

**SA4400**  
**ministreaker™**  
**Floppy Disk**  
**Drive Controller**

OEM Manual

 **Shugart Associates**

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## 1.0 INTRODUCTION

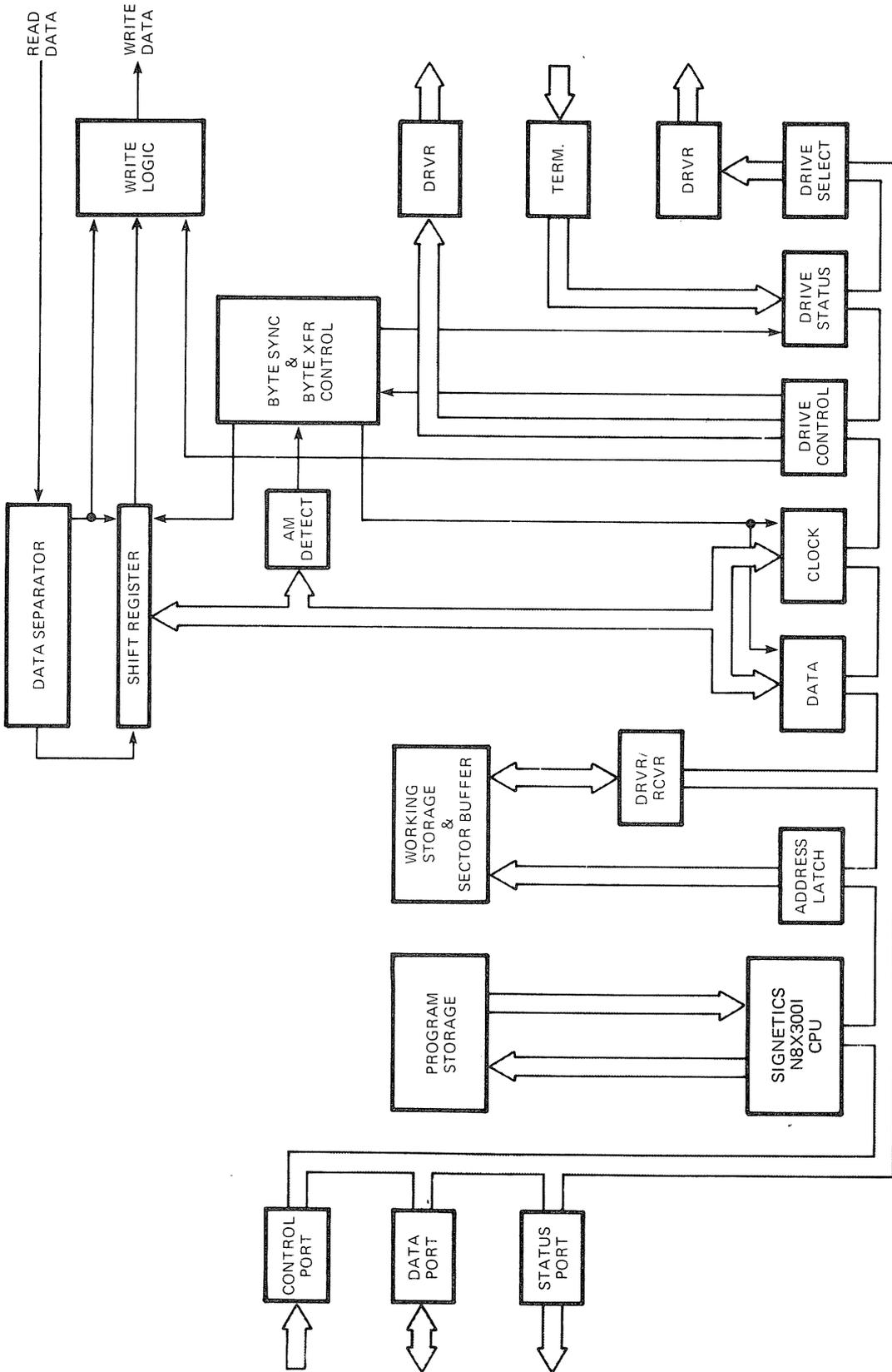
The SA4400 Floppy Disk Controller (FDC) is a complete preprogrammed controller for Shugart SA400 floppy disk drives. It performs control functions to transfer data between 1 to 3 disk drives and a host system and to format disks according to the modified IBM type format specifications. The SA4400 provides a General Purpose Host Interface which can easily interface to mini-computer/microprocessor I/O busses, CRT terminals, instruments, TTL/MSI microprocessors, industrial controllers, and other byte oriented systems.

The General Purpose Host Interface receives commands from the host system which allow data to be addressed and transferred between the floppy disk drive and host system. These macro level commands are interpreted and implemented by the SA4400. The FDC microprocessor is used to execute a sequence of ROM based instructions to implement each macro command from the host system.

The SA4400 features include:

- Single byte oriented TTL interface for easy interface to host system.
- Eight macro commands which provide all disk functions with a minimum of host system software overhead.
- Command queuing for maximum CPU utilization.
- Modified IBM type format functions preprogrammed.
- Approximately 40 TTL circuits for low cost and high reliability.
- Bipolar microprocessor for maximum flexibility.
- Sector data buffer for fully buffered data transfer operation.
- Control of up to 3 disk drives with overlapped head positioning to increase system throughput.
- Single five volt supply.
- Direct mounting to SA400 base casting.

FLOPPY DISK DRIVE INTERFACE

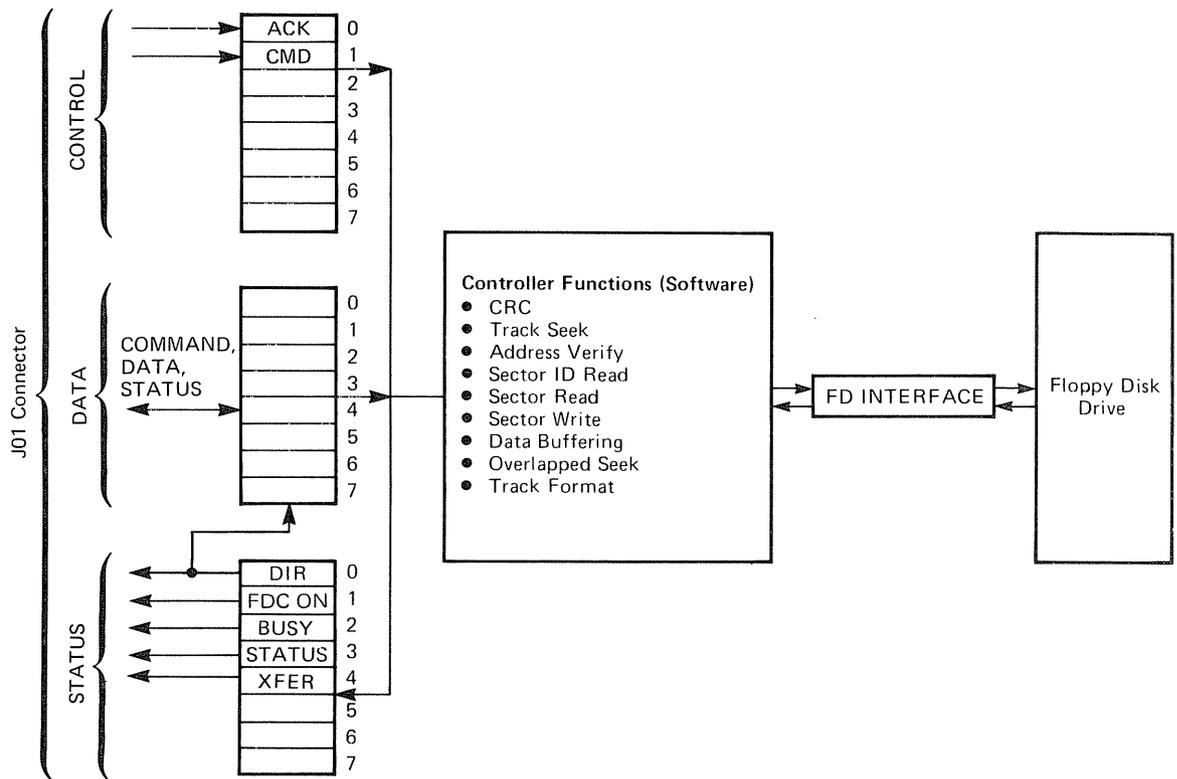


SHUGART SA4400 SYSTEM BLOCK DIAGRAM

G.P. HOST INTERFACE

## 2.0 GENERAL PURPOSE HOST INTERFACE

The General Purpose Host Interface provides 17 TTL signal lines for interface to a host system (see Figure 1). Each TTL signal is defined in terms of function and timing. The interface consists of 3 I/O ports which provide control, status, and data paths between the host system and the SA4400 Floppy Disk Drive Controller (FDC).



CONTROLLER WITH GENERAL PURPOSE HOST INTERFACE

The DATA lines (Data Port) are used for read data, write data, command data, and FDC system status.

The STATUS lines are used to transmit handshake signals to the host and to signify that status information is available on the DATA port.

The CONTROL lines are used to initiate FDC operations and to acknowledge handshake signals from the FDC when data transfers are occurring between the FDC and the host system.

## CONTROL and STATUS Lines

### CONTROL Lines:

<b>HALT</b>	Active Low halts FDC operation—operation resumes when HALT is Hi. This signal is normally not used by the host system.
<b>RESET</b>	Active Low resets the FDC CPU program counter to zero, restarts the FDC control program and resets all drives in the system to Track 00.
<b>CMD</b>	Signal set by host to initiate FDC operation.
<b>ACK</b>	Handshake signal set by host to acknowledge data transfer.

### STATUS Lines:

<b>DIR</b>	Defines direction of data port: 1 = data output (user read), 0 = data input (user write).
<b>FDC ON</b>	1 = FDC is off line, 0 = FDC is on line.
<b>BUSY</b>	1 = controller active, 0 = controller inactive.
<b>STATUS</b>	1 = status available to host on data port.
<b>XFR</b>	Handshake signal used for data exchange between data port and host system.

