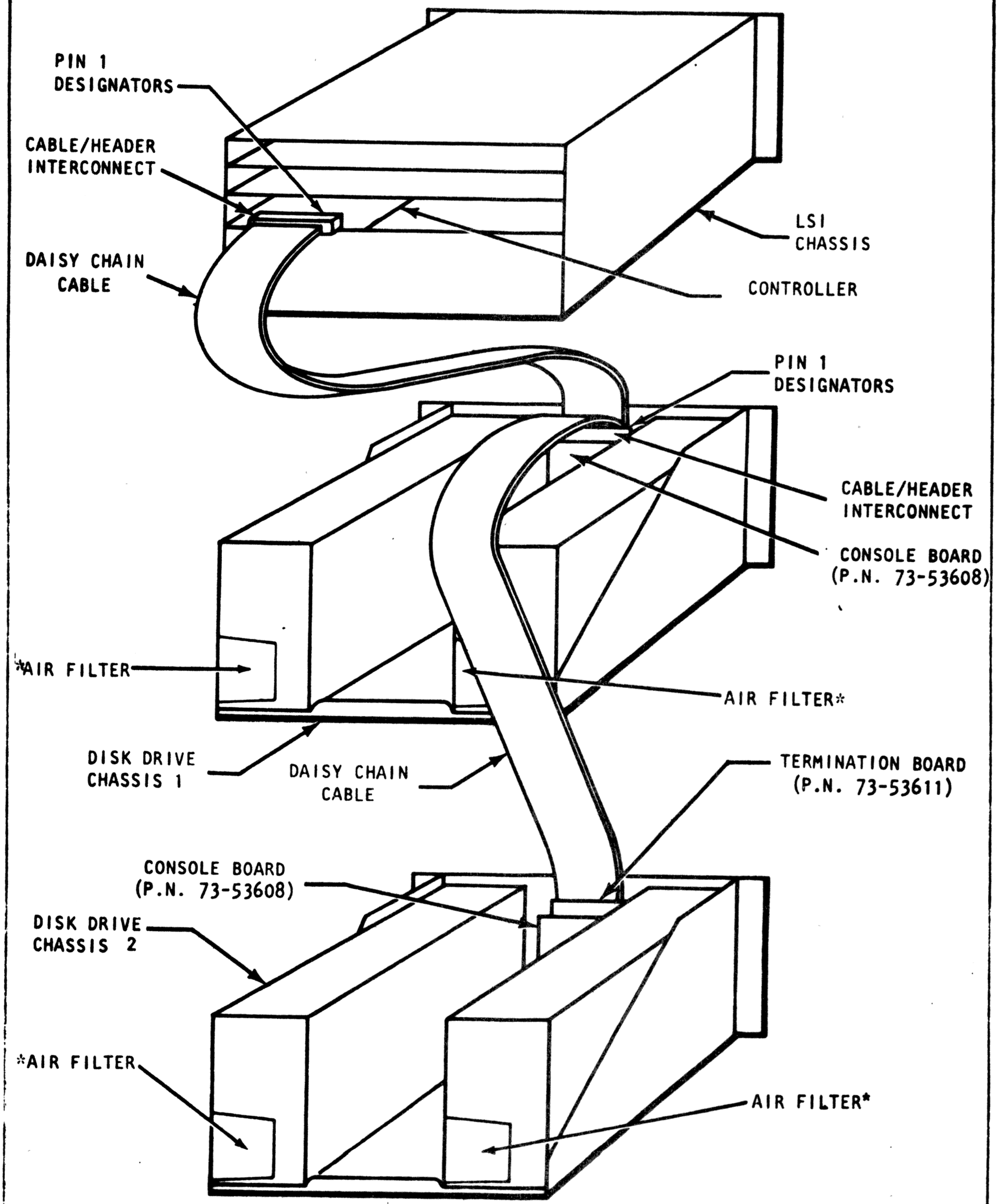
4.3 PERIODIC MAINTENANCE

4.3.1 Chassis and Read/Write Head

Cleaning of the chassis or read/write head is not normally required. A special wiping fabric within the plastic envelope of each diskette removes and traps excess oxide and other debris from the surface of the magnetic disk. However, should cleaning of the read/write head become necessary as a consequence of the continued use of a contaminated diskette, it can be accomplished using lintless gauze dampened with 91% isopropyl alcohol. After the head has been cleaned, dry clean gauze should be used to remove any residue remaining as a result of the evaporation of the alcohol.

4.3.2 Calcomp Air Filters

Each Calcomp drive unit is equipped with a positive pressure air system. A fan driven by the spindle drive motor draws air through a filter, located at the rear of the unit (see figures 4-1 and 4-2), then across the diskette. Because the environmental conditions under which the disk drive chassis may be used vary widely, a recommended schedule for the replacement of air filters is not provided. It is recommended that the user determine a filter replacement schedule that considers the severity of the environmental conditions associated with his application.



*CALCOMP DRIVE ONLY

Figure 4-2. Dual Chassis Drive System Installation

Appendix A

PROGRAMMING EXAMPLES

A.1 INITIALIZE/RESTORE ALL DRIVES

A sample program to initialize and restore all drives is shown in figure A-1. After first establishing the control and termination block in consecutive memory locations and setting a cylinder address of zero, a sense instruction with function code 4 (SEN DA,4) is executed. A positive response indicates that the controller is present. A negative response terminates the program since the controller is not present.

The controller is initialized by a select instruction with function code 4 (SEA DA,4). A sense instruction with function code zero (SEN DA,0) is then executed to sense if the controller is idle. The sense instruction is repeated (jump to IDLE1) until a positive response is obtained. Next, the starting address of the control block (IOBP) is loaded into the X register (LDX IOBP) and the A register is loaded with the op code of 9 for Seek Only (LAP 9). The Seek Only op code in the A register is stored in memory at the op code cell (STA @:0).

Next, the A register is set to zero by LAP 0 and the zero value is stored in cell :1, the Unit Number cell, and in cell :7, the Interrupt Address and Enable cell. This selects unit 0 as the first drive to be restored and the zero value in cell :7 disables interrupts. The A register is loaded with -4 (LAM 4) indicating that four drives are to be restored. This value is stored in LOOPC.

To ensure that the head is positioned in the formatted portion of the diskette, a Seek Only of +2 is performed before the Restore operation (see paragraph 3.3.1.10). The positive Seek Only is set up by storing 2 into the Relative Seek cell (LAP 2 and STA @:3). The output instruction (OTX DA,0) causes Seek Only to be executed on the first drive. The program waits for the drive to enter the idle state with the SEN and JMP instructions.

When the drive is idle (Seek Only finished), the program sets up the Restore operation. The A register is loaded with a -80 (LAM 80) and then transferred into cell location :3 (STA @:3), the Relative Seek Count cell. This leaves the head positioned at cylinder zero at the end of the Seek operation.

The output instruction (OTX DA,0) is issued, the instruction at the IOB start address is executed and the Seek Only (Restore) operation is performed on the first drive. The sense instruction (SEN DA,0) waits for a positive response to indicate that the operation on the first drive is finished. When it is, a LAP :FF instruction sets the lower byte of the A register to all ones. The A register is then ANDed with the status word in the termination block (AND @:9). If any of the first eight bits of the status word is set, an error is indicated and the program jumps to an error routine (JAN ERROR). If no error condition exists, the count at the unit number cell (IMS @:1) and the count at LOOPC (IMS LOOPC) are incremented and the program jumps back to LOOP to repeat the Seek Only (+2) and Restore operations on the next unit. If the LOOPC location increments to zero, all drives have been restored and the program exits.

```
IOB       DATA    0000      Op Code
          DATA    0000      Unit Number
          DATA    0000      Cylinder Address
          DATA    0000      Relative Seek Count
          DATA    0000      Sector Number
          DATA    0000      Word Count
          DATA    0000      Memory Address
          DATA    0000      Interrupt Enable/Address
          DATA    0000      Number of Words Processed
          DATA    0000      Status
IOBP      DATA    IOB       Pointer to IOB

          REL     0
RESTOR    SEN     DA,4      Is Controller present?
          JMP     NOCONT    No Controller.  Exit.
          SEA     DA,4      Yes, Initialize it (contents of A reg. ignored)
IDLE1     SEN     DA,0      Is Controller idle?
          JMP     IDLE1     No.  Wait.
          LDX     IOBP      Yes.  Get IOB pointer
          LAP     9         Load A with Seek Only op code
          STA     @:0       Store it in Op Code cell
          LAP     :0        Zero A register
          STA     @:1       Store it in Unit Number cell
          STA     @:7       Disable interrupts
          LAM     4         Set Loop Control For 4
          STA     LOOPC     Drives (0-3)
LOOP      LAP     2         Seek = +2
          STA     @:3       Store it in Relative Seek cell
OUT1      OTX     DA,0      Seek Only operation
IDLE2     SEN     DA,0      Wait for Idle
          JMP     IDLE2
          LAM     80        Load A with -80 for Restore
          STA     @:3       Store it in Relative Seek cell
OUT2      OTX     DA,0      Restore
IDLE3     SEN     DA,0      Wait for Idle
          JMP     IDLE3
          LAP     :FF       Set up mask for terminal error bits
          AND     @:9       And with status
          JAN     ERROR     If non-zero, error exists
          IMS     @:1       Increment Unit Number
          IMS     LOOPC     All units done?
          JMP     LOOP      No, do next unit
EXIT      NOP               Done
```

