RM 65 FAMILY

FLOPPY DISK CONTROLLER (FDC) MODULE

USER'S MANUAL

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RM 65 FAMILY

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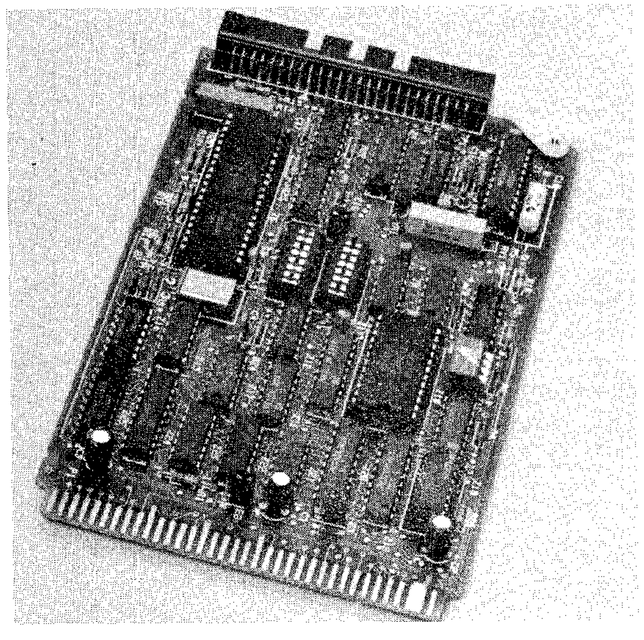
INTRODUCTION

1.1 PURPOSE/FUNCTION

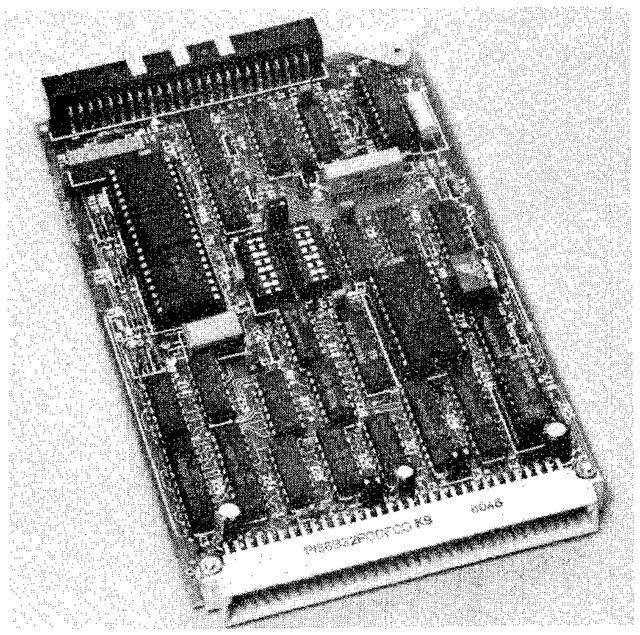
The RM 65 Floppy Disk Controller (FDC) module supports an AIM 65, AIM 65/40 or RM 65 SBC based system with floppy disk mass storage capability. The FDC module controls up to four standard (8") or mini-(5-1/4") floppy disk drives, single- or double-sided, soft sectored with either single-density (FM) or double-density (MFM) format. (8" double-density format requires installation of the RM 65 DMA Controller module--RM65-5104). Software control of media density allows single- or double-density disks to be used in any of the interfacing drives. Two DIP headers configure the FDC module to interface with either standard or mini-floppy disk drives and an on-board jumper selects single- or double-sided operation. The FDC module directly interfaces to most popular drives with only switch and/or header changes.

Bank Select and Bank Select Enable switches dedicate the module to one of two 65K byte memory banks, or assign it common to both banks. Program ROM and I/O Disable switches allow the on-board ROM or FDC module I/O to be enabled or disabled. The module base address is assigned by the Base Address Selection PROM for operation with the Program ROM firmware. When the Program ROM is deselected, the FDC module I/O can be assigned to any page (256 bytes) by replacing the Base Address Selection PROM.

The FDC module is available in a 72-pin Edge Connector version and in a 64-pin Eurocard version. Both versions are shown in Figure 1-1. The pin assignments of the two versions are identical except the edge connector version has four additional pins connected to +5VDC, and four unused pins (see Table 3-3 for pin assignments).



a. Edge Connector Version



b. Eurocard Version

Figure 1-1. FDC Module

The FDC module and optional firmware are identified as follows:

Order No.	Description
RM65-5101	FDC Module (Edge Connector) with on-board ROM*
RM65-5101N	FDC Module (Edge Connector) without on-board ROM
RM65-5101E	FDC Module (Euroconnector) with on-board ROM*
RM65-5101NE	FDC Module (Euroconnector) without on-board ROM
A65-090	AIM 65 DOS 1.0 ROM**
A65/40-7090	AIM 65/40 DOS 1.0 ROM**

NOTES
* Program ROM contains FDC module primitive subroutines only.
**Program ROM contains FDC module primitive subroutines and DOS functions integrated with host computer I/O.

1.2 FEATURES

- . RM 65 Bus compatible
- . Compact size--about 4" x 6-1/4" (100 mm x 160 mm)
- . Buffered address, data and control lines
- . Supports single- or double-sided, standard or mini-floppy disk drives
- . Controls up to four disk drives
- . Interfaces directly to Shugart SA850 or SA450 disk drives, and other popular floppy disk drives
- . Supports single-density IBM 3740 (FM) or double-density IBM System 34 (MFM) formats
- . DMA data transfer capability
- . Supports interrupt-driven or polled operation
- . Bipolar PROM Base Address decoding
- . Switches or jumpers for
  - Bank Selection to one or two banks
  - Single- or double-sided operation
  - Select or deselect ROM
  - Select or deselect I/O
- . On-board header configures I/O for 8" or 5-1/4" drives
- . On-board ROM contains FDC module primitive subroutines
- . Optional Disk Operating System (DOS) Version 1.0 ROMs support AIM 65 or AIM 65/40 microcomputers
- . Fully assembled, tested and warranted

1.3 CHARACTERISTICS

The physical and electrical characteristics of the the FDC module are listed in Table 1-1.

Table 1-1. FDC Module Physical and Electrical Characteristics

Characteristics	Value
Dimensions (see Figure 1-2)	
Edge Connector Version	
Width	3.9 in. (100 mm)
Length	6.5 in. (164 mm)
Height	0.56 in. (14 mm)
Weight	4.8 oz. (130 g)
Eurocard Version	
Width	3.94 in. (100 mm)
Length	6.30 in. (160 mm)
Height	0.56 in. (14 mm)
Weight	5.2 oz. (140 g)
Environment	
Operating Temperature	$0^{o}C$ to $70^{o}C$
Storage Temperature	$-40^{o}C$ to $85^{o}C$
Relative Humidity	0% to 85% (without condensation)
Power Requirements	+5 Vdc $\pm$ 5% 600 mA (3.2 W) - typical 900 mA (4.8 W) - maximum +12 Vdc $\pm$5% 60 mA (0.76W) - typical 100 mA (1.26W) - maximum
Interface Connector P1	
Edge Connector Version	72-pin edge connector (0.100 in. centers)
Eurocard Version	64-pin plug (0.100 in. centers) per DIN 41612 (Row b not installed)
Module I/O Interface J1	50-pin mass terminated (0.100 in. centers). Mates with T&B/Ansley Part No. 609-5001M or equivalent.

NOTES

1. The height includes the maximum values for component height above the board surface (0.4 in. for populated modules), printed circuit board (PCB) thickness (0.062 in.), and pin extension beyond the PCB (0.1 in.).
2. The length does not include the module ejector.
3. The Eurocard dimensions conform to DIN 41612.

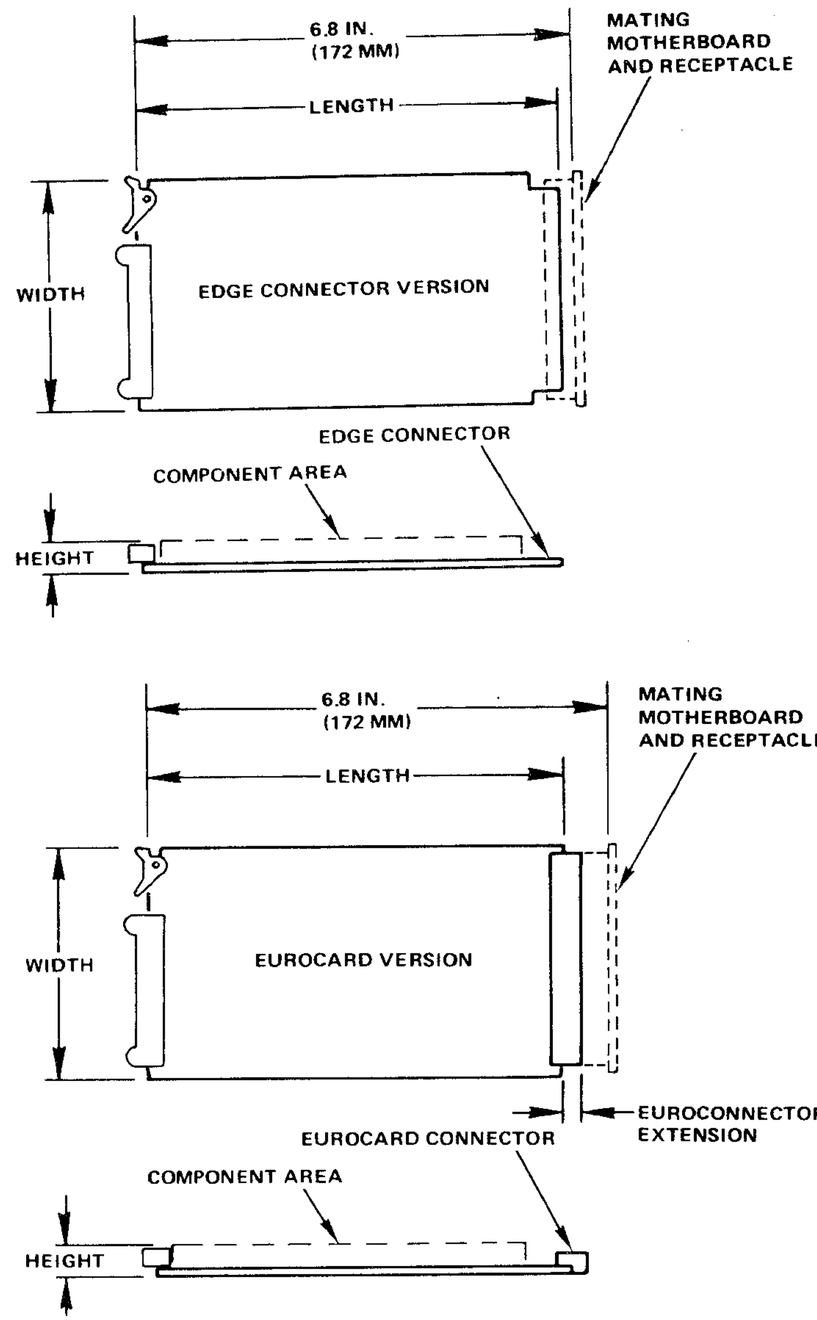


Figure 1-2. FDC Module Outline

1.4 REFERENCE DOCUMENTS

Rockwell

General

29650N30 R6500 Programming Manual
Order No. 202

29650N31 R6500 Hardware Manual
Order No. 201

AIM 65 Microcomputer

29650N36 AIM 65 Microcomputer User's Guide
Order No. 209

29650N72 AIM 65 FORTH User's Manual
Order No. 265

AIM 65/40 Microcomputer

29650N86 AIM 65/40 Microcomputer System User's Manual
Order No. 280

29651N07 AIM 65/40 FORTH User's Manual
Order No. 263

RM 65 Modules

29801N19 RM 65 Direct Memory Access (DMA) Module
Order No. 801 User's Manual

Western Digital

FD179X-02 Floppy Disk Formatter/Controller Family Data Sheet

WD1691 Floppy Support Logic Data

WD2143-01 Four-Phase Clock Generator Data Sheet

SECTION 2

INSTALLATION AND OPERATION

2.1 UNPACKING

Unpack the FDC module from its shipping carton and refer to the packing sheet to verify that all of the parts are included. Save the packing material for storing the module.

> **CAUTION**
>
> This module contains voltage-sensitive items. The module should be stored in an anti-static container when not in use and anyone handling the unit should observe anti-static precautions. Damage to the unit may result if anti-static protection is not maintained.

2.2 OPERATING OPTIONS

Seven operating options are switch, PROM, or jumper selectable:

- Base Address selection
- Bank selection
- Program ROM and I/O selection
- DMA Channel selection
- Standard/Mini-floppy selection
- Precompensation
- Dual Head Drive

Figure 2-1 identifies the detail on the FDC module. The function of each switch, jumper, and connector is identified in Table 2-1, along with reference to the section and table that describes its use.

Table 2-1. FDC Module Switches, Jumpers, and Connectors

Category	Item	Description	Reference
Switches	S1-1	Bank Select Enable	Section 2.2.2 Table 2-3
	S1-2	Bank Select	
	S1-3	I/O Selection	Section 2.2.3 Table 2-4
	S1-4	Program ROM Selection	
Headers	JB1, JB2	Standard/Mini-Floppy Selection	Section 2.2.5 Table 2-6 Figure 2-2
Jumpers	E1	Precompensation Selection	Section 2.2.6 Table 2-7
	E2	DMA Channel Selection	Section 2.2.4 Table 2-5
	E3	Dual Head Drive	Section 2.2.7 Table 2-8
Connectors	P1	RM 65 Bus	Tables 3-1 & 3-3
	J1	Disk Drive I/O	Table 3-2 & 3-4
PROM	Z18	Base Address Selection	Section 2.2.1 Table 2-2

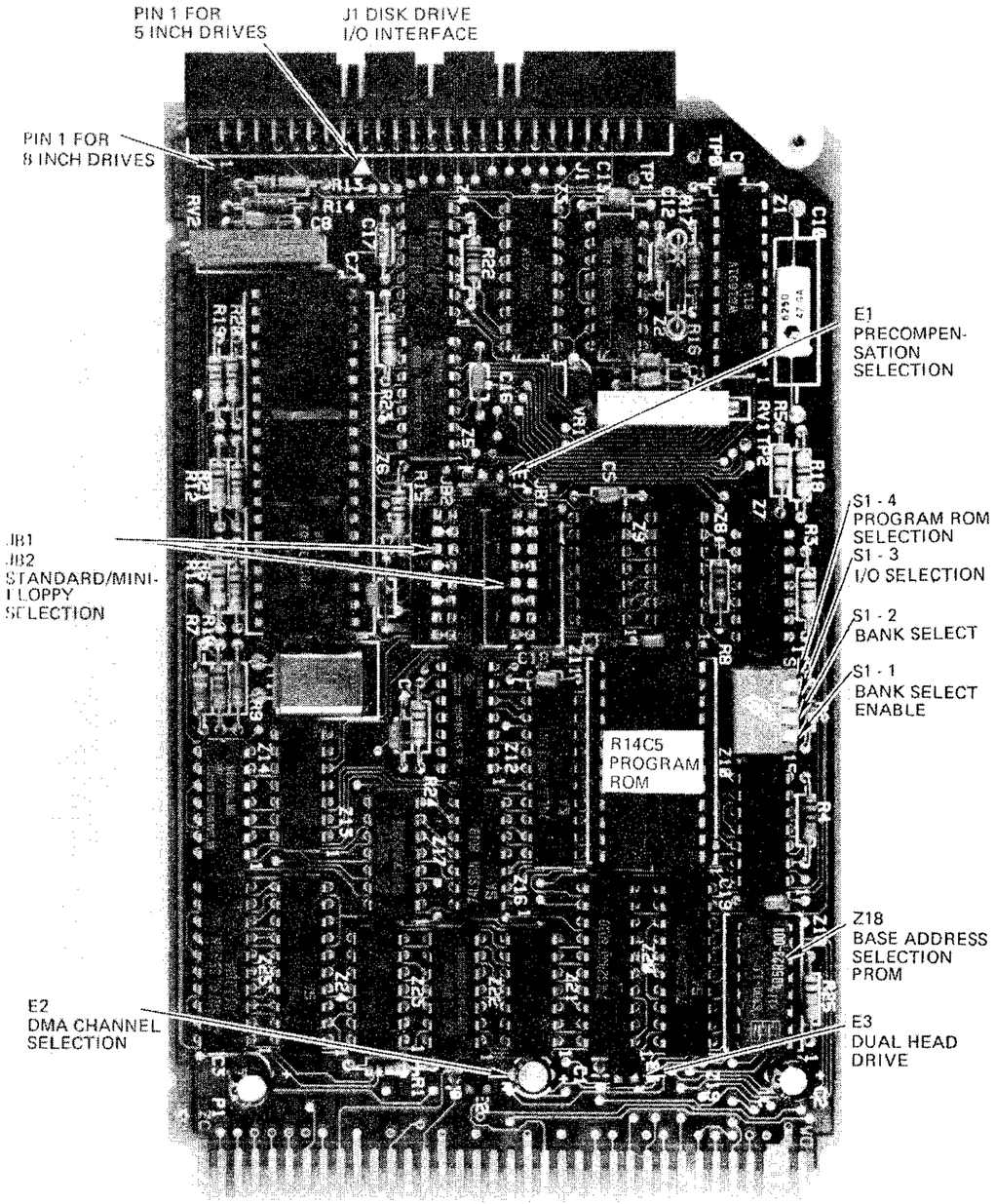


Figure 2-1. FDC Module Detail

2.2.1 Base Address Selection

The FDC module has a factory programmed base address. The Base Address Selection PROM (Z18) is programmed with this addressing information and cannot be altered. The programmed outputs for the Addressing PROM are shown (for reference only) in Table 2-2.

