

VECTORS

DUAL-MODE DISK
CONTROLLER BOARD

Eng. Documentation

DUAL-MODE DISK CONTROLLER BOARD

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FOREWORD

Audience

This manual is intended for experienced assembly language programmers, who have an in depth knowledge of disk systems and disk controllers.

Scope

It will describe how to implement a disk driver to use the Vector Graphic Dual-Mode Controller Subsystem in other S-100 systems.

Organization

Each section is written at a uniform level of technical depth. Each section contains specific information about the disks and controller. Latter sections of the manual build on the beginning sections. To write a successful driver it is imperative that the manual be read in its entirety.

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VECTOR DUAL-MODE CONTROLLER SUBSYSTEM

1.1 INTRODUCTION

This section describes the Vector Dual-Mode Controller Subsystem (VEDMCS) in sufficient detail to enable the experienced assembly language programmer to implement a disk driver.

1.2 ORGANIZATION

This manual will start with each titled section divided into pairs of subsections. The hard disk (H/D) will be discussed first, followed by the same discussion as it relates to the floppy disk (F/D). This is to separate the specific information for each type of disk. As we progress into writing the disk driver the discussion will move to combining the two types of drives into the same routines.

1.3 HARDWARE FUNDAMENTALS

The Vector dual mode controller is a self contained unit on a single board. On-board memory, which is accessed through a control port, provides the high speed loading and unloading of data to and from the controller. Control and status each have two 8-bit registers accessed through data ports. After the controller receives the control signals and data in the correct format, it will automatically sequence the physical reading or writing of the disk. These features save valuable memory locations through reduced software, and spare the programmer from tedious timing requirements.

Other features include a built in hardware generated Error Correction Code (ECC). If the single control bit "ECC on/off" is on, the ECC will be generated and inserted immediately following the data during a disk write. During a read a new ECC is calculated and compared with the one already written. If an error is detected a correction code is inserted in the ECC block immediately following the data. In the off mode ECC is transparent.

Write pre-compensation is another single control bit feature. The programmer need only determine the track number above which pre-compensation is necessary, and turn it on or off.

Figure 1.1 is a block diagram of the controller subsystem. It is provided as a reference. All specifics will be provided in the text and tables following.

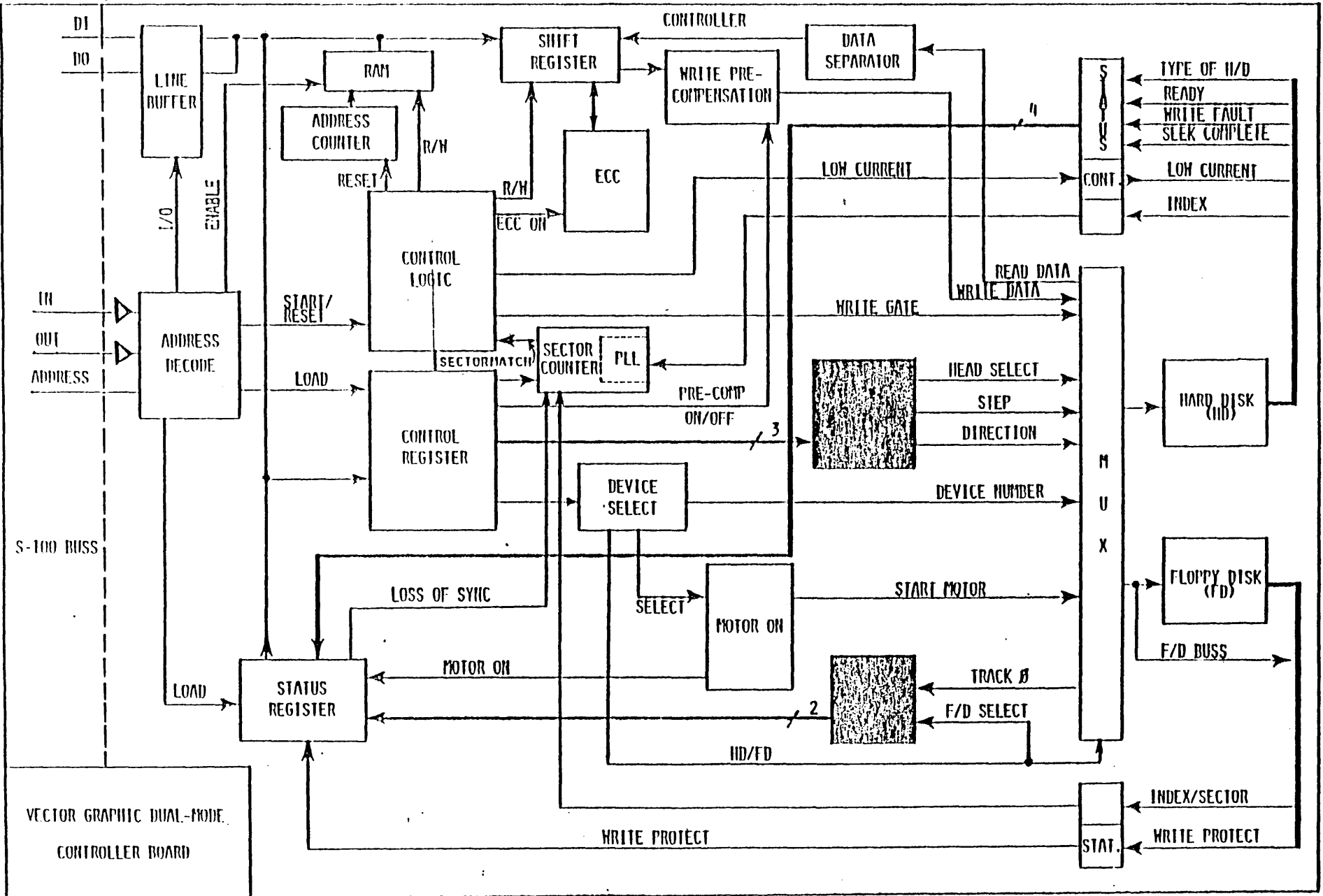


FIGURE 1

1.4 CONTROLLER SUPPORT CAPACITY

1.4.1 H/D Configuration

The VEDMCS has the capacity to multiplex up to a total of four drives. However, it can support only ONE hard disk at a time. The remaining slots can be filled with anywhere from zero to three floppy disk drives in a daisy-chain configuration.

1.4.2 F/D Configuration

One to four floppy disk drives may be attached in parallel, with the fourth disk drive filling in the address normally used by the hard disk drive.

1.4.3 H/D Format

Following are the specifications in the hard disk configuration.

HEADS or SURFACES (data)	4
TRACKS or CYLINDERS (ea. surface)	153
TYPE of SECTORING	HARD
SECTORS	32
BYTES/SECTOR (formatted)	256
TYPE of RECORDING	MFM

1.4.4 F/D Format

HEADS or SURFACES (data)	2
TRACKS or CYLINDERS (ea. surface)	77
TYPE of SECTORING	HARD
SECTORS	16
BYTES/SECTOR (formatted)	256
TYPE of RECORDING	MFM

1.5 CONTROLLER PORT DESCRIPTION

Both the hard and floppy disks are operated through the same controller ports. As the user, you, must take care in the management of the controller to insure the correct format at each access. This section is an introduction to the theory of operation for which specific breakdowns will be provided later.

1.5.1 Status and Control Ports

There are two status and control ports addressed at C0H (HEX) and C1H. Each port provides 8 bits IN and 8 bits OUT. To these ports you will OUTPUT information such as drive, head, sector, and step select to the controller. Some examples of the information that you will INPUT include, write protect, ready, and track 0.