Figure A-1. Sample Program - Initialize and Restore All Drives

Note from the example that the controller may not be idle immediately following the initialize instruction (SEA DA,4). It will, however, go idle and will be in a defined state when it does. Note also that the entire control block is present for all operations, but the Seek operation does not use all of the parameters.

A.2 READ ONE SECTOR

A second sample program is shown in figure A-2. In this case, data is to be read from one sector of the diskette.

The first operations are to sense if the controller is installed and, if it is, to sense when it becomes idle. These instructions are similar to those described in the first sample program.

The X register is loaded with the IOB Pointer (LDX IOBP) and the A register is loaded with a value of 7 (LAP 7) representing the op code for Read All Data. The A register is then transferred to the Op Code cell (STA @:0). The A register is loaded with 64 (LAP 64) representing the number of words per sector. This value is stored in the Word Count cell (STA @:5). The A register is next loaded with the data buffer pointer from memory location BUFFP (LDA BUFFP). This address is stored in the Memory Address cell (STA @:6). The unit number N (0-3) is loaded into the A register (LAP N) and stored in the Unit Number cell (STA @:1). The sector number S (1-26) is loaded into the A register (LAP S) and stored in the Sector Number cell (STA @:4). The cylinder number C is loaded into the A register (LAP C) and stored in the Cylinder Address cell (STA @:2). The present cylinder number is subtracted from the selected cylinder number in the A register (SUB PC) and the result is stored in the Relative Seek Count cell (STA @:3).

```
            REL     0
READ        SEN     DA,4        Is Controller present?
            JMP     NOCONT      No Controller.  Exit.
IDLE1       SEN     DA,0        Yes.  Is it idle?
            JMP     IDLE1       No
            LDX     IOBP        Yes.  Get IOB pointer
            LAP     7           Op code for Read All Data
            STA     @:0         Store it in Op Code cell
            LAP     64          Number of words per sector
            STA     @:5         Word Count cell
            LDA     BUFFP       Data buffer pointer
            STA     @:6         Memory Address cell
            LAP     N           N=Unit Number (0-3)
            STA     @:1         Unit Number cell
            LAP     S           S=Sector Number (1-26)
            STA     @:4         Sector Number cell
            LAP     C           C=Cylinder Number
            STA     @:2         Cylinder Number cell
            SUB     PC          Subtract present cylinder
            STA     @:3         Rel Seek Count
            LAP     :0          Zero A register
            STA     @:7         Disable interrupts
            OTX     DA,0        Now do it
IDLE2       SEN     DA,0        Done yet?
            JMP     IDLE2       No. Wait some more
            LAP     :FF         Yes.  Load status mask
            AND     @:9         And status
            JAN     ERROR       If non-zero, error exists
            LDA     @:2         New present cylinder
            STA     PC          Save for next operation
EXIT
```

Figure A-2. Sample Program - Read One Sector

The A register is set to zero by LAP 0 and stored in the Interrupt Enable/Address cell (STA @:7) to disable interrupts as was done in the first example.

The output instruction (OTX DA,0) is executed and the Read All Data operation begins. The sense instruction looks for a positive response indicating that the operation is complete. When a positive response is obtained, the lower byte of the A register is loaded with ones (LAP :FF) and ANDed with the status word as in the first example. A non-zero result jumps the program to an error routine. A zero result indicates that the selected sector has been read from the diskette with no errors. The program is complete.

A.3 CRC CALCULATION

The sample program shown in figure A-3 is used to compute CRC values for both ID and Data fields. Address marks are included in the field on which CRC is generated.

The A register is first set to a value equal to the number of words in the field including the address mark with the upper byte zero:

```
:00FE       ID Address Mark
:00FB       Non-deleted Data Address Mark
:00F8       Deleted Data Address Mark
```

```
            REL     0
BEGIN       NAR                 Negate A register
            STA     LOOPCT      Save it
            LDA     INCRC       Get initial value of CRC
            STA     CRC         Put it in CRC location
            JMP     $+2         Skip next inst 1st time
LOOP        AXI     1           Bump X register
            LAM     16          Number of bits in word
            STA     NOBITS      Save it
            LDA     CRC         Get last CRC
            XOR     @:00        Exclusive-OR with present word
            LLA     1           Shift it left one place
            JOR     $+2         Is overflow reset?
            XOR     POLY        No.  Exclusive-OR with polynomial
            IMS     NOBITS      Word done?
            JMP     $-4         No.  Do some more
            STA     CRC         Save CRC
            IMS     LOOPCT      All words done?
            JMP     LOOP        No.  Go do another word
            LDA     CRC         Get CRC back
            JMP     EXIT        And exit
LOOPCT      DATA    :0000
NOBITS      DATA    :0000
POLY        DATA    :1021       X^16 + X^12 + X^5 + 1
CRC         DATA    :0000
INCRC       DATA    :1E0C       Value so CRC will be :FFFF after 1st
                                  byte of zeroes before Address Mark
```

Figure A-3. Sample Program - CRC Calculation

The X register is set to the location of the first word (address mark) of the field.

First, the contents of the A register are negated and stored in LOOPCT. The initial value of CRC is loaded into the A register. This value (:1E0C) is calculated so that the CRC value will be :FFFF after the first byte of zeros (before address mark). This value is stored in the CRC location and the next instruction is skipped.

The A register is loaded with -16 (LAM 16) representing the number of bits in a word. This value is stored in location NOBITS. The previous value of CRC is loaded into the A register. The present word is exclusive-OR'd with the contents of the A register (XOR @:00). The A register is then shifted left (LLA 1) and the bit shifted into the OV register is tested. If a zero is shifted into OV, the JOR instruction causes the next instruction to be skipped. The bit count in NOBITS is incremented and the A register is again shifted left. When a one is detected in the OV bit (OV set), the A register contents are exclusive-OR'd with the CRC polynomial (XOR POLY) and the bit count at NOBITS is again incremented. As long as NOBITS is not incremented to zero, the left shift operation is repeated and the A register is exclusive-OR'd with the polynomial each time a one is shifted into OV.

When NOBITS increments to zero, the CRC word is complete and it is stored in the CRC location (STA CRC). The word count at LOOPCT is then incremented and, if not incremented to zero, the program jumps to LOOP, the X register (word count) is incremented and another word is processed as described above.

When LOOPCT increments to zero, CRC values for all words have been calculated. The CRC word is loaded into the A register from the CRC location (LDA CRC) and the program exits.

Appendix B

GENERAL CONTROL BLOCK INFORMATION

B.1 CONTROL BLOCK WORD USAGE

At the beginning of each operation, the entire control block is acquired by the controller. However, not all of the information is used for every operation. The following table indicates which words are used by each operation.