### DATA Lines:

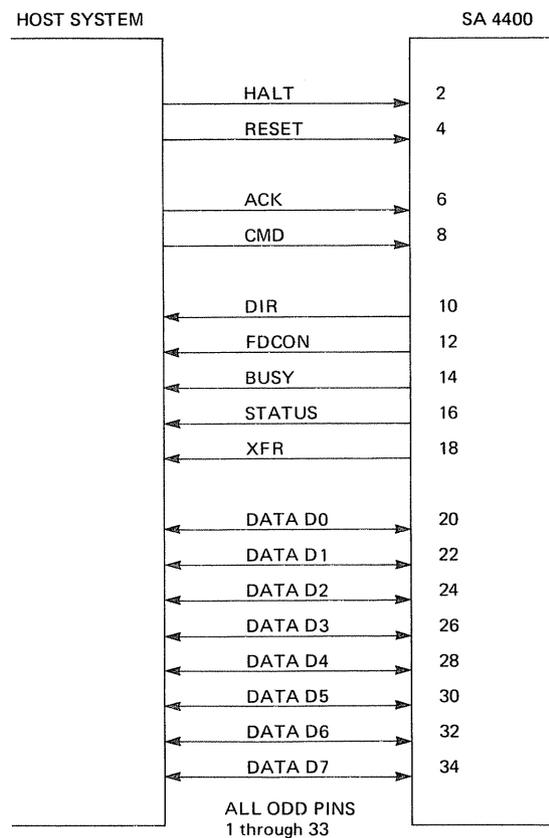
Eight bidirectional lines used to transmit commands to the FDC, transfer data between the host and FDC, and report status to the host system.

## 2.1 FDC Functions

The SA4400 provides eight functions which implement all the basic operations required to address, read, and write user data. The eight functions are:

Function Name	Function	Description
INIT	System Reset	Resets controller and all floppy disks in system, and controls disk drive motor on/off.

<b>SEEK</b>	Position Head on Track	Steps head to specified track.
<b>READ</b>	Read Disk Sector	Reads a sector of data from specified sector.
<b>READID</b>	Read Next ID	Reads the next sector ID information.
<b>WRITE</b>	Write Disk Sector	Writes a sector of data with normal Data AM to specified sector.
<b>WRDEL</b>	Write Sector of Deleted Data	Writes a sector of data with Deleted Data AM to specified sector.
<b>FORMAT</b>	Format Track	Writes address marks, gaps, and data on entire track per modified IBM type format.
<b>STATUS</b>	Drive Status	Returns status for addressed drive.



HOST SA4400 INTERFACE

## 2.2 Sector Buffering

The sector buffer function provides 128 bytes of data buffering for the READ, WRITE, and WRDEL operations. The host may specify in these operations that the operation is to be: a data transfer between the host and disk, a data transfer between the host and the FDC's buffer, or a data transfer between the FDC's buffer and the disk.

This function permits the host to transfer data to a buffer at a data rate determined by the host and to subsequently request a buffer to disk operation which is performed independent of the host. Similarly, the host may request a disk to buffer operation and subsequently read the buffer contents at a data rate determined by the host. A buffer command must have a valid disk drive address. If it has the address of a drive that is not in the system, the command will be aborted and FDC status will be returned to the user with bit DISK NOT READY set.

The buffer function also allows the host to write the buffer contents to more than one sector and to transfer data between sectors via the buffer, without requiring an actual data transfer between the host and FDC. In a multiple disk system, the buffer function may be used to perform disk copies via the buffer. The buffer function is described in detail under the READ, WRITE, and WRDEL operations. The buffer contents are unaffected by a transfer to disk or host.

## 2.3 Queued Commands

The queued command feature is provided for maximum host CPU utilization. The host can first issue a seek to a drive and then issue a READ/WRITE to the same drive while seek is in progress. The FDC will store the command bytes in memory and as soon as the seek is completed it will proceed with the execution of the R/W command. Host-FDC interaction will be required again when XFR line is toggled by the FDC to indicate that a byte transfer is ready or status acknowledgement is needed.

Host systems featuring interrupt capabilities may use the XFR line to get interrupted when host-FDC interaction is needed. Non-interruptable systems must use polling algorithms to determine when to service the FDC.

The following examples illustrate the use of queued commands:

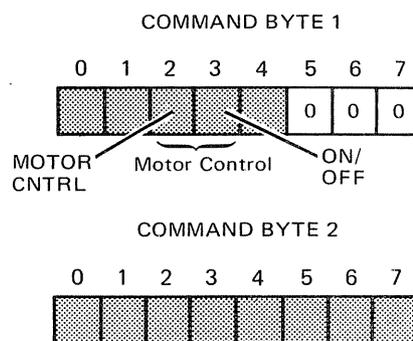
- a) Proper command sequence—SEEK (DRIVE 0), SEEK (DRIVE 1), READ (DRIVE 0)
- b) Illegal command sequence—SEEK (DRIVE 0), READ (DRIVE 0), SEEK (DRIVE 1)\*

\*When a READ/WRITE command is issued, BUSY line is set. Consequently, if command line is raised again, the operation will be aborted.

## 2.4 Command Descriptions

All commands to the FDC are two bytes long. In case of commands with no command data required (i.e., INIT, STATUS, READID or host-buffer commands), the second command byte can have any value. A description of the command formats and command functions follows. Command input and timing is described in the next section.

### 2.4.1 INIT Command



The INIT command resets all disks in the system to track 00; a SEEK to track 00 may be used to reset a single disk. No status or status handshake occurs for a INIT command; the FDC initiates SEEKS on all disks in the system and makes itself ready (BUSY=0) for a new command.

Bit 2 of the INIT command byte, in effect, splits the INIT command into two separate functions. If bit 2 = 0, then the command acts as a normal INIT command. If bit 2 = 1, then the INIT command is ignored and the command functions as a motor on/off control for *all* drives in the system.

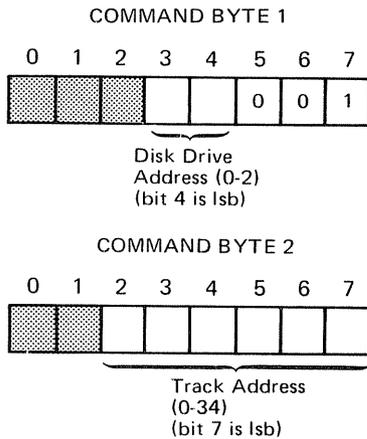
#### Floppy Disk Motor Control

When bit 2 = 1 ;INIT provides motor control to the user.

when bit 3 = 0 turns motor on.

when bit 3 = 1 turns motor off.

## 2.4.2 SEEK Command



The SEEK command steps the head of the addressed drive to the track specified in the command. Following acceptance of the SEEK command by the FDC, the head is stepped one track and FDC reports status with bit SEEK-IN-PROGRESS set. *The user, then, must acknowledge status HANDSHAKE before the SEEK can be completed.*

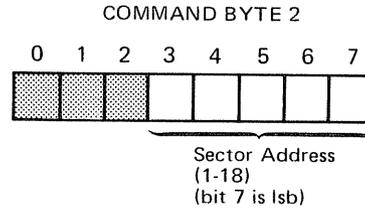
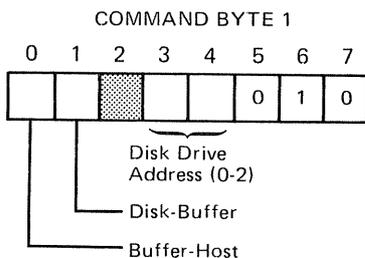
After the status acknowledging handshake is done, BUSY signal goes low. This indicates that FDC is ready to accept a new command, while SEEK is in progress.

If the new command is a SEEK to another drive (overlapped SEEK), FDC will step one track in the new drive, report status to the host and upon completion of the status acknowledging handshake, stepping will be done concurrently in all drives.

If a SEEK is performed to a track where the head is currently residing, a step does not occur but the user must still acknowledge status. The status byte will have SEEK-IN-PROGRESS set.

The SEEK operation does *not* verify the track address by reading the ID gap. However, the host may do this by doing a "READID" after a SEEK operation and comparing the track address with the last SEEK track address.

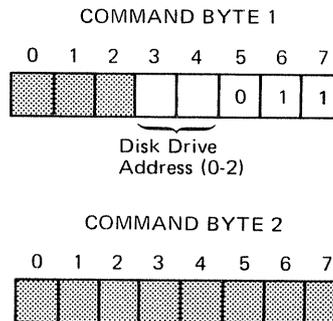
## 2.4.3 READ Command



The READ command initiates a read of the sector specified in the second command byte or a read of the FDC's buffer. If the operation is a disk read, the host may specify a disk-to-host data transfer (first command byte bits 0, 1=00) or a disk-to-buffer data transfer (first command byte bits 0, 1=01); in either case, a SEEK command is assumed to have positioned the disk to the proper track.

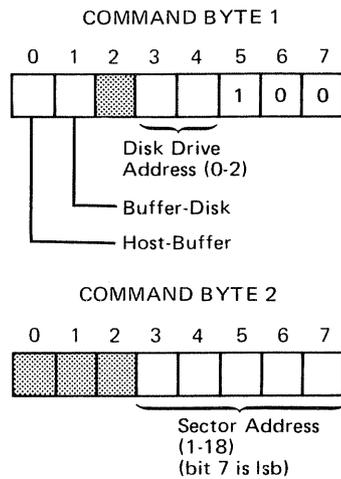
The READ command will automatically verify the track address by comparing the previous SEEK address to the address read from the track. If these do not agree, the operation is aborted with the status bit 'head positioning error' set. If the operation is a buffer read (first command byte bits 0, 1=10), the sector address is ignored, and, if the addressed drive is ready, the contents of the FDC's buffer are transferred to the host; it is the host's responsibility to precede a buffer read with the proper disk read. In all cases, a full sector of data is transferred, a byte at a time, according to the protocol and timing described under DATA TRANSFER. Error and status reporting for a READ operation is described under STATUS HANDSHAKE.

## 2.4.4 READID Command



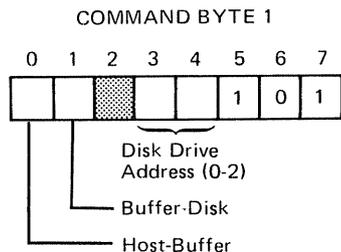
The READID command causes the FDC to read the next available sector ID. When the data becomes available, XFR line is toggled. Byte transfer can be done at the user speed (buffered transfer). The first byte of data is the track address read while the second byte is the sector address. Error and status reporting for a "READID" operation is described under STATUS HANDSHAKE.

### 2.4.5 WRITE Command

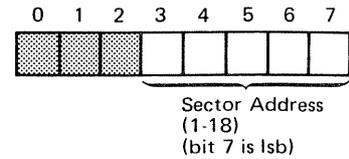


The WRITE command initiates a write of the sector specified in the second command byte or a write of the FDC's buffer. If the operation is a disk write, the host may specify a host-to-disk data transfer (first command byte bits 0, 1=00) or a buffer-to-disk data transfer (first command byte bits 0, 1=01); in either case, a SEEK command is assumed to have positioned the disk to the proper track. The WRITE command will automatically verify the track address by comparing the previous SEEK address to the address read from the track. If these do not agree, the operation is aborted with the status bit 'head positioning error' set. If the operation is a buffer-to-disk operation, the contents of the FDC's buffer are written to the disk; it is the host's responsibility to precede the operation with the proper buffer write. If the operation is a buffer write (first command byte bits 0, 1=10), the sector address is ignored and, if the addressed drive is ready, the host data is transferred directly to the FDC's buffer. In all cases, a full sector of data is transferred, a byte at a time, according to the protocol and timing described under DATA TRANSFER. Error and status reporting for a WRITE operation is described under STATUS HANDSHAKE.