Table 2-2. Base Address Selection PROM Programmed Outputs

PROM Address Inputs								PROM Select Outputs			
H	G	F	E	D	C	B	A	D1	D2	D3	D4
Ø	Ø	X	X	X	X	X	X	1	1	X	X
Ø	1	Ø	X	X	X	X	X	1	1	X	X
Ø	1	1	Ø	X	X	X	X	1	1	X	X
Ø	1	1	1	Ø	Ø	Ø	Ø	Ø	1	X	X
Ø	1	1	1	Ø	Ø	Ø	1	1	Ø	X	X
Ø	1	1	1	Ø	Ø	1	X	1	Ø	X	X
Ø	1	1	1	Ø	1	X	X	1	Ø	X	X
Ø	1	1	1	1	X	X	X	1	Ø	X	X
1	X	X	X	X	X	X	X	1	1	X	X

NOTES

1. X is a don't care level.
2. PROM inputs A to H correspond to RM 65 signals BA8/ to BA15/, respectively.
3. PROM outputs D1 and D2 correspond to device selects $\overline{\text{FDC}}$ and $\overline{\text{ROM}}$, respectively.
4. PROM outputs D3 and D4 are not used.
5. This program reflects the following base address:
   $8000 to $8EFF - ROM selection
   $8F00 to $8FFF - I/O selection

For custom applications where the standard FDC firmware is not used, the Addressing PROM can be replaced with a user-provided PROM which has any desired address programmed. The FDC module will be active in any address range for which the $\overline{\text{ROM}}$ or $\overline{\text{FDC}}$ selects are programmed active. These two selects must not be programmed active in the same page (that is, for any PROM address input, only one PROM select output may be low).

2.2.2 Bank Selection

The Bank Select Enable switch (S1-1), in conjunction with the Bank Select switch (S1-2), allows the module to be assigned common to both memory banks (Bank Ø and Bank 1) or to be dedicated to a selected memory bank (either Bank Ø or Bank 1). When OPEN, the Bank Select Enable switch assigns the I/O logic and Program ROM to both banks regardless of the position of the Bank Select switch. When the Bank Select Enable switch is CLOSED, the assigned bank is determined by the position of the Bank Select switch. See Table 2-3 for the switch positions.

In applications where the module is to be addressed by a microcomputer that does not have bank addressing capabilities, the module must be assigned common to Bank Ø and Bank 1, or dedicated to Bank Ø.

Table 2-3. Bank Select Switch Positions

Memory Bank Selected	Switch Position	
	Bank Select Enable Switch S1-1	Bank Select Switch S1-2
Bank Ø and 1	OPEN	EITHER
Bank Ø (Lower 65K)	CLOSED	OPEN
Bank 1 (Upper 65K)	CLOSED	CLOSED

2.2.3 Program ROM and I/O Selection

The Program ROM Selection switch (S1-4) and the I/O Selection switch (S1-3) allow the module to operate with the ROM and I/O active, with I/O only active, or with the module disabled from the bus. When only the I/O is selected, the module is active in the page assigned by the Base Address Selection PROM. When the Program ROM and I/O are both selected, the module is active in the 4K-byte block assigned by the Base Address Selection PROM with the Program ROM active in all pages except the I/O page. Both the Program ROM and the I/O can be deselected which removes the FDC module entirely from the RM 65 memory map.

To use the Program ROM firmware, i.e., primitive routines or optional DOS, the Program ROM and I/O must be selected and the module base address assigned to $8000. The module may also be used with user-provided firmware, with the Program ROM selected installed on-board or deselected (firmware installed off-board). The switch positions are summarized in Table 2-4.

Table 2-4. Program ROM and I/O Selection Switch Positions

Module Operation and Program Location	Switch Positions	
	Program ROM Selection Switch S1-4	I/O Selection Switch S1-3
Supplied Firmware (on-board)	CLOSED	CLOSED
User Firmware (on-board)	CLOSED	CLOSED
User Firmware (off-board)	OPEN	CLOSED
Module Deselected	OPEN	OPEN

2.2.4 DMA Channel Selection

For most applications, all data transfers between the module and the RM 65 bus can be directly controlled by the CPU, with no need for a DMA Controller. In this case, the DMA Channel Selection jumper (E2) is not used and can be in either position. For applications that require a DMA Controller (such as 8-inch double-density format), the DMA request can be generated on either of the two RM 65 DMA Request lines (BDRQ1/, BDRQ2/). Install the DMA Channel Selection jumper (E2) in position A for DMA Request 1, or in position B for DMA Request 2 (see Table 2-5).

Table 2-5. DMA Channel Selection Jumper Positions

Module Operation	RM 65 Signal	Jumper Positions
Operation without a DMA Controller	-	E2 = EITHER
Operation using a DMA Controller		
DMA Request Channel 1	BDRQ1/	E2 = A
DMA Request Channel 2	BDRQ2/	E2 = B

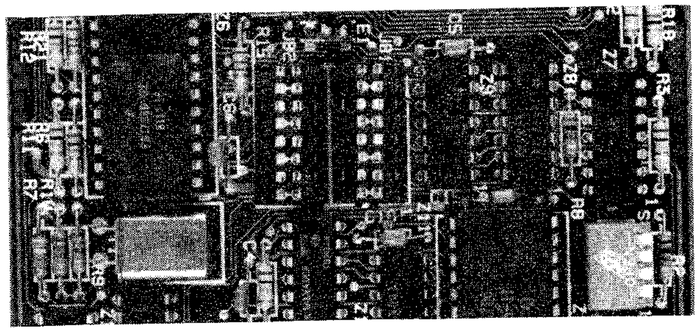
2.2.5 Standard/Mini-Floppy Selection

The standard/mini-floppy selection headers (JB1, JB2) configure the module to operate with standard floppy (8") or mini-floppy (5") disk drives. These headers consist of two factory programmed 16-pin shunting bars with alternate shunts removed. By rotating these headers 180° the shorted pins can be changed (refer to Figure 2-2 and Table 2-6).

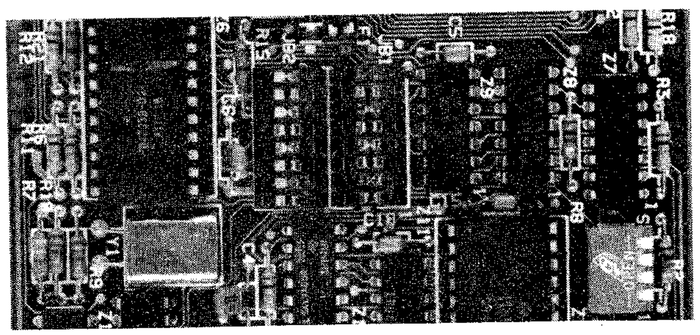
In the 5" Position (see Figure 2-2a), pins 1, 3, 5, and 7 of headers JB1 and JB2 are shunted to the opposite pins 10, 12, 14, 16, with the remaining pins left open. In this mode, the FDC module is configured for mini-floppy disk operation, with only 34 pins on the I/O connector used. Signals re-assigned on the I/O connector include Second Side Select, Drive Four Select, Index Hole, Motor On (used for Head Load in 8"

position), and Drive Ready which is forced always active (logic 1). The FDC controller clock is set to 1 MHz and the VCO reference clock is set to 2 MHz. To indicate the 5" position, bit 6 of the Drive Status Buffer is set low (logic Ø).

In the 8" position (see Figure 2-2b) pins 2, 4, 6, and 8 of headers JB1 and JB2 are shunted to the opposite pins 9, 11, 13, 15, with the remaining pins left open. In this mode, the FDC module is configured for standard floppy disk operation with all 5Ø pins on the I/O connector used. The drive interface signals that differ from the 5" position include the 2nd side select, Drive Four select, Index Hole, Drive Ready, and Head Load (used for Motor On in 5" position). The FDC controller clock is set to 2 MHz and the VCO reference clock is set to 4 MHz. To indicate the 8" position, bit 6 of the Drive Status Buffer is set high (logic 1).



a. 5" Floppy Drive Header Placement



b. 8" Floppy Drive Header Placement

Figure 2-2. Standard/Mini-Floppy Selection Header Locations

Table 2-6. Standard/Mini-Floppy Selection Header Position

	Pins	Mini-Floppy (5") Selected		Standard Floppy (8") Selected	
JB1	1, 16	SHUNT	Drive Status Buffer - logic Ø on bit 6	OPEN	Drive Status Buffer - logic 1 on bit 6
	2, 15	OPEN		SHUNT	
	3, 14	SHUNT	FDC Controller Clock - 1 MHz Reference	OPEN	FDC Controller Clock - 2 MHz Reference
	4, 13	OPEN		SHUNT	
	5, 12	SHUNT		OPEN	
	6, 11	OPEN	PLL Clock - 2 MHz Reference	SHUNT	PLL Clock - 4 MHz Reference
	7, 1Ø	SHUNT	2nd Side Select - pin 48 (32) of J1	OPEN	2nd Side Select - pin 14 of J1
	8, 9	OPEN		SHUNT	
JB2	1, 16	SHUNT	Drive Four Select - pin 22 (6) of J1	OPEN	Drive Four Select - pin 32 of J1
	2, 15	OPEN		SHUNT	
	3, 14	SHUNT	Motor On - pin 32 (16) of J1	OPEN	Head Load - pin 18 of J1
	4, 13	OPEN		SHUNT	
	5, 12	SHUNT	Drive Ready - always active	OPEN	Drive Ready - pin 22 of J1
	6, 11	OPEN		SHUNT	
	7, 1Ø	SHUNT	Index Hole - pin 24 (8) of J1	OPEN	Index Hole - pin 2Ø of J1
	8, 9	OPEN		SHUNT	

NOTE

1. Pin numbers in ( ) refer to a 34-pin receptacle for 5" drives.

2.2.6 Precompensation

The Precompensation jumper (E1) selects the recording mode of the write circuitry (see Table 2-7). For single-density recording, place jumper E1 in position A so precompensation is not performed. When double-density recording is used, precompensation is performed in two ways. For typical applications, precompensation is not used on the outer cylinders. For this mode, install jumper E1 in the B position to precompensate only on tracks greater than 43. Alternatively, remove jumper E1 so precompensation will be performed on every track.

Table 2-7. Precompensation Jumper Positions

Recording Mode	Jumper Positions
Single-Density - No Precompensation	E1 = A
Double-Density - Precompensation on Tracks >43 - Precompensation on all Tracks	E1 = B E1 = REMOVE

2.2.7 Dual Head Drive

The FDC module can use either single head floppy disk drives, double head drives, or combination of both types. If only single head drives are used, set the Dual Head Drive jumper (E3) to position B. If there are any double head drives, set this jumper to position A. These positions are shown in Table 2-8.

Table 2-8. Dual Head Drive Selection Jumper Positions

Types of Floppy Drives	Jumper Positions
Single Head Drives Only	E3 = B
Single and Dual Head Drives	E3 = A

2.3 INSTALLING THE MODULE

Before installing the module, ensure that it is not damaged and is free of grease, dirt, liquid or other foreign matter.

> **CAUTION**
>
> Prior to module installation turn off power to the RM 65 bus. Also, turn off power to the RM 65 bus when the Floppy Disk Controller module is installed prior to changing switch or jumper positions.

a. Based on the RM 65 system memory map and requirements (refer to Section 3.1), select the proper module operating options relating to the RM 65 bus interface:

   (1) Select common or dedicated bank operation for the module by positioning switches S1-1 and S1-2 (refer to Section 2.2.2 and Table 2-3).

   (2) Install the desired on-board Program ROM:

ROM ID	Description	Address Range
R14C5	FDC Primitive Routines	$8800-$8FFF
R324E	AIM 65 DOS 1.0	$8000-$8EFF
R325E	AIM 65/40 DOS 1.0	$8000-$8EFF
Other	User-provided	

Note that the R14C5 ROM is 2K bytes while the two DOS ROMs are 4K bytes. The factory configured base address PROM assigns address range $8000-$8EFFF) to the on-board PROM/ROM to allow either 2K- or 4K-byte devices to be installed. Early deliveries of the R14C5 ROM code may be installed in a 4K-byte PROM.

(3) Select or deselect the program ROM and I/O by positioning switches S1-3 and S1-4 (refer to Section 2.2.3 and Table 2-4). If the program ROM routines will be used, the ROM must be installed and selected.

(4) Select the DMA request channel by positioning jumper E2 (refer to Section 2.2.4 and Table 2-5)

b. Based on the Floppy Disk system requirements, select the remaining operating options:

(1) Set the module for 8" or 5" drives with the selection headers JB1 and JB2 (refer to Section 2.2.5, Figure 2-2, and Table 2-6).

(2) Select the precompensation mode by positioning jumper E1 (refer to Section 2.2.6 and Table 2-7).

(3) Select for single or dual headed drives by positioning jumper E3 (refer to Section 2.2.7 and Table 2-8).

c. Align pin Wa (for Edge Connector version) or pin 1a (for Eurocard version) of the module with the identical pin on the mating RM 65 bus receptacle.

> CAUTION
>
> RM connectors are keyed to prevent improper module connection. If the module does not insert into the receptacle with moderate pressure applied, check the orientation and the connector alignment of the module. Forcing the module improperly into the receptacle will damage the receptacle and/or the module.

d. Insert the module into the desired card slot (if a card cage is used) and position it in front of the mating receptacle.

e. If an 8" disk drive is to be operated in the double-density mode, install an RM 65 DMA Controller Module (RM65-5104).

f. Insure that all interfacing drives are properly configured (refer to their operating manuals) and apply any necessary power supplies.

g. Connect the required cable to the Disk Drive connector J1 on the module (see Figure 2-1) and to the interfacing disk drives.

h. Press in firmly on the end of the module until all pins are securely seated.

i. Reapply power to the RM 65 bus.

> NOTE
>
> The FDC Module requires +12 VDC on the RM 65 bus (pin 17a of connector P1).

2.4 REMOVING THE MODULE

a. Turn off power to the RM 65 bus and interfacing disk drives.

b. Disconnect the cable from the disk drive connector.

c. If the module is installed in a card cage, lift up on the module ejector tab to release the module from the mating receptacle. Pull the module straight back until it is free from the module guides.

d. If the module is installed in a single card adapter, or in a motherboard without a card cage, pull back on the module while moving it slightly from side to side until it is free from the mating receptacle.

2.5 FDC MODULE CALIBRATION PROCEDURE

The FDC module has two trimmer potentiometers (RV1, RV2) which are factory adjusted to nominal values in order for the FDC module to operate with most disk drives. Under normal conditions, these settings will not require changing.

Trim pot RV1 controls the VCO reference frequency. When properly adjusted, there should be a 4.1 MHz waveform between the test point (TP1) and ground (TP0). This frequency is the same regardless of the disk drive units used.

Trim pot RV2 controls the write precompensation pulse width. If the disk drive manufacturer specifies a different value than 150 ns, the calibration procedure is as follows:

a. Insert a blank or scratch disk into the desired disk drive 1. The drive will be selected for double-density mode, side one.

b. Adjust RV2 to get a negative-going pulse on TP2 of the specified time period while the track is being repeatedly formatted by the following Precomp Adjust Routine:

CALIBRATION TEST FOR RM 65 FDC MODULE

SOURCE

```
DCONR=$8F04
EXEC03=$8BD3
FDAR=$8F03
FORFLG=$4BB
FSTOP=$8F15
        *=$0800
ENTRY   LDA #$FF            ;FLAG FOR IRQ HANDLER
        STA FORFLG
PRECOM  LDA #$E2            ;DRV.1,SID.1,DBL DENS,IRQ ENABLED
        STA DCONR
        JSR WRTRAK          ;WRITE A TRACK
        JMP PRECOM          ;REPEAT UNTIL RESET
```


CALIBRATION TEST FOR RM 65 FDC MODULE (CONTINUED)

SOURCE

```
WRTRAK LDA #$F0             ;FDC WRITE TRACK COMMAND
       JSR EXEC03           ;EXECUTE THE FDC COMMAND
WDATA  BIT FSTOP            ;STOP CPU UNTIL DATA REQUEST
       STA FDAR             ;WRITE DUMMY BYTE FOR REQUEST
       JMP WDATA            ;LOOP UNTIL IRQ EXITS
        END
```

c. When done, press RESET to return control to the Monitor command level.

SECTION 3

FUNCTIONAL AND INTERFACE DESCRIPTION

3.1 MEMORY MAP

If the on-board Program ROM is selected (by switch S1-4, see Table 2-4), the FDC module is assigned 4096 bytes ($8000-$8FFF). The first 3840 bytes ($8000-$8EFF) are available to the Program ROM while the last 256 bytes ($8F00-$8FFF) are dedicated to the I/O logic. Of these 256 bytes, only six are unique and are assigned to the controller device or module logic; the other 250 bytes are redundant, i.e., copies of these six bytes. Table 3-1 shows the general FDC Module Memory Map and Table 3-2 lists the FDC module detailed I/O functions.

The primitive subroutines and variables are identified in the FDC Primitive ROM (R323E), the AIM 65 DOS 1.0 ROM (R324E) and the AIM 65/40 DOS 1.0 ROM (R325E). If any of these ROMs are installed, the primitives require 90 bytes of off-board RAM; four bytes on page zero and 86 bytes on page four (see Table 4-7 for the variable address assignments). The primitives also require two RAM buffers for data input/output, each of which must be at least one sector in length (128 bytes for single-density or 256 bytes for double-density). See Section 4 for the description of the primitive routines. If the optional DOS 1.0 ROM is installed, it requires four additional bytes of RAM on page zero and 100 bytes on page five (see Tables 5-4 and 6-4 for AIM 65 and AIM 65/40 variable addresses, respectively). The default I/O buffer locations for the DOS are $600-$7FF for the AIM 65 and $3E00-$3FFF for the AIM 65/40 (these locations are user-alterable, see Tables 5-4 and 6-4). See Sections 5 and 6 for descriptions of the AIM 65 and AIM 65/40 DOS 1.0, respectively.

If the on-board Program ROM is not selected, the constraints on the base address (i.e., $8000-$8FFF) do not apply and the I/O logic may be assigned to any available page (see Section 2.2.1).