Table B-1. Control Block Word Usage

Word No.	0	1	2	3	4	5	6	7
No-Op	*	*						*
Format	*	*		*		*	*	*
Write Non-Deleted Data	*	*	*	*	*	*	*	*
Write Deleted Data	*	*	*	*	*	*	*	*
Read Non-Deleted Data	*	*	*	*	*	*	*	*
Read Deleted Data	*	*	*	*	*	*	*	*
Read Regardless	*	*		*		*	*	*
Read All Data	*	*	*	*	*	*	*	*
Read Verify	*	*	*	*	*	*		*
Seek Only	*	*	*	*				*

B.2 COMMONLY USED CONTROL BLOCKS

The following examples are of commonly used forms of control blocks:

1. Seek Only, Unit 1, from cylinder 46 to cylinder 32, with interrupt address at :1C10.

Opcode	:0009
Unit Number	:0001
Cylinder Number	:0020
Relative Seek Count	:FFF3
Sector Number	:0000
Word Count	:0000
Memory Address	:0000
Interrupt Enable and Address	:1C10

2. Write Non-Deleted Data, Unit 3, cylinder 7, sector 18, 64 words (1 sector), buffer at :2A00, interrupt address at :3CF0, with the head presently at cylinder 0.

Opcode	:0002
Unit Number	:0003
Cylinder Number	:0007
Relative Seek Count	:0007
Sector Number	:0012
Word Count	:0040
Memory Address	:2A00
Interrupt Enable and Address	:3CF0

3. Read All Data, Unit 0, cylinder 10, sector 12, 64 words, buffer at :0100, without interrupts, and head presently at cylinder 1.

Opcode	:0007
Unit Number	:0000
Cylinder Number	:000A
Relative Seek Count	:0009
Sector Number	:000C
Word Count	:0040
Memory Address	:0100
Interrupt Enable and Address	:0000

Appendix C

CABLES AND CONNECTOR PIN ASSIGNMENTS

C.1 DISK DRIVE CHASSIS-TO-CONTROLLER CABLE CONNECTOR PIN ASSIGNMENTS

The disk drive chassis is connected to the controller board by a ribbon cable. The following is a list of pin assignments for the cable connectors.

Signal	Pin	Signal	Pin
Head Load Return	1	Read Data Return	21
Head Load-	2	Read Data-	22
Direction Return	3	Write Protect Return	23
Direction-	4	Write Protect-	24
Low Current Return	5	Track 0 Return	25
Low Current-	6	Track 0-	26
Step Return	7	Index Return	27
Step-	8	Index-	28
U0 Return	9	File Inoperative Return	29
U0-	10	File Inoperative-	30
U2 Return	11	Ready Return	31
U2-	12	Ready-	32
U3 Return	13	N/C	33
U3-	14	N/C	34
U1 Return	15	Write Enable Return	35
U1-	16	Write Enable-	36
N/C	17	Write Data Return	37
N/C	18	Write Data-	38
N/C	19	N/C	39
N/C	20	N/C	40

C.2 DISK DRIVE INTERNAL CABLE CONNECTOR PIN ASSIGNMENTS

Each disk drive in the disk drive chassis is connected to the console board in the disk drive chassis by a separate ribbon cable. The following is a list of pin assignments for the cable connectors.

Signal	Signal Pin	Ground Pin	Signal	Signal Pin	Ground Pin
+5 Vdc	P-2	P-1	Ready-	P-22	P-21
+5 Vdc	P-4	P-3	Low Current-	P-24	P-23
Direction	P-6	P-5	Index-	P-26	P-25
Step-	P-8	P-7	Not Used	P-28	P-27
+24 Vdc	P-10	P-9	Write Enabled-	P-30	P-29
+24 Vdc	P-12	P-11	Write Data-	P-32	P-31
+24 Vdc	P-14	P-13	Write Enable-	P-34	P-33
Select-	P-16	P-15	Not Used	P-36	P-35
Track 00-	P-18	P-17	Read Data-	P-38	P-37
Head Load-	P-20	P-19	Not Used	P-40	P-39

Appendix D

INPUT POWER CONVERSION

D.1 POWER SUPPLY STRAPPING

Computer Automation supplies the floppy disk chassis in two input power configurations:

115 Vac 60 Hz
220 Vac 50 Hz

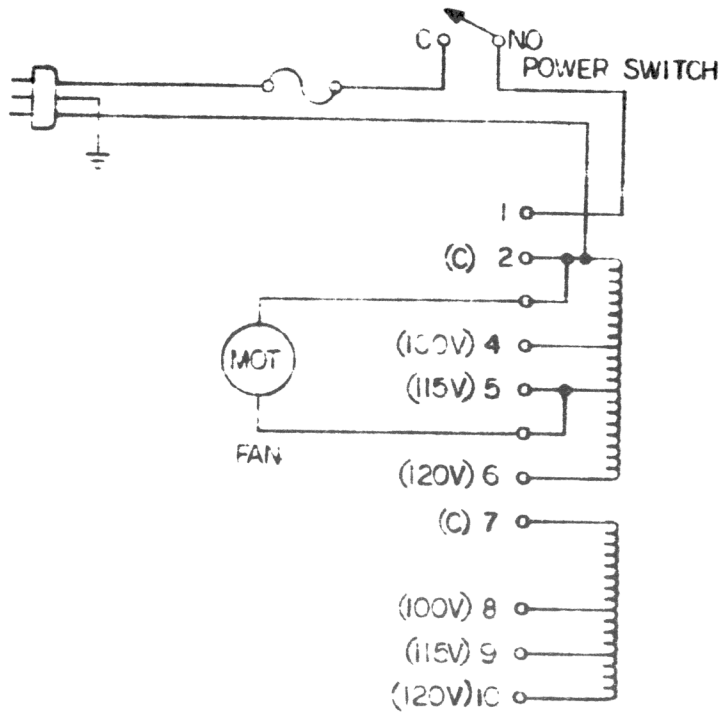
The input line frequency is fixed by the drive(s); however, the user may restrap the power supply to his requirements as indicated in figure D-1.

D.2 FUSE VALUES REQUIRED

The following fuse values should be observed for the corresponding line voltages.

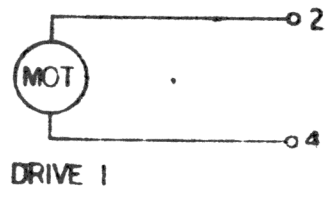
Line Voltage	Fuse Rating (two drives)	Fuse Rating (one drive)
100 Vac	5 A 125 V	3 A 125 V
115 Vac	5 A 125 V	3 A 125 V
220 Vac	2.5 A 250 V	1.5 A 250 V
230 Vac	2.5 A 250 V	1.5 A 250 V
240 Vac	2.5 A 250 V	1.5 A 250 V

PRIMARY WIRING

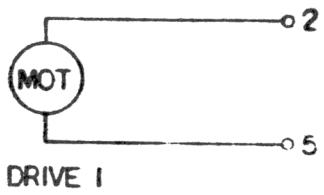


DISK DRIVE MOTOR CONNECTIONS

50 HZ



60 HZ

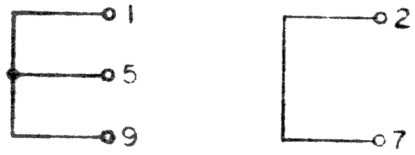


INPUT WIRING (TERMINAL BLOCK)

100 VAC



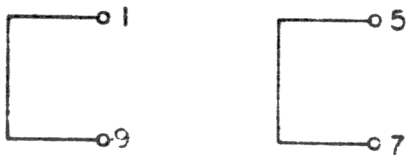
115VAC



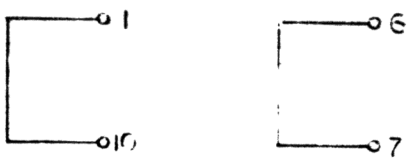
220 VAC



230VAC



240 VAC



STANDARD CONFIGURATION

115VAC AT 60HZ (-01)
220VAC AT 50HZ (-02)

NOTE: This conversion information applies to the B0 revision level or later. Earlier versions are fixed-wired and are not convertible.