### 2.4.6 WRDEL Command

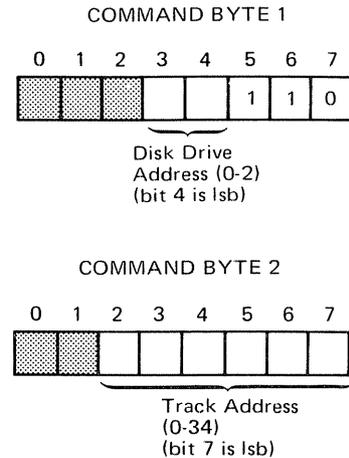


### COMMAND BYTE 2



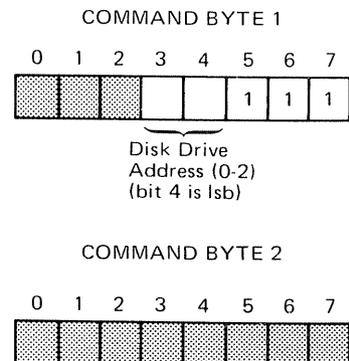
The WRDEL command is the same in all ways as the WRITE command except that a DELETED DATA address mark is written on the data sector.

### 2.4.7 FORMAT Command



The FORMAT command causes the FDC to write an entire track with the appropriate address marks, record gaps, and sector data (Hex E5) as specified by the modified IBM type format. A SEEK command should precede the FORMAT command to position the head properly but the FDC will use the track address specified in the FORMAT command as the track address to be written in the sector IDs. Error and status reporting is described under STATUS HANDSHAKE.

### 2.4.8 STATUS Command



The STATUS command returns device status for the specified disk (CMD and Disk Drive Status). The status which may be returned is: a) disk not ready, b) motor off, c) disk write protected, d) seek in progress.

All track and sector addresses are verified by the controller. If the address is incorrect the status byte will indicate "invalid TRK/Sec address". However, in the case of a track address, bits 0 & 1 are ignored. These bits may contain a "1" but the controller will not report an error. The same rule applies with a sector address bits 0, 1, & 2.

#### 2.4.8.1 Description of SA4400 States

##### A) Initialization Sequence

FDC Status Lines: 1) XFR=1      CMD=0  
 2) STATUS=1      ACK=0  
 3) BUSY=1  
 4) DIR=1  
 5) FDCON=1

FDC enters the initialization sequence at power-up, hardware reset or through the INIT command (bit 2 = 0). Exit from the initialization sequence will occur when at least one drive of the system is determined ready. (Time controller requires to complete INIT sequence is 1 sec (min)).

##### B) Command Handshake

FDC Status Lines: 1) XFR=0/1      CMD=0  
 2) STATUS=0      ACK=0/1  
 3) BUSY=0  
 4) DIR=0  
 5) FDCON=0

FDC is ready to accept a new command. The command handshake is carried out as follows:

CMD=1  
 ACK=0/1      XFR=0/1

Host raises CMD line to indicate communication with FDC is needed, places data on port and toggles ACK line, (ACK line must toggle within 5 usec after CMD is raised). FDC reads data in and toggles XFR line. Host then places second command byte on port and toggles ACK line. FDC reads in second byte, toggles XFR line and waits for CMD line to go low before continuing with the execution of the command.

CMD line can also be used to abort an operation (when BUSY=1). That will result in status being available on data port. (STATUS HANDSHAKE).

Before raising CMD line, host should set ACK line to the value of XFR line. This prevents the system from hanging up in case of a data overrun or operation aborted condition.

##### C) Data Transfer

FDC Status Lines: 1) XFR=0/1      CMD=0  
 2) STATUS=0      ACK=0/1  
 3) BUSY=1  
 4) DIR=0/1  
 5) FDCON=0

When data is transferred between the FDC and the host system, the XFR line and ACK line are used to complete a handshake between the FDC and the host system. The XFR line is toggled by the FDC to indicate a data byte transfer (data available from FDC or data requested from host system) and the ACK line is toggled by the host system to acknowledge the data byte transfer (data accepted or made available by host system).

During a Direct Data Transfer operation the XFR line is toggled by the FDC every 64µsecs (±4µsecs) to indicate data is available on the DATA port (READ) or data is requested from the host (WRITE). The host acknowledges the data transfer/request by toggling the ACK line. If the host fails to acknowledge a data transfer by failing to toggle the ACK line, the READ/WRITE operation is aborted and a data overrun error is generated.

During a buffer to disk or disk to buffer data transfer, the host does *not* provide data transfer handshaking. After acceptance of the data transfer command, the operation is transparent to the host system.

During a direct host to disk or disk to host transfer, the contents of the FDC buffer are unaffected.

##### D) Status Handshake

FDC Status Lines: 1) XFR=0/1      CMD=0  
 2) STATUS=1      ACK=0/1  
 3) BUSY=1  
 4) DIR=1  
 5) FDCON=0

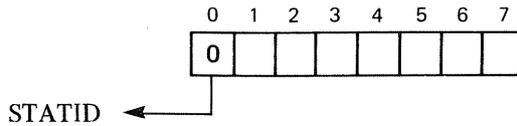
Status is available on data port: 1) at the end of an operation, 2) if an operation was interrupted, 3) if an operation was not performed because of drive malfunction.

The status handshake is carried out as follows:

FDC sets STATUS line high, places status byte on data port, and toggles XFR line. Host reads data from port and toggles ACK line. FDC will return to idle loop and will set STATUS line low. Two types of status bytes may appear at the data port. They can be distinguished by examining the most significant bit of the status byte (STATID).

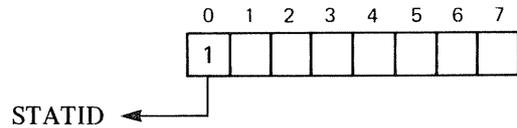
#### 2.4.8.2 Status Bytes

##### 1) CMD and Disk Drive Status



- 7. Disk drive not ready = 1
- 6. Disk write protected = 1
- 5. Head positioning error = 1
- 4. Motor off = 1
- 3. Seek in progress = 1
- 2. Invalid sector/track address = 1
- 1. Invalid buffer specification/drive address = 1

##### 2) Operation Status



- 7. Operation aborted = 1
- 6. Data overrun = 1
- 5. No AMS found = 1
- 4. Data address mark missing = 1
- 3. Sector unrecoverable = 1
- 2. CRC error = 1
- 1. Deleted data read = 1

#### Interpretation of Status Bits

Command and Disk Drive Status: (STATID – Bit 0 = 0)

- Bit 7 Disk Drive Not Ready: Addressed drive is not in system, has the door open, or has no disk inserted.
- Bit 6 Disk Write Protected: Indicates an attempt to write on a read only disk.
- Bit 5 Head Positioning Error: Track address read does not match address from last seek. May indicate drive problems.
- Bit 4 Motor Off: Motor not activated thru 'INIT' command.
- Bit 3 Seek In Progress: Indicates that a seek has been initiated.
- Bit 2 Invalid Sector/Track Address: Sector address exceeded 18 or track address exceeded 35.
- Bit 1 Invalid Buffer Specification/Drive Address: A buffer function of 3 has been given and is illegal.

## Operation Status (STATID – Bit 0 = 1)

- Bit 7 Operation Aborted: Errors which caused abort are reflected in bits 4-6. Nothing in 4-6 means command given while busy.
- Bit 6 Data Overrun: User failed to acknowledge data transfer. If during WRITE, the sector is probably written incorrectly.
- Bit 5 No AMS Found: No address marks in full disk revolution. May indicate bad track or unformatted disk.
- Bit 4 Data Address Mark Missing: Data AM following sector ID not detected. Failure after retry may indicate bad track.
- Bit 3 Sector Unrecoverable: CRC error occurred on sector ID read or sector ID was not found. Repeated errors on retry may indicate bad track.
- Bit 2 CRC Error: CRC error occurred on data sector read. Repeated errors after retry may indicate bad track.
- Bit 1 Deleted Data Read: Sector read contained deleted data AM.

## 2.5 Program Considerations

### 1) Handling Motor On/Off

On power-up or hardware reset, FDC sets motor on (all drives). Motors can be turned off through INIT command. This same command can be used to turn motors on programmatically.

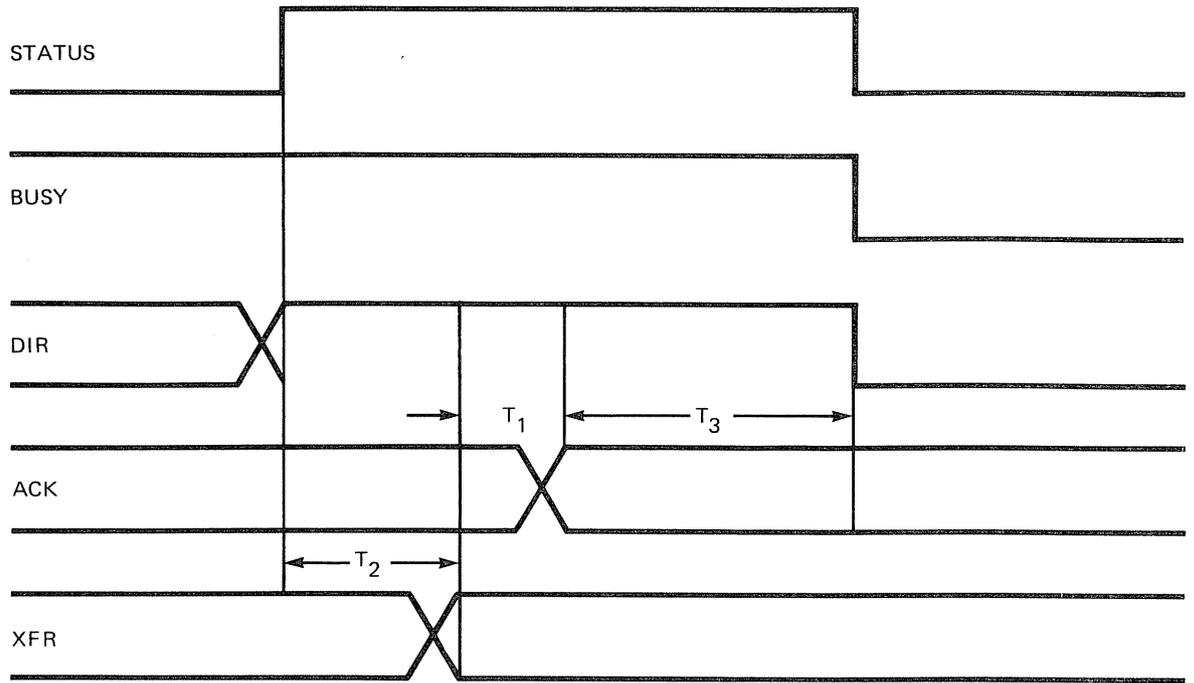
### 2) Ready Line

The FDC expects to receive a READY signal from the drive. Since the SA400 disk drive has no such signal, the user has two options:

- A) To connect READY (pin 34 on J106) low and make sure drive is ready before using it; or
- B) To leave READY unconnected. In this case, program will test for INDEX before executing a READ/WRITE command. Option B introduces an average latency of 100 ms to the execution of the READ, WRITE, and FORMAT commands.