1.5.2 Data Port

The data port addressed at C2H contains 8 bits of IN/OUT data information. The buss is tied to a bi-directional 512 byte RAM on board the controller. The memory is filled or read back sequentially from address zero, with the address counter incrementing automatically after each access until the desired address is reached. All the information is contained in approximately the first 400 bytes of memory with the remainder of RAM not used. Loading the address counter to zero is handled by the reset/start port.

1.5.3 Reset/Start Port

The reset/start port is a control only port and there are no data lines associated with it. By performing an INPUT command from port C3H the controller will automatically RESET the memory address register to all zeroes. A RESET should be accomplished before each START READ/WRITE, or INPUT/OUTPUT DATA operation. A START is accomplished by issuing an OUTPUT command to port C3H with the control bit "Read/Write" (Port C0H) set to the appropriate position. The controller will then automatically READ from the disk into the controller RAM or WRITE on the disk the contents of the controller RAM. The controller will NOT operate correctly unless the Status and Control Ports are serviced properly before issuing a Start command.

1.6 SECTOR DATA FORMAT

1.6.1 H/D Sector format

The recommended sector format is illustrated below.

<u>PREAMBLE</u>	<u>SYNC</u>	<u>HEAD</u>	<u>TRACK</u>	<u>SECTOR</u>	<u>DATA</u>	<u>ECC</u>	<u>POSTAMBLE</u>
30 bytes	1	1	1	1	256	4 bytes	to end of sector

A hard disk sector consists of the following fields:

- 1) PREAMBLE: The preamble is a field of 30 bytes of 00H data. It provides a tolerance for mechanical and electronic deviations against the sector pulse, and a known data pattern for synchronization of the read data decoder. The preamble is the first thing that you must place in the controller memory for a write operation, although it will not appear in the memory during a read.
- 2) SYNC: The sync byte is a byte of 0FFH data and is used in the disk controller to determine the beginning of useful data. During a read, the sync byte is the first data byte to appear in the controller memory. Also, it should follow the preamble during a write operation.
- 3) HEAD: The head byte is a single byte of data in the range of 0 to 3 written into all sectors. Its value should be equal to the head number of any given surface and also equal to the value sent on the 'Head Select' lines to the control port. The head byte should be used to verify that the proper surface is being accessed. It also follows the sync byte in I/O operations.
- 4) TRACK: The track byte is a single byte of data in the range of 0 to 152. It follows the head byte and should be used to verify that the correct track is being accessed during a disk I/O.
- 5) SECTOR: The sector byte is a single byte of data in the range of 0 to 31. It follows the track byte in I/O operations, and should also be equal to the value sent on the 'Sector Select' lines to the control port.

- 6) DATA: The data field consists of 256 bytes of user data, and follows the sector byte in I/O operations.
- 7) ECC: The Error Correction Code is 4 hardware generated bytes and is automatically inserted after the last byte of the data field in this format. When performing a read operation, the controller calculates a new ECC, compares it with the ECC that was written, and returns with 4 bytes of 00H if the two numbers match. If it returns with anything other than 00H you will need the ECC software to make any corrections. The ECC field in the controller memory MUST be zeroed prior to a write operation.
- 8) POSTAMBLE: The rest of the sector from end of the ECC to the next sector pulse should be filled with zeroes. We recommend a minimum of 128 bytes of 00H data be filled into the memory to cover the worst case conditions. The controller itself will use only as many as is required for that particular sector.

1.6.2 F/D Sector Format

The recommended sector format is illustrated below.

PREAMBLE	SYNC	TRACK	SECTOR	FILLER	DATA	CK/SUM.	ECC	ECC/VALID	POSTAMBLE
40	1	1	1	10	256	1	4	1	to end of
bytes								bytes	sector

A floppy disk sector consists of the following fields:

- 1) PREAMBLE: The preamble is a field of 40 bytes of 00H data, and is otherwise identical to the hard disk preamble.
- 2) SYNC: The sync byte is identical to the hard disk sync byte.
- 3) TRACK: The track byte is a single byte of data in the range of 0 to 76. It follows the sync byte in I/O operations, and should be used to verify that the correct track is being accessed during disk I/O.
- 4) SECTOR: The sector byte is a single byte of data in the range of 0 to 15. It is otherwise identical to the hard disk sector byte.

- 5) FILLER: The filler is 10 bytes of 00H data, and is used to keep the placement of the data field at a 'standard' position within the sector. It follows the sector byte in all disk I/O operations.
- 6) DATA: The data field consists of 256 bytes of user data, and follows the filler in I/O operations.
- 7) CHECKSUM: The checksum is 1 byte of data resulting from the software add with carry instruction of all the bytes from the track byte through the last byte of the data field. It's placement should be immediately following the last byte of the data field in disk I/O.
- 8) ECC: The use of the Error Correction Code is identical to that in the hard disk format. It's placement here is immediately following the checksum.
- 9) ECC VALID: The ECC valid byte is a single byte of data. If it has a value of 0AAH ECC is valid. Any other value indicates that ECC is not being used. We have defined this byte for software purposes so that your disk driver can compensate and make your 'old' disks upwardly compatible. ECC valid follows the ECC byte in disk I/O operations.
- 10) POSTAMBLE: The postamble follows the ECC valid byte, and is otherwise identical to that of the hard disk format. You should also maintain the minimum recommended 128 bytes of 00H data.

1.7 PORT FORMAT

1.7.1 Control Bits

Control is accomplished by outputting to the appropriate port the following bits:

<u>PORT</u>	<u>BIT</u>	<u>NAME</u>	<u>COMMENTS</u>
COH	0	DRIVE SELECT 0	
"	1	DRIVE SELECT 1	
"	2	HEAD SELECT 0	F/D HEAD SEL = 0 TO 1
"	3	HEAD SELECT 1	H/D = 0 TO 3
"	4	HEAD SELECT 2	RESERVED FOR 10 M/BYTE
"	5	STEP A TRACK	
"	6	DIRECTION IN/ <u>OUT</u>	
"	7	LOW CURRENT	H/D TRACK > 127
CIH	0	SECTOR 0	F/D SECTOR = 0 TO 15
"	1	SECTOR 1	H/D = 0 TO 31
"	2	SECTOR 2	
"	3	SECTOR 3	
"	4	SECTOR 4	
"	5	READ/ <u>WRITE</u>	
"	6	ECC ENABLE	
"	7	WRITE PRE-COMPENSATION	H/D TRACK > 63

The bit description is as follows:

<u>PORT</u>	<u>BITS</u>	<u>DESCRIPTION</u>
COH	0-1	<u>DRIVE SELECT:</u> These two bits define the address of the drive to be used. The hard disk is always addressed as drive 0. Be careful to change the address jumper on the floppy drive, to 1, 2, or 3 as more drives are added.