Figure D-1. Power Supply Strapping

Appendix E

INTERFACING THE CALCOMP 140-C FLOPPY DISK DRIVE

E.1 INTRODUCTION

The Computer Automation Floppy Disk Controller (73-53566 or 73-53696) can service up to four Calcomp 140-C Floppy Disk Drives. There are two ways to interface the controller to these drives:

1. In systems that use Computer Automation's Floppy Disk Chassis, power supply and control panel, the Floppy Disk Controller is cabled directly to the Floppy Disk Chassis and the Floppy Disk Chassis is cabled to the Calcomp Floppy Disk Drive(s).

2. Alternatively, the Floppy Disk Controller can be cabled directly to the Calcomp 140-C Floppy Disk Drive(s). This approach, however, requires minor modifications to both the Floppy Disk Controller and the Calcomp Floppy Disk Drive(s); these modifications are described in Section E.2.

Sections E.3 and E.4 describe the settings of the Controller switches and interface cable fabrication, respectively. These sections are pertinent to either of the above interface situations.

E.2 MODIFICATIONS FOR DIRECT INTERFACING (CONTROLLER TO DRIVE)

E.2.1 Calcomp 140-C Floppy Disk Drive Modifications

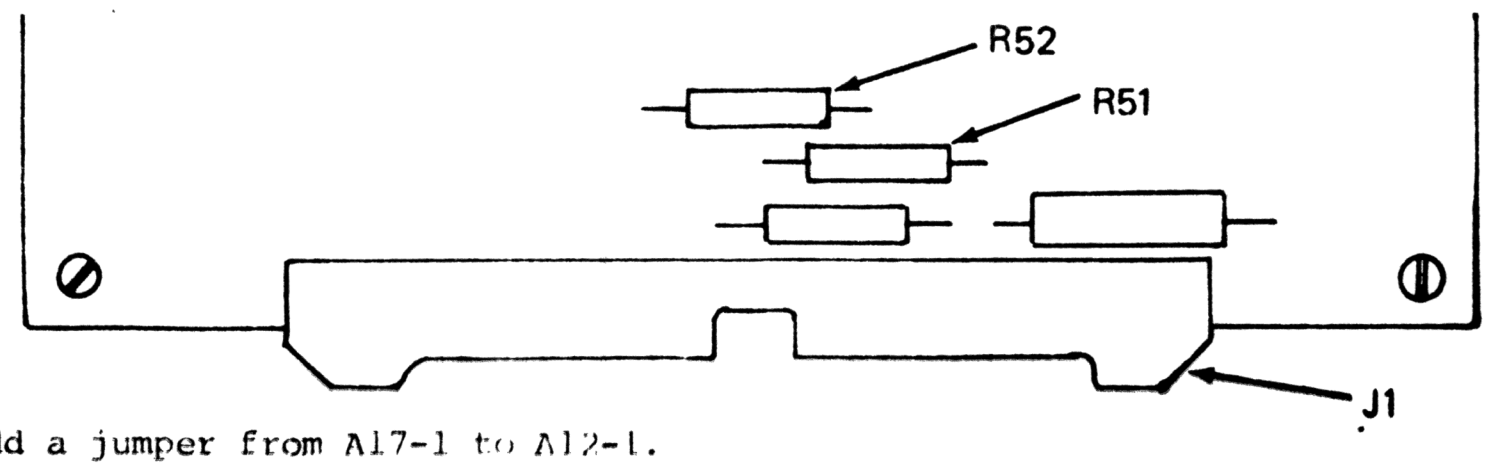
Refer to the vendor manual covering the Calcomp 140-C Floppy Disk Drive for the locations of the drive modifications described below.

MODIFICATIONS FOR DRIVES WITH REVISION LEVELS LOWER THAN "J"

Select the raw data output by adding a jumper from A6-4 to A6-5 on the header.

Place the READY- signal under unit select control by making the following modifications:

1. Remove resistors R51 and R52 (shown below).



2. Add a jumper from A17-1 to A12-1.

Place the WRITE ENABLED- signal under unit select control by making the following modifications:

1. Remove the jumper between A5-2 and A5-4.
2. Add a jumper from A4-10 to A5-2.

MODIFICATIONS FOR DRIVES WITH REVISION LEVELS OF "J" AND ABOVE

Only two modifications are required to these drives:

1. Cut the etch connecting A17-4 to A17-5 (component side).
2. Add a jumper from A12-1 to A17-2.

E.2.2 Floppy Disk Controller Modifications

Make the following modifications:

1. Cut the etch at IC76-2 (solder side).
2. Add a jumper from IC76-1 to IC22-14.

E.3 FLOPPY DISK CONTROLLER SWITCH SETTINGS

Set controller switches 5 and 6, which select cylinder-to-cylinder timing, head load timing, and head step direction, as indicated below:

Switch	Function	Position
5	Controls cylinder-to-cylinder and head load timing	ON (10.5 ms cylinder-to-cylinder: 50 ms head settling time)
6	Controls head step direction	OFF (Out = 0 volts) (In = 5 volts)

E.4 INTERFACE CABLE FABRICATION

Fabricate a cable in accordance with the wire list given below.

Signal	Controller Pin No.	Drive Pin No.
Head Load Return	1	19
Head Load-	2	20
Direction Return	3	5
Direction-	4	6
Low Current Return	5	23
Low Current-	6	24
Step Return	7	7
Step-	8	8

Signal	Controller Pin No.		Drive Pin No.
UO Return	9	Selectable pairs assign the logical unit number to the drive. (radial signal)	
UO-	10		
U2 Return	11		
U2-	12		15
U3 Return	13		16
U3-	14		
Ul Return	15		
Ul-	16		
N/C	17		
N/C	18		
N/C	19		
N/C	20		
Read Data Return	21		37
Read Data-	22		38
Write Protect Return	23		29
Write Protect-	24		30
Track 0 Return	25		17
Track 0-	26		18
Index Return	27		25
Index-	28		26
File Inoperative Return	29		
File Inoperative-	30		
Ready Return	31		21
Ready-	32		22
N/C	33		
N/C	34		
Write Enable Return	35		33
Write Enable-	36		34
Write Data Return	37		31
Write Data-	38		32
N/C	39		
N/C	40		
+5 Vdc			2,4
+5 Return			1,3
+24 Vdc			10, 12, 14
+24 Return			9, 11, 13

NOTE

Pin numbers not included in the list are unused and must be left open.

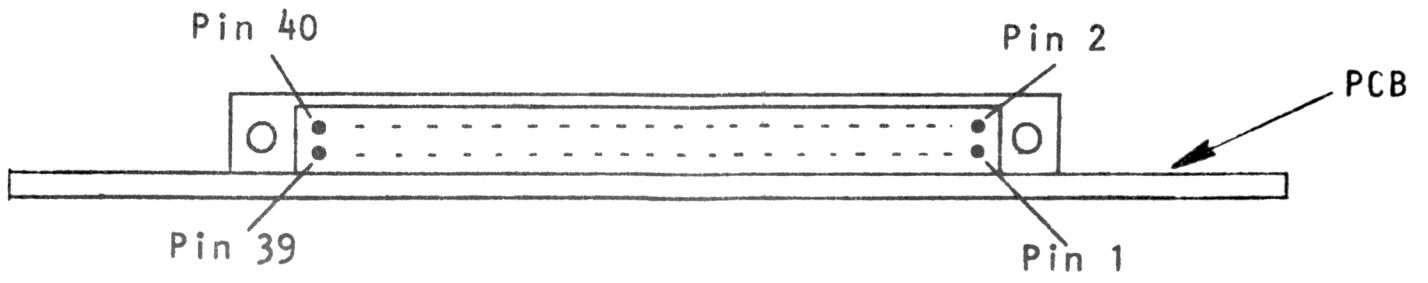
If flat ribbon cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

3M P/N 3417-3000

If twisted pair cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

Cannon P/N 121-7326-020 (connector body)
Cannon P/N 030-7312-021 (contacts)