Table 3-1. FDC Module Memory Map

Hex Addr.	Function	Hex Addr.	Function
$0000	Page Zero RAM: $0D7 - $0DE Page Four RAM: $4A0 - $4FA Page Five RAM: $500 - $563 (Page Five for DOS use only)	$8000	15 Pages ROM: $8000 - $8EFF 1 Page I/O: $8F00 - $8FFF
$1000	User Available	$9000	User Available
$2000		$A000	
$3000		$B000	
$4000		$C000	
$5000		$D000	
$6000		$E000	
$7000		$F000	

NOTES

1. Base Address Selection PROM is factory programmed to $8000.
2. RAM is not on the FDC module.
3. The DMAC module (optional) can be assigned to any available page.

Table 3-2. FDC Module I/O Memory Map

Hex Addr.	Buffer/Register	
	Write (R/$\overline{W}$ = Low)	Read (R/$\overline{W}$ = High)
XY00	Command Register	Status Register
XY01	Track Register	Track Register
XY02	Sector Register	Sector Register
XY03	Data Register	Data Register
XY04	Drive Control Register	Drive Status Register
XY15	- - -	Force a not ready to stop the CPU until the FDC device is ready.

NOTES

1. XY corresponds to the assigned Base Address of any two hexadecimal values. For the standard FDC, XY=8F.
2. The remaining locations in the I/O page are redundant.
3. The Drive Control Register is as follows:

Bit	Meaning
0	Side Select: 0 = Side 1, 1 = Side 2
1	Drive 1 Select: 1 = On
2	Drive 2 Select: 1 = On
3	Drive 3 Select: 1 = On
4	Drive 4 Select: 1 = On
5	5" Motor On/8" Head Load: 1 = Active
6	STOPEN: 1 = Generate not ready, Clear IRQ
7	Density: 0 = Double, 1 = Single

4. The Drive Status Register is as follows:

Bit	Meaning
0	Selected Side: 0 = Side 2, 1 = Side 1
1	- - -
2	- - -
3	- - -
4	- - -
5	Number of Heads: 0 = One, 1 = Two
6	Selected Size: 0 = 8", 1 = 5"
7	Selected Density: 0 = Single, 1 = Double

3.2 FUNCTIONAL DESCRIPTION

The block diagram in Figure 3-1 identifies the FDC module functions and interface signals.

The Controller Clock derives a reference frequency for the FDC device from a crystal-controlled oscillator. This reference frequency is 1 MHz or 2 MHz, depending on the Standard/Mini-Floppy Selection Header position.

The FDC device, in conjunction with the Data Separator and Precompensation Circuitry, interfaces the RM 65 bus to the floppy disk medium. The circuitry supports 5-1/4" or 8" disks, with choice of single-density (FM) or double-density (MFM) soft sector formats. The FDC features powerful commands, including read/write head movements, reading and writing of data, and reading and writing of track format, with selectable record lengths. Write precompensation circuitry ensures reliable data recovery in double density formats. The Precompensation jumper (E1) selects precompensation on all tracks, only on tracks greater than 43, or no precompensation at all.

The Standard/Mini-Floppy Selection header (JB1, JB2) selects the Disk Drive connector (J1) and FDC circuitry for either 5" mini-floppy or 8" standard floppy disk formats. The 50-pin I/O receptacle connects the FDC module to a mass terminated cable connected to the installed disk drives. A 34-pin cable and mating connector can be used to connect the 5" mini-floppy drives while a 50-pin cable and mating connector is needed to connect to the 8" floppy drives.

The Drive Status Buffer allows detection of the Standard/Mini-Floppy Selection header and Dual Head Drive jumper (E3) positions, as well as selected density and side information.

The Drive Control Register provides control of the side and drive selection, motor on (5" only) or head load (8" only), the recording density, and the interrupt request disable.

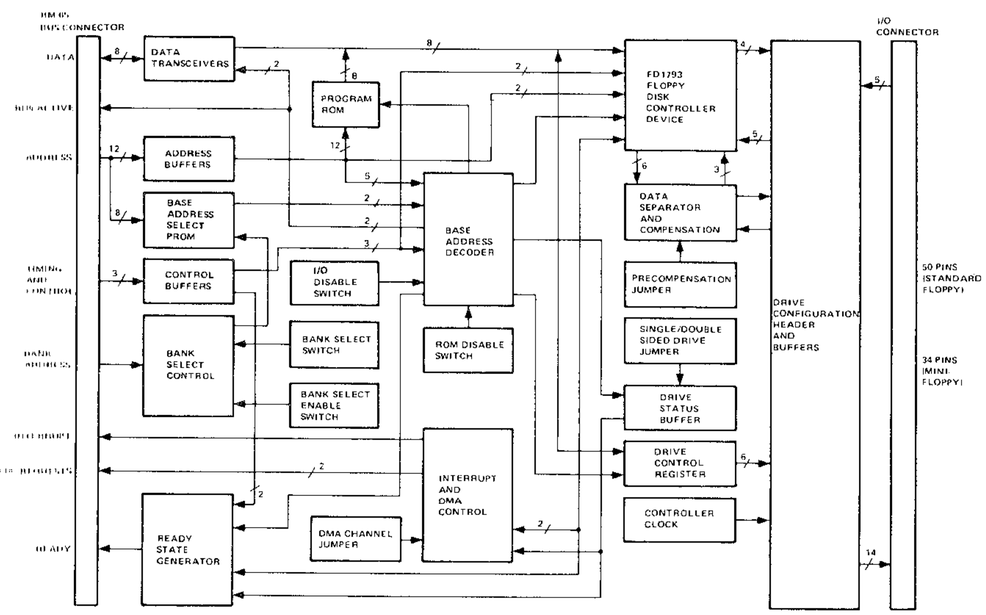


Figure 3-1. FDC Module Block Diagram

The Interrupt and DMA control circuit allows operation in either an interrupt-driven mode or under DMA control. An interrupt request latch holds all interrupt requests until serviced and cleared (STOPEN). DMA requests from the FDC module can be driven on either of two DMA request channels (BDRQ1/, BDRQ2/), as selected by the DMA Channel Selection jumper (E2), or disabled by removing the jumper.

The Ready State Generator provides wait states as required by the FDC device.

The Base Address Decoder, with the Base Address Select PROM (Z18), the Bank Select Control circuit, the ROM and I/O Disable switches (S1-2, S1-4), and the phase 2 and read/write signals control device selection on the module. The Base Address Select PROM compares the eight most significant address lines to the programmed addresses to generate device select signals to the Program ROM and the I/O devices. The ROM Disable switch assigns the module to be active either in a 256-byte page (disabled) or in a 4K-byte block (enabled). The I/O Disable switch allows the FDC I/O to be disabled.

When the ROM is disabled, only the I/O devices are active in the 256-byte page that matches all eight Base Address Select bits. For the I/O devices, the three least significant address lines, along with the phase 2 clock and read/write control signals, drive register select lines to the FDC device, and device select lines to the Drive Status Buffer and Drive Control Register.

When the ROM is enabled, the module is active in the 4K byte block that matches the four most significant Base Address Select bits. The program ROM is selected except when the address matches the four least significant Base Address Select bits, in which case the I/O device select lines are selected.

The Bank Select Control circuit detects when the module's assigned memory bank is addressed by comparing the bank address signal (BADR/) from the RM 65 bus to the Bank Select (S1-2) and Bank Select Enable (S1-1) switches. The Bank Select Enable switch allows the board to reside in common memory (both Bank Ø and Bank 1) or only in the bank set by the Bank Select switch (either Bank Ø or Bank 1).

The Control Buffers invert and transfer phase 2 clock (BØ2/), reset (BRES/), and read/write (BR/$\overline{W}$/) control signals from the RM 65 bus onto the module. The interrupt request (BIRQ/) is buffered and driven onto the RM 65 bus.

The Data Transceivers invert and buffer 8-bits of parallel data (BDØ/-BD7/) between the module and the RM 65 bus based on control signals from the Base Address Decoder and the Control Bufers. Data to the module is latched (Ø2) by the write data latch, extending the data hold time for the FDC device. Data from the module is buffered by the read data buffers. The transceivers are enabled by the Base Address Decoder when the module is addressed.

The Address Buffers invert and transfer 12 of the 16 parallel address bits (BAØ/-BA11/) from the RM 65 bus to the Base Address Decoder (AØ-A4), to the Program ROM (AØ-A11), and to the FDC device (AØ, A1).

3.3 INTERFACE DESCRIPTION

Tables 3-3 and 3-4 list the interface signals and pin assignments for connector P1 (RM 65 Bus) and connector J1 (Disk Drive), respectively.

Tables 3-5 and 3-6 define the interface signals for connectors P1 and J1, respectively.

Table 3-3. Connector P1 (RM 65 Bus) Pin Assignments

Pin	Signal Mnemonic	Signal Name	Input/Output
Wa		Not Connected (See Note)	
Wc		Not Connected (See Note)	
Xa	+5V	+5 VDC (See Note)	
Xc	+5V	+5 VDC (See Note)	
1a	GND	Ground	
1c	+5V	+5 VDC	
2a	BADR/	Buffered Bank Address	I
2c	BA15/	Buffered Address Bit 15	I
3a	GND	Ground	
3c	BA14/	Buffered Address Bit 14	I
4a	BA13/	Buffered Address Bit 13	I
4c	BA12/	Buffered Address Bit 12	I
5a	BA11/	Buffered Address Bit 11	I
5c	GND	Ground	
6a	BA10/	Buffered Address Bit 10	I
6c	BA9/	Buffered Address Bit 9	I
7a	BA8/	Buffered Address Bit 8	I
7c	BA7/	Buffered Address Bit 7	I
8a	GND	Ground	
8c	BA6/	Buffered Address Bit 6	I
9a	BA5/	Buffered Address Bit 5	I
9c	BA4/	Buffered Address Bit 4	I
10a	BA3/	Buffered Address Bit 3	I
10c	GND	Ground	
11a	BA2/	Buffered Address Bit 2	I
11c	BA1/	Buffered Address Bit 1	I
12a	BA0/	Buffered Address Bit 0	I
12c	BØ1	Not Used	
13a	GND	Ground	
13c	BSYNC	Not Used	
14a	BSD	Not Used	
14c	BDRQ1	Buffered DMA Request 1	O
15a	BRDY	Buffered Ready	O

Table 3-3. Connector P1 (RM 65 Bus) Pin Assignments (Cont'd)

Pin	Signal Mnemonic	Signal Name	Input/Output
15c	GND	Ground	
16a		Not Used	
16c		Not Used	
17a	+12V	+12V	
17c		Not Used	
18a	GND	Ground	
18c		Not Used	
19a	BFLT/	Not Used	
19c	BØØ	Not Used	
20a		Not Used	
20c	GND	Ground	
21a	BR/$\overline{W}$/	Buffered Read/Write "Not"	I
21c	BDRQ2/	Buffered DMA Request 2	O
22a		Not Used	
22c	BR/$\overline{W}$	Not Used	
23a	GND	Ground	
23c	BACT/	Buffered Bus Active	O
24a	BIRQ/	Buffered Interrupt Request	O
24c	BNMI/	Not Used	
25a	BØ2/	Buffered Phase 2 "Not" Clock	I
25c	GND	Ground	
26a	BØ2	Not Used	
26c	BRES/	Buffered Reset	I
27a	BD7/	Buffered Data Bit 7	I/O
27c	BD6/	Buffered Data Bit 6	I/O
28a	GND	Ground	
28c	BD5/	Buffered Data Bit 5	I/O
29a	BD4/	Buffered Data Bit 4	I/O
29c	BD3/	Buffered Data Bit 3	I/O
30a	BD2/	Buffered Data Bit 2	I/O
30c	GND	Ground	
31a	BD1/	Buffered Data Bit 1	I/O

Table 3-3. Connector P1 (RM 65 Bus) Pin Assignments (Cont'd)

Pin	Signal Mnemonic	Signal Name	Input/Output
31c	BDØ/	Buffered Data Bit Ø	I/O
32a	+5V	+5 VDC	
32c	GND	Ground	
Ya	+5V	+5 VDC (See Note)	
Yc	+5V	+5 VDC (See Note)	
Za		Not Connected (See Note)	
Zc		Not Connected (See Note)	

NOTES

1. Pins Wa, Wc, Xa, Xc, Ya, Yc, Za and Zc are available on Edge Connector version only.
2. "/" suffix denotes signal active at negative or low voltage level.

Table 3-4. Connector J1 (Disk Drive) Pin Assignments

FDC Module I/O Connector Pin	Standard Floppy Disk Drive Interface Cable Connector		Mini-Floppy Disk Drive Interface Cable Connector (2)	
	Pin	Signal Name	Pin	Signal Name
2	2	Track >43 (Remex & MFE or equivalents)		
4	4	N.C.		
6	6	N.C.		
8	8	Track >43 (C. disk or equivalents)		
10	10	N.C.		
12	12	N.C		
14	14	2 .J Side Select		
16	16	N.C.		
18	18	Head Load	2	N.C.
20	20	Index	4	N.C.
22	22	Drive Ready	6	Drive Select #4
24	24	N.C.	8	Index
26	26	Drive Select #1	10	Drive Select #1
28	28	Drive Select #2	12	Drive Select #2
30	30	Drive Select #3	14	Drive Select #3
32	32	Drive Select #4	16	Motor On
34	34	Direction In	18	Direction In
36	36	Step Pulse	20	Step Pulse
38	38	Write Data	22	Write Data
40	40	Write Gate	24	Write Gate
42	42	Track Zero	26	Track Zero
44	44	Write Protected	28	Write Protected
46	46	Read Data	30	Read Data
48	48	N.C.	32	2nd Side Select
50	50	N.C.	34	N.C.

NOTES:

1. All odd numbered pins are GND.
2. Pin 1 of the 34-pin mini-floppy disk drive interface cable connector should be keyed to pin 17 of the FDC module I/O connector.

Table 3-5. Connector P1 (RM 65 Bus) Signal Descriptions

Mnemonic	Signal Name and Signal Description
+5V	+5 VDC supplied to the module from the RM 65 Bus.
+12V	+12 VDC supplied to the module from the Bus.
GND	Ground System ground.
BA0/-BA15/	Buffered Address Bits 0-15 Sixteen address lines transfer an inverted 16-bit parallel address from the Bus to the module.
BADR/	Buffered Bank Address A high BADR/ signal addresses the lower 65K (Bank 0) memory bank; a low BADR/ addresses the upper 65K (Bank 1) memory bank.
BD0/-BD7/	Buffered Data Bits 0-7 Eight bidirectional inverted data lines transfer 8-bit data bytes between the Data Transceivers in the module and the Bus.
BACT/	Buffered Bus Active A low BACT/indicates that the module has been addressed and the Data Transceivers are enabled in either the receive (write operation) or transmit (read operation) direction.
B02/	Buffered Phase 2 Clock "NOT" The B02/ signal synchronizes data transfers on the Bus. The address and read/write lines are setup in the positive portion of B02/. The data lines are set-up in the negative portion of B02/.

Table 3-5. Connector P1 (RM 65 Bus) Signal Descriptions (Cont'd)

Mnemonic	Signal Name and Signal Description
BR/$\overline{W}$/	Buffered Read/Write "Not" The BR/$\overline{W}$/ signal controls the direction of data transfer on the Bus. A low BR/$\overline{W}$/ indicates a read operation. A high BR/$\overline{W}$/ indicates a write operation.
BRDY	Buffered Ready The BRDY signal is generated by the module. When the R6502 CPU receives a low BRDY, the CPU will stop execution in the next read cycle. Execution will resume when BRDY returns high.
BIRQ/	Buffered Interrupt Request The BIRQ/ signal is generated by the module for the Bus to request interrupt service. BIRQ/ is forced low by any interrupt condition in the FDC device.
BDRQ1/, BDRQ2/	Buffered DMA Requests 1 and 2 Either BDRQ1/ or BDRQ2/ can be assigned to the module to request DMA service. When the FDC is ready for a data byte transfer, a DMA request is generated.
BRES/	Buffered Reset The BRES/ signal is received by the module from the Bus. A low BRES/ clears the Drive Status Register and the Wait State Generator, and resets the FDC device.
	NOTE All signals interfaced to and from the module are driven at TTL voltage levels.

Table 3-6. Connector J1 (Disk Drive) Signal Descriptions

Signal Name and Signal Description	Signal Source
Drive Select No. 1 to No. 4 These signals allow up to four disk drives to to be individually selected by the FDC when active.	FDC
Second Side Select This signal is used by the FDC to access side 1 when inactive and side 2 when active.	FDC
Index This signal is pulsed (logic Ø) by the selected disk drive when the one disk medium is at the start of a revolution.	Drive
Read Data This signal is the serial NRZ data from the selected disk drive medium (FM if single-density, MFM if double-density).	Drive
Write Data This signal is the serial NRZ data from the FDC to be written to the selected disk drive medium (FM is single-density, MFM if double-density).	FDC
Write Gate This signal, when made active by the FDC, indicates that the Write Data line is valid. When inactive, the FDC is in the read mode.	FDC
Track Zero This signal is made active by the selected disk drive when the read/write head is on the outermost track.	Drive

Table 3-6. Connector J1 (Disk Drive) Signal Descriptions (Cont'd)

Signal Name and Signal Description	Signal Source
Direction In This signal is made active by the FDC when the read/write head of the selected disk drive is to be moved toward an inner (higher number) track. When inactive, movement will be toward an outer (lower number) track.	FDC
Step Pulse This signal is pulsed (logic Ø) by the FDC to move the read\write head of the selected floppy drive in the direction set by the Direction In signal. The head moves one track position on each negative transition.	FDC
Write Protected This signal is made active by the selected disk drive to indicate that the medium is write protected. For 5" drives, this means the write protect tab is on the disk; for 8" drives, this means the write protect notch is not covered.	Drive
Motor On (5" Drive Only) This signal, when made active by the FDC, turns on the motor of the selected disk drive.	FDC
Head Load (8" Drive Only) This signal, when made active by the FDC, lowers the read/write head of the selected disk drive onto the medium.	FDC

Table 3-6. Connector J1 (Disk Drive) Signal Descriptions (Cont'd)

Signal Name and Signal Description	Signal Source
Drive Ready (8" Drive Only) This signal is made active by the selected disk drive to indicate that it is ready for data transfers.	Drive
Track >43 (8" Drive Only) This signal is made active by the selected disk drive when the read/write head is positioned on an inner track (track 44 and higher).	Drive

NOTE

All signals interfaced to and from the module are driven at standard TTL voltage levels. An active signal (logic 0) is an electrical low while an inactive (logic 1) is an electrical high.