- COH 2-4 HEAD SELECT: Head select 0 and 1 are used to access the four surfaces of the current S/T disk drive. Head select 2 is reserved for the additional surfaces of the 10 megabyte version. For floppy operation, set these bits to zero to maintain compatibility with your older single sided disks so as not to read or write to the wrong side of the disk.
- " 5 STEP A TRACK: Toggling the step bit, from 0 to 1 and back to 0 will cause the drive identified by the drive select bits to change the head position +1 track in the direction specified by the direction bit.
- " 6 DIRECTION IN/OUT: The direction bit specifies whether to move the head in (1) toward the center hub (increasing the track number), or out (0) toward the outside edge of the disk (decreasing the track number).
- " 7 LOW CURRENT: The low current bit should be set (1) only when performing a hard disk write when the track number is 128 or greater.
- CLH 0-4 SECTOR: The sector bits specify which sector is to be accessed in a disk I/O. Sector 0-4 is used to address the 32 hard disk sectors, and Sector 0-3 is used to access the 16 floppy disk sectors.
- " 5 READ/WRITE: To read the disk this bit is set to 1. To perform a write operation it should be set to 0. Remember, this and all other control lines should be set up correctly before performing a START.
- " 6 ECC ENABLE: If the ECC Enable bit is set, the controller hardware will automatically insert the ECC into each sector as it is written. It also calculates, compares, and returns with zero or ECC in the read sector. Remember to zero the ECC field in the controller memory prior to a write operation.
- " 7 WRITE PRE-COMPENSATION: Write pre-compensation should be set (1), only when performing a hard disk write with a track address of 64 or greater. It should be set to 0 at all other times.

1.7.2 Status Bits

Status is received by inputting from the appropriate port the following bits:

<u>PORT</u>	<u>BIT</u>	<u>NAME</u>	<u>COMMENTS</u>
COH	0	WRITE PROTECT	F/D
"	1	READY	H/D
"	2	TRACK 0	H/D & F/D
"	3	WRITE FAULT	H/D
"	4	SEEK COMPLETE	H/D
"	5	LOSS OF SYNC	H/D
"	6-7	RESERVED	FULLED UP
CIH	0	FLOPPY DISK SELECTED	
"	1	CONTROLLER BUSY	R/W
"	2	MOTOR ON	F/D
"	3	TYPE OF HARD DISK	0=5MEG 1=10MEG
"	4-7	RESERVED	FULLED UP

The bit description is as follows:

<u>PORT</u>	<u>BIT</u>	<u>DESCRIPTION</u>
COH	0	<u>WRITE PROTECT:</u> The write protect is an active high signal, indicating that a write protect tab is installed on the floppy disk which has been selected by the drive select lines. You should check this bit, and when it is set, disable all write operations to this particular drive through software. There is no provision to write protect the hard disk.
"	1	<u>READY:</u> The ready line is a hard disk only interface signal. When it is true, together with Seek Complete, indicates that the drive is ready to read or write, and that all I/O signals are valid. When this line is low all writing and seeking operations are inhibited. Ready time after power on is approximately 15 seconds.

- COH 2 TRACK 0: When the active high track 0 signal is set to a one, the drive indicated by the drive select lines has its heads positioned at track zero.
- " 3 WRITE FAULT: This hard disk only interface signal is used to indicate that a condition exists in the drive that can cause improper writing of the disk. This active high signal (1) indicates a fault, and inhibits further writing until the condition is corrected. The three conditions detected are as follows:
- A. Write current exists in a head without a write gate signal or no write current exists in the head with a write gate and drive select signal.
 - B. Multiple heads selected.
 - C. DC voltages are grossly out of tolerance.
- " 4 SEEK COMPLETE: This hard disk only signal is high only when the heads have settled on the final track desired after a series of step and delay instructions. Seek complete will be low during a power on recalibration which has been issued by the drive logic at power on because the heads are not over track zero. This signal must be high prior to performing any R/W operation..
- " 5 LOSS OF SYNC: This hard disk active low signal (0) indicates that the phase lock loop sector counter has not achieved synchronization.
- " 6-7 RESERVED: Reserved for future features. They are pulled up at the current time.
- CIH 0 FLOPPY DISK SELECTED: This signal is high whenever the drive select lines decode a floppy drive address.
- " 1 CONTROLLER BUSY: This signal is high only when a Start command has been issued, and a read or write operation is in progress.
- " 2 MOTOR ON: This floppy disk only signal is high only when the motor of the drive selected has not timed out from a previous drive select operation.
- " 3 TYPE OF HARD DISK: This is a hardwired signal indicating the type of hard disk selected, 0=5megabyte version, and 1=10megabyte version.
- " 4-7 RESERVED: Reserved for future use. (Pulled up)

1.7.3 Data Bits

The data port addressed at C2H contains 8 bits of IN/OUT data information. These are the DI and DO bits 0-7 of the S-100 bus. The bus is tied through tri-state driver/receivers to a bi-directional 512 byte RAM on-board the controller. The memory is filled or read back sequentially from address zero. The address counter increments automatically after each access until the desired address is reached. All the information is contained in approximately the first 400 bytes of memory with the remainder of RAM not used. Before performing any I/O or R/W operation you must set up the control bits via the two control ports, check the appropriate status bits on the two status ports, and load the address counter to zero by issuing a RESET through the reset/start port. When outputting to the controller in preparation for a write operation, you must load, starting at address zero, the preamble through postamble. When inputting from the controller after a read operation, the first byte read will be the sync byte followed by the remainder of the bytes through the postamble, in the appropriate disk format.

1.7.4 Reset/Start Port Format

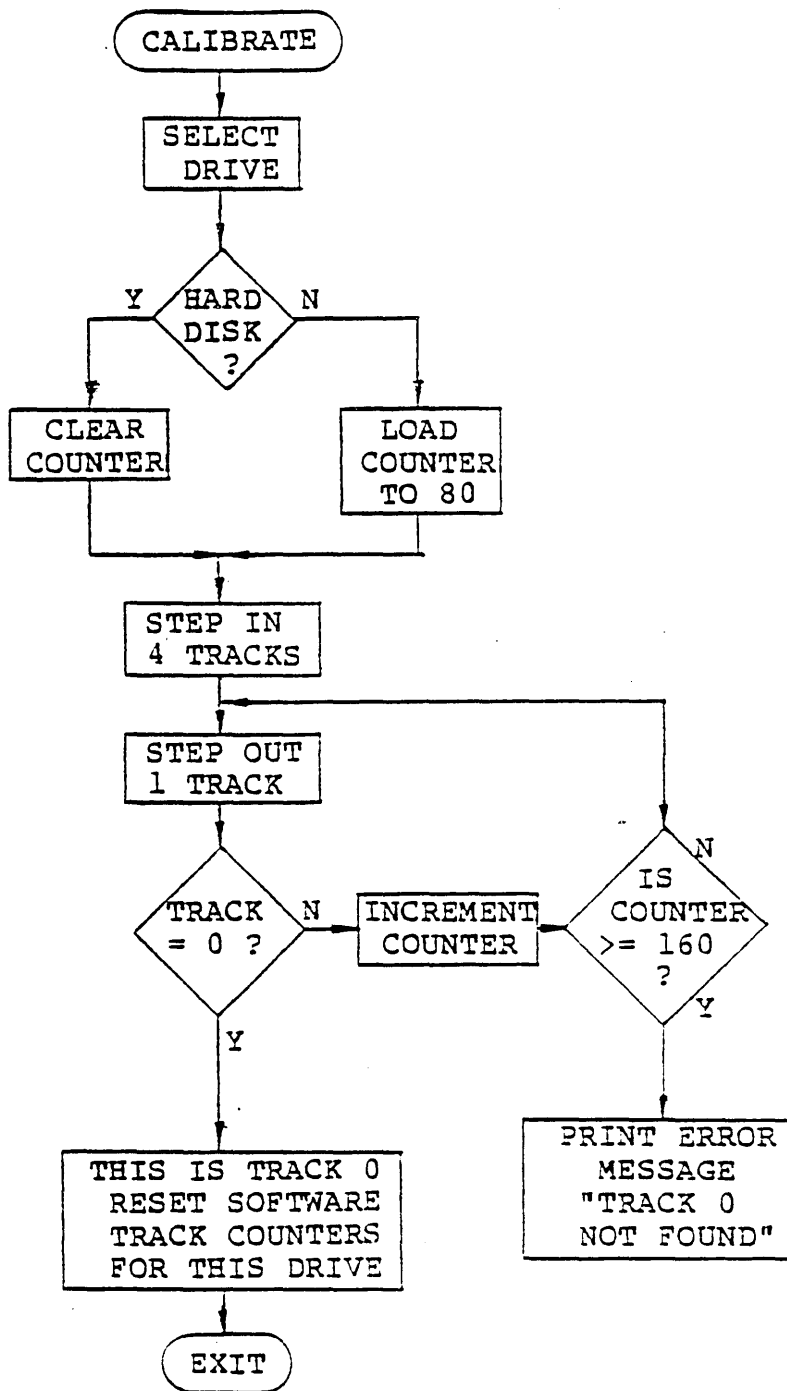
The reset/start port is a control only port, and there are no data lines associated with it. By performing an INPUT command from port C3H the controller will automatically RESET the memory address register to all zeroes. A RESET should be accomplished before each START READ/WRITE, or INPUT/OUTPUT DATA operation. A START is accomplished by issuing an OUTPUT command to port C3H with the control bit "Read/Write" (Port C0H) set to the appropriate position. The controller will then automatically READ from the disk into the controller RAM or WRITE on the disk the contents of the controller RAM. The controller will NOT operate correctly unless the Status and Control Ports are serviced properly before issuing a Start command. Remember that a reset only sets the controller memory address counter to zero, and that a start only initiates and completes a transfer of data between the disk and controller memory as specified by the control bits.