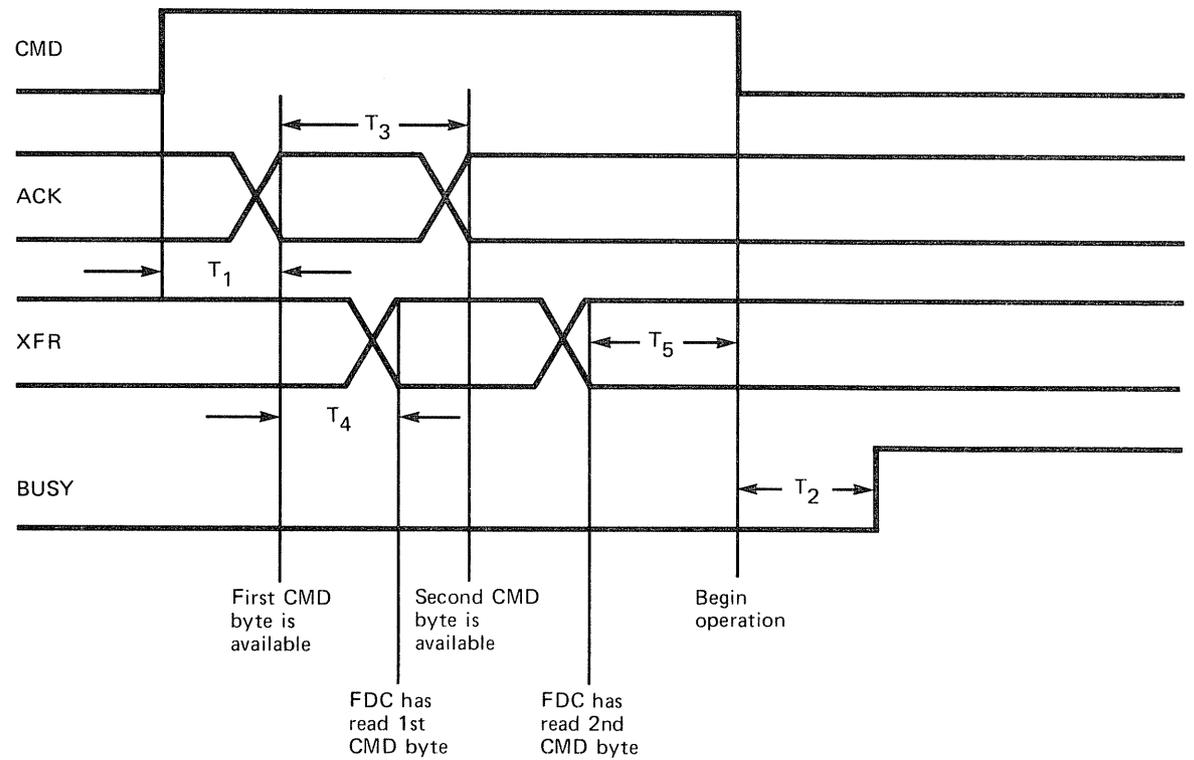
## 2.6 Further Information

Electrical specifications and pin-outs for the host interface connectors can be found in the SPECIFICATIONS section of this manual. Cabling information for the host interface can be found in the INSTALLATION section.



$T_1 = 0 \mu\text{s (min)}$   
 $T_2 = 1 \mu\text{s (min)}$   
 $T_3 = 2 \mu\text{s (min), 4 \mu\text{s (max)}$

STATUS HANDSHAKE



$T_1 = 0 \mu\text{s (min), 5 \mu\text{s (max)}$   
 $T_2 = 1.2 \mu\text{s}$   
 $T_3 = 3 \mu\text{s (min)}$

$T_4 = 2 \mu\text{s (min), 20 \text{ms (max) (if seek in progress)}$   
 $T_5 = 0 \mu\text{s (min)}$

COMMAND HANDSHAKE



### **3.0 FLOPPY DISK DRIVE INTERFACE**

The Floppy Disk Drive Interface receives data and status from the drive and transmits data and control to the drive. All status and control signals required by the SA400 floppy disk drive are present at the interface.

#### **3.1 Read Operation**

The data separation logic is organized around a crystal controlled oscillator and provides all necessary timing information. Recorded double frequency data is buffered into bytes of clock bits and data bits and is then passed on to the FDC CPU through the I/O port during read operations. The nominal time from a clock (data) bit to a data (clock) bit is  $4 \mu\text{s}$ . The nominal time from a clock (data) bit to the next clock (data) bit, when there is no intervening bit, is  $8 \mu\text{s}$ .

#### **3.2 Write Operation**

During write operations, the clock and data information is passed from the FDC I/O port and recorded serially in double frequency format on the disk. The data and clock bits appear as 400 ns pulses on the WRITE DATA line. (The actual pulse duration is not critical since the edge is used to change the direction of current flow in the read/write head.) The variation from the nominal  $4 \mu\text{s}$  or  $8 \mu\text{s}$  period is  $\pm 1\%$ .

#### **3.3 Drive Selection**

Floppy disk drive selection is performed through a single CPU I/O port on the drive interface. Both binary encoded and one-out-of-three addressing schemes are supported for daisy chain configurations of up to three floppy disk drives. DRIVE SELECT loads the drives' R/W head.

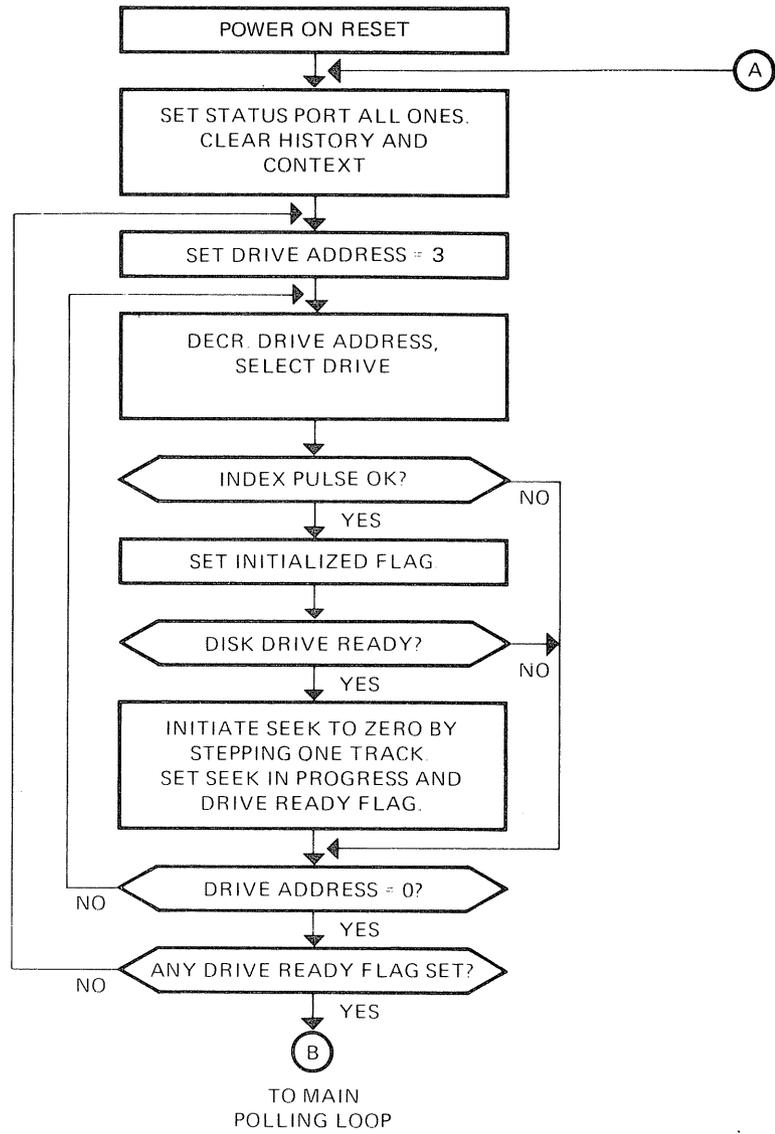
#### **3.4 Drive Status**

Disk drive status is accessed through a single CPU I/O port on the interface. Status is sampled by the controller at various times between and during operations as well as during system initialization. INDEX is sampled during system initialization to assure a drive ready status for the selected drive. The WRITE PROTECT signal is used to prevent writing on a read only disk and TRACK 00 is used to prevent incorrect head retraction.