3.3.1 Mini-Floppy Disk Drive Interface Cable Assembly

The mating ribbon cable connector to the Disk Drive connector (J1) must be a 50-pin mass terminating receptacle (3M No. 3425-6000 or equivalent). For interfacing with industry standard 5" mini-floppy disk drives, this connector must be attached to a 34 wire ribbon cable, displaced such that wire 1 mates to pin 17, and wire 34 mates to pin 50.

The mini-floppy disk drives (Shugart SA-450 or equivalent) have a 34-pin edge connector for the signal interface, with a pin assignment shown in Table 3-6. Up to four 34-pin mass terminating card edge receptacles (3M No. 3463-0001 or equivalent) may be attached to the ribbon cable, one connector for each drive used. The cable length should be less than four feet, however, spacing between connectors is not critical. Figure 3-2 shows the typical connector placement.

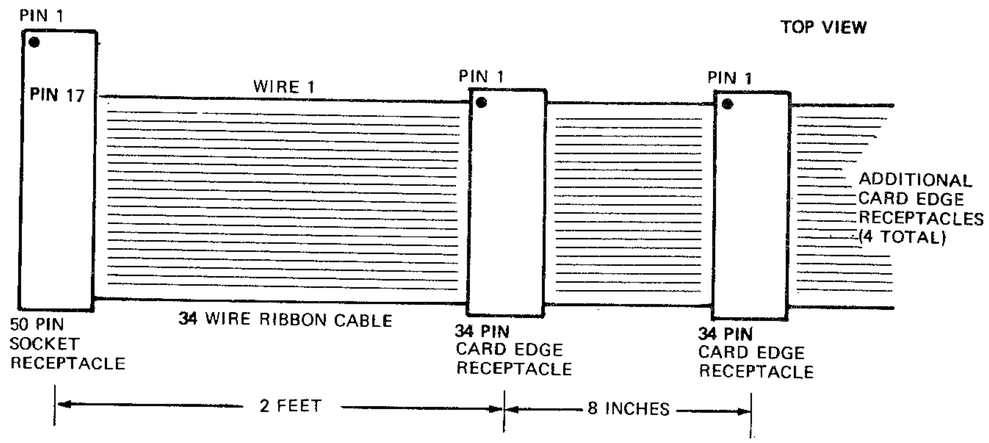


Figure 3-2. Mini-Floppy Disk Drive Interface Cable

3.3.2 Standard Floppy Disk Drive Interface Cable Assembly

The mating ribbon cable connector to the Disk Drive connector (J1) must be a 50-pin mass terminating receptacle (3M No. 3425-6000 or equivalent). For interfacing with industry standard 8" floppy disk drives, this connector must be attached to a 50 wire ribbon cable with wire 1 mating to pin 1.

The standard floppy disk drives (Shugart SA-850 or equivalent) have a 50-pin card edge connector for the signal interface, with a pin assignment shown in Table 3-6. One 50-pin mass terminating card edge receptacle (3M No. 3415-0001 or equivalent) must be attached to the ribbon cable for each drive used (maximum of four). The cable length should be less than four feet, however, spacing between connectors is not critical. Figure 3-3 shows the typical connector placement.

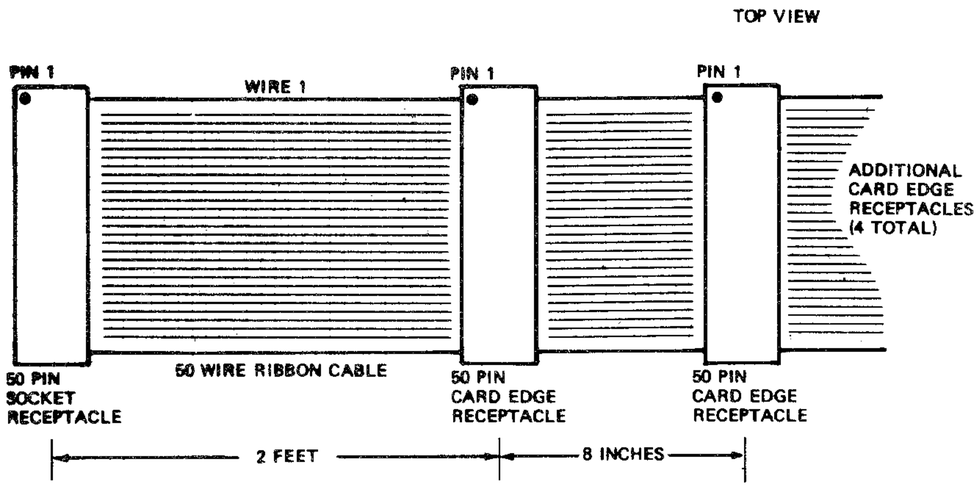


Figure 3-3. Standard Floppy Disk Drive Interface Cable

SECTION 4

FDC MODULE PRIMITIVE ROUTINES

4.1 PRIMITIVE ROUTINE DESCRIPTIONS

The FDC primitive routines simplify the operation of the FDC module by:

- Handling the detail protocol to interface with the FD 1793 Floppy Disk Controller device.
- Providing a set of closed subroutines that initialize and format a disk, position drive heads, write data on a disk, and read data from a disk.

These primitives allow additional higher level functions, such as a disk operating system or specialized data recording, to be easily implemented without being concerned with the detailed operation of the controller device. The optional AIM 65 DOS 1.0 and AIM 65/40 DOS 1.0 functions described in Section 5 and 6, respectively, use these primitive routines. If you are using one of these DOS versions, skip to the appropriate section. If you are designing a DOS or other specialized disk interface/file handling function using the primitive routines, the detailed description of these routines included in this section will be helpful.

The primitive routines perform the following major functions to support operation of up to four disk drives (single- or double-sided; single- or double-density:

Format a Disk
Read or Write a Sector
Seek or Verify Seek of a Track
Reset or Re-zero the Head
Read or Write Multiple Sectors
Read or Write a Track
Turn Motors On or Off
Select or De-select any Drive

3.3.2 Standard Floppy Disk Drive Interface Cable Assembly

The mating ribbon cable connector to the Disk Drive connector (J1) must be a 50-pin mass terminating receptacle (3M No. 3425-6000 or equivalent). For interfacing with industry standard 8" floppy disk drives, this connector must be attached to a 50 wire ribbon cable with wire 1 mating to pin 1.

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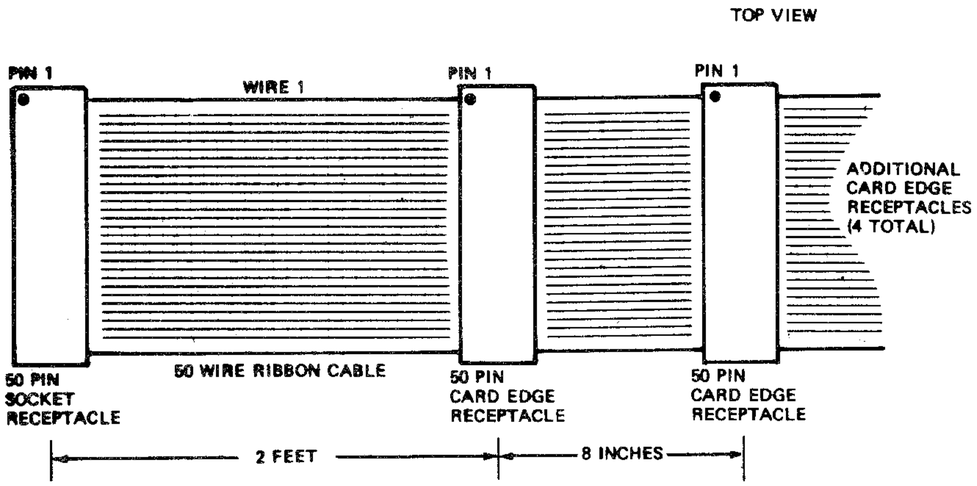

Figure 3-3. Standard Floppy Disk Drive Interface Cable

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Read or Write a Sector
Seek or Verify Seek of a Track
Reset or Re-zero the Head
Read or Write Multiple Sectors
Read or Write a Track
Turn Motors On or Off
Select or De-select any Drive

These functions are implemented in 15 major primitive routines. Each of these routines can be classified into one of four general categories:

INITIALIZE - These initialize the FDC module or prepare a disk for use.

DRIVE - These control the selection and read/write head movement of the floppy disk drives.

READ - These support reading data from the floppy disk medium.

WRITE - These support writing data onto the floppy disk medium.

The primitive routines are identified along with their entry points in Table 4-1 (in alphabetical order of their labels). The labels and addresses of the I/O registers are listed in Table 4-2.

The primitive routines are described in Table 4-3. The entry and exit conditions are specified along with the processing performed.

For the primitive routines, the following conditions apply:

Drive number: Ø to 3.
Side number: Ø for side one, 1 for side two.
Density: 1 for single, Ø for double.
Track number: Ø to 34 (5") or Ø to 76 (8").
Sector number: 1 to 16 (5") or 1 to 26 (8").

NOTE

There is no error checking done on the entry parameters of the primitive routines. This is the responsibility of the user in the disk operating software.

Table 4-1. Primitive Routine Addresses

Label	Address	Function
DESEL	$8CE2	Deselects drive
FORCOF	$8DB9	Cancel any command in progress
FORMAT	$89ØD	Formats a side (with interleaving)
INIT	$886C	Initializes variables and buffers
IRQHAN	$8BED	FDC Interrupt Handler
MOTOFF	$8CF7	Turns motor off
MOTON	$8C53	Sets motor on, selects drive, side and density
RDMSC	$8D8D	Reads multiple sectors within a track
RDSEC	$8D29	Reads a sector of data
RDTRK	$8CFB	Reads entire track (sector headers also)
SEEK	$8938	Seek with verify to a track
SELECT	$8CBC	Selects drive, side and density (only one at a time)
WRTMSC	$8DEA	Writes multiple sectors within a track
WRTRK	$8994	Writes an IBM formatted track
WRTSEC	$8D61	Writes a sector of data

Table 4-2. FDC Module I/O Register Addresses

Label	Address	Description
FCOMR	$8FØØ	Command register (Write only)
FSTAR	$8FØØ	Status register (Read only)
FCYLR	$8FØ1	Track register (Read or Write)
FSECR	$8FØ2	Sector register (Read or Write)
FDAR	$8FØ3	Data register (Read or Write)
DSTAR	$8FØ4	Drive Status register (Read only)
DCONR	$8FØ5	Drive Control register (Write only)
FSTOP	$8F15	Stop CPU (Write only)

Table 4-3. Primitive Routine Descriptions

Routine	Description	Category
DESEL	Deselects all disk drives. Any selected drive is deselected, with Drive Select No. 1 to No. 4 made inactive. The Motor On/Head Load line is left active. On entry, nothing is required. On exit, nothing is saved.	DRIVE
FORCOF	Stops execution of any FDC command in progress by forcing an interrupt command to the FDC device. Also clears the DMA command register (if DMAFLG is enabled) and disables the IRQ latch. This routine should always be called after a hardware reset. Typically, this will be part of the warm RESET processing. On entry, nothing is required. No drive needs to be active. On exit, any errors (type I, if no command was in progress) are indicated in the A register or STFLG.	INITIALIZE
FORMAT	Formats the disk in the selected drive. In single-density mode, FM encoding (IBM 3740) is used with 128 data bytes per sector. For double-density, MFM encoding (System 34) is used with 256 data bytes per sector. In both modes, every sector data field is filled with the character in PADB (default is $E5). For 5" mode, the disk is formatted with CYL5 tracks, SECT5 sectors per track, and sector interleaving as specified in TABLE5 area. For 8" mode, the disk is formatted with CYL8	INITIALIZE

Table 4-3. Primitive Routine Descriptions (Cont'd)

Routine	Description	Category
FORMAT (Cont'd)	tracks, SECTK8 sectors per track, and sector interleaving as specified in TABLE8 area. The read/write head is left on the inner-most track. Refer to Section 4.4.1 for default disk formats. On entry, the drive must be active (MOTON/SELECT). On exit, any errors (the error type depends on the FDC command that was executing when the error occurred) are indicated in the A register or STFLG.	INITIALIZE
INIT	Initializes the RM 65 system for the FDC module. Sets up all default values for the FDC variables (see Table 4-7). This must always precede any other FDC firmware routines. Typically, this will be part of the cold RESET processing. On entry, nothing is required. On exit, nothing is saved.	INITIALIZE
IRQHAN	Interrupt handling routine that services all RM 65 FDC interrupts. The system interrupt vector must be set up with IRQHAN before the FDC firmware routines are used. Typically, this would be set-up in the cold RESET processing. If an additional interrupt service routine is to follow, IRQOUT must point to it. Since this is an interrupt handler, it is never called directly by a user program, but is used by most of the firmware routines.	INITIALIZE

Table 4-3. Primitive Routine Descriptions (Cont'd)

Routine	Description	Category
MOTOFF		DRIVE
	Turns off all drive motors (5")/unloads the read/write heads (8") and deselects all disk drives. Any selected drive is deselected, with Drive Select No. 1 to No. 4 made inactive. The drive motor flag MOFLG is reset and the Motor On/Head Load line is made inactive. On entry, nothing is required. On exit, nothing is saved.	
MOTON		DRIVE
	Turns on all drive motors(5")/loads the read/write heads (8") and selects the desired disk drive. Any selected drive is deselected then the desired Drive No. 1 to No. 4 is made active (uses SELECT), the drive motor flag MOFLG is set, and the Motor On/Head Load line is made active. The number of heads selected by the Single/Double Sided Drive jumper is set in NHEAD. On Entry, the drive (Ø-3) is in A, the side (Ø,1) is in Y, and the density (1 for single, Ø for double) is in X. On exit, nothing is saved.	

Table 4-3. Primitive Routine Descriptions (Cont'd)

Routine	Description	Category
RDMSC		READ
	Reads multiple sectors of data from the present track of selected disk drive. Any number of sequential sectors on a given cylinder may be read. The read buffer (RDBUF) must be as large as the number of sectors being read. RDMSC will use the DMA module if DMAFLG is enabled; the Source Bank must correspond to the FDC module, while the Destination Bank is the RDBUF RAM buffer. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper cylinder (SEEK). The starting sector is in A and the last sector is in X. On exit, the data read is pointed to by RDBUF. Any errors (type II) will be indicated in the A register or STFLG.	
RDSEC		READ
	Reads the desired sector of data from the present track of the selected disk drive. The read buffer (RDBUF) must be as large as the sector size. RDSEC will use the DMA module if DMAFLG is enabled; the Source Bank must correspond to the FDC module, while the Destination Bank is the RDBUF RAM buffer. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper track (SEEK). The sector number is in A. On exit, the data read is pointed to by RDBUF. Any errors (type II) will be indicated in A register or STFLG.	

Table 4-3. Primitive Routines Description (Cont'd)

Routine	Description	Category
RDTRK		READ
	Reads the present track from the selected disk drive. This reads the entire track -- including data, clock, address marks and gaps--starting and ending at the index hole. The read buffer (RDBUF) must be large enough for the entire track. RDTRK will use the DMA module if DMAFLG is enabled; the Source Bank must correspond to the FDC module, while the Destination Bank is the RDBUF RAM buffer. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper cylinder (SEEK). On exit, everything read from the track is left in the buffer pointed to by RDBUF. Any errors (type III) will be indicated in the A register or STFLG.	
SEEK		DRIVE
	Seeks to the specified track of the selected disk drive and verifies that the track was reached. The selected disk drive is restored (or re-zeroed) by a SEEK to track Ø. This recalibrates the disk drive read/write head back out to track ØØ. On entry, the drive must be active (MOTON/SELECT). The track number to seek is in the A register. On exit, any errors (type I) are indicated in the A register or STFLG.	

Table 4-3. Primitive Routines Description (Cont'd)

Routine	Description	Category
SELECT		DRIVE
	Selects the desired disk drive. The drive is made active and the read/write head is loaded (8" drives only). Only one drive may be active (by MOTON or SELECT) at a time, so other drives will first be deselected (DESEL) automatically. On entry, the drive (Ø-3) is in A, the side (Ø = one, 1 = two) is in Y, and the density (Ø = double, 1 = single) is in X. The drive motors must be on (MOTON). On exit, if the motors are not on, an error is indicated by an $8Ø in the A register or STFLG.	
WRTMSC		WRITE
	Writes multiple sectors of data to the present track of the selected disk drive. Any number of sequential sectors on a given track may be written. The write buffer (WRBUF) must be filled with the data for all the sectors. WRTMSC will use the DMA module if DMAFLG is enabled. In this case, Source Bank must correspond to the WRBUF RAM buffer, while the Destination Bank is the FDC module. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper track (SEEK). The start sector number is in A and the last sector number is in X. The data written is pointed to by WRBUF. On exit, any errors (type II) are indicated in the A register or STFLG.	

Table 4-3. Primitive Routine Descriptions (Cont'd)

Routine	Description	Category
WRTRK		WRITE
Writes an IBM compatible track onto the selected disk drive. This writes the entire track--including data, clock, address marks and gaps--starting and ending at the index hole. The track format used depends on the density and the disk size. In single-density mode, FM encoding (IBM 3740) is used with 128 data bytes per sector. For double-density, MFM encoding (System 34) is used with 256 data bytes per sector. The data fields are filled with PADB characters. For 5" disks, the number of sectors written is from SECT5 with interleaving from TABLE5 area. For 8" disks, the number of sectors written is from SECTK8 with interleaving from TABLE8. A disk can be formatted by performing WRTRK for every track. Refer to Section 4.4.1 for the default formats. WRTRK does not use the DMA module. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper track (SEEK). On exit, any errors (type III) are indicated in the A register or STFLG.		