1.8 OPERATION

This section will discuss only the basic functions of calibrate, select, seek, read, write, and use of the status and control bits. In the next section we will discuss some of the features that you might want to add to your driver, such as functions and error detection. At this time we are going to recombine the hard and floppy disk sections as an aid to help you use the same routines for both types of drives.

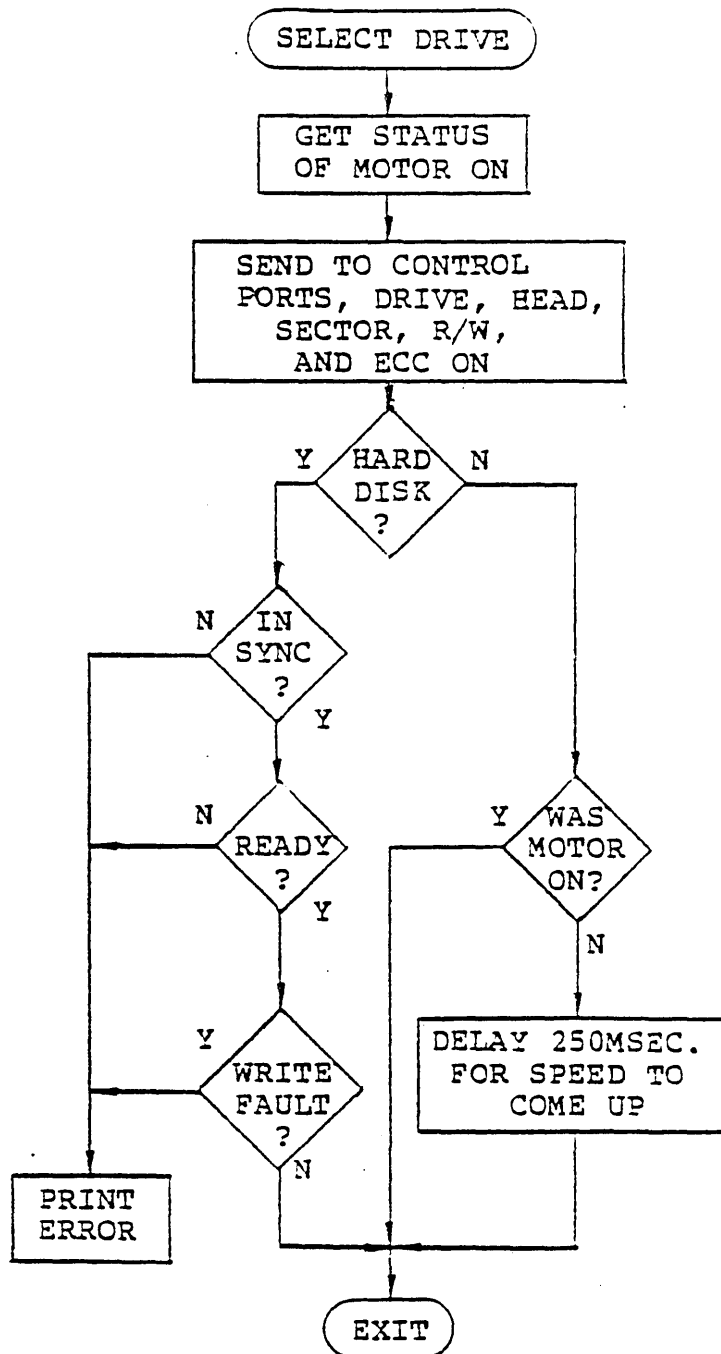
1.8.1 Calibration

Although the hard disk drives themselves provide a power on calibration, it is possible to be behind track 0. You may also at some time lose track of the drive head position and want to perform a recalibration cycle. Note the use of the counter to prevent a loop of excessive attempts. The suggested flowchart is as follows:



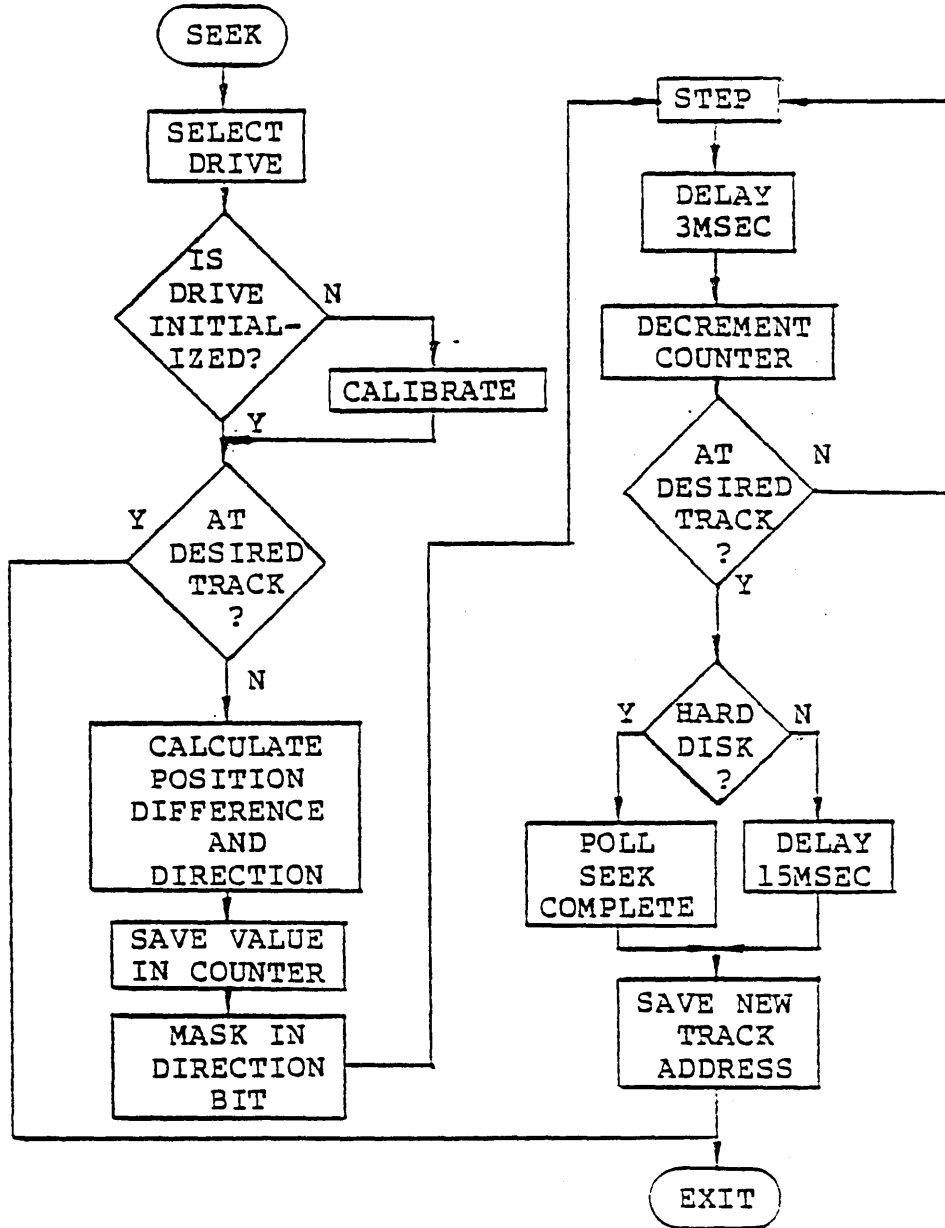
1.8.2 Drive Selection

The physical selection of a drive is the result of the drive select bits arriving at the controller via an output command to port COH. The result of this is that the hard disk then immediately responds with a ready signal and it's other status bits. In the case of floppy disks, it starts all the motors. Checking the status bit Motor On indicates that all floppy drive motors are running. The suggested format is:



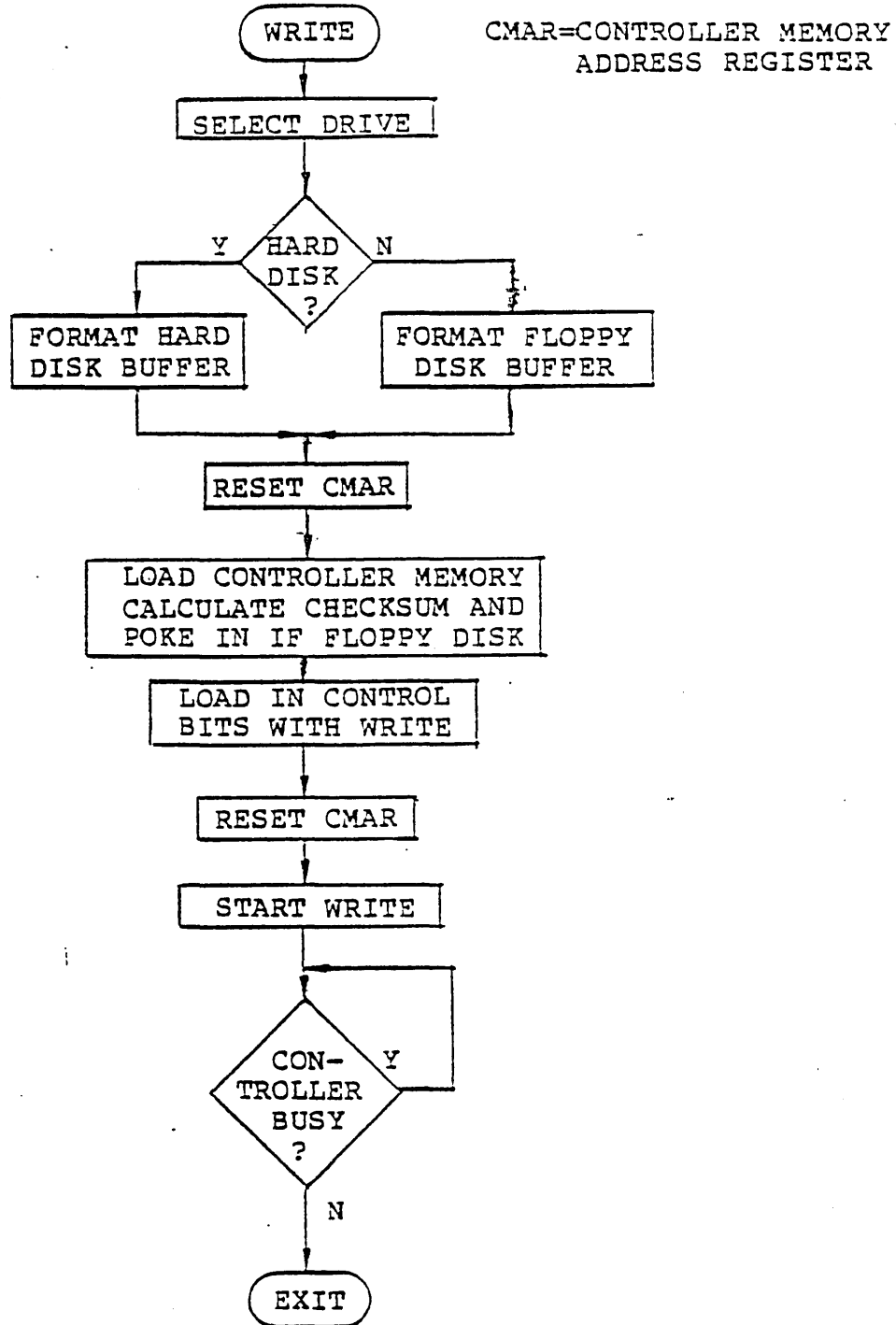
1.8.3 Seek a Track

Seeking is simply a series of step commands (Toggle Bit 5, Control Port COH) with each step followed by a 3 millisecond delay to allow the mechanism to react. Additional head settling time is necessary after the final track is reached. For the floppy disk it is 15 milliseconds, and for the hard disk it is automatically provided in the status bit, Seek Complete. The direction bit must be set 100 nsec. prior to the step bit. Seperate instructions are recommended.