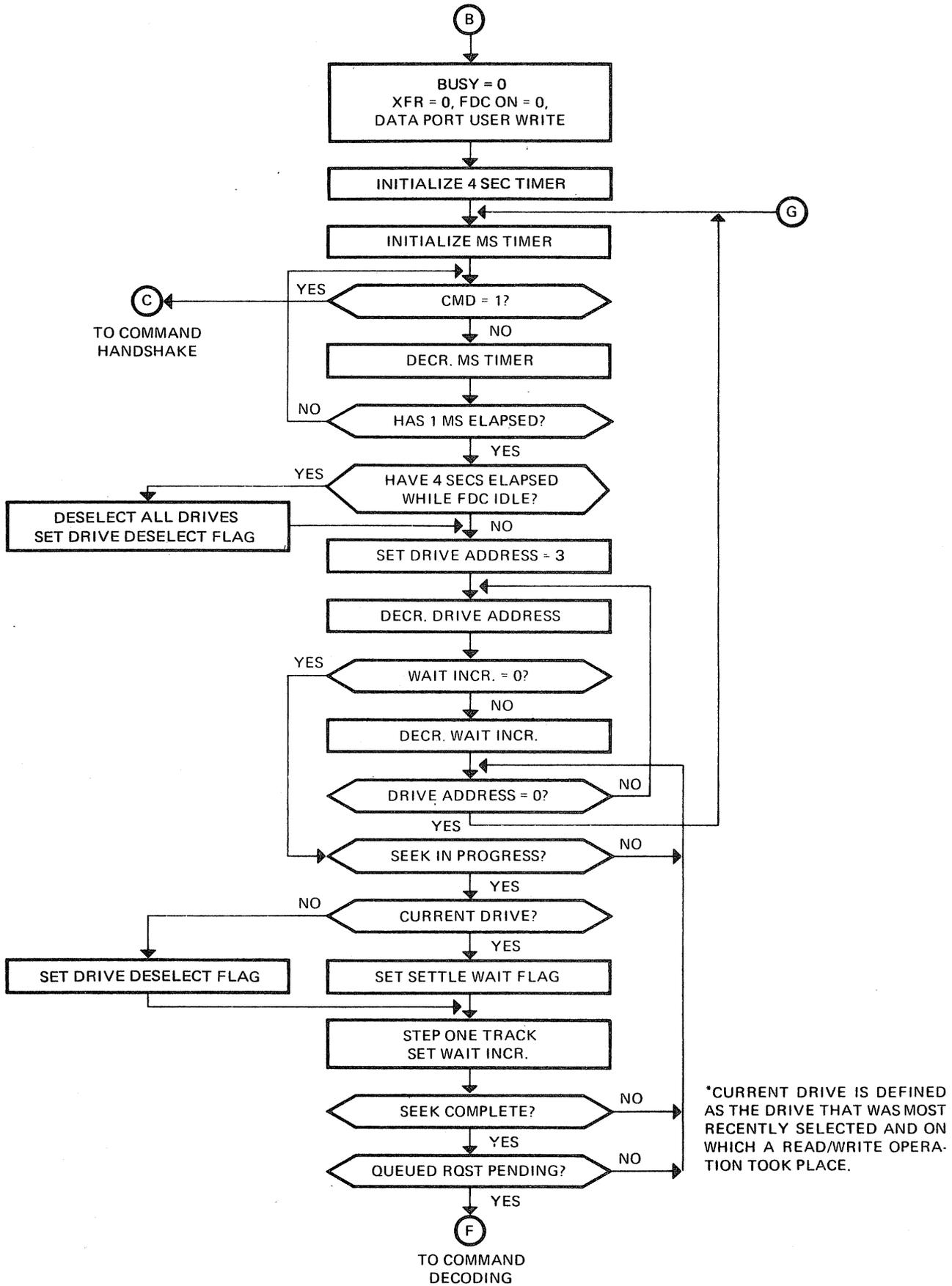
### 3.5 Drive Control

Disk drive control is performed through a single CPU I/O port on the interface. Head positioning is done with the STEP, and DIRECTION signals. WRITE GATE is used to activate the drive's write logic. MOTOR ON is used to control the drive's spindle motor. Timing on all of these signals meets the SA400 specifications.

#### 4.0 FDC PROGRAM FLOW-CHARTS

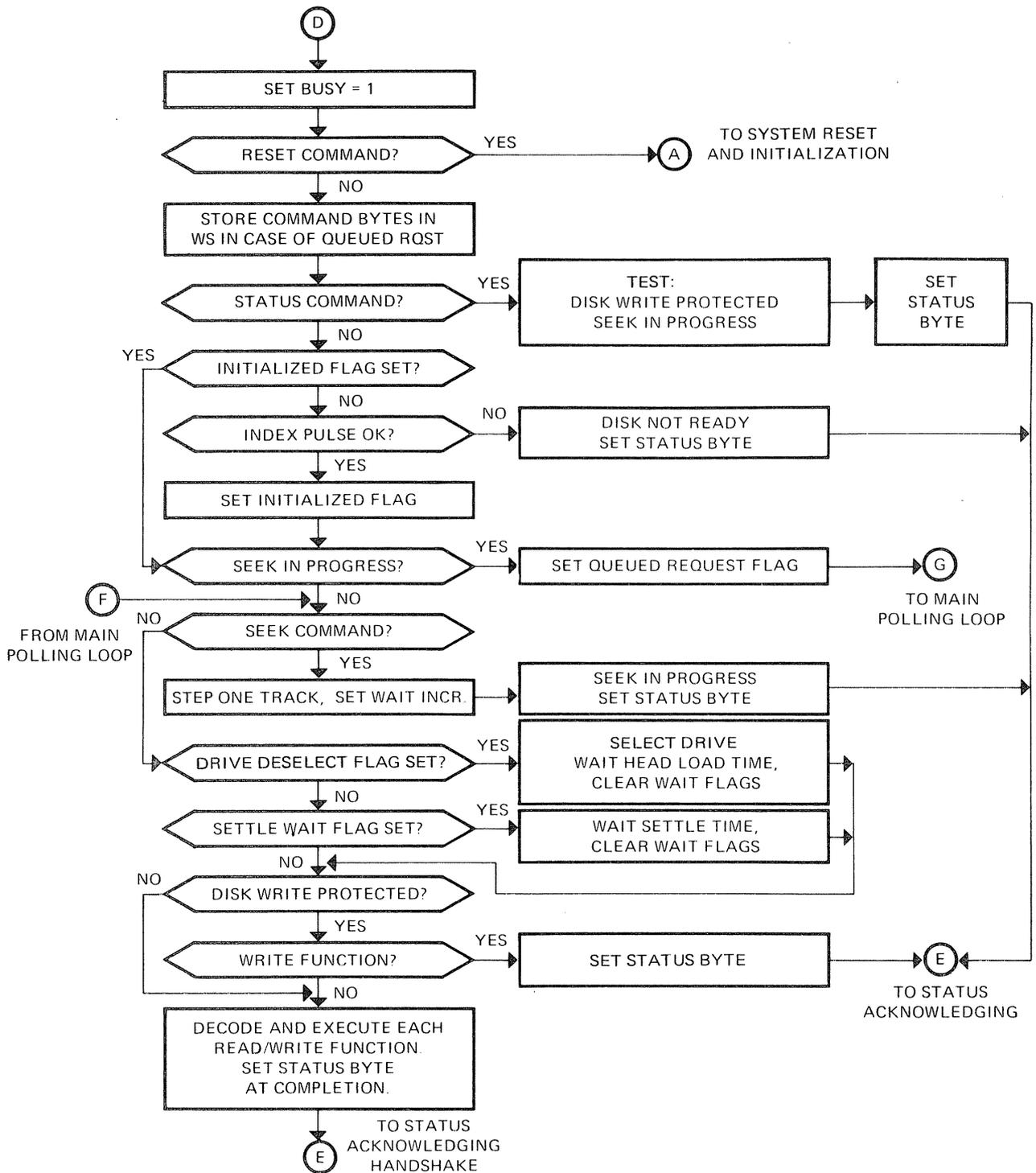


System Reset and Initialization Sequence

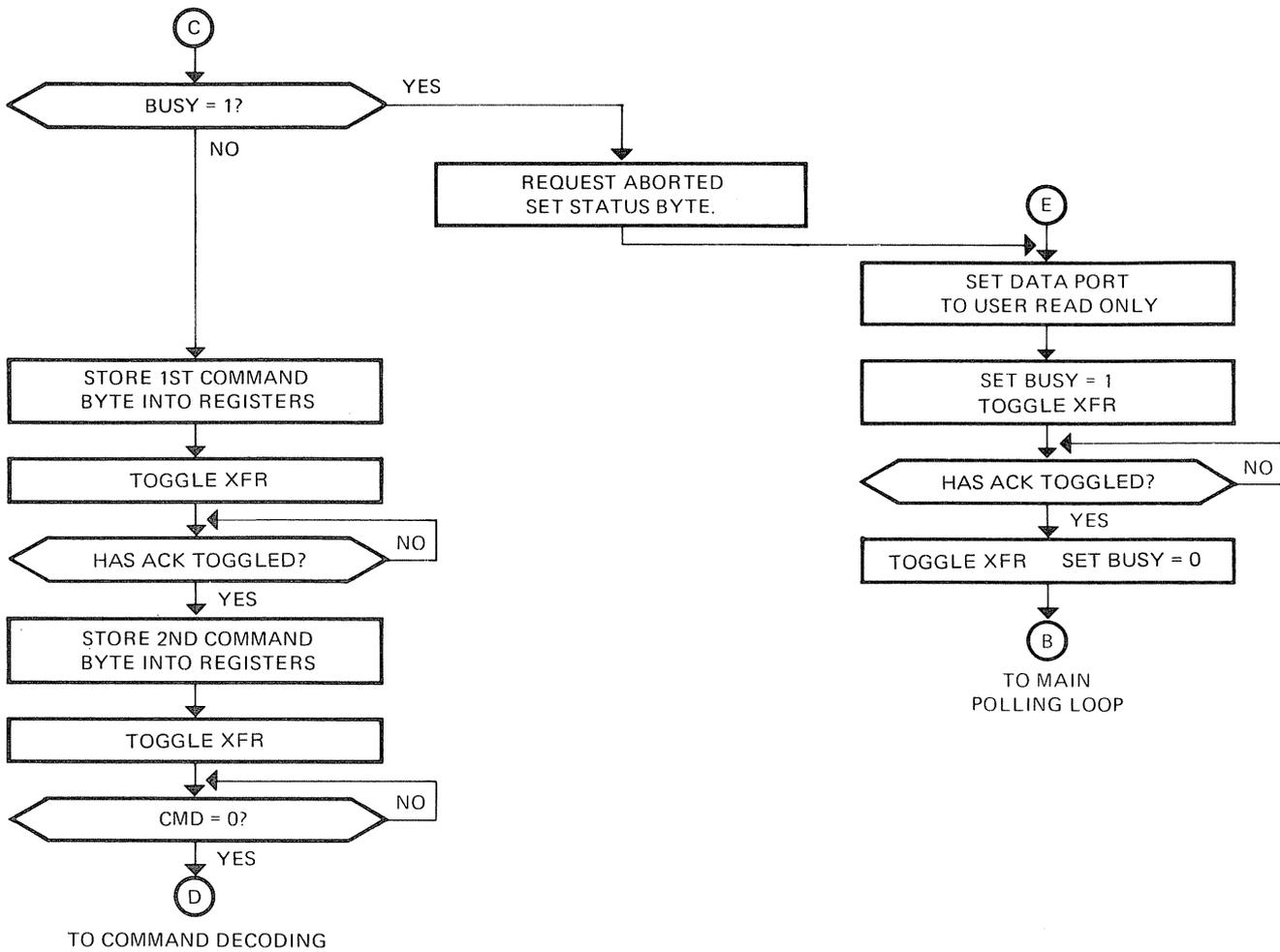


\*CURRENT DRIVE IS DEFINED AS THE DRIVE THAT WAS MOST RECENTLY SELECTED AND ON WHICH A READ/WRITE OPERATION TOOK PLACE.