Table 4-3. Primitive Routine Descriptions (Cont'd)

Routine	Description	Category
WRTSEC		WRITE
Writes the desired sector of the data to the present track of the selected disk drive. The write buffer (WRBUF) must be filled with the data. WRTSEC will use the DMA module if DMAFLG is enabled. In this case, the Source Bank must correspond to the WRBUF RAM buffer, while the Destination Bank is the FDC module. On entry, the drive must be active (MOTON/SELECT) with the read/write head positioned on the proper cylinder (SEEK). The sector number is in the A register. The data written is pointed to by WRTBUF. On exit, any errors (type II) are indicated in the A register or STFLG.		

4.2 CALLING CONSIDERATIONS

The primitives are designed to work with any RM 65 system, with the memory constraints described in Section 3.1. This software can be interfaced to work with any system since it is I/O independent. A necessary vector to be set is the IRQ interrupt. The address of the routine IRQHAN must be put into the IRQ vector.

Due to the physical timing constraints of the floppy disk medium (i.e., the disk rotating at a fixed speed), the FDC routines that read or write data from the disk are time-critical and must not be interrupted (by either IRQ or NMI interrupts) except by the FDC device. If an interruption does occur, the FDC operation will be invalid and the error will be flagged in the status register.

To avoid such errors, calls to a primitive read or write routine should always be preceeded by a disabling of all interrupt sources except the FDC module (this cannot be an SEI instruction). Care must be taken with the non-maskable interrupt to ensure proper error handling. After the returning from the primitive routine, the interrupts can then be re-enabled.

There are two data buffers needed for input and output of data to/from the disk. The addresses of these buffers should be put into RDBUF and WRBUF. These buffers should be 128 bytes for single-density and 256 bytes for double-density.

When calling a primitive routine, the action of the CPU depends on the type of the FDC command being performed (every primitive routine typically corresponds to one FDC command). After the FDC device (and DMA controller if applicable) is set up with the appropriate control data, the FDC command is then issued to the FDC device. If a type I command is issued, the CPU will wait until an interrupt is received, indicating command completion. For the type II and III commands - in which data is moved between the disk and memory--the CPU controls the transfer of the data a byte at a time (the FDC device stops the

CPU with the Ready line), with an interrupt indicating completion of the command. When the DMA module is used with type II and III commands, the DMA controls the transfer of data while the CPU will wait for the command completion interrupt.

After receiving an interrupt indicating command completion, the status register is checked to report if the primitive routine was successful. A return is now done to the calling program, which should always examine the status in A or STFLG to ensure that a disk error did not occur before continuing (see Section 4.5).

4.3 DISK INITIALIZATION

4.3.1 Procedure

The standard initialization procedure for the FDC Module consists of calling INIT. This routine sets up the default variables by initializing the RAM locations used by the operating software and clears the FDC I/O logic. Before initialization, insure that all switches, jumpers, and headers are properly set. If any of the default values must be changed, it must be done after the initialization. Refer to Table 4-1 for the primitive routine addresses.

The typical sequence for initialization (which would be part of the cold RESET procedure) is as follows:

a) Load the IRQ interrupt request vector for the system interrupt handler with the address of IRQHAN (beginning of the FDC interrupt service routine).

b) Load the address of the IRQ service routine to follow the FDC interrupt handler into IRQOUT. If there are no additional routines, this IRQOUT can point to an RTI instruction.

c) Call the INIT subroutine.

d) Change any default variables to their new value (refer to Sections 4.3.2 and 4.6).

e) If the DMA module is being used, load the page number (high order byte of the assigned base address) into DMAADR and the source bank, destination bank, and enable information into DMAFLG.

The system is now prepared to operate with any of the primitive routines (refer to Section 4.4).

Whenever a reset occurs while an FDC operation is in progress, it is necessary to force a software interrupt to the FDC device. This is done by the FORCOF routine. Thus, the FORCOF routine will typically be included as part of the warm RESET processing.

4.3.2 Default Conditions

When the FDC module is initialized, the default parameters that are set up will be used for a majority of applications of the module. Any of these default values can be changed to meet the user's requirements. A list of default conditions that might be changed is given in Table 4-4. Refer to Table 4-7 for the variable addresses.

Table 4-4. Primary User-Alterable Variable Default Values

Variable	Default	Description
CYL5	35	Number of tracks on 5" disk
CYL8	77	Number of tracks on 8" disk
DMAADR	Ø	Pointer to page in which the DMA module resides
DMAFLG	Ø	DMA module enable and bank selection flags
IRQOUT	None	Pointer to additional interrupt service routines
PADB	$E5	Pad character used to fill data field
RDBUF	$1ØØØ	Read buffer pointer

Table 4-4. Primary User-Alterable Variable Default Values (Cont'd)

Variable	Default	Description
SECTK5	16	Number of sectors/track on 5" disk
SECTK8	26	Number of sectors/track on 8" disk
TABLE5	Section 4.4.1	Sector interleaving table for 5" disk
TABLE8	Section 4.4.1	Sector interleaving table for 8" disk
TUNDEL	1ØØ	Write tunnel delay of 1mS (needed by some drives)
WRTBUF	$2ØØØ	Write buffer pointer

4.4 DISK PRIMITIVE OPERATION

After the RM 65 FDC Module has been initialized (refer to Section 4.3) the module is prepared for all disk operations. The procedures for some of the more common primitive operations are described in this section.

The primitive routines all fall into four major categories--Initialize, Drive, Read, and Write. These categories provide a functional grouping of commands. In building application programs with the primitives, these categories should be kept in mind. For example, in a typical disk read access:

Set up or recover system	-	INIT	(Initialize)
Select drive and track	-	MOTON and SEEK	(Drive)
Read the data	-	RDSEC	(Read)
Deselect the drive	-	MOTOFF	(Drive)

The system or disk must always be set up first (Initialize). After this, the drive selection and head positioning must take place (Drive). The disk access operation can now be performed (Read or Write), followed by drive deselection (Drive). The routines are not fully independent, requiring proper sequencing for meaningful results.

4.4.1 Formatting a Disk

Before any disk can be used for read/write data, the disk must be initialized or formatted. This consists of writing on all tracks of the disk: clock information; track, sector, and side identification (ID Field); data marker and data (Data Field). This disk initialization is compatable with the IBM 3740 format in single-density mode and IBM System 34 format in double-density mode.

In typical IBM compatible disks, sectors will be written sequentially on each track--1, 2, 3, ..., 15, 16 for 5" disks and 1, 2, 3, ..., 25, 26 for 8" disks. When doing sequential disk accesses (which is most of the time), all data movement and calculations preparing for the next sector must be done within the short intersector gap time, otherwise the sector is missed and an entire disk revolution must pass before the sector is available again. This makes the typical access time between sectors very long.

To shorten the typical access time between adjacent sectors, the disks are formatted with sequential sectors not adjacent, i.e., they are interleaved. Sequential sectors are separated by twelve sectors for 5" disks and 20 sectors for 8" disks, which gives at least 12 full sector time periods for data movement and calculations between sectors. This interleaving actually shortens the typical access time between sectors. For 5" disks, the physical sector format recorded on the disk is 1, 6, 11, 16, 5, 10, 15, 4, 9, 14, 3, 8, 13, 2, 7, 12. For 8" disks, the sector order is 1, 6, 11, 16, 21, 26, 5, 10, 15, 20, 25, 4, 9, 14, 19, 24, 3, 8, 13, 18, 23, 2, 7, 12, 17, 22.

The sector interleaving information is kept as a table of data starting at TABLE5 for 5" disks and TABLE8 for 8" disks. Because this is RAM based, the interleaving order can be modified--either to support additional sectors per track or to optimize the inter-sector time period for a specific application.

NOTES

1. Disks formatted by the FDC module using the FORMAT routine are IBM compatible in recording technique (FM for single density, MFM for double density) and field structure, therefore they can be read/written on other IBM compatible equipment. This does not imply compatibility of the file structure used or the meaning of the data stored on the disk with other IBM compatible systems.
2. Diskettes created on the Rockwell System 65 cannot be used with the firmware routines because they are not IBM compatible.

There are four disk formats as summarized in Table 4-5.

Table 4-5. Disk Format Parameters

Disk Format	Bytes per Sector	Sectors per Track	Total No. Tracks
Single-density, 5" (FM)	128	16	35
Single-density, 8" (FM)	128	26	77
Double-density, 5" (MFM)	256	16	35
Double-density, 8" (MFM)	256	26	77

To format a disk, the following steps are taken:

a. Initialize the FDC module (refer to Section 4.3).

b. Call MOTON (for initial selection), or SELECT (on subsequent selections) to select the drive, side, and density of the disk to be formatted. Check the A register or STFLG and process any errors.

c. Call FORMAT. The disk in the selected drive will now be formatted for the selected density (refer to Table 4-5). This will take a few seconds. Upon return from FORMAT, check the A register for error conditions (such as disk write protected).

d. The read/write head is left at the inner-most track. Call SEEK to bring the head back to the desired track (typically, track Ø).

e. Call DESEL or MOTOFF to deselect the drive.

The disk is now prepared for read/write operations. All data fields on the disk are filled with the character in PADB (default is $E5).

4.4.2 Reading a Sector

To read a sector of data from a formatted disk, the following steps may be followed:

a. Initialize the FDC module (refer to Section 4.3).

b. Call MOTON (for initial selection) or SELECT (on subsequent selections) to select the drive, side, and density of the disk being read. Check the A register or STFLG and process any errors.

c. Call SEEK to move the read/write head to the desired track to be read. The head will remain at this track until another head movement command is performed. Check the A register for errors.

d. Call RDSEC to read the desired sector of data. The data left is pointed to by RDBUF. Check the A register for errors.

e. Call DESEL or MOTOFF to deselect the drive.

The read buffer now contains the sector of data read from the disk.

4.4.3 Writing a Sector

To write a sector of data to a formatted disk, the following steps may be followed:

a. Initialize the FDC module (refer to Section 4.3).

b. Call MOTON or SELECT to select the drive, side and density of the disk to be written. Check the A register or STFLG and process any errors.

c. Call SEEK to move the read/write head to the desired track. The head will remain at this track until another head movement command is performed. Check the A register for errors.

d. Call WRTSEC to write data to the desired sector. The data must be in the buffer pointed to by WRBUF. Check the A register for errors.

e. Call DESEL or MOTOFF to deselect the drive.

The write buffer data is now written on the disk.

4.5 PRIMITIVE ROUTINES

Whenever a disk operation is performed, error conditions can keep the operation from being completed. Most of the FDC primitive routines return with a status of the operation-- this status reports on incorrect or incomplete operation. After primitive disk functions, the status is left in the A register and STFLG. This status is typically the FDC device status register contents. The meaning of the status bits depends on the type of the routine. Table 4-6 lists the error definitions.

The Type I routines involve the selection of drives or movement of the read/write head. The Type I routines are: FORCOF and SEEK.

The Type II routines control reading and writing sectors of data to and from the disk. The Type II routines are: RDMSC, RDSEC, WRTMSC, and WRTSEC.

The Type III routines are for reading and writing of data and clock information, a track at a time, as well as reading the ID Field. The Type III routines are: FORMAT, RDTRK, and WRTRK.

All the above routines (types I, II, and III) can also return a motors not on (the SELECT routine does also) or no drive selected error ($80).

The remaining primitive routines do not return any error information: DESEL, INIT, MOTOFF, MOTON.

Dependent on the routine called, certain error checks should always be performed on return. Some of the error conditions (such as write protection) are checked within the routines, while others rely entirely on the application software for correction.

4.6 PRIMITIVE ROUTINES VARIABLES

The variables used by the primitive routines are located and identified in Table 4-7.

Table 4-6. Primitive Routine Error Definitions

Type	STFLG(A)	Description
I	Bit 1	Drive not ready (8" Drive only).
	Bit 6	Disk is write protected
	Bit 5	- - -
	Bit 4	Seek error
	Bit 3	CRC error in ID Field
	Bit 2	Track 00
	Bit 1	- - -
	Bit 0	FDC device is busy
II and III	Bit 7	Drive not ready (8" Drive only).
	Bit 6	Disk is write protected
	Bit 5	Read Record Type error (1 = Deleted Data Mark) Write error
	Bit 4	Record not found
	Bit 3	CRC error in ID Field
	Bit 2	Lost Data error
	Bit 1	- - -
	Bit 0	FDC device busy.

NOTE

An $80 indicates a Motors Not On or No Drives Selected error for Type I, II, and III routines.

Table 4-7. Primitive Routine Variables

Addr (Hex)	Label	No. Bytes	Init Value (Hex)	Definition
ØDB	PTR	2	-	Source/Dest. Buffer Pointer
ØDD	DMAPTR	2	-	Pointer to DMA Module Addr.
4AØ	IRQOUT	2	-	IRQ Exit Address*
4A2	FLAG	1	ØØ	Last Command Performed
4A3	CNTR	1	ØØ	Counter
4A4	TEMP	2	ØØ ØØ	Temporary Storage
4A6	TEMP2	1	ØØ	Temporary Storage
4A7	MSC	1	ØØ	DMA Most Significant Count
4A8	LSC	1	ØØ	DMA Least Significant Count
4A9	NCYL	1	ØØ	No. of Tracks
4AA	NSEC	1	ØØ	No. of Sectors
4AB	CURSEC	1	ØØ	Current Sector No.
4AC	LSECR	1	ØØ	Current Sector To Read Or Write
4AD	STFLG	1	ØØ	Status Flag
4AE	CURCMD	1	ØØ	Current Command Being Executed
4AF	WRTFLG	1	ØØ	Write Command Flag
4BØ	SELFLG	1	ØØ	Select Flag
4B1	MOFLG	1	ØØ	Motor Flag
4B2	USIDE	1	ØØ	Side No.
4B3	UCYL	1	ØØ	Track No.
4B4	UDRV	1	ØØ	Drive No.
4B5	CURCYL	4	ØØ -> ØØ	Current Track For Each Drive
4B9	DMAADR	1	ØØ	DMA MSB I/O Address*
4BA	DMAFLG	1	ØØ	DMA Flag*
4BB	FORFLG	1	ØØ	Write Track Flag
4BE	DBLCNT	1	FF	Double-Density Counter
4BF	SNGLCT	1	7F	Single-Density Counter

NOTES

*User-alterable.

Table 4-7. Primitive Routine Variables (Cont'd)

Addr (Hex)	Label	No. Bytes	Init Value (Hex)	Definition
4CØ	NBYTE	1	8Ø	Bytes Per Sector
4C1	NHEAD	1	Ø1	No. of Heads*
4C2	CYL5	1	23	Tracks Per 5" Disk*
4C3	CYL8	1	4D	Tracks Per 8" Disk*
4C4	SECTK5	1	1Ø	Sectors Per 5" Disk*
4C5	SECTK8	1	1A	Sectors Per 8" Disk*
4C6	HDEL	1	1E	Delay for Head Load*
4C7	SFLAG	1	Ø6	Side CMP & Data Mark (C&E)
4C8	TUNDEL	1	64	Delay for Non-Shugart Tunnel
4C9	RDBUF	2	ØØ 3E	FDC Source Buffer Vector*
4CB	WRBUF	2	ØØ 3F	FDC Destination Buffer Vector*
4CD	RATE	1	Ø7	Stepping Rate
4CF	RETRY	1	Ø5	Number Of Retries
4CF	PADB	1	E5	Format Byte Pattern*
4DØ	TABLE5	16	(Note 1)	5" Sector Interleaving Table*
4EØ	TABLE8	26	(Note 2)	8" Sector Interleaving Table*

NOTES

*User-alterable.

1. 6,7,8,9,10,11,12,13,14,15,16,Ø,2,3,4,5 (decimal).
2. 6,7,8,9,10,11,12,13,14,15,16,17,18,19,2Ø,21,22,23,24,25, 26,Ø,2,3,4,5 (decimal).

SECTION 5

USING AIM 65 DOS VERSION 1.0

The AIM 65 Disk Operating System (DOS) Version 1.0 (A65-090) integrates the RM 65 FDC primitive subroutines with fundamental file management functions for use on the AIM 65 Microcomputer. These ROM-based functions, contained in a 4K-byte R2332 ROM, are accessible from the operator through the Debug Monitor/Text Editor ROMs as well as language ROMs and from an application program. Being ROM-based, DOS operation may proceed immediately upon power turn-on without waiting for separate loading of the DOS into RAM.

Text and program source code may be written to, and read from, floppy disk with the Editor List and Read commands, respectively. Similarly, binary data and program object code may be written to, and loaded from, disk using the Monitor Dump and Load commands, respectively. Files containing source and object code for application programs written in AIM 65 Assembler, BASIC, FORTH, PL/65 and Pascal languages are, therefore, supported.

DOS primary commands are selected by the operator at the Monitor command level. These commands invoke the following functions:

Format a Disk
List the Directory
Backup a Disk
List a File
Delete a File
Recover a File

Files are created automatically upon writing a file to disk. A file name and the disk drive number are operator entered in response to system prompts.

Disk read or write errors, both at the DOS and FDC device level, are reported upon detection. User-alterable variables allow changing of default values to application unique values.

5.1 INITIALIZATION

After installing the AIM 65 DOS ROM on the RM 65 FDC module, the DOS is ready for use. The DOS must first be initialized, however, by executing the startup routine, e.g.:

```
<*>=8000
<G>/.
```

The FDC module primitive subroutine variables are initialized, the DOS variables are set to default values (see Section 5.7), the IRQ vectors are initialized, the F1 and F2 user function keys are linked to DOS, the user-defined I/O vectors are loaded for floppy disk I/O, and other temporary variables are initialized. Control then returns to the I/O ROM and subsequently to the Monitor command level. DOS commands may be entered when the Monitor prompt is displayed. (The DOS may not be operated without the Monitor/Editor ROMs installed.)

AIM 65 DOS 1.0 is designed primarily to support AIM 65 Monitor/Editor and language functions in response to commands entered from the keyboard with response directed to the display/printer. When used in this manner, the Monitor/Editor ROMs must be installed. The DOS may also be used to write and read a data file under program control (see Section 5.5). In this case, the Monitor/Editor ROMs are not required unless a Monitor subroutine is used.