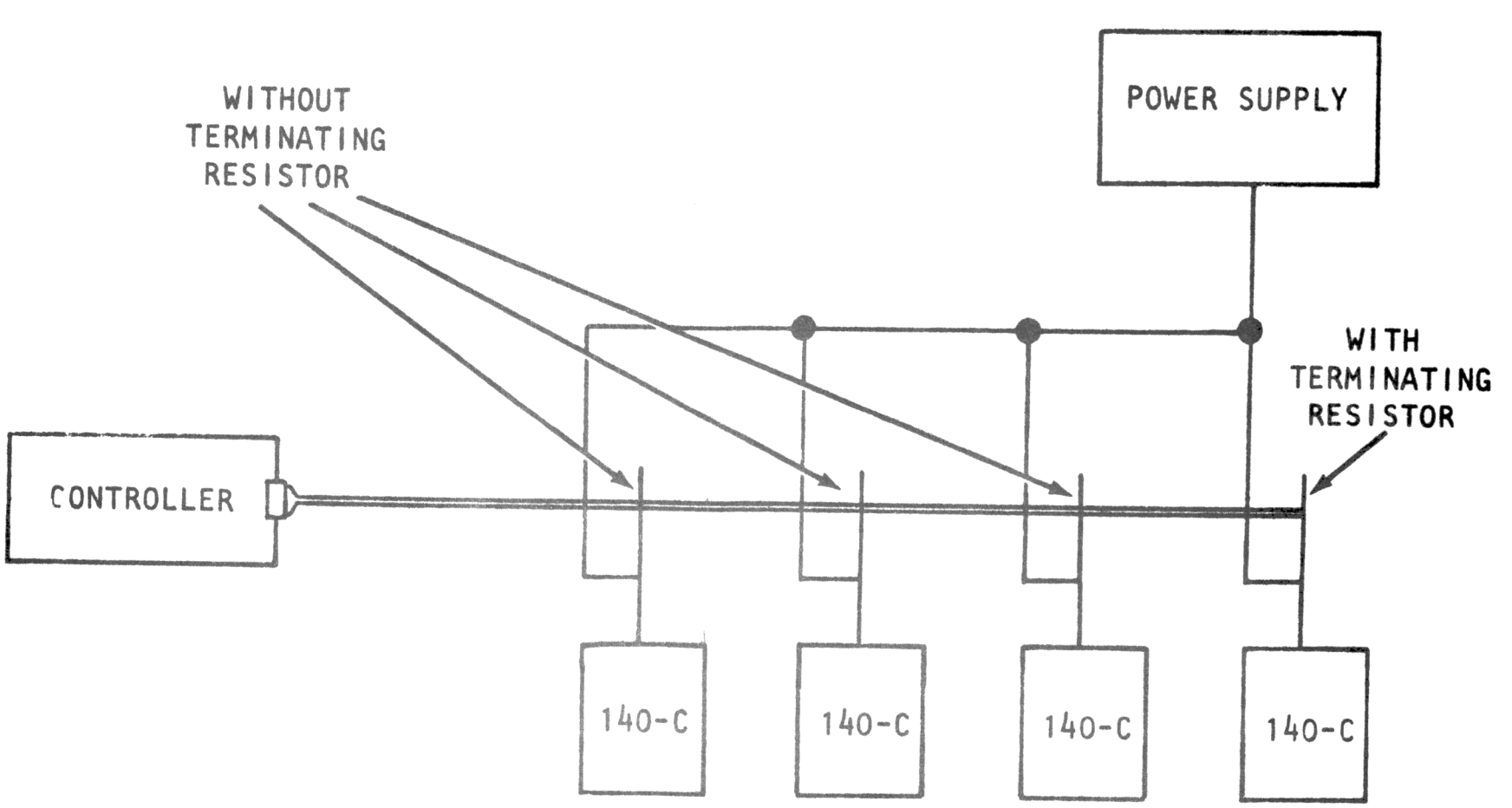
The connector used at the end of the cable that connects to the drive must mate with connector J1 on the drive. Refer to the pertinent vendor manual for the appropriate connector specification. Shown below is the pin configuration of connector J1.



Cable fabrication can be facilitated by incorporating the appropriate Calcomp termination board (paddle board). Two paddle boards are available from Calcomp:

Calcomp P/N 12084-001 (with termination resistors)
Calcomp P/N 12084-002 (without termination resistors)

Typical utilization of the paddle boards is illustrated below.



Appendix F

INTERFACING THE PERTEC FD400 FLOPPY DISK DRIVE

F.1 INTRODUCTION

The Computer Automation Floppy Disk Controller (73-53566 or 7353696) can be service to four Pertec FD400 Floppy Disk Drive(s). To implement the interface, Pertec FD400 Daisy Chain Adapter(s) (-12 version) must be obtained and connected to the drive(s), an interfacing cable must be fabricated and connected between the daisy chain adapter(s) and the controller, and two switches on the controller must be set as specified. Information needed for installing the daisy chain adapter(s), for fabricating the interface cable, and for setting the controller switches is presented below. This information is intended to supplement the information in the Pertec OEM Reference Manual and Daisy Chain Adapter Manual.

F.2 PERTEC FD400 DAISY CHAIN ADAPTER INSTALLATION

Install the Pertec FD400 Daisy Chain Adapter as specified in the pertinent vendor manual.

F.3 INTERFACE CABLE FABRICATION

Fabricate a cable in accordance with the wire list given below.

Signal	Controller Pin No.	Daisy Chain Adapter Pin No.
Head Load Return	1	24
Head Load-	2	23
Direction Return	3	20
Direction-	4	19
Low Current Return	5	16
Low Current-	6	15
Step Return	7	22
Step-	8	21
U0 Return	9	4
U0-	10	1
U2 Return	11	
U2-	12	3
U3 Return	13	
U3-	14	5
U1 Return	15	
U1-	16	2
N/C	17	
N/C	18	
N/C	19	
N/C	20	

	Controller Pin No.	Daisy Chain Adapter Pin No.
Read Data Return	21	30
Read Data	22	29
Write Protect Return	23	
Write Protect	24	33
Track 0 Return	25	
Track 0	26	32
Index Return	27	46
Index	28	45
File Inoperative Return	29	
File Inoperative	30	
Ready Return	31	34
Ready	32	31
N/C	33	
N/C	34	
Write Enable Return	35	12
Write Enable	36	11
Write Data Return	37	18
Write Data	38	17
N/C	39	
N/C	40	

NOTE

Eight signals available at the daisy chain adapter are not used by the controller. Four of these signals, DRIVE MOTOR ENABLE 0-3, must be grounded somewhere in the system. The other four signals, READY 0-3, may be utilized to drive a visual "ready" indicator for each drive; otherwise, they are unused.

Power connection and cable termination information is provided in Pertec's Daisy Chain Adapter specification.

If flat ribbon cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

3M P/N 3417-3000

If twisted pair cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

Cannon P/N 121-7326-020 (connector body)
Cannon P/N 030-7312-021 (contacts)

Refer to the pertinent vendor manual to determine the appropriate connector for use at the end of the cable that connects to the adapter.

F.4 FLOPPY DISK CONTROLLER SWITCH SETTINGS

Set controller switches 5 and 6, which select cylinder-to-cylinder timing, head load timing, and head step direction, as indicated below:

Switch	Function	Position
5	Controls cylinder-to-cylinder and head load timing	ON (10.5 ms cylinder-to-cylinder; 50 ms head settling time)
6	Controls head step directions	ON (out = 5 volts) (In = 0 volts)

Appendix G

IMPLEMENTATION OF SYSTEM FUNCTIONS

G.1 INTRODUCTION

The information in this appendix is intended to aid the user who obtains only the Computer Automation Floppy Disk Controller and must implement in his system necessary system functions (external to the controller) that are normally provided by the Computer Automation Floppy Disk Drive chassis. The floppy disk chassis incorporates a console board which is used to provide the following system functions:

1. Unit selection and indicators
2. WRITE PROTECT indicators
3. READY indicators
4. DC power distribution to drives
5. Cable termination
6. Interconnection between controller signal cable and drive signal/dc power cable.

The user who does not use the Computer Automation floppy disk chassis must, by some means, implement at least items 4 thru 6.

The following text and diagrams, which describe Computer Automation's implementation of the listed system functions, are presented to assist the user in devising equivalent implementations appropriate to his system.

G.2 INTERCONNECTION SCHEME

Figure G-1 illustrates the interconnection scheme employed at the console board of the floppy disk chassis.