Main Polling Loop



Command Decoding



Command Handshake

Status Acknowledging Handshake

## 5.0 SPECIFICATIONS

The following section contains the SA4400 specifications including electrical parameters and pin-out of all connectors normally used in a floppy disk drive system. (Note that other connectors are provided for testing and system expansion.) In addition, a tabular description of the program specifications is included.

### 5.1 System Environment Ratings

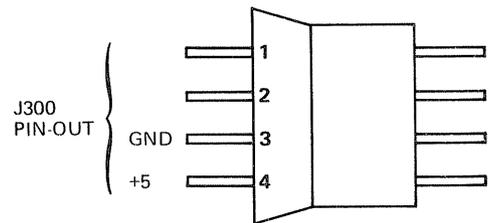
Supply Voltage, $V_{cc}$ *	0.5 to 6 V
Input Voltage*	-0.5 to 5.5 V
Operating Voltage	5 V $\pm$ 5%
Output Current, Short Circuit*	100 ma
Operating Temperature	0°C to 50°C
Storage Temperature	-65°C to 125°C

NOTE: Stresses outside and extended time at the limits of these ratings may cause permanent damage or affect device reliability. Functional operation at these limits is not guaranteed or implied.

### 5.2 System Power Requirements (J300)

Voltage: 5V  $\pm$ 5% at J300

Current: 3.0 amps (maximum)



AMP PN-350211-1

### 5.3 Host Interface Electrical Parameters (J01)

All general purpose interface signal lines provide standard TTL input and output levels with Tristate outputs. The DC electrical characteristics are shown in Table 1 below:

(Limits apply for  $V_{CC} = 5V \pm 5\%$  and  $0^\circ C \leq T_A \leq 50^\circ C$  unless specified otherwise)

PARAMETER	SYMBOL	CONDITIONS	LIMITS			UNITS
			MIN.	TYP.	MAX.	
High-Level Input Voltage	$V_{IH}$		2.0			V
Low-Level Input Voltage	$V_{IL}$				.8	V
Input Clamp Voltage	$V_{CL}$	$I_I = -5mA$			-1	V
High-Level Input Current	$I_{IH}$	$V_{CC} = 5.25V$ $V_{IH} = 5.25V$		<10	100	$\mu A$
Low-Level Input Current	$I_{IL}$	$V_{CC} = 5.25V$ $V_{IL} = .5V$		-350	-500	$\mu A$
Low-Level Output Voltage	$V_{OL}$	$V_{CC} = 4.75V$ $I_{OL} = 16mA$			.55	V
High-Level Output Voltage	$V_{OH}$	$V_{CC} = 4.75V$ $I_{OH} = 3.2mA$		2.4		V
Short-Circuit Output Current	$I_{OS}$	$V_{CC} = 5.25V$	10			mA

### 5.4 Interface Connectors to SA4400

J106: Drive Interface

J01: Host Interface

J300: Power Supply (Pin 4:  $V_{CC} = +5V$ )  
(Pin 3: GND = 0V)

### 5.5 Drive Interface Electrical Parameters (J106)

The following parameters describe the control lines and the select lines to the floppy disk drive and are independent of the drive manufacturer.

#### 5.5.1 DC Electrical Characteristics (Output)

(Limits apply for  $V_{CC} = 5V \pm 5\%$  and  $0^\circ C \leq T_A \leq 50^\circ C$  unless specified otherwise.)

Note: Outputs all open collector.)

PARAMETER	SYMBOL	CONDITIONS	LIMITS			UNITS
			MIN.	TYP.	MAX.	
Low-Level Output Voltage (WRITE DATA)	$V_{OL}$	$V_{CC} = 4.75V$ $I_{OL} = 60mA$			.5	V
Low-Level Output Voltage (all others)	$V_{OL}$	$V_{CC} = 4.75V$ $I_{OL} = 100mA$			.4	V

The following parameters specify the loading presented to the drive, and the voltage levels required, by the SA4400.

### 5.5.2 DC Electrical Characteristics (Input)

(Limits apply for  $V_{CC} = 5V \pm 5\%$  and  $0^\circ C \leq T_A \leq 50^\circ C$  unless specified otherwise.  
Open collector outputs assumed at drive.)

PARAMETER	SYMBOL	CONDITIONS	LIMITS			UNITS
			MIN.	TYP.	MAX.	
Low-Level Input Voltage	$V_{IL}$				.8	V
Low-Level Input Current	$V_{IL}$				25	mA

### J106 PIN-OUT FOR SA400

Signal Name	Pin Number
read data	30
ground return	29
write data	22
ground return	21
write gate	24
ground return	23
write protect	28
ground return	27
step	20
ground return	19
direction	18
ground return	17
track 00	26
ground return	25
index	8
ground return	7
drive select 1	10
ground return	9
drive select 2	12
ground return	11
drive select 3	14
ground return	13

### 5.6 Shugart SA400 Controller Performance Specifications

allowed SELECT to INDEX time: 207 ms (max)  
 allowed INDEX pulse time: 100  $\mu$ s (min), 2.2 ms (max)  
 allowed INDEX to INDEX time: 192.8 ms (min), 207.2 ms (max)  
 motor turn on time: 1 sec. (max)  
 head load time: 75 ms  
 track step time: 40 ms  
 head settle time: 10 ms (additive to step or load)  
 STEP pulse duration: 10  $\mu$ s  
 DIRECTION to STEP delay: 1.2  $\mu$ s  
 DIRECTION polarity: low level  $\rightarrow$  step in  
 WRITE GATE to WRITE DATA delay: 1.6  $\mu$ s (min), 3.6  $\mu$ s (max)  
 WRITE PROTECT polarity: low level  $\rightarrow$  read only disk



## **6.0 SYSTEM INSTALLATION**

The following section describes the cables and installation procedures for the SA4400 floppy disk drive controller.

### **6.1 Host Interface**

The host computer is interfaced to the SA4400 through connector J01. The pin-out of these connectors is described in the preceding section and the use of the host interface lines is described in section II. The cable to J01 is a standard flat cable with alternating grounds to minimize cross-talk. The remainder of the interface is initialized by the CPU when power is applied or when a reset is performed through J01 (not a controller INIT command but rather an active level on the RESET line in J01). The cable required for J01 is described in the diagrams which follow. VCC and ground are supplied through connector J300.

### **6.2 Drive Interface**

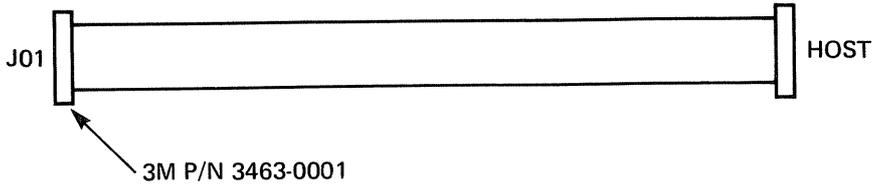
The floppy disk drives are interfaced to the SA4400 through connector J106. The electrical specifications and the pin-out of J106 are given in the preceding section. The cable required for J106 is described in the diagrams which follow. (No dc power is supplied to the drive through J106 since this is a high impedance cable.)

### **6.3 Drive Options**

1. 'MUX' option must be opened on all drives even in a one drive system.

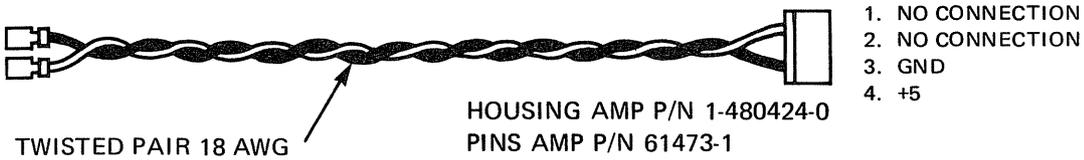
In addition T1, T2, T3, T4 and T5 should be jumpered at the last drive on the signal cable and one of the DS1-DS3 should be jumpered on each drive to assign the logical address. (See the SA400 OEM manual for a complete description of the drive options.)

HOST CABLES (FDC to HOST):



Host cables are 34-conductor ribbon cable. (10 feet maximum)

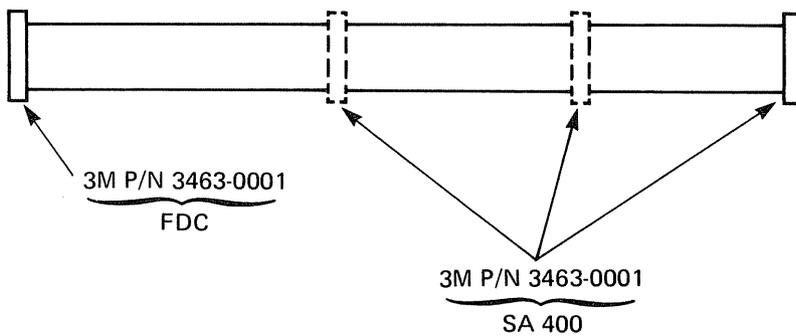
FDC VCC CABLE (POWER SUPPLY TO FDC J300):



The FDC VCC cable supplies 5V and ground to the SA4400 series floppy disk drive controller.

SA400 CABLES

SIGNAL CABLE (FDC J106 to SA 400 J1):



Signal cable is 34-conductor ribbon cable.

HOST INTERFACE CABLES

#### 6.4 Additional Information About The SA4400

1. All references to logic 1 are active high TTL levels.

All references to logic 0 are active low TTL levels.

2. Most significant bit is bit 0 in all cases.
3. The head is loaded whenever the drive is selected. The drive is deselected and the head is unloaded after 4 seconds of no disk activity.
4. The command byte data must be stable from the leading edge of CMD to the leading edge of XFR.
5. RESET signal line should be held low for a minimum of 1  $\mu$ sec. The SA4400 program resumes when RESET returns to +5volts.

6. During power up the SA4400 tests for a floppy disk drive which is ready or which is generating an INDEX pulse within a specific time interval. If at least one drive is ready, the SA4400 indicates via the status port (i.e., BUSY=0) that it will accept a command.

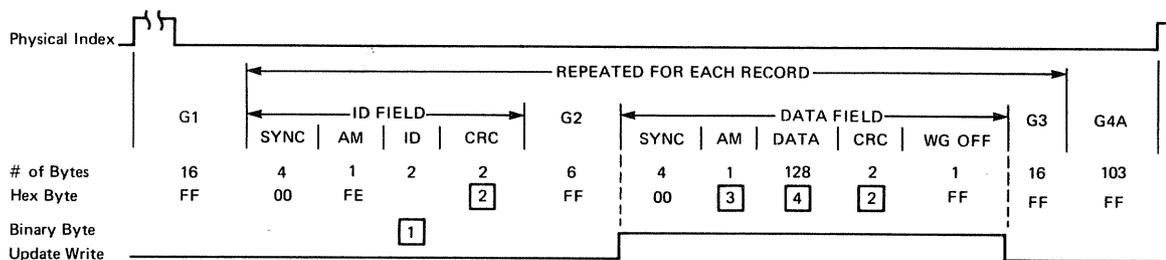
7. All STATUS and DATA bits=1 until initialization is complete. When initialization is complete, FDCON $\rightarrow$ 0 and all STATUS bits are cleared to 0, and DATA port is readied to receive a command.