> **NOTE**
>
> The DOS uses two contiguous 256-byte buffers, the output buffer and the input buffer, to transfer data between RAM and a floppy disk (as well as for other intermediate data storage). The high byte of the output (or source) buffer is specified by the variable BUFFER (see Section 5.7). The input (or destination) buffer is located immediately above the output buffer. BUFFER is initialized by the startup routine ($8000) to $06 which locates the buffers in low RAM (i.e., $600-7FF).

> **NOTE (Cont'd)**
>
> Application programs must be located above the FDC module primitive subroutine variables ($040A-$4FF--see Section 4.6), DOS 1.0 variables ($0500-$0564--see Section 5.7) and above the DOS buffers (if left at their default locations, i.e., $600-$7FF).

5.2 DISK FORMAT

A floppy disk must be formatted in the AIM 65 DOS 1.0 format before it can be used (see Section 5.3.3). The DOS disk format (illustrated in Figure 5-1) reserves track 0 for future use, uses track 1 and one-half of track 2 for the directory, and the rest of the tracks for sector header and data storage. The sectors are formatted sequentially on the disk.

Trk No.	Sect No.	Function	Single-Density			Double-Density		
			Byte No.	File No. 5"	File No. 8"	Byte No.	File No. 5"	File No. 8"
0	All	Reserved	1-128	-	-	1-256	-	-
1	1	File Entry	1- 16	1	1	1- 16	1	1
		File Status	1			1		
		00=Directory End 01=Active File 02=Deleted File						
		File Name	2- 11			2- 11		
		Start Track	12			12		
		Start Sector	13			13		
		Length-Low Byte	14			14		
		Length-High Byte	15			15		
		Null (00)	16			16		
		File Entries	17-128	2- 8	2- 8	17-256	2- 16	2- 16
	2	File Entries	1-128	9-16	9- 16	1-256	17- 32	17- 32
	3- 8	File Entries	1-128	17-64	17- 64	1-256	33-128	33-128
	9-13	File Entries	1-128	-	65-104	1-256	-	129-208
	14-16	Free	1-128	-	-	1-256	-	-
2	All	Free	1-128	-	-	1-256	-	-

Figure 5-1. AIM 65 DOS 1.0 Disk Format

5.3 PRIMARY OPERATOR COMMANDS

The primary operator commands are selected by using one of two keys: F1 and F2. The F1 key directly commands the List Directory Function, (see Section 5.3.1) while the F2 key displays a UTILITY = prompt. One of five utility functions may then be commanded (see Sections 5.3.2 through 5.3.3). If an invalid key is pressed for a utility function, the utility menu is displayed, e.g.:

```
<]> UTILITY=<RETURN>
(F)ORMAT, (B)ACKUP, (L)IST, (D)EL, (R)EC
```

The <ESC> key is vectored through variable FESCIV (see Section 5.7) to jump to the Monitor command level. The <ESC> key vector is initialized upon cold reset and may be user-altered. Note that this vector is also used to return control to the Monitor after reporting an error condition (see Section 5.6).

NOTE

Upon cold reset, the density selection corresponding to each disk drive is initially set to double. If a disk cannot be read at the selected density, DOS automatically switches to the other density, and attempts to read the disk again. If the read is successful, the selected density is saved for future reading from that disk drive (until a cold reset is performed). This process is essentially transparent to the operator except for a slight delay.

If DOS cannot read the disk at either density, the operator will be prompted to enter the disk density (e.g., DENSITY=) upon the next disk command. The DOS will then attempt to read the disk again at the commanded density (and, if necessary, the other density).

5.3.1 List the Directory

The List Directory function displays the file name of all files recorded on the disk, the sector length of the files and the active/deleted status of each file. The number of free sectors, i.e., the amount of space left on the disk, is also reported.

To list the directory, press the F1 key, then enter the disk drive number in response to the prompt.

Example:

To list the contents of the directory on disk drive No. 1:

```
<[>
DISK=1
FILE NAME     LEN S
LOGGER1.OBJ   269 A
TEXT1         193 A
TEXT2          26 A
SEC LEFT= 178
```

5.3.2 Backup a Disk

The Backup Disk function copies all the active files from one disk to another disk. Since deleted files on the input disk are not copied to the output disk, the newly created disk is essentially compressed (i.e., deleted files removed) to provide additional free space.

To backup a disk, press the F2 key to request the utilities prompt, then press the B key. Enter the disk drive number of the disk to copy from, then the disk drive number of the disk to copy to, in response to prompts.

Example:

To copy a disk on disk drive No. 1 to a disk on disk drive No. 2:

```
<]>
UTILITY=B DISK=1
DISK=2
```

5.3.3 Format a Disk

The Format Disk function initializes a disk to prepare it for subsequent use (see Section 5.2). A new disk, i.e., an unformatted disk, must be formatted before a file can be written upon it. It may also be desired to initialize a previously formatted disk to remove all existing files before re-use.

The Format Disk function also verifies proper operation of the disk media before file storage use. The disk is first initialized by writing sector headers, gaps and CRC data, then a $E5 byte pattern to all sectors. The directory is next initialized to all $00 bytes. If the NOVRFY flag (see Section 5.7) is non-zero (default value), the sector headers are verified, otherwise control returns to the Monitor command level. If the NOVRFY flag is zero, the sector headers are not checked, allowing a faster formatting of the disk.

To format a disk, press the F2 key to request the utilities prompt, then press the F key. Enter the desired disk number and density character when requested. The disk number may vary from 1 to 4 for single-sided disks and from 1 to 8 for double-sided disks (i.e., each side is treated as a separate drive number with odd numbers being the front side and even numbers being the back side). The density character may be either S (for single-density) or D (for double-density).

Since the initialization completely overwrites the disk, a command verification prompt, "ARE YOU SURE?", is displayed before continuing, to prevent inadvertent reformatting. Press Y to continue, or any other key to terminate the command.

The WAIT message is displayed during disk initialization, followed by the Monitor command prompt upon completion. The number of free sectors and bytes is dependent upon disk size and density while the initialization time is dependent upon the state of the NOVRFY flag:

Disk Size	Density Code	Approx. Format Time (Min:Sec)		Free Sectors	Free Bytes
		Verify NOVRFY≠0	No Verify NOVRFY=0		
5"	S	1:45	0:20	535	68,480
5"	D	1:45	0:20	535	136,960
8"	S	5:00	0:30	1962	251,136
8"	D	5:00	0:30	1962	502,272

Example:

Initialize a 5" disk in disk drive No. 1 to single-density then list the directory to check it.

```
<]> UTILITY=F
DISK=1 DENSITY=S
ARE YOU SURE?Y
WAIT

<[>
DISK=1
FILE NAME  LEN S
SEC LEFT= 535
```

NOTES

1. An RM 65 DMA module (RM65-5104) must be used to write and read double-density on 8" disks.
2. If an RM 65 DMA module is used (with either 5" or 8" disk drives), refer to Section A.3 for operating instructions.

5.3.4 List a File

The List File function lists the contents of a file from a disk to another peripheral device. If the peripheral is another disk, a file may be copied from one disk to another.

To list a file, press the F2 key to request the utilities prompt, then press the L key. Enter the file name, disk drive number, and output device code as requested. Respond to output device code subprompts.

Example 1:

To list a text file to the display/printer:

```
<]> UTILITY=L F=TEXT3
DISK=1
OUT=<RETURN>
```

Example 2:

To list an object code file from disk drive No. 1 to disk drive No. 2:

```
<]>
UTILITY=L F=PROG1.OBJ
DISK=1
OUT=U F=PROG1.OBJ
DISK=2
```

The listing may be suspended by pressing the <SPACE> bar, then resumed by pressing the <SPACE> bar again (or one of the other keys).

5.3.5 Delete a File

The Delete File Function changes a file from the active (A) state to the deleted (D) state. In the deleted state, the file cannot be accessed by file name by any function except Recover File (see Section 5.3.5).

To delete a file, press the F2 key to request the utilities prompt, then press the D key. Enter the file name and disk drive number in response to prompts. The Monitor prompt will be displayed upon completion. List the directory to verify the file deletion.

Example:

To delete file TEXT3 (currently active) from disk drive No. 1:

```
<]>
UTILITY=D F=TEXT3
DISK=1
{[}
DISK=1
FILE NAME  LEN S
TEXT1      193 A
TEXT2       94 A
TEXT3       63 D
SEC LEFT= 238
```

A deleted file may be returned to the active state by using the Recover File function.

5.3.6 Recover a File

The Recover File function changes a file from the deleted (D) state to the active (A) state. In the active state, the file can be accessed by file name by other DOS functions.

To recover a file, press F2 key to request the utilities prompt, then press the R key. Enter the file name and disk drive number in response to prompts. The Monitor prompt will be displayed upon completion. List the directory to verify file recovery.

Example:

To recover file TEXT3 (currently deleted) from a disk on disk drive No. 1:

```
<]>
UTILITY=R F=TEXT3
DISK=1
<[>
DISK=1
FILE NAME  LEN S
TEXT1      193 A
TEXT2       44 A
TEXT3       63 A
SEC LEFT= 238
```

5.3.7 Extension of UTILITY Functions

The DOS links to the UTILITY functions through two indirect jump vectors. These two vectors, MENUVC and MENULS, are user-alterable and may be changed to provide alternative linkage and functions. Upon depression of the] key, the DOS jumps through the before menu vector, MENUVC, to check for the five default command characters. If the command character is an F, B, L, D or R, the appropriate processing is performed (see Section 5.3.2 through 5.3.6). If the command character is not one of these letters, the DOS jumps through the after menu vector, MENULS, to display the command menu then redisplay the "UTILITY=" prompt.

Either one or both of these vectors may be altered to meet application dependent requirements.

5.4 FILE HANDLING UNDER OPERATOR CONTROL

A file may be written to, or read from, a disk under operator control by pressing U in response to the OUT=, or IN=, prompt displayed by other major functions, e.g., Monitor, Editor or language. Enter the file name and disk number in response to subprompts.

5.4.1 Using the AIM 65 Monitor

The Monitor Dump (D) function can be used to output machine code from memory to a disk file in ASCII format, while the Monitor Load (L) function can be used to read the file from a disk into RAM (see Sections 4.8.2 and 4.8.1, respectively, in the AIM 65 User's Guide).

a. Writing a File

Example:

Dump machine code, in ASCII, from addresses 0800 through 08FF to file PGM1*A on disk drive No. 1:

```
<D>
FROM=0800 TO=08FF
OUT=U F=PGM1*A
DISK=1
MORE?N
```

b. Reading a File

Example:

Load file PGM1*A from disk drive No. 1 into RAM:

```
<L>IN=U F=PGM1*A
DISK=1
```

5.4.2 Using the AIM 65 Editor

The Editor List (L) function can be used to output ASCII text from the Editor Text Buffer in RAM to a disk file while the Read (R) function can be used to read the file into the Text Buffer (see Sections 5.4.9 and 5.4.1, respectively, in the AIM 65 User's Guide).

Be sure that the Text Buffer is located above the DOS variables and input/output buffers, e.g., $800. If the buffers are relocated, the Text Buffer may start at $600.

a. Writing a File

Example:

Write all the text in the Text Buffer to file PGM1 on disk drive No. 1:

```
=<T>
=<L>
/.
OUT=U F=PGM1
DISK=1
```

b. Reading a File

Example:

Read file PGM1 from disk drive no. 1 into the Text Buffer:

```
=<R>
IN=U F=PGM1
DISK=1

END
```

5.4.3 Using the AIM 65 Assembler

Source code may be read from a disk file into the AIM 65 assembler and/or object code may be written to a disk file from the assembler during the assembly process.

Be sure that the symbol table and, if located in RAM, the source and/or object code are located above the DOS variables and buffers, e.g., $800. If the DOS buffers are relocated, RAM can be used starting at $600.

To assemble a program from source code on the disk, the program shown in Figure 5-2 must first be loaded. Entry to the assembler is now made using the <F3> rather than the usual <N> command. Only use this <F3> entry when assembly is from source code on disk. When using this program, the motors must be turned off after the assembly is complete by depressing the RESET switch. Use of this program is demonstrated in Examples 2 and 3.

> **NOTE**
> When assembling from disk using the driver in Figure 5-2, the first character of the source file is ignored. Begin the first line with a space to avoid an error from occurring.

LINKAGE TO ASSEMBLE SOURCE FROM DISK ON AIM 65

```
ADDR OBJECT   SOURCE

                FOPIN=$8110
                NOPENA=$8155
                ASMVEC=$53F
                ASMFLG=$536
                      *=$112          ;SET UP F3 KEY FOR ENTRY
0112 4C 41 05         JMP START
                      *=ASMVEC+2      ;FREE MEMORY
0541 A9 01    START   LDA #01         ;FLAG FOR SOURCE ON DISK
0543 8D 36 05         STA ASMFLG
0546 A9 53            LDA #<PASSCK    ;CHECK ON EVERY BYTE OF SOURCE
0548 A0 05            LDY #>PASSCK    ;THAT IT IS STILL PASS 1
054A 8D 3F 05         STA ASMVEC
054D 8C 40 05         STY ASMVEC+1
0550 4C 00 D0         JMP $D000       ;ENTER THE ASSEMBLER

0553 A5 23    PASSCK  LDA $23         ;CHECK FOR PASS 2
0555 2D 36 05         AND ASMFLG
0558 D0 03            BNE PASS2       ;STILL PASS 1 -- CONTINUE
055A 4C 55 81         JMP NOPENA

055D A9 00    PASS2   LDA #00         ;ZERO THE ASSEMBLER FLAG
055F 8D 36 05         STA ASMFLG      ;TO SKIP PASSCK
0562 20 10 81         JSR FOPIN       ;REOPEN FILE
0565 4C 55 81         JMP NOPENA      ;GET THE CHAR
                      .END
```

Figure 5-2. Driver to Assemble from Source Code on Disk

Example 1:

Assemble source code from memory (i.e., the Text Buffer) and write the generated object code in ASCII to file PGM1*A on disk drive No. 2:

```
<N>
ASSEMBLER
FROM=1800 TO=1FFF
IN=M
LIST?N
LIST-OUT=<RETURN>

OBJ?Y
OBJ-OUT=U F=PGM1*A
DISK1

PASS 1

PASS 2

ERRORS= 0000
```

Example 2:

Assemble source code from file PGM1 on disk drive No. 1 and do not generate object code.

```
<F3>
ASSEMBLER
FROM=1800 TO=1FFF
IN=U F=PGM1
DISK=1
LIST ?N
LIST-OUT=<RETURN>

OBJ?Y
OBJ-OUT=X

PASS 1

PASS 2

ERRORS= 0000
```

Example 3:

Assemble source code from file PGM1 on disk drive No. 1 and write the generated object code to file PGM1* on disk drive No. 1:

```
<F3>
ASSEMBLER
FROM=1800 TO=1FFF
IN=U F=PGM1
DISK=1

LIST?N
LIST-OUT=<RETURN>

OBJ?Y
OBJ-OUT=U F=PGM1*
DISK=1

PASS 1

PASS 2

ERRORS= 0000
```


5.4.4 Using AIM 65 BASIC

The starting address of RAM used by BASIC to store the application program and variables must be changed from its default value of $211 to a value above the DOS 1.0 variables and input/output buffers, e.g., $0800.

a. BASIC Program Relocation

The following can be used to change the start of the BASIC program:

1. Enter BASIC from the Monitor and enter the memory size and terminal width in response to prompts.

```
<5>
MEMORY SIZE?
WIDTH?
 11758 BYTES FREE
  AIM 65 BASIC V1.1
```

2. Press <ESC> to return to the Monitor.

3. Move the BASIC program and variables start address from $211 to greater than $7FF, e.g., $800. Also, load zeros into three bytes at the start of the BASIC program.

```
<M>=0073 12 02 14 02
</> 0073 01 08 03 08
<M>=0800 AA AA AA AA
</> 0800 00 00 00    <RETURN>
```

4. Initialize DOS 1.0:

```
<*>=8000
<G>/.
```

5. Re-enter BASIC.

```
<6>
```

6. Enter BASIC commands.

The AIM 65 BASIC SAVE and LOAD functions may be used to write and read a BASIC application program, to and from a disk file, respectively (see Section 303 in the AIM 65 BASIC Language Reference Manual).

b. Saving a File

Example:

Save the BASIC program in RAM to file PGM3 on disk drive No. 1:

```
SAVE
OUT=U F=PGM3
DISK=1
```

c. Loading a File

Example:

Load a BASIC program into RAM file PGM3 on disk drive No. 1:

```
LOAD
IN=U F=PGM3
DISK=1
```

5.4.5 Using AIM 65 FORTH

The source code for an application program written in AIM 65 FORTH may be formatted to edit in the AM 65 Text Editor or to input in the FORTH screen format. Refer to Sections 5.4.9 and 5.4.1 in the AIM 65 User's Guide to write source code from the Text Editor to disk or to read source code from disk into the Text Editor. Refer to Section 12 in the AIM 65 FORTH User's Manual for FORTH screen format usage.

The start-up address of RAM used by AIM 65 FORTH to store the application words must be changed from its default value of $300 to a value above the DOS variables and input/output buffers, e.g., $0800.

a. FORTH Application Dictionary Relocation

The following procedure can be used to change the start of the application words:

1. Enter FORTH from the Monitor with the 5 key.

```
<5>
 AIM 65 FORTH V1.2
```

2. Move the FORTH starting address from $300 to greater than $7FF, e.g., $800.

```
FORGET TASK
1280 ALLOT
:TASK ;
```

> **NOTE**
>
> Any time FORTH is entered with the 5 key, the above steps must be repeated.