When used in a single chassis configuration, the flat ribbon input signal cable is plugged into the controller and the terminator board is plugged into the output signal connector. If a dual chassis configuration is used, the flat ribbon input signal cable of the first console board is plugged into the controller; the flat ribbon input signal cable of the second console board is plugged into the output signal connector of the first console board; and the terminator board is plugged into the output connector of the second console board.

G.3 UNIT SELECT LOGIC

Unit select logic is illustrated in figure G-2.

The unit select signals from the controller are low-true. If the user desires to convert these signals to high-true, IC's 73 and 74 on the controller must be changed from SN 75452's to SN 75451's. These IC locations are socketed for this purpose. If the user does not require alterable logical unit numbers as a feature, the unit select lines may be connected directly to the respective drive (unit select 0 to drive 0, unit select 1 to drive 1, etc.). Unit select LED's may be driven directly

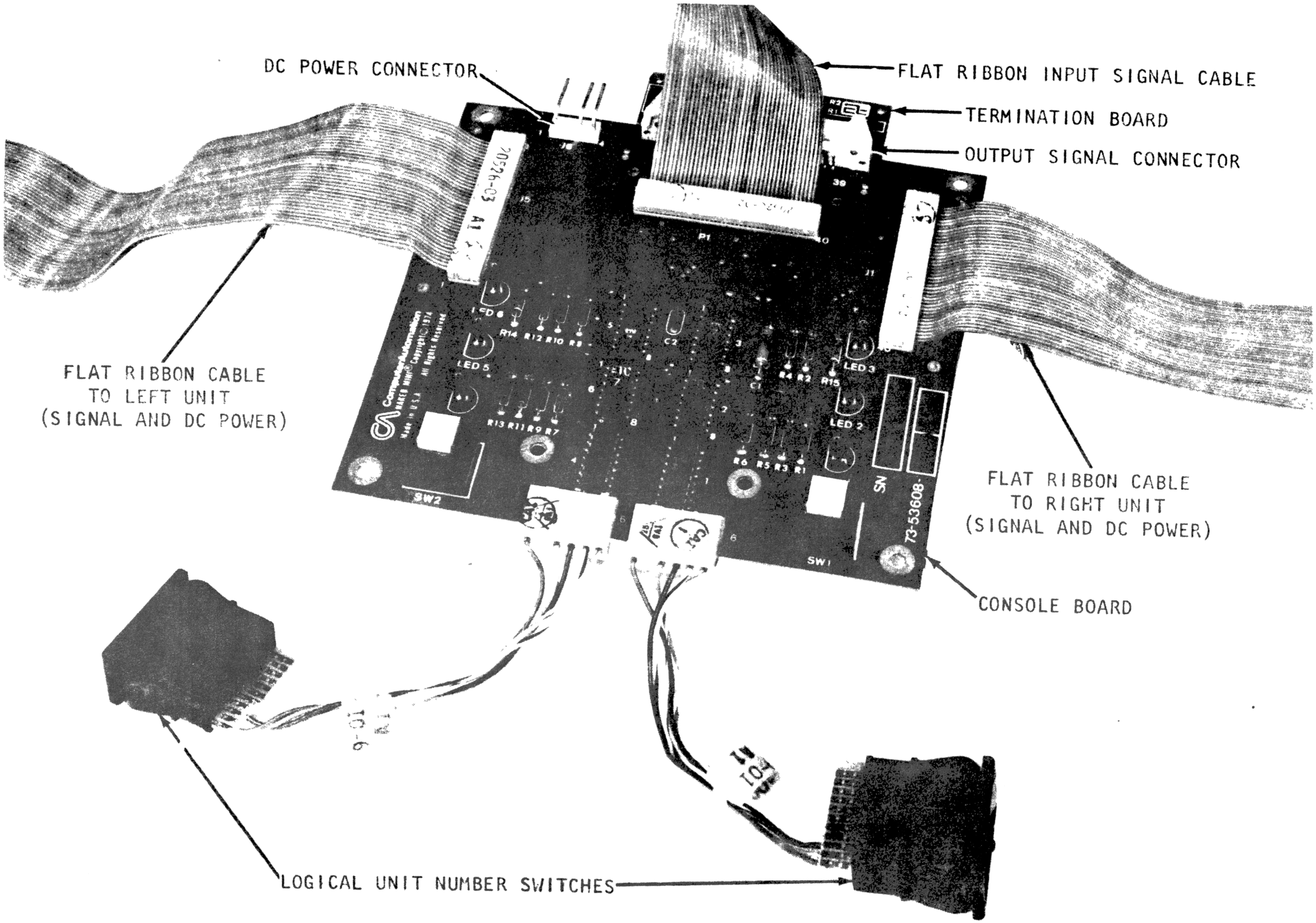


Figure G-1. Interconnections at the Console Board

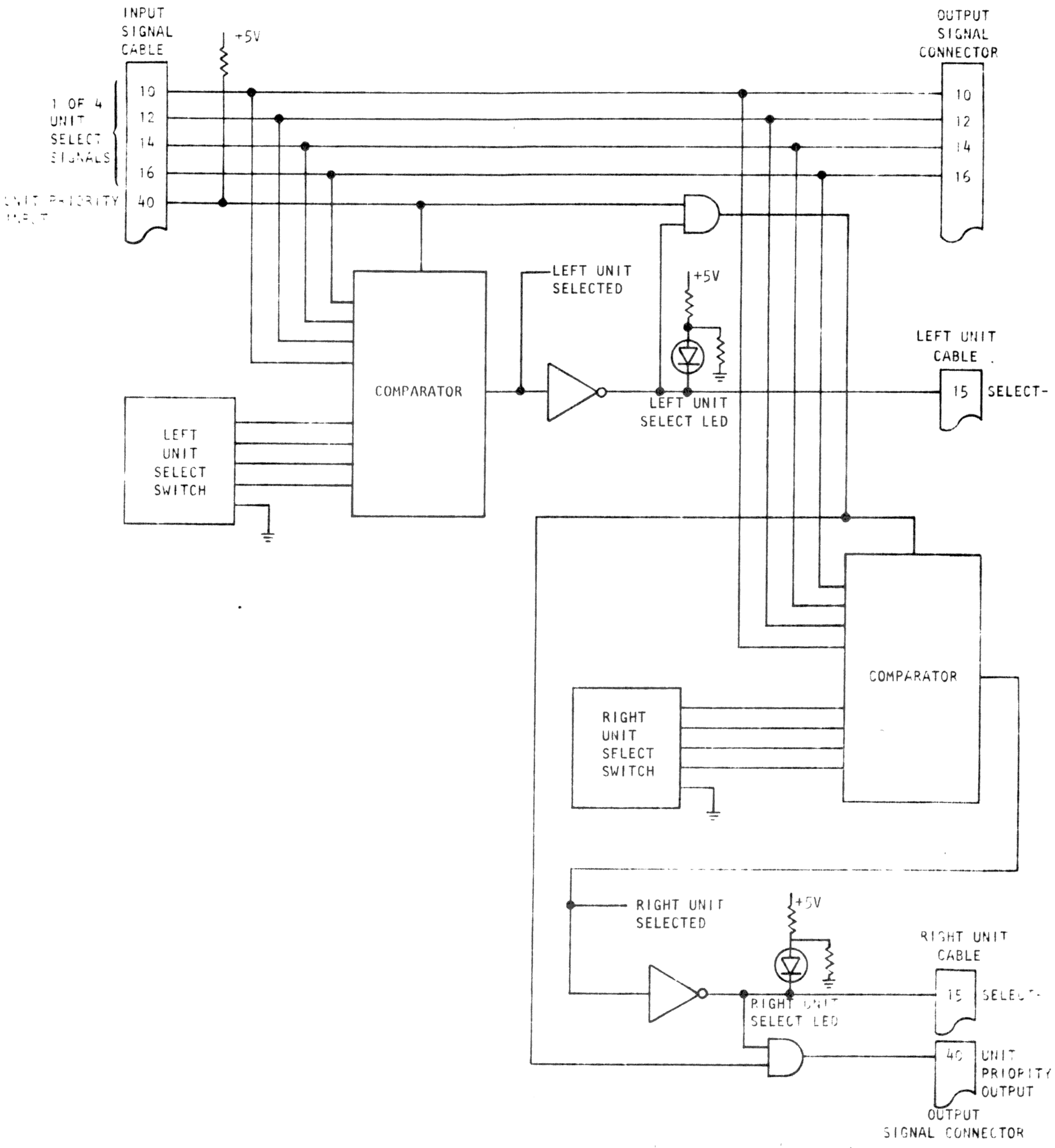


Figure G-2. Unit Select Logic Diagram

from the unit select lines, if desired. If the drive that is used has a terminated select line, then a pull-down resistor must be provided to prevent the LED from being turned on when the drive is not selected (e.g., Computer Automation's implementation).