8. Since the SA4400 performs READ/WRITE operations on a sector-by-sector basis, sector interleaving must be accomplished by the host system through appropriate READ/WRITE sequences.

9. To achieve the stated MTBF of the SA400 drive, the host system must turn the drive motor off thru the 'INIT' command if no new commands are anticipated.

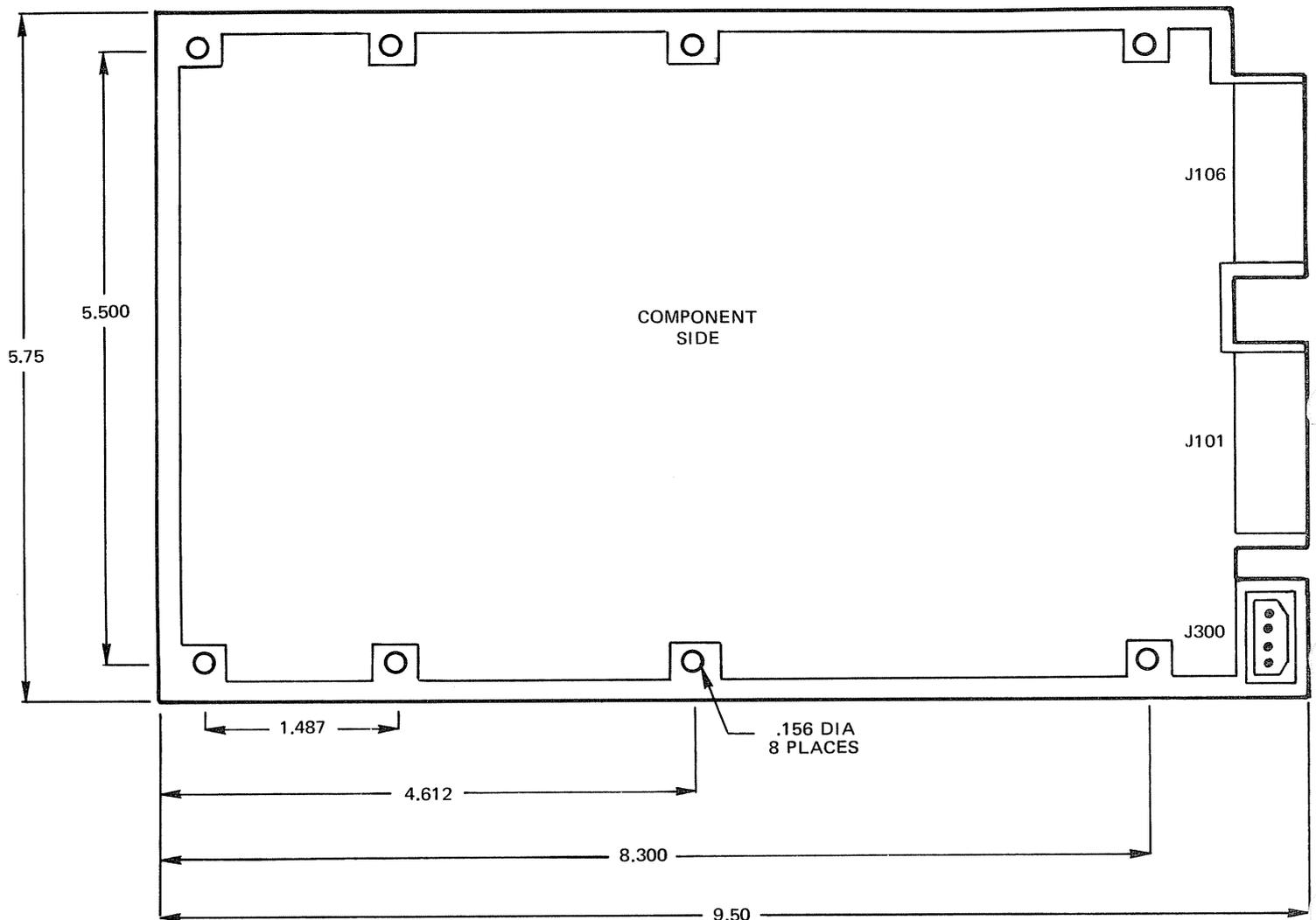
10. For commands which specify a drive address; bit 4 is the LSB. If bits 3 & 4 = 00, the DS1 line will be activated. If bits 3 & 4 = 01, the DS2 line will be activated. If bits 3 & 4 = 10, the DS3 line will be activated.

FM Recommended Format - 128 Byte & 18 Records/Track



- 1 Track Addr, Sector Addr
- 2 Generated by CRC Generator which should be IBM or equiv.
- 3 FB for data field or F8 for deleted data field
- 4 User data

#### SOFT SECTORING - MODIFIED IBM TYPE FORMAT



### SA4400 PC BOARD DIMENSIONS

**NOTE:** Minimum of .30 diameter around mounting holes on component side is free of metal traces. This provides screw head clearance.



# Schematics

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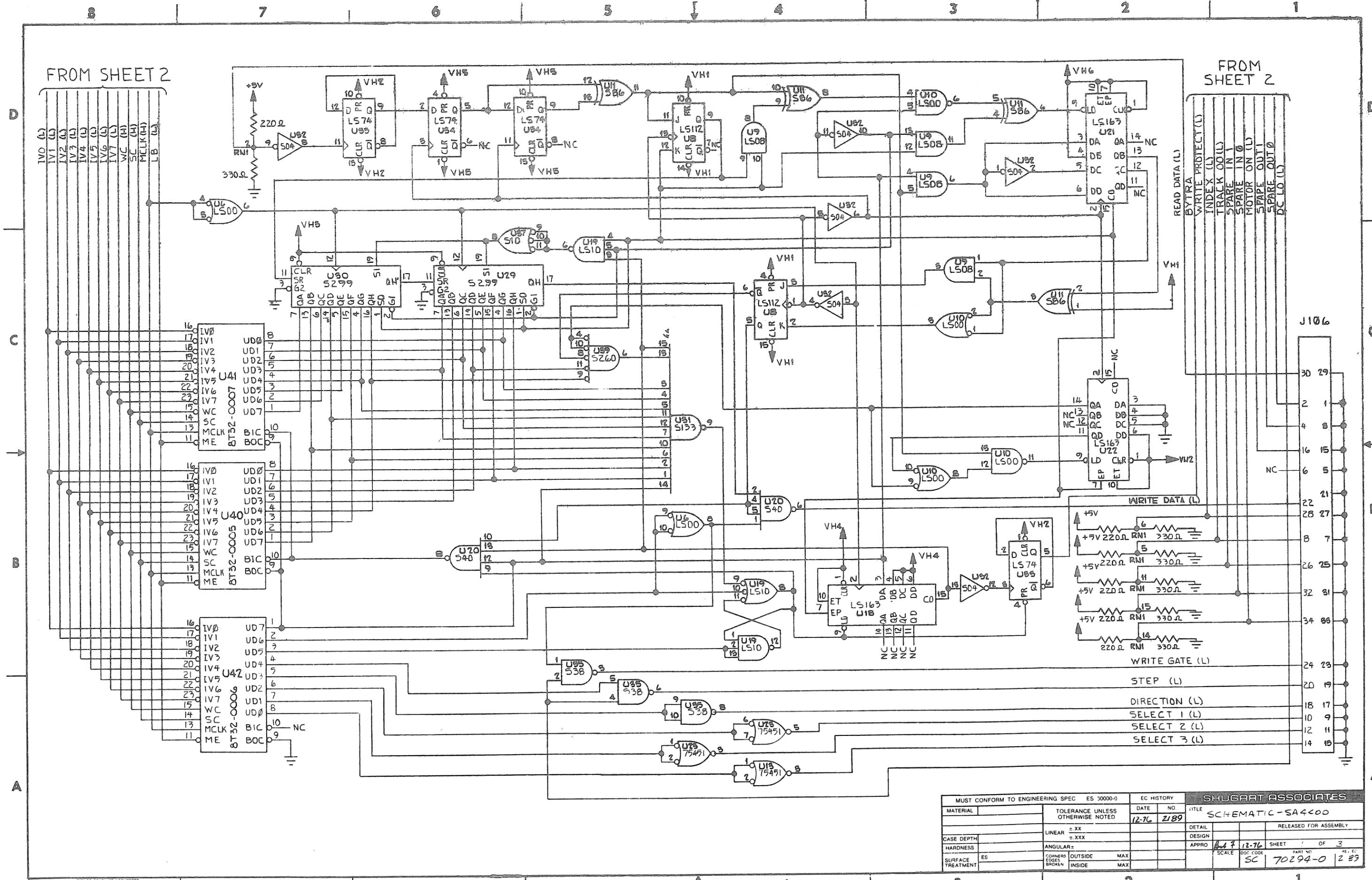
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5