3. Press <ESC> to return to the Monitor.

4. Initialize DOS:

```
<*>=8000
<G>/.
```

5. Re-enter FORTH with the 6 key.

```
<6>
```

6. Enter FORTH commands.

5.4.6 Using AIM 65 PL/65

The source code for an application program written in AIM 65 PL/65 may be read from disk into the PL/65 compiler and/or the generated object code (i.e., in 6502 assembly language) may be written to disk (see Section 2.6 in the AIM 65 PL/65 User's Manual).

a. Writing a File

Compile source code from memory (i.e., the Text Buffer) and write the output assembler code to file PGM2 or disk drive No. 2:

```
<5>
AIM 65 PL/65 V1.0
IN=M OUT=U F=PGM2
DISK=1
PASS(1 OR 2)?2

ERRORS=00
```

b. Reading a File

Compile source code from file PGM2L on disk drive No. 1 and output the generated assembly language to memory:

```
<5>
AIM 65 PL/65 V1.0
IN=U F=PGM2L
OUT=M
PASS(1 OR 2)?2

ERRORS=00
```

5.4.7 Using AIM 65 Instant Pascal

An application program written in Pascal can be compiled (i.e., to an internal language code for interpretation) into RAM, from a disk file, by AIM 65 Instant Pascal. The source code for an application program in RAM may also be translated from internal format to structured Pascal statements and written to a disk file. Refer to Sections 3.1 and 3.2.3, respectively, in the AIM 65 Instant Pascal User's Manual for user instructions.

The start-up address of RAM used by AIM 65 Instant Pascal to start the application program internal code must be changed from it's default value of $02FC to a value above the DOS 1.0 variables and input/output buffers, e.g., $0800.

a. Instant Pascal Program Relocation

The following procedure can be used to move the start-up address of the internal code:

1. Enter Instant Pascal from the Monitor and enter the memory size and terminal width in response to prompts.

```
<5>MEMORY WIDTH?
WIDTH?
```

2. Press <ESC> to return to the Monitor.

3. Change the program start-up address to a value greater than $7FF, e.g., $800:

```
<M>=001A FC 02 XX XX
</> 001A FC 07 XX XX
```

4. Initialize AIM 65 DOS 1.0:

```
<*>=8000
<G>/.
```

5. Re-enter Instant Pascal:

```
<5>
```

6. Enter Pascal statements.

> **NOTE**
>
> Any time a Cold Reset (Pascal Z command) is performed, location $1A-$1B will be reset to $02FC.

b. Writing a File

Example:

Write the Pascal statements for a program from AIM 65 Instant Pascal to file PGM4P on disk drive No. 1:

```
+<L>/.
OUT=U F=PGM4P
DISK=1
```

c. Reading a File

Example:

Read the Pascal statements into AIM 65 Instant Pascal from file PGM4P on disk drive No. 1:

```
+<R>IN=U F=PGM4P
DISK=1
```

c. Read a File

Compile source code from file PGM2L on disk drive No. 1 and output the generated assembly language to memory:

```
<5>AIM 65 PL/65 V1.Ø
 IN=F F=PGM2L
 DISK=1
 OUT=M
 PASS(1 OR 2)?2
 ERRORS=ØØ
```

5.5 FILE HANDLING UNDER PROGRAM CONTROL

Often it is desirable to store and/or retrieve data from a floppy disk entirely under program control, e.g., when collecting data in an unattended installation. While this can be easily done by writing a program which calls the primitive routines (see Section 4), use of the primitive routines alone do not support the directory format used by AIM 65 DOS 1.Ø. DOS compatible data files written under program control allow easy examination and handling under operator control using DOS

utility functions. This section describes a method to write data to and read data from a floppy disk in a format that is compatible with the AIM 65 DOS 1.Ø file structure.

5.5.1 Writing and Reading Data Files

The AIM 65 DOS 1.Ø file structure allows the writing and reading of data to and from disk independent of the data meaning (e.g., program source code, program object code, or symbol table) or data format (e.g., ASCII coding or machine code). The assembly listing in Figure 5-3 details a DOS compatible file handler. This handler contains both an output driver (to write a file to disk) and an input driver (to read a file from disk). The DOS subroutines and variables used by these drivers are listed in Tables 5-1 and 5-2, respectively.

To write a file, first set up the file name, disk number and side number, then call the write open subroutine (OPENWR). Next, pass data a byte at a time to the disk file by loading each byte into the Accumulator and calling the Monitor OUTALL subroutine. When all data bytes have been output, output an End of File (EOF) character ($1A) and call the write close subroutine (CLOSEW) to close the file. The CLOSEW subroutine automatically outputs the additional fill bytes (value=$ØØ) to complete the last sector.

To read a file, first set up the file name, disk number and side number, then call the read open subroutine (OPENRD). Next, read data from the disk file, a byte at a time, by calling the Monitor INALL subroutine and storing the read byte in the Accumulator into memory. When an EOF is received, turn off the disk drives, call the read close file (CLOSER) to close the file.

> NOTE
>
> This input driver uses $1A as the EOF indicator. When $1A is detected by the INALL subroutine, the disk drive motors are turned off. The user program must close the file however.

```
ADDR OBJECT   SOURCE

                ;
                ; FDC ADDRESSES ( 5-26-82 )
                DISK2=$885B
                DISK1=$884A
                TRKSK=$84E6
                CLOPEN=$81A7
                FOPIN=$8110
                CLSOUT=$82AD
                CLSIN=$8195
                LISTRT=$8353
                DOSSET=$8006
                WRTIT=$8248
                ; FDC VARIABLES
                FINOUT=$522
                DSTBUF=$D9
                SRCBUF=$D7
                BUFFER=$531
                CLOUTV=$52E
                EOF=$537
                ;
                ; AIM 65 VARIABLES
                OUTFLG=$A413
                INFLG=$A412
                ;
                      *=$F00
                ;
                ; AFTER TURNING ON THE SYSTEM , THE FDC FIRMWARE MUST BE
                ; INITIALIZED ( TYPICALLY AS A RESET PROCEDURE ).
                ; THIS CAN BE UNDER OPERATOR CONTROL BY EXECUTING $8000
                ; OR UNDER PROGRAM CONTROL BY :
                ;   INIT  JSR  DOSSET     ;INITIALIZE FDC DOS
                ;
                ; TO OPEN A WRITE FILE , SET UP DISK,SIDE AND
                ; NAME BEFORE CALLING THIS OPEN ROUTINE:
                ;  DISK = $501 - NUMBER 0-7
                ;  SIDE = $503 - 0 FOR FIRST SIDE
                ;  FILENAME = $518 - 10 CHARACTERS PADDED WITH $20
                ;  DENSITY = $505 - 0 FOR DOUBLE (OPTIONAL)
                ;
0F00 A2 01      OPENW  LDX #1             ;USE WRITE BUFFER
0F02 8E 22 05          STX FINOUT
0F05 A9 53             LDA #<LISTRT       ;DISABLE CHARACTER CHECKS
0F07 A0 83             LDY #>LISTRT
0F09 8D 2E 05          STA CLOUTV
0F0C 8C 2F 05          STY CLOUTV+1
0F0F 20 5B 88          JSR DISK2          ;TURN ON WRITE DRIVE
0F12 A9 00             LDA #0             ;SET UP DESTINATION BUFFER
0F14 85 D9             STA DSTBUF
0F16 AC 31 05          LDY BUFFER
0F19 C8                INY                ;WRITES USE BUFFER+1
0F1A 84 DA             STY DSTBUF+1
0F1C 20 E6 84          JSR TRKSK          ;RESTORE WITH DENSITY CHECK
0F1F 20 A7 81          JSR CLOPEN         ;OPEN THE FILE
0F22 A9 55             LDA #'U            ;POINT OUTALL TO FLOPPY
0F24 8D 13 A4          STA OUTFLG
0F27 60                RTS
```

Figure 5-3. Program Control File Handler


```
ADDR OBJECT   SOURCE

                ;
                ; TO WRITE DATA , CALL OUTALL WITH BYTE THE IN A .
                ; THE USER DRIVER WILL WRITE 128/256 BYTES AT A TIME .
                ; PASS AN EOF AS THE LAST CHARACTER .
                ;
                ; TO CLOSE THE WRITE FILE
0F28 AD 37 05   CLOSEW LDA EOF            ;CLOSE OUT LAST SECTOR
0F2B 20 48 82          JSR WRTIT
0F2E A9 20             LDA #$20           ;RESTORE ADD TO AIM 65
0F30 8D 13 A4          STA OUTFLG
0F33 4C AD 82          JMP CLSOUT         ;CLOSE DISK FILE
                ;
                ; TO OPEN A READ FILE , SET UP DISK,SIDE AND
                ; NAME BEFORE CALLING THIS OPEN ROUTINE:
                ;  DISK = $500 - DRIVE NO.  0-7
                ;  SIDE = $502 - 0 FOR FIRST SIDE
                ;  FILENAME = $50E - 10 CHARACTERS PADDED WITH $20
                ;  DENSITY = $504 - 0 FOR DOUBLE (OPTIONAL)
                ;
0F36 A2 00      OPENR  LDX #0             ;USE READ BUFFER
0F38 8E 22 05          STX FINOUT
0F3B 20 4A 88          JSR DISK1          ;TURN ON READ DRIVE
0F3E A9 00             LDA #0             ;SET UP SOURCE BUFFER
0F40 85 D7             STA SRCBUF
0F42 AC 31 05          LDY BUFFER
0F45 84 D8             STY SRCBUF+1
0F47 20 E6 84          JSR TRKSK          ;RESTORE WITH DENSITY CHECK
0F4A 20 10 81          JSR FOPIN          ;OPEN THE READ FILE
0F4D 60                RTS
                ;
                ; TO READ DATA , CALL INALL - BYTE RETURNED IN A .
                ; CHECK FOR AN EOF CHARACTER IF NEEDED .
                ;
                ; TO CLOSE THE READ FILE
0F4E 4C 95 81   CLOSER JMP CLSIN          ;CLOSE DISK READ FILE
                       END

 ERRORS=0000
```

Figure 5-3. Program Control File Handler (Cont'd)

Table 5-1. Commonly Used AIM 65 DOS 1.Ø Subroutines

Label	Address (Hex)	Function
CLOPEN	81A7	Open the Write Disk File.
CLSIN	8195	Close the Read Disk File and Turn Off the Drives.
CLSOUT	82AD	Close the Write Disk File and Turn Off the Drives.
DISK1	884A	Set Up and Turn On the Read Drive.
DISK2	885B	Set Up and Turn On the Write Drive.
DOSSET	8ØØ6	Iintialize FDC Primitive and DOS Variables.
ERRLCL	84D6	Error Handler for the AIM 65 DOS (includes FESC).
FESC	84DA	Turn Off Motors and Jump Through FESCIV.
FOPIN	811Ø	Open the Read Disk File.
LISTRT	8353	Return Instructions.
TRKSK	84E6	Seek to the Track in UCYL with Verify and Density Check.
WRTIT	8248	Write out one Byte from A (called through OUTALL).

Table 5-2. Commonly Used AIM 65 DOS 1.Ø Variables

Label	Address (Hex)	Function
BUFFER	531	MSB of Pointer to DOS Buffer.
CLOUTV	52E	Pointer to the close check for write files.
CURCMD	4AE	Last Command Executed by FDC device.
EOF	537	Character used as an End-of-File marker.
DSTBUF	ØD9	Pointer to DOS write buffer.
ERSTAT	524	DOS error status.
ERRVEC	532	Pointer to the DOS error processing routine
FBYTE	5ØA	Buffer 1 current byte (Read).
	5ØB	Buffer 2 current byte (Write).
FESCIV	534	Pointer to the DOS escape processing routine
FDISK	5ØØ	Buffer 1 disk number (Read).
	5Ø1	Buffer 2 disk number (Write).
FSIDE	5Ø2	Buffer 1 side number (Read).
	5Ø3	Buffer 2 side number (Write).
FDEN	5Ø4	Buffer 1 density (Read).
	5Ø5	Buffer 2 density (Write).
FNAMES	5ØE-517	Buffer 1 file name (Read - 1Ø characters.
	518-521	Buffer 2 file name (Write) - 1Ø characters.
FINOUT	522	Read/Write indicator (Ø=Read).
LEN	53D	Number of remaining sectors (Read).
STFLG	4AD	Image of FDC device status register.
SRCBUF	ØD7	Pointer to DOS Read buffer.

If an error occurs during writing or reading using this handler, the IRQ interrupts are reenabled, the disk drive motors are turned off and control is returned to the AIM 65 Monitor command level. The source of the error can be determined by examining the command type (WRCMD), the FDC Status Register (STFLG), and the DOS error status (ERSTAT).

Note that the address of the error handler is placed in ERRVEC and the address to jump to after the error has been serviced is placed in FESCIV. If errors are to be handled under program control, these vectors must be loaded appropriately. The error handler must isolate and service the error as required. If the disk operation is to be terminated, the IRQ interrupts must be reenabled (JSR ION) the disk drive motors turned off (JMP FESC) and I/O restored to the system terminal.

5.5.2 DOS Compatibility Considerations

The user is responsible for the meaning and coding of all data in files created under program control, including the definition and inclusion of control bytes. Sometimes the files are handled by knowing exactly how many bytes are written to a file, and therefore how many to expect upon reading it (which can be detected by a logical zero result in LEN, LEN+1 and FBYTE). Any $00 pad bytes used to fill the last sector can be ignored.

Another approach is to include one or more special characters to indicate the end of a file. The end of file character(s) must not conflict with valid data values using their approach, however.

In order for a data file to be listed using the DOS list utility function (UTILITY=L, see Section 5.3.4), the data must be coded in ASCII and terminated with an ASCII End of File (EOF) character (byte value = $1A).

An example program using the handler shown in Figure 5-3 is listed in Figure 5-4. This example writes a series of ASCII characters to disk then reads the file. Since an $1A EOF terminator is used, the written file can be examined using the UTILITY=L DOS function. Constants are used for the file name, disk number and side number in this example.

5.6 DOS ERROR REPORTING

The DOS reports an error condition and value indicating the cause of the error whenever improper disk operation is detected. These errors may occur due to reasons such as improper disk drive operation, incorrect disk drive/FDC module connection, bad disk media, and operator error (e.g., wrong disk installed, wrong file name specified, wrong disk drive specified, attempted use of unformatted disk, etc.).

The error reporting format is:

```
DISK ERROR=
```

where:

XX = DOS detected errors plus seek error from the FDC device on the FDC module.

YY = The contents of the FDC device Status Register (less SEEK error) on the FDC module (see Section 4.5).

The error definitions are described in Table 5-3.

The error reporting linkage is through two vectors, ERRVEC (vector before error handling) and FESCIV (vector after error handling)--see Section 5.7. These vectors are initialized upon cold reset and may be altered to link to user-provided additional or alternative error handling.

Note that the default error handler return is to the Monitor (to COMIN at $A32E) after reporting an error code.

```
ADDR OBJECT   SOURCE

                OUTALL=$E9BC
                INALL=$E993
                OUTPUT=$E97A
                OPENW=$F00
                OPENR=$F36
                CLOSEW=$F28
                CLOSER=$F4E
                EOF=$537
                CHAR   =0
                       *=$F80
                ;
                ; THIS TEST PROGRAM WRITES OUT TWO SECTORS OF NUMBERS TO
                ; TO THE DISK .  THE FILE IS THEN READ AND DISPLAYED .  ALL
                ; UNDER PROGRAM CONTROL .  THE FILE ( NAME IS FROM FNAME )
                ; IS SUITABLE TO BE LISTED FROM DOS
                ;
                ; SET UP THE READ AND WRITE DISK PARAMETERS FIRST
                ;
0F80 A9 00      TEST   LDA #0
                ; SET UP THE DRIVES
0F82 8D 00 05          STA $500          ;READ DRIVE
0F85 8D 01 05          STA $501          ;WRITE DRIVE
                ; SET UP THE SIDES
0F88 8D 03 05          STA $503          ;READ SIDE
0F8B 8D 04 05          STA $504          ;WRITE SIDE
                ; DOWNLOAD FILENAME FROM FNAME
0F8E A2 0A      NAME   LDX #10
0F90 BD DD 0F   NAME1  LDA FNAME,X
0F93 9D 0E 05          STA $50E,X        ;READ FILE NAME
0F96 9D 18 05          STA $518,X        ;WRITE FILE NAME
0F99 CA                DEX
0F9A 10 F4             BPL NAME1
                ;
                ; NEXT WRITE OUT A TEST FILE
                ;
0F9C 20 00 0F   TESTWR JSR OPENW         ;OPEN FILE
0F9F A2 07      ISSUE  LDX #7
0FA1 A0 3C      NEWLIN LDY #60
0FA3 A9 30      ZERO   LDA #'0
0FA5 85 00             STA CHAR
0FA7 A5 00      LOOP   LDA CHAR
0FA9 C9 3A             CMP #':
0FAB F0 F6             BEQ ZERO
0FAD 20 BC E9   WRITE  JSR OUTALL
0FB0 E6 00             INC CHAR
0FB2 88                DEY
0FB3 D0 F2             BNE LOOP
0FB5 A9 0D             LDA #$0D          ;CR
0FB7 20 BC E9          JSR OUTALL
0FBA CA                DEX
0FBB D0 E4             BNE NEWLIN
0FBD AD 37 05   END    LDA EOF           ;SHOULD BE $1A
0FC0 20 BC E9          JSR OUTALL
0FC3 20 28 0F   DONE   JSR CLOSEW
```

Figure 5-4. Example Program Using File Handler


```
ADDR OBJECT   SOURCE

                ;
                ; NOW READ IN THE TEST FILE
                ;
0FC6 20 36 0F   TESTRD JSR OPENR         ;OPEN FILE
0FC9 20 93 E9   READ   JSR INALL         ;READ IN A CHARACTER
0FCC CD 37 05          CMP EOF           ;SAME AS MARK WRITTEN
0FCF F0 06             BEQ EOFOUT
0FD1 20 7A E9   OUTWIT JSR OUTPUT
0FD4 4C C9 0F          JMP READ
0FD7 20 4E 0F   EOFOUT JSR CLOSER
0FDA 4C A1 E1          JMP $E1A1         ;COMIN1 ==>
                ;
                ; THE NAME OF THE FILE IS  ...
0FDD 54 45      FNAME  .BYT 'TESTFILE11'
                       .END

 ERRORS=0000
```

Figure 5-4. Example Program Using File Handler (Cont'd)

Table 5-3. AIM 65 DOS 1.0 Error Definitions

Code	Error	Definition
ØlYY	SEEK ERROR	The FDC device did not locate the data on the disk.
Ø2YY	Undefined	
Ø4YY	DISK FULL	The disk is full, thus, no more data may be written on it.
Ø8YY	DIRECTORY FULL	The directory is full, thus, no more file names may be entered.
1ØYY	FILE NAME NOT FOUND	The specified file name is not in the directory.
2ØYY	FILE NAME EXISTS	The specified file name already exists for an active file.
8ØYY	DIRECTORY ERROR	The directory terminator was not found within the directory limits.
XXØ1	BUSY	The FDC device is busy.
XXØ2	Undefined	
XXØ4	LOST DATA	The CPU did not respond to DRQ in one byte time.
XXØ8	CRC ERROR	If RECORD NOT FOUND error exists, an error was found in one or more ID fields, otherwise a data field error exists.
XX1Ø	RECORD NOT FOUND	The desired track, sector, or side were not found.
XX2Ø	RECORD TYPE/WRITE FAULT	On read record, this bit indicates the record-type code from the data field address mark (1=Deleted Data Mark, Ø=Data Mark). On a write, this bit indicates a write fault.
XX4Ø	WRITE PROTECT ERROR	Writing was attempted to a write protected disk.
XX8Ø	NOT READY	The drive is not ready.