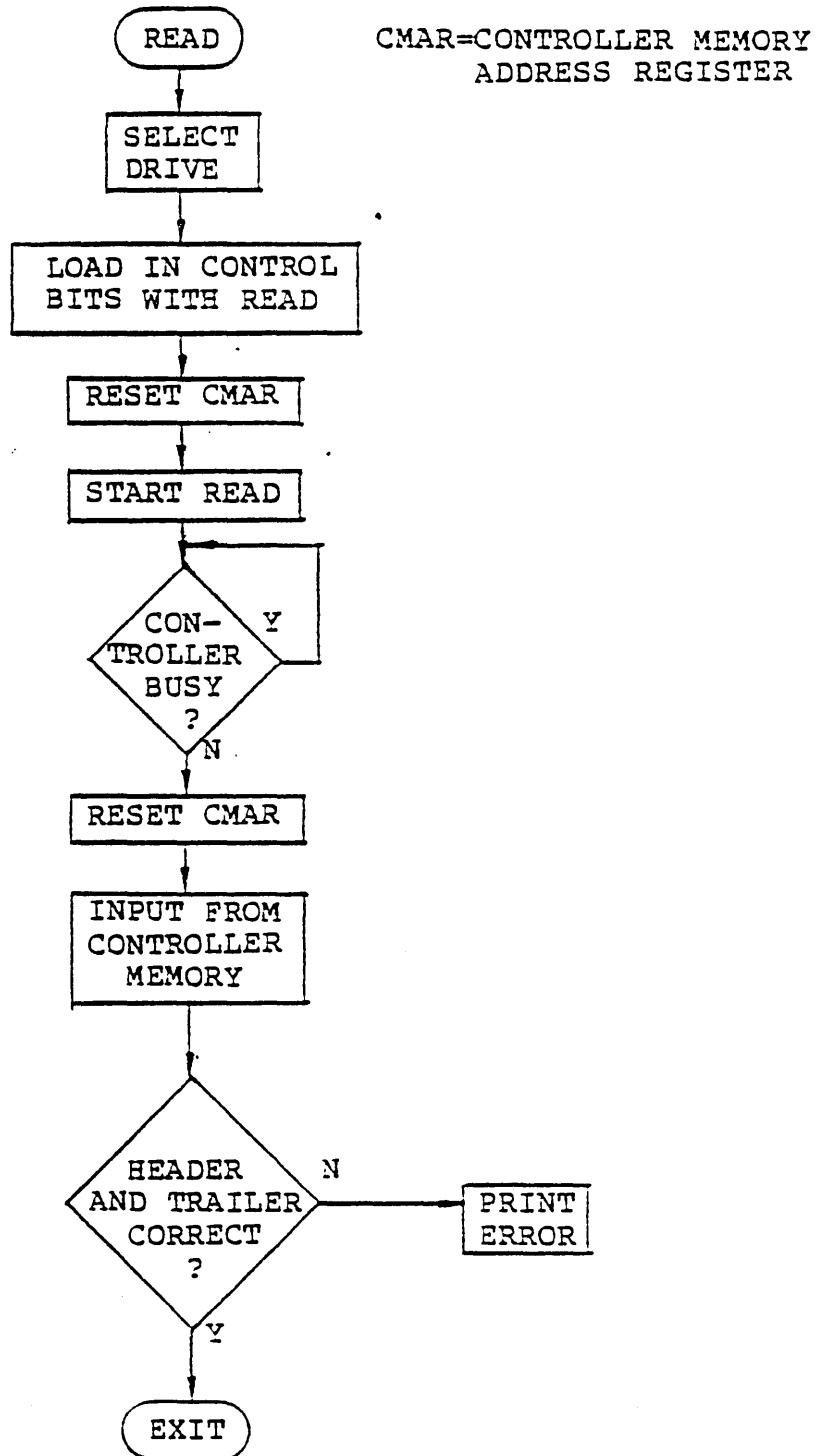
1.8.4 Write

When writing the disk be sure to load the correct data format for the type of disk in use. The controller memory can be read or written at the rate that I/O instructions can be issued. One method is:



1.8.5 Read

Reading is approximately the reverse process of writing. The difference is that you check the header for the correct head, track, and sector, and check the trailer for ECC and checksum. The suggested flowchart follows:



1.9 ERROR HANDLING

An important consideration, which may not be ignored in the design of a flexible disk driver, is the handling of errors which occur. Magnetic storage devices, in general, are subject to errors. Flexible disks are subject to damage or contamination due to handling, making error detection particularly important. Although contamination is not the problem with the Winchester hard disk technology, should a hard error occur, it must be dealt with for successful system operation. Most errors are of a temporary nature and will be invisible to the system with a properly designed disk driver. The following discussion leaves it up to the user to implement flexible error routines to handle E/D and F/D combination systems. Examples of basic and specific error codes and types can be found in the sample disk driver at the end of the manual. Most errors can be attributed to one or more of the following sources:

- 1) Transient Electrical Noise
- 2) Media Contamination - Particles of foreign substances may become lodged between the head and the recording surface of the disk and cause data errors.
- 3) Head Positioning - The read write head may be positioned to the wrong track if the specified step rate is exceeded or may be marginally positioned if a drive is misadjusted.
- 4) Disk Centering - Due to the way a flexible disk is constructed, or in the event the disk is damaged or distorted due to mis-handling, it is possible that a diskette may be improperly clamped to the spindle in the disk drive.

The following are the suggested procedures to perform proper error handling in disk read/write operations:

1.9.1 Read Operations

- 1) Step the positioner to the desired track.
- 2) Perform a read operation as described in Section 1.6.5. If a header or checksum error occurs, re-read the sector up to 6 times. If an ECC error occurs, re-read the sector up to 6 times checking for 2 consecutive read operations in which the Error Correction Code is identical. At that time it would be safe to say that the ECC is good and to go to the software ECC in your system for the correction.

- 3) If the six retries were unsuccessful, step the positioner off one track and then back to the desired track. Repeat Step 2. If still unsuccessful, step the positioner off one track in the other direction and then back. Repeat Step 2.
- 4) Perform the restep procedure given in Step 3 up to 4 times. If still unsuccessful, deselect the unit and delay about 200msec. Reselect the unit, restore to track 0, and re-seek to the desired track. Repeat Steps 2 and 3. Perform this reselect function up to 3 times. If still unsuccessful, abort the operation with a permanent I/O error.

1.9.2 Write Operations

- 1) Step the positioner to the desired track.
- 2) Read the sector immediately preceding the desired sector. Any errors which occur should be handled in the manner described for normal read operations. This ensures that the correct head and track have been selected and that the sector counter is synchronized with the disk.
- 3) Write the desired sector as described in Section 1.6.4.
- 4) Read the sector just written to check that the data was recorded properly. If an error occurs, repeat Steps 2, 3, and 4 up to five times.
- 5) If unsuccessful, perform the restep operation as described for the read operation and repeat Steps 2, 3, and 4.
- 6) If 4 restep operations are unsuccessful, perform the reselect operation as described for the read operation up to 3 times. If still unsuccessful, abort the operation with a permanent I/O error.

If a permanent I/O error occurs, there may be a defect in or damage to the recording surface of the disk, the disk may be improperly centered, or the disk may have been written on a marginal drive.

The restep procedure takes advantage of the friction in the positioner system causing the head position to deviate slightly from the nominal track position. This position will be different when the head is stepped to a track from different positions. In normal operations this position difference has no effect, but it can possibly recover data that was written on a marginally aligned drive.

The reselect procedure serves to dislodge any foreign particles and to recalibrate the positioner, should it be positioned to the wrong track.

1.10 DISK DRIVER

As an example of all the principles in this manual, a sample disk driver is presented following this section. This driver provides the facilities to seek to a track, seek and read a sector, seek and write a sector, seek and verify a sector, initialize the disk driver, and perform a write-protect detect test.

The power-on recalibration is transparent. The driver maintains a table containing the current track address of each drive connected to the controller. The user's power-on initialize software must set the entries in the table to OFFH. The first time a drive is accessed, the driver will recognize this flag and recalibrate the positioner on the drive before performing the specified operation.

When the driver is called, a register pair must point to a parameter block referred to as the Disk Control Block or DCB which specifies the operation to be performed. When the driver returns, the condition code will reflect the status of the operation. (See the listing for details.)