The unit priority signals are used when multiple chassis are connected to the controller. The signal is high-true and is open at the controller. If a valid comparison is made between the unit select lines and the left unit select switch, the right unit and units in subsequent chassis are inhibited from being selected.

The LEFT UNIT SELECTED and RIGHT UNIT SELECTED signals are used to control other signals which are described below.

G.4 WRITE PROTECT AND READY LOGIC

Figure G-3 illustrates write protect and ready logic, and the associated write protect and ready indicators. For simplicity, only the logic for the left unit is shown. The logic is identical for the right unit, except that the inputs are from the right unit cable.

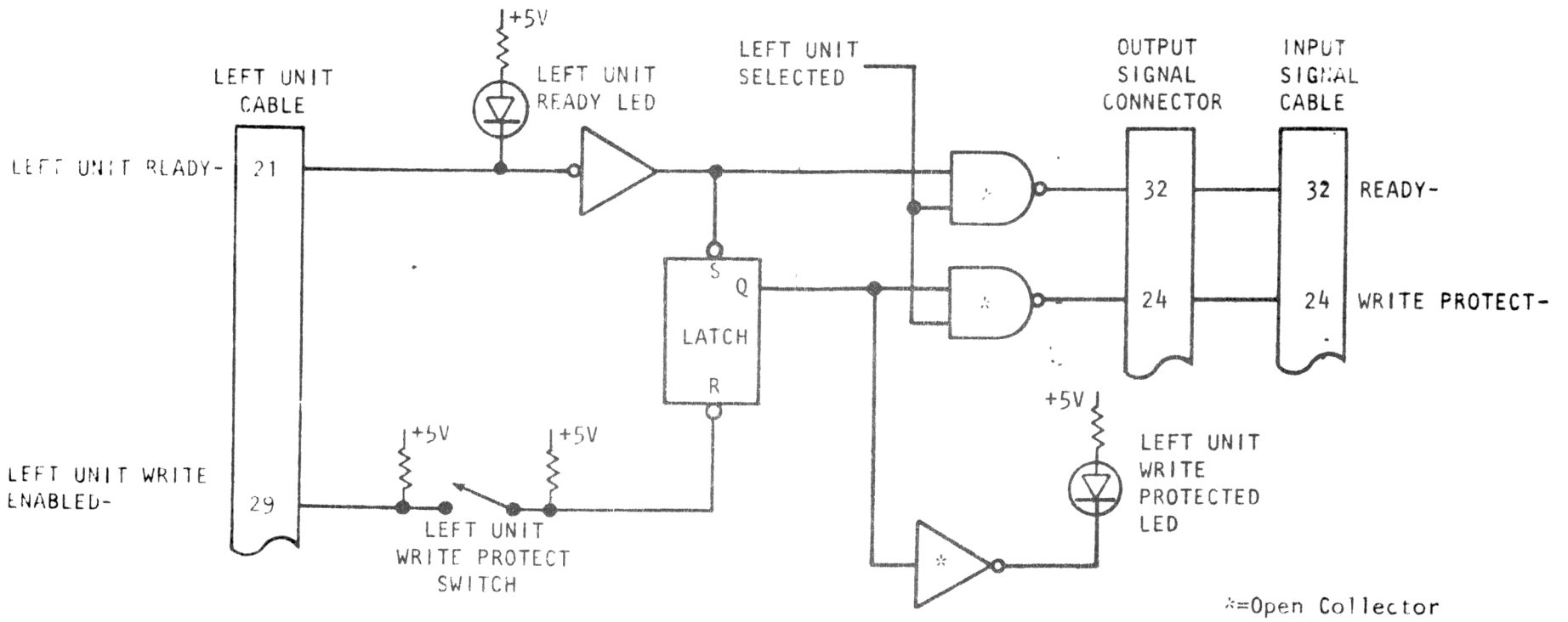


Figure G-3. Write Protect and Ready Logic Diagram

The inputs from the drive are radial signals in order to drive the indicators even when the drive is not selected. The signals are then converted to daisy-chain signals and input to the signal cable. If the user does not require the indicators, the signals must be under control of unit select as they come out of the drive.

Computer Automation's implementation of this logic is such that the unit becomes write protected any time the unit is not ready. The unit remains write protected until the write protect switch is depressed after the unit becomes ready.

G.5 DC POWER DISTRIBUTION

Distribution of dc power is illustrated in figure G-4.

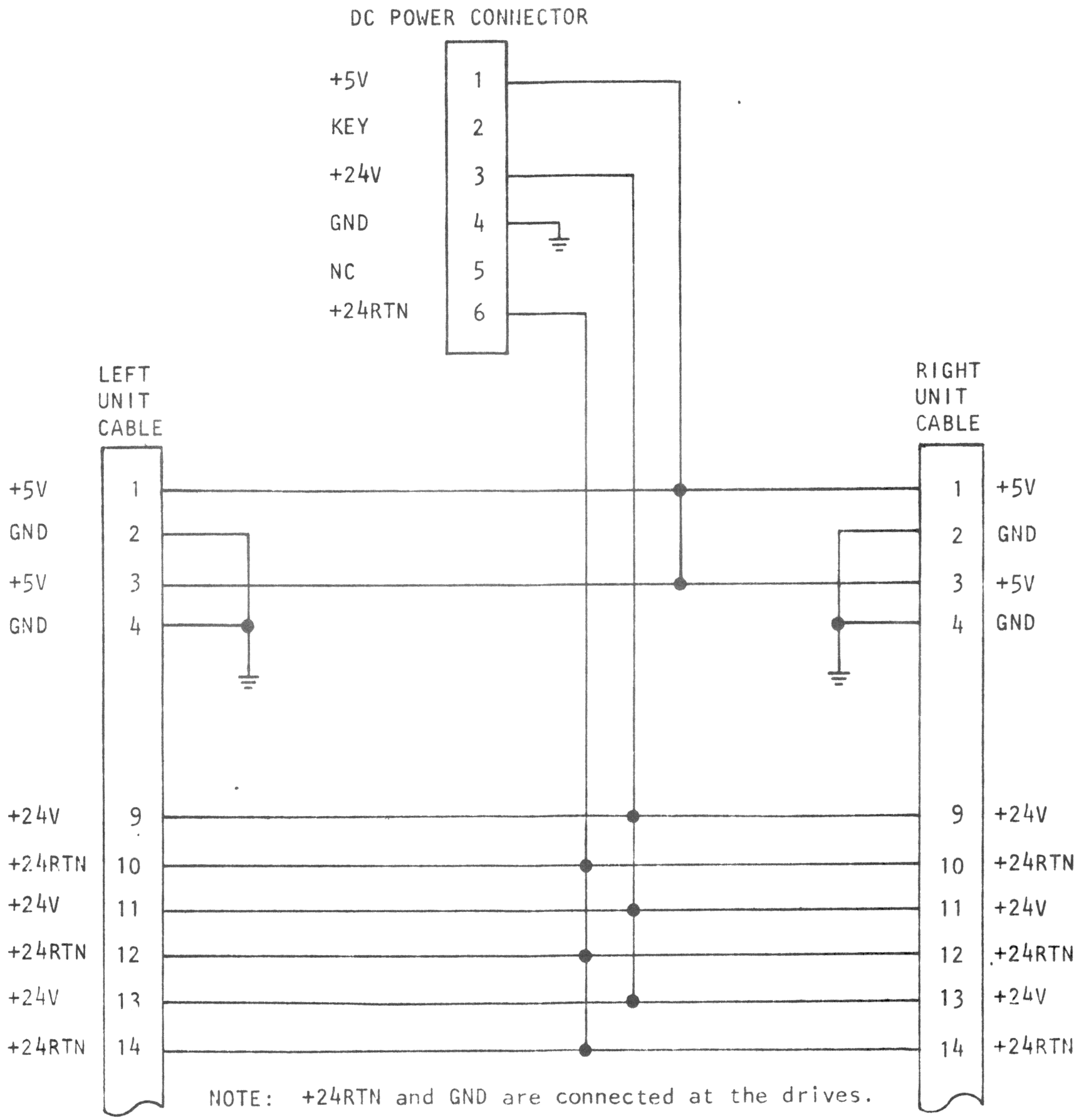
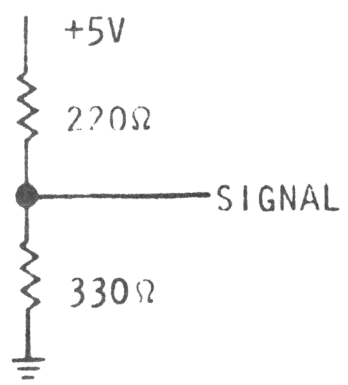