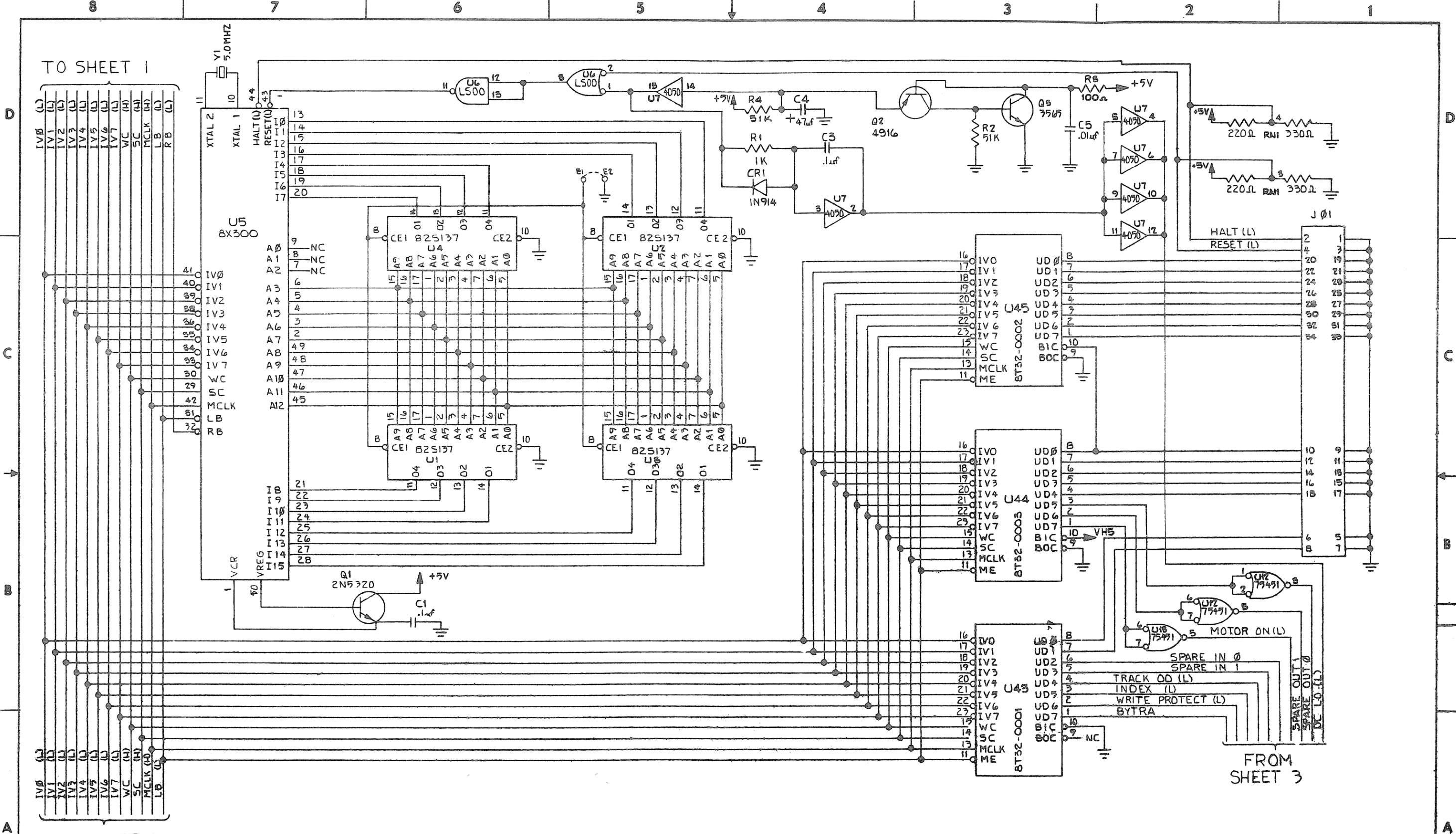


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5



MUST CONFORM TO ENGINEERING SPEC ES 30000-0		EC HISTORY		SHUGART ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	RELEASED FOR ASSEMBLY
	LINEAR ±.XX	12-76	2189	SCHEMATIC-SA2200	
CASE DEPTH	ANGULAR ±			DESIGN	
HARDNESS	CORNERS BROKEN			APPRO	
SURFACE TREATMENT	OUTSIDE MAX			SCALE	
	INSIDE MAX			DOC CODE	
				PART NO	
				70294-0	
				REV. EC	
				2 89	

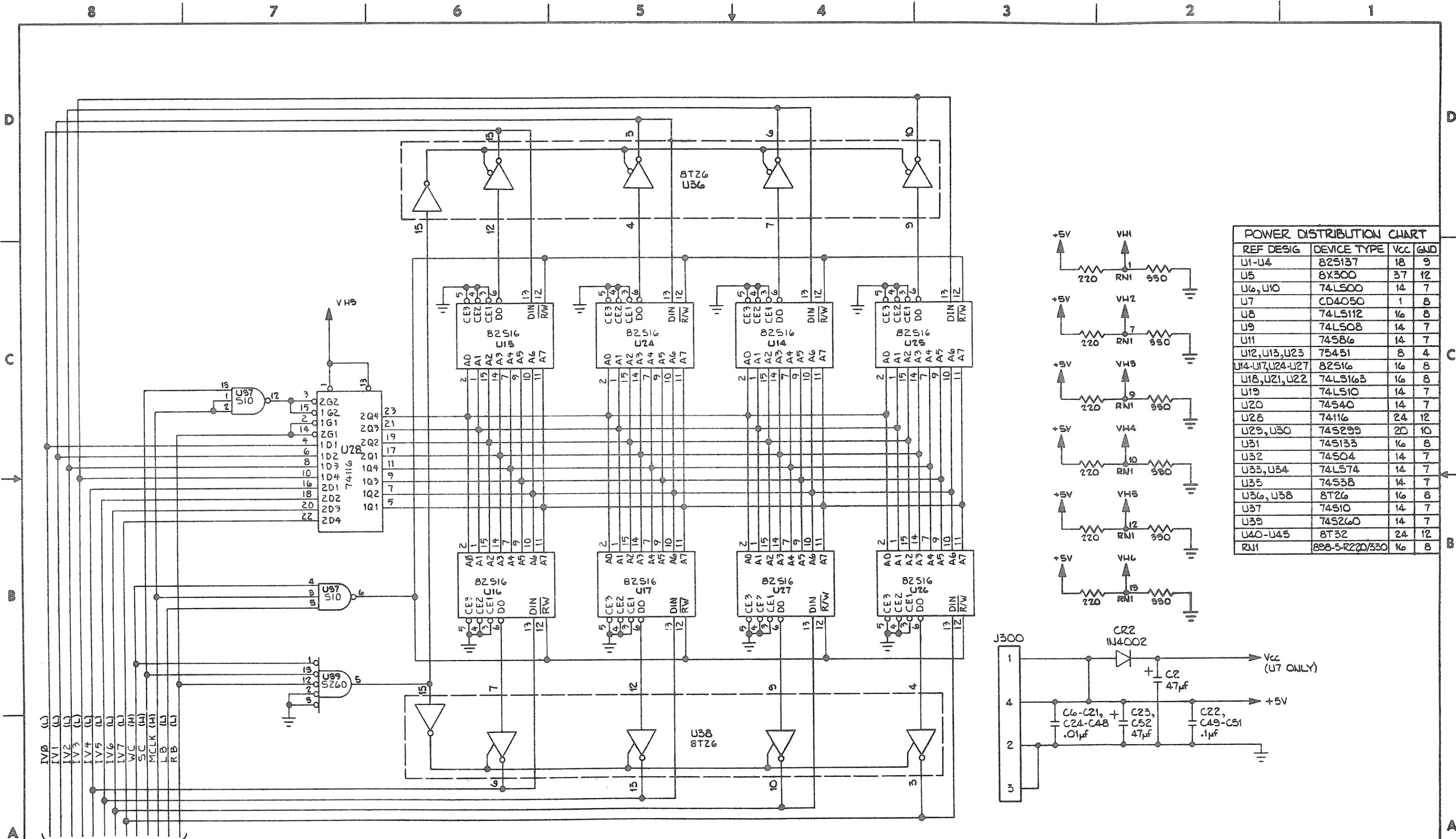


TO SHEET 1

TO SHEET 3

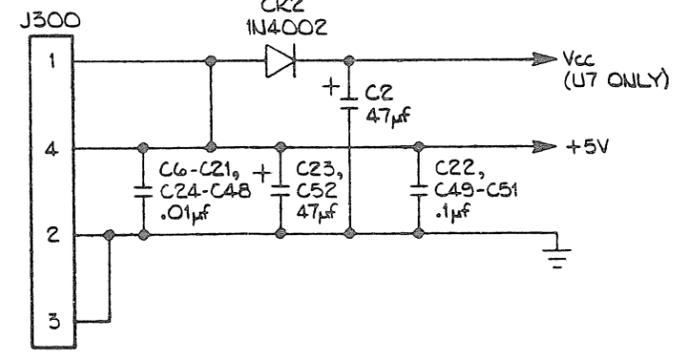
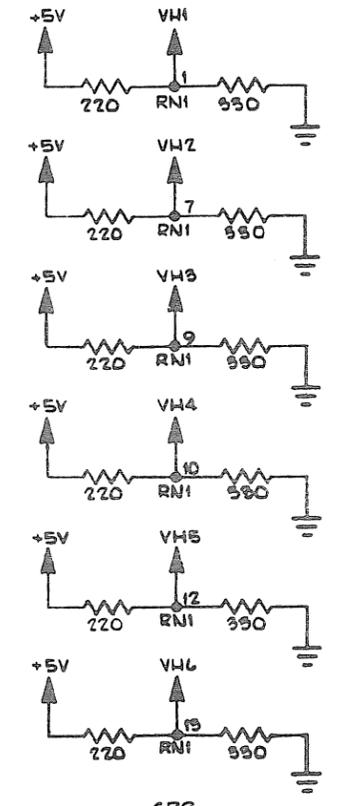
FROM SHEET 3

MUST CONFORM TO ENGINEERING SPEC ES 30000-0		EC HISTORY		SHUGART ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	RELEASED FOR ASSEMBLY
		12-76	2189	SCHEMATIC - SF4400	
CASE DEPTH	LINEAR = XX OTHERWISE = XXX			DESIGN	
HARDNESS	ANGULAR =			APPRO	
SURFACE TREATMENT	EL. IS T. SIDE MAX BROKEN INSIDE MAX			SCALE	
				DOC. NO.	REV. NO.
				SC 70294-0	2189



**POWER DISTRIBUTION CHART**

REF DESIG	DEVICE TYPE	VCC	GND
U1-U4	825137	18	9
U5	8X300	37	12
U6, U10	74LS00	14	7
U7	CD4050	1	8
U8	74LS112	16	8
U9	74LS08	14	7
U11	74586	14	7
U12, U13, U23	75451	8	4
U14-U17, U24-U27	82516	16	8
U18, U21, U22	74LS163	16	8
U19	74LS10	14	7
U20	74540	14	7
U28	74116	24	12
U29, U30	745299	20	10
U31	745133	16	8
U32	74504	14	7
U33, U34	74LS74	14	7
U35	74538	14	7
U36, U38	8T26	16	8
U37	74510	14	7
U39	745260	14	7
U40-U45	8T32	24	12
RN1	898-S-R220/330	16	8



FROM SHEET 2

MUST CONFORM TO ENGINEERING SPEC ES 30000-0		EC HISTORY		SHUGART ASSOCIATES	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO	TITLE	REL. FOR ASSEMBLY
		12-76	2189	SCHMATIC - SA 4400	
CASE DEPTH	L NEAR ±.XX			DE	
HARDNESS	±.XXX			DESIGN	
SURFACE TREATMENT	ANGULAR =			APPRO	
	CORNERS =			SCALE	
	EDGES =			DOC CODE	
	BROWN =			SCALE	
	INSIDE =			SCALE	
	MAX			SCALE	
	MAX			SCALE	

607 12-76 SHEET 3 OF 3  
SC 70294-0 12-87





415 Oakmead Parkway Sunnyvale, California 94086  
Telephone: (408) 733-0100 TWX: 910-339-9355 SHUGART SUVL