The DCB is structured as follows:

<u>ADDRESS</u>	<u>BIT</u>	<u>DESCRIPTION</u>
<u>FUNCTION CODE</u>		
DCB + 0	0	SEEK TRACK ONLY
"	1	SEEK AND READ SECTOR
"	2	SEEK AND WRITE SECTOR
"	3	SEEK AND VERIFY SECTOR
"	4	INITIALIZE DISK DRIVER
"	5	WRITE PROTECT DETECT TEST
<u>CONTROL FLAGS/UNIT SELECT</u>		
DCB + 1	0-3	UNIT ADDRESS
"	4	INTERRUPT SAVE
"	5	WRITE PROTECT DETECT 0=INHIBIT 1=PERFORM
"	6	COMPARE VERIFY AND WRITE CHECKSUM 0=INHIBIT 1=PERFORM
"	7	PRE-WRITE ID CHECK CONTROL 0=PERFORM 1=INHIBIT
DCB + 2		SECTOR ADDRESS (0 TO 15)
DCB + 3		TRACK ADDRESS (LSB)
DCB + 4		TRACK ADDRESS (MSB) (0 TO 153)

(cont.)

DCB + 5

BUFFER ADDRESS (LSB)

DCB + 6

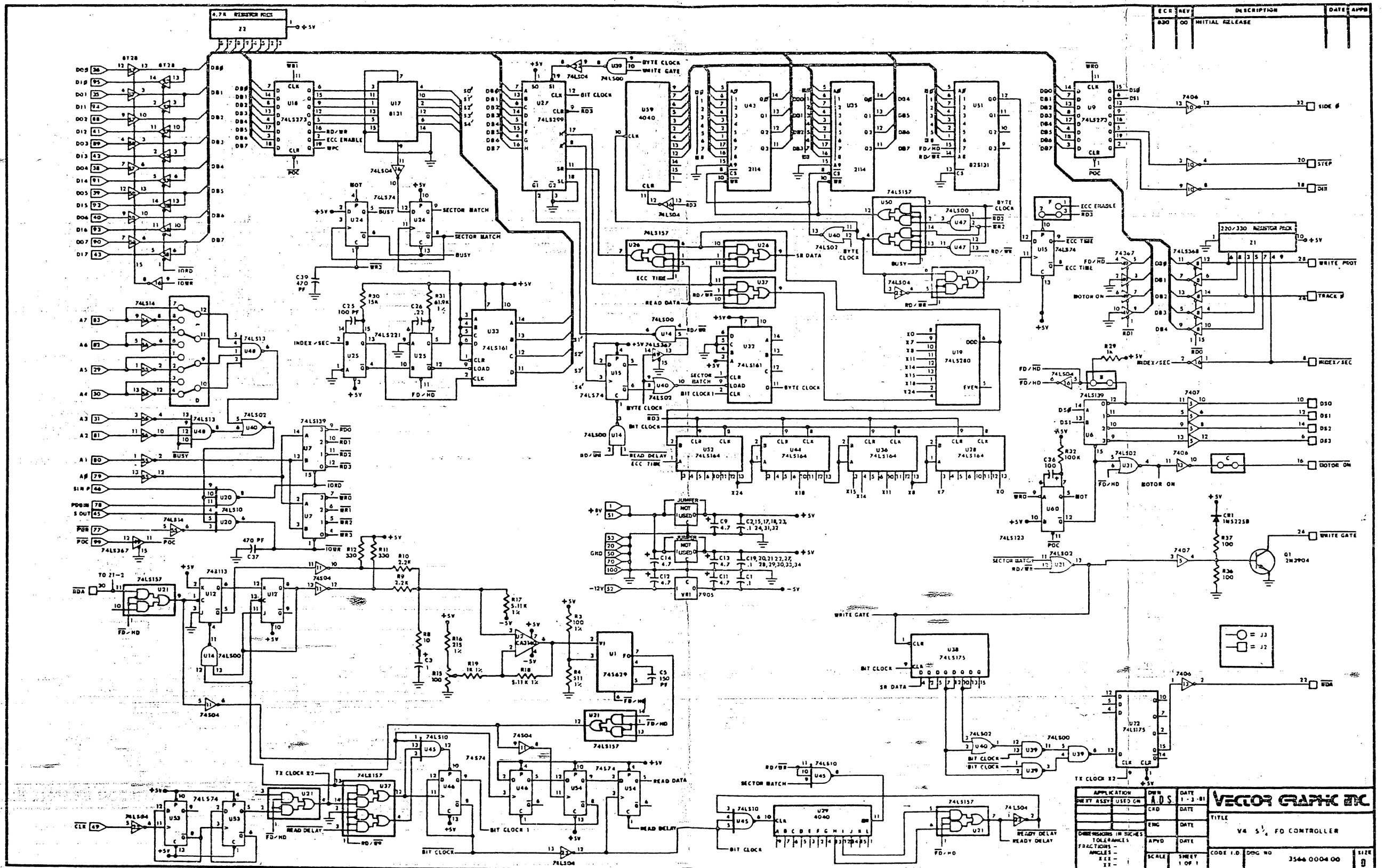
BUFFER ADDRESS (MSB)

BUFFER ADDRESS IS THE START ADDRESS OF THE 268 BYTE READ/WRITE BUFFER TO BE USED IN PERFORMING THE OPERATION. EXAMPLES OF THE BUFFER ORGANIZATION FOR THE FLOPPY AND HARD DISK CAN BE FOUND IN THE SAMPLE DRIVER FOLLOWING THIS SECTION.

To perform a write operation, move the data to the read/write buffer, set up the DCB, and call the driver.

To perform a read operation, set up the DCB and call the driver. When the operation is complete, the data from the desired sector will be in the read buffer.