5.7 DOS VARIABLES

The DOS variables, located on page zero and five are listed in Table 5-4. Some of these variables are for internal use only (to store temporary values) while others are user-alterable and constant after initialization. The default values for the user-alterable variables, initialized by the sub-routine DOSSET, are also shown in Table 5-4.

Table 5-4. AIM 65 DOS 1.0 Variables

Addr (Hex)	Label	No. Bytes	Init Value	Definition
0D7	SRCBUF	2	-	DOS Source Buffer Vector
0D9	DSTBUF	2	-	DOS Destination Buffer Vector
500	FDISK	1	00	Buffer 1 Disk No.
501		1	00	Buffer 2 Disk No.
502	FSIDE	1	00	Buffer 1 Side No.
503		1	00	Buffer 2 Side No.
504	FDEN	1	00	Buffer 1 Density
505		1	00	Buffer 2 Density
506	FTRACK	1	00	Buffer 1 Track No.
507		1	00	Buffer 2 Track No.
508	FSECTR	1	00	Buffer 1 Sector No.
509		1	00	Buffer 2 Sector No.
50A	FBYTE	1	00	Buffer 1 Byte Count
50B		1	00	Buffer 2 Byte Count
50C	SECLEN	1	00	Buffer 1 Bytes/Sector
50D		1	00	Buffer 2 Bytes/Sector
50E	FNAMES	10	00 -> 00	Buffer 1 File Name
518		10	00 -> 00	Buffer 2 File Name
522	FINOUT	1	00	Buffer to use
523	CHAR	1	00	Character (Temporary) Storage
524	ERSTAT	1	00	Error Status
525	FILNM1	2	00 00	Temporary Storage
527	FILNM2	2	00 00	Temporary Storage
529	FILNM3	2	00 00	Temporary Storage
52B	RETCNT	1	00	Retry Count
52C	READSV	1	00	Temporary Storage
52D	LSTCHR	1	00	Last Character
52E	CLOUTV	2	00 00	Close Output Vector
530	INITFL	1	00	Density Ask Flag
531	BUFFER	1	06	Source Buffer Addr. High Byte*
532	ERRVEC	2	EB 84	Before Error Handler Vector*
534	FESCIV	2	56 E9	After Error Handler Vector*
536	ASMFLG	1	00	Assembly Flag
537	EOF	1	1A	End of File Marker

Table 5-4. AIM 65 DOS 1.0 Variables (Cont'd)

Addr (Hex)	Label	No. Bytes	Init Value	Definition
538	MENUVC	2	64 80	Before UTILITY Decode Vector*
53A	MENULS	2	8A 80	After UTILITY Decode Vector*
53C	NOVRFY	1	01	Format Disk No Verify Flag*
53D	LEN	2	-	Length Count for Read File
53F	ASMVEC	2	-	Assembler Check Vector

NOTE

*User-alterable

1. The DOS 1.0 variables are initialized by calling the DOS routine DOSSET ($8006).

SECTION 6

USING AIM 65/40 DOS VERSION 1.0

The AIM 65/40 Disk Operating System (DOS) Version 1.0 (A65/40-7090) integrates the RM 65 FDC primitive subroutines with fundamental file management functions for use on the AIM 65/40 Microcomputer. These ROM-based functions, contained in a 4K-byte R2332 ROM, are accessible from the operator through the I/O and Debug Monitor/Text Editor ROMs as well as language ROMs and from an application program. Being ROM-based, DOS operation may proceed immediately upon power turn-on without waiting for separate loading of the DOS into RAM.

Text and program source code may be written to, and read from, disk with the Editor List and Read commands, respectively. Similarly, binary data and program object code may be written to, and loaded from, disk using the Monitor Dump and Load commands, respectively. Files containing source and object code for application programs written in AIM 65/40 Assembler, BASIC, FORTH, and PL/65 languages are, therefore, supported.

DOS primary commands are selected by the operator at the Monitor command level. These commands invoke the following functions:

Format a Disk
List the Directory
Backup a Disk
List a File
Delete a File
Recover a File

Files are created automatically upon writing a file to disk. A file name and the disk drive number are operator entered in response to system prompts.

Disk read or write errors, both at the DOS and FDC device level, are reported upon detection. User-alterable variables allow changing of default values to application unique values.

6.1 INITIALIZATION

After installing the AIM 65/40 DOS ROM on the RM 65 FDC module, the DOS is ready for use. Be sure that address range $8000-$8FFF is selected for off-board operation on the AIM 65/40 SBC module.

The DOS is initialized automatically through the I/O ROM Auto-start linkage. The FDC module primitive subroutine variables are initialized, the DOS variables are set to default values (see Section 6.7), the IRQ vectors are initialized, the Monitor key decode linkage is altered (to allow DOS to decode the [and] keys), the user-defined I/O vectors are loaded for floppy disk I/O, and other temporary variables are initialized. Control then returns to the I/O ROM and subsequently to the Monitor command level. DOS commands may be entered when the Monitor prompt is displayed (the DOS may not be operated without the Monitor/Editor ROMs installed).

AIM 65/40 DOS 1.0 is designed primarily to support the AIM 65/40 Monitor/Editor and language functions in response to commands entered from the keyboard with messages directed to the display/printer. When used in this manner, the Monitor/Editor ROMs must be installed. The DOS may also be used to write and read a data file under program control (see Section 6.5). In this case, the Monitor/Editor ROMs are not required unless a Monitor subroutine is used.

NOTE

The DOS uses two contiguous 256-byte buffers, the output buffer and the input buffer, to transfer data between RAM and a floppy disk (as well as for other intermediate data storage). The high byte of the output (or source) buffer is specified by the variable BUFFER (see Section 6.7). The input (or destination) buffer is located immediately above the output buffer. BUFFER is initialized by a cold reset to $3E which locates the buffers at the top of 16K bytes (i.e., $3E00-$3FFF). If

NOTE (Cont'd)

more RAM is available, you will probably want to move this buffer to the top of RAM, e.g., change the Buffer value to $7E for 32K bytes of RAM.

6.2 DISK FORMAT

A floppy disk must be formatted in the AIM 65/40 DOS 1.0 format before it can be (see Section 6.3.3) used. The DOS disk format (illustrated in Figure 6-1) reserves track 0 for future use, uses track 1 and one-half of track 2 for the directory, and the rest of the tracks for sector header and data storage. The sectors are formatted in an interleaved manner. Files are stored sequentially on the disk.

Trk No.	Sect No.	Function	Single-Density			Double-Density		
			Byte No.	File No. 5"	File No. 8"	Byte No.	File No. 5"	File No. 8"
0	All	Reserved	1-128	-	-	1-256	-	-
1	1	File Entry	1- 16	1	1	1- 16	1	1
		File Status	1			1		
		00=Directory End 01=Active File 02=Deleted File						
		File Name	2- 11			2- 11		
		Start Track	12			12		
		Start Sector	13			13		
		Length-Low Byte	14			14		
		Length-High Byte	15			15		
		Null (00)	16			16		
		File Entries	17-128	2- 8	2- 8	17-256	2- 16	2- 16
	2	File Entries	1-128	9-16	9- 16	1-256	17- 32	17- 32
	3- 8	File Entries	1-128	17-64	17- 64	1-256	33-128	33-128
	9-13	File Entries	1-128	-	65-104	1-256	-	129-208
	14-16	Free	1-128	-	-	1-256	-	-
2	All	Free	1-128	-	-	1-256	-	-

Figure 6-1. AIM 65/40 DOS 1.0 Disk Format

6.3 PRIMARY OPERATOR COMMANDS

The primary operator commands are selected by using one of two keys: [and]. The [key directly commands the List Directory function, (see Section 6.3.1) while the] key displays a UTILITY= prompt. One of five utility functions may then be commanded (see Sections 6.3.2 through 6.3.6). If an invalid key is pressed for a utility function, the utility menu is displayed, e.g.:

```
{]} UTILITY=<RETURN>
(F)ORMAT, (B)ACKUP, (L)IST, (D)EL, (R)EC
```

The <ESC> key is vectored through variable FESCIV (see Section 6.7) to jump to the Monitor command level. This vector is initialized upon cold reset and may be user-altered. The <ESC> key vector is also used to return control to the Monitor after reporting an error condition (see Section 6.6). Note that some other major functions reconfigure the Escape vector to return to their command level, e.g., the Text Editor and BASIC. In these cases, if the <ESC> key is pressed, the function in process will be terminated.

> **NOTE**
>
> Upon cold reset, the density selection corresponding to each disk drive is initially set to double. If a disk cannot be read at the selected density, DOS automatically switches to the other density, and attempts to read the disk again. If the read is successful, the selected density is saved for future reading from that disk drive (until a cold reset is performed). This process is essentially transparent to the operator except for a slight delay.
>
> If DOS cannot read the disk at either density, the operator will be prompted to enter the disk density (e.g., DENSITY=) upon the next disk

> **NOTE (Cont'd)**
>
> command. The DOS will then attempt to read the disk again at the commanded density (and, if necessary, the other density).

6.3.1 List the Directory

The List Directory function displays the file name of all files recorded on the disk, the sector length of the files and the active/deleted status of each file. The number of free sectors, i.e., the amount of space left on the disk, is also reported.

To list the directory, press the [key, then enter the disk drive number in response to the prompt.

Example:

To list the contents of the directory on disk drive No. 1:

```
{[} DISK=1
FILE NAME     LEN S
LOGGER1.OBJ   269 A
TEXT1         193 A
TEXT2          26 A
SEC LEFT= 178
```

The data output rate may be altered by pressing the Ø key (fastest) through the 9 key (slowest) while the directory is being listed, or by using the Monitor @ command prior to the List Direct command.

6.3.2 Backup a Disk

The Backup Disk function copies all the active files from one disk to another disk. Since deleted files on the input disk are not copied to the output disk, the newly created disk is essentially compressed (i.e., deleted files removed) to provide additional free space.

To backup a disk, press the] key to request the utilities prompt, then press the B key. Enter the disk drive number of the disk to copy from, then the disk drive number of the disk to copy to, in response to prompts.

Example:

To copy a disk on disk drive No. 1 to a disk on disk drive No. 2:

```
{]} UTILITY=B DISK=1
DISK=2
```

6.3.3 Format a Disk

The Format Disk function initializes a disk to prepare it for subsequent use (see Section 6.2). A new disk, i.e., an unformatted disk, must be formatted before a file can be written upon it. It may also be desired to initialize a previously formatted disk to remove all existing files before re-use.

The Format Disk function also verifies proper operation of the disk media before file storage use. The disk is first initialized by writing sector headers, gaps and CRC data, then a $EA byte pattern to all sectors. The directory is next initialized to all $00 bytes. If the NOVRFY flag (see Section 6.7) is non-zero (default value), the sector headers are verified, otherwise control returns to the Monitor command level. If the NOVRFY flag is zero, the sector headers are not checked, allowing a faster formatting of the disk.

To format a disk, press the] key to request the utilities prompt, then press the F key. Enter the desired disk number and density character when requested. The disk number may vary from 1 to 4 for single-sided disks and from 1 to 8 for double-sided disks (i.e., each side is treated as a separate drive number with odd numbers being the front side and even numbers being the back side). The density character may be either S (for single-density) or D (for double-density).

Since the initialization completely overwrites the disk, a command verification prompt, "ARE YOU SURE?", is displayed before continuing, to prevent inadvertent reformatting. Press Y to continue, or any other key to terminate the command.

The WAIT message is displayed during disk initialization, followed by the Monitor command prompt upon completion. The number of free sectors and bytes is dependent upon disk size and density while the initialization time is dependent upon the state of the NOVRFY flag:

Disk Size	Density Code	Approx. Format Time (Min:Sec) Verify NOVRFY≠0	Approx. Format Time (Min:Sec) No Verify NOVRFY=0	Free Sectors	Free Bytes
5"	S	1:45	0:20	535	68,480
5"	D	1:45	0:20	535	136,960
8"	S	5:00	0:30	1962	251,136
8"	D	5:00	0:30	1962	502,272

Example:

Initialize a 5" disk in disk drive No. 1 to single-density then list the directory to check it.

```
{]} UTILITY= F DISK=1 DENSITY=S
ARE YOU SURE?Y
WAIT

{[} DISK=1
FILE NAME  LEN S
SEC LEFT= 535
```

NOTE

1. An RM 65 DMA module (RM65-5104) must be used to write and read double-density on 8" disks.
2. If an RM 65 DMA module is used (with either 5" or 8" disk drives), refer to Section A.3 for operating instructions.

6.3.4 List a File

The List File function lists the contents of a file from a disk to another peripheral device. If the peripheral is another disk, a file may be copied from one disk to another.

To list a file, press the] key to request the utilities prompt, then press the L key. Enter the file name, disk drive number, and output device code as requested. Respond to output device code subprompts.

Example 1:

To list a text file to the display/printer:

```
{]} UTILITY=L FILE=TEXT3 DISK=1
OUT=<RETURN>
```

Example 2:

To list an object code file from disk drive No. 1 to disk drive No. 2:

```
{]} UTILITY=L FILE=PROG1.OBJ DISK=1
OUT=F FILE=PROG1.OBJ DISK=2
```

The data output rate to the display/printer may be altered by pressing the Ø key (fastest) through the 9 key (slowest) while the file is being listed, or by using the Monitor @ command prior to the List File command.

The listing may be suspended by pressing the <SPACE> bar, then resumed by pressing the <SPACE> bar again (or one of the other keys).

6.3.5 Delete a File

The Delete File Function changes a file from the active (A) state to the deleted (D) state. In the deleted state, the file cannot be accessed by file name by any function except Recover File (see Section 6.3.5).

To delete a file, press the] key to request the utilities prompt, then press the D key. Enter the file name and disk drive number in response to prompts. The Monitor prompt will be displayed upon completion. List the directory to verify the file deletion.

Example:

To delete file TEXT3 (currently active) from a disk on disk drive No. 1:

```
{]} UTILITY=D FILE=TEXT3 DISK=1
{[} DISK=1
FILE NAME  LEN S
TEXT1      193 A
TEXT2       94 A
TEXT3       63 D
SEC LEFT= 238
```

A deleted file may be returned to the active state by using the Recover File function.

6.3.6 Recover a File

The Recover File function changes a file from the deleted (D) state to the active (A) state. In the active state, the file can be accessed by file name by other DOS functions.

To recover a file, press] key to request the utilities prompt, then press the R key. Enter the file name and disk drive number in response to prompts. The Monitor prompt will be displayed upon completion. List the directory to verify file recovery.

Example:

To recover file TEXT3 (currently deleted) from disk drive No. 1:

```
{]} UTILITY=R FILE=TEXT3 DISK=1
{[} DISK=1
FILE NAME  LEN S
TEXT1      193 A
TEXT2       44 A
TEXT3       63 A
SEC LEFT= 238
```

6.3.7 Extension of UTILITY Functions

The DOS links to the UTILITY functions through two indirect jump vectors. These two vectors, MENUVC and MENULS, are user-alterable and may be changed to provide alternative linkage and functions. Upon depression of the] key, the DOS jumps through the before menu vector, MENUVC, to check for the five default command characters. If the command character is an F, B, L, D or R, the appropriate processing is performed (see Section 6.3.2 through 6.3.6). If the command character is not one of these letters, the DOS jumps through the after menu vector, MENULS, to display the command menu then redisplay the "UTILITY=" prompt.

Either one or both of these vectors may be altered to meet application dependent requirements.

6.4 FILE HANDLING UNDER OPERATOR CONTROL

A file may be written to, or read from, a disk under operator control by pressing F in response to the OUT=, or IN=, prompt displayed by other major functions, e.g., Monitor, Editor or language. Enter the file name and disk number in response to subprompts.

6.4.1 Using the AIM 65/40 Monitor

The Monitor Dump (D) function can be used to output machine code from memory to a disk file in either ASCII or binary

format, while the Monitor Load (L) function can be used to read the file from a disk into RAM (see Sections 4.8.2 and 4.8.1, respectively, in the AIM 65/40 System User's Manual).

a. Dumping a File in ASCII

Example:

Dump machine code, in ASCII, from addresses $0800 through $08FF to file PGM1*A on disk drive No. 1:

```
{D}
 FROM=0800 TO=08FF OFFSET=0000 MORE?N
 TYPE=A OUT=F FILE=PGM1*A      DISK=1
```

b. Dumping a File in Binary

Example:

Dump machine code, in binary, from addresses $0800 through $08FF to file PGM1*B on disk drive No. 1:

```
{D}
 FROM=0800 TO=08FF OFFSET=0000 MORE?N
 TYPE=B DUMP SYMBOLS?N OUT=F FILE=PGM1*