Figure G-4. DC Power Distribution Diagram

G.6 SIGNAL TERMINATION

A typical signal termination network is illustrated below:



The following signals, which are outputs from the controller, are terminated at the output signal connector farthest from the controller:

Signal	Output Connector Pin Number
HEAD LOAD-	2
DIRECTION	4
LOW CURRENT-	6
STEP-	8
U0-	10
U2-	12
U3-	14
U1-	16
WRITE ENABLE-	36
WRITE DATA-	38

+5 volts is supplied on pin 18 of the output signal connector to power the terminator.

G.7 CABLING METHOD

Use of the console board in the Computer Automation system resolves the problem that arises when flat ribbon cable is utilized to carry a combination of daisy-chain signals and radial signals. The user may resolve the problem by implementing the required cabling with twisted pair cable.

Appendix H

INTERFACING THE SHUGART SA800 FLOPPY DISK DRIVE

H.1 INTRODUCTION

The Computer Automation Floppy Disk Controller (73-53566 or 73-53696) can service up to four Shugart SA800 Floppy Disk Drives. There are two ways to interface the controller to the drives:

1. In systems that use Computer Automation's Floppy Disk Chassis, power supply, and control panel, the Floppy Disk Controller is cabled directly to the Computer Automation Floppy Disk Chassis. In turn the Floppy Disk Chassis is cabled to each Shugart Floppy Disk Drive through a paddle board, P/N 73-53681-00.

2. Alternatively, the Floppy Disk Controller can be cabled directly to the Shugart Floppy Disk Drive(s). This approach, however, requires a specific set of customer installable options be selected on the Shugart Floppy Disk Drive(s). Section H.2 describes the options to be selected.

Sections H.3 and H.4 describe the setting of the controller switches and interface cabling, respectively.

H.2 SHUGART SA800 CUSTOMER OPTIONS FOR DIRECT INTERFACING.

Table H-1 indicates the drive configuration as shipped from the factory.

Table H-2 indicates the drive configuration as required to interface directly to Computer Automation's Floppy Disk Controller.

Table H-1.

CUSTOMER CUT/ADD TRACE OPTIONS

TRACE DESIGNATOR	DESCRIPTION	SHIPPED FROM FACTORY	
		OPEN	SHORT
T3,T4,T5,T6	Terminations for Multiplexed Inputs		Plugged
T1	Terminator for Drive Select		Plugged
T2	Spare Terminator for Radial Head Load	X	
DS1,DS2,DS3,DS4	Drive Select Input Pins	X	DS1 is Plugged
RR	Radial Ready		X
RI	Radial Index and Sector		X
R,I,S,	Ready, Index, Sector Alternate Output Pads		X
HL	Stepper Power From Head Load		Plugged
DS	Stepper Power From Drive Select	X	
WP	Inhibit Write When Write Protected		X
NP	Allow Write When Write Protected	X	
8,16,32,	8, 16, 32 Sectors (SA801 Only)	8 & 16	32
D	Altenate Input-In Use	X	
2,4,6,8,10,12,14,16,18	Nine Alternate I/O Pins	X	
D1,D2,D4,DDS	Customer Installable Decode Drive Select Option	X	
A,B,X	Radial Head Load		Plugged
C	Alternate Input-Head Load	X	
Z	In Use from Drive Slect		Plugged
Y	In Use from HD LD	X	
DC	Alternate Output-Disk Change	X	

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Table H-2.

CUSTOMER CUT/ADD TRACE OPTIONS FOR CAI FLOPPY DISK

TRACE DESIGNATOR	DESCRIPTION	AS REQUIRED	
		OPEN	SHORT
T3,T4,T5,T6	Terminations for Multiplexed Inputs		Note 1
T1	Terminator for Drive Select		Note 1
T2	Spare Terminator for Radial Head Load		Note 1
DS1,DS2,DS3,DS4	Drive Select Input Pins		Note 2
RR	Radial Ready		X
RI	Radial Index and Sector		X
R,I,S,	Ready, Index, Sector Alternate Output Pads		X
HL	Stepper Power From Head Load	X	
DS	Stepper Power From Drive Select		X
WP	Inhibit Write When Write Protected		X
NP	Allow Write When Write Protected	X	
8,16,32,	8, 16, 32 Sectors (SA801 Only)	8 & 16	32
D	Alternate Input-In Use	X	
2,4,6,8,10,12,14,16,18	Nine Alternate I/O Pins	X	
D1,D2,D4,DDS	Customer Installable Decode Drive Select Option	X	
A,B,X	Radial Head Load	"X"	A,B Plugged
C	Alternate Input-Head Load		Plugged
Z	In Use from Drive Slect		Plugged
Y	In Use from HD LD	X	
DC	Alternate Output-Disk Change	X	

Note 1: Terminations should be on only the last drive in the daisy chain.

Note 2: Install drive select jumper plugs to assign unit number to drive.

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H.3 FLOPPY DISK CONTROLLER SWITCH SETTINGS.

Set controller switches 5 and 6, which select cylinder-to-cylinder timing, head load timing, and head step direction, as indicated below:

Switch	Function	Position
5	Controls cylinder-to-cylinder and head load timing	ON (10.5 ms cylinder-to-cylinder: 50 ms head settling time)
6	Controls head step direction	ON (Out = 5 volts) (In = 0 volts)

H.4 INTERFACE CABLE FABRICATION

Fabricate a cable in accordance with the wire list given below.

Signal	Controller Pin No.	Drive Pin No.
Head Load Return	1	17
Head Load-	2	18
Direction Return	3	33
Direction-	4	34
Low Current Return	5	N/C
Low Current-	6	N/C
Step Return	7	35
Step-	8	36
UO Return	9	25
UO-	10	26
U2 Return	11	29
U2-	12	30
U3 Return	13	31
U3-	14	32
Ul Return	15	27
Ul	16	28
N/C	17	28
N/C	18	
N/C	19	
N/C	20	
Read Data Return	21	45
Read Data-	22	46
Write Protect Return	23	43
Write Protect-	24	44
Track O Return	25	41
Track O-	26	42
Index Return	27	19
Index-	28	20
File Inoperative Return	29	N/C
File Inoperative-	30	N/C

Signal	Controller Pin No.	Drive Pin No.
Ready Return	31	21
Ready	32	22
N/C	33	
N/C	34	
Write Enable Return	35	39
Write Enable	36	40
Write Data Return	37	37
Write Data	38	38
N/C	39	
N/C	40	

NOTE

Pin numbers not included in the list are unused and must be left open.

If flat ribbon cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

3M P/N 3417-3000

If twisted pair cable is employed in fabricating the interface cable, the connector specified below or equivalent must be used at the end of the cable that is to be attached to the controller.

Cannon P/N 121-7326-020 (connector body)
Cannon P/N 030-7312-021 (contacts)

The connector used at the end of the cable that connects to the drive must mate with connector J1 on the drive. Refer to the pertinent vendor manual for the appropriate connector specification.

Seperate connectors are provided on the drive for A.C. and D.C. power inputs. Refer to the vendor's manual for this information.