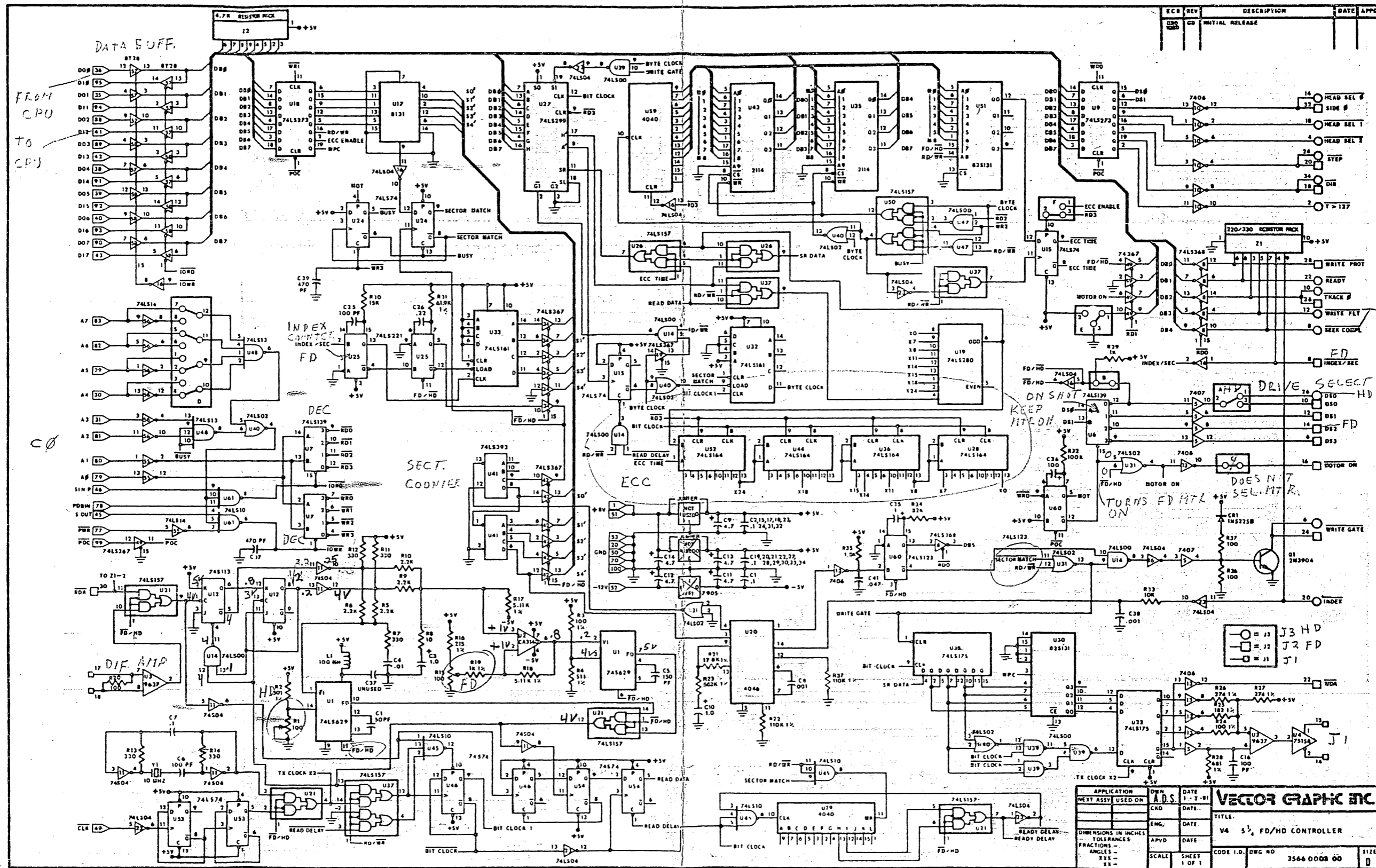
EXHIBIT VI-12 SCHEMATIC OF 5 1/4 FD CONTROLLER BOARD



REV	DESCRIPTION	DATE	APPD
000	INITIAL RELEASE		

APPLICATION	DWG	DATE	VECTOR GRAPHIC ETC
DESIGN ASSY	USED ON	1-3-81	
			TITLE
			V4 5 1/4 FD CONTROLLER
			CODE I.D. DWG NO. 3546 0004 00
			SIZE

EXHIBIT VI-13 SCHEMATIC OF 5 1/4 FD/HD CONTROLLER BOARD



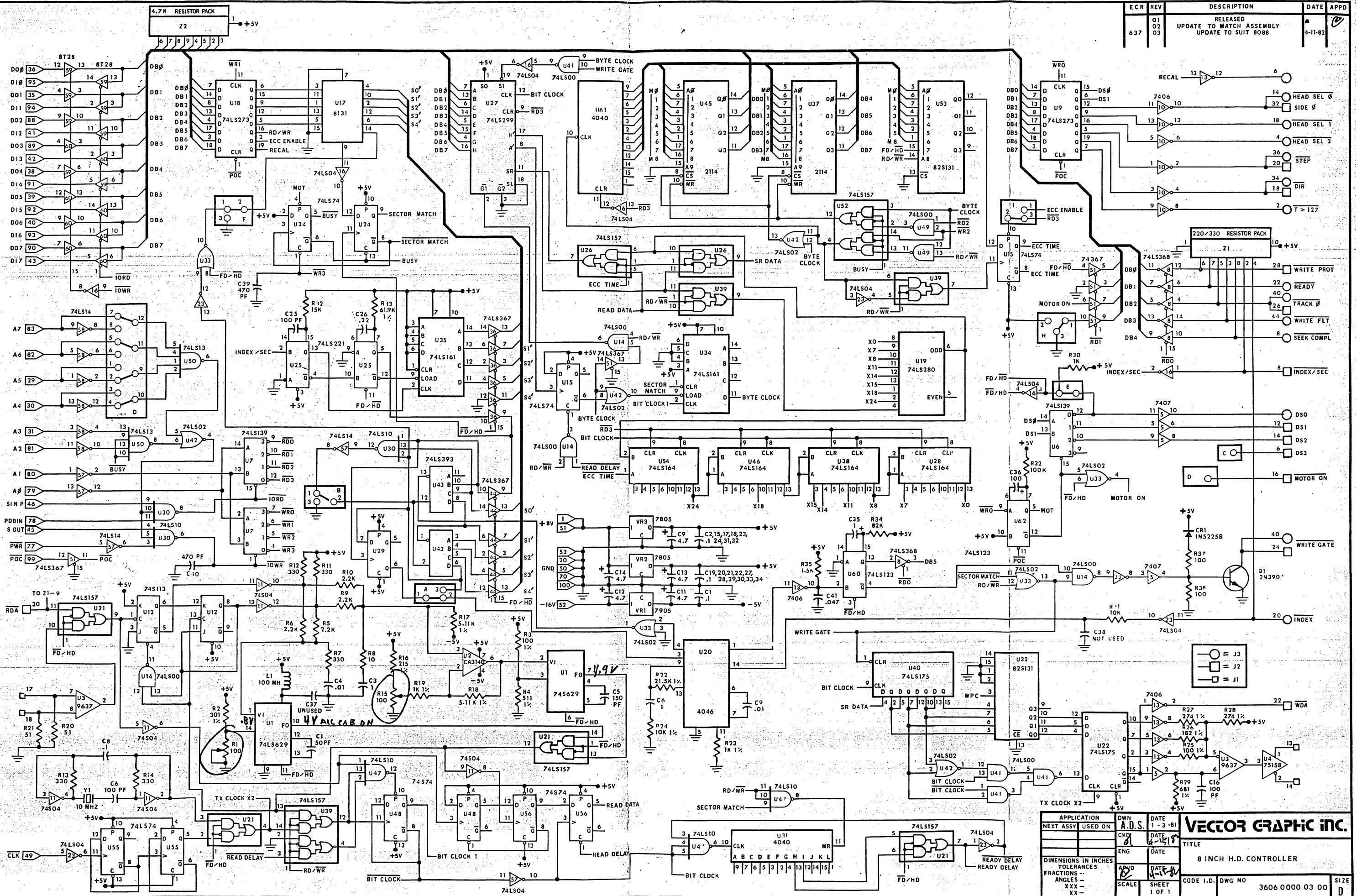
ECR	REV	DESCRIPTION	DATE	APPO
000	00	INITIAL RELEASE		

APPLICATION	DATE	DATE	DATE	DATE
NEXT ASSY USED ON	1-7-81			
ENG.				
APVD				
SCALE	SHEET	CODE I.D.	DWG NO	SIZE
	1 OF 1		3566 0008 00	D

VECTOR GRAPHIC INC

V4 5 1/4 FD/HD CONTROLLER

ECR	REV	DESCRIPTION	DATE	APPD
637	01	RELEASED		
	02	UPDATE TO MATCH ASSEMBLY		
	03	UPDATE TO SUIT 8088	4-11-82	



APPLICATION	DWN	DATE	VECTOR GRAPHIC INC.
NEXT ASSY USED ON	A.D.S.	1-3-81	
ENG			
DIMENSIONS IN INCHES			TITLE
TOLERANCES			8 INCH H.D. CONTROLLER
FRACTIONS --			CODE I.D.
ANGLES --			DWG NO
SCALE			3606 0000 03 00
SHEET			SIZE
1 OF 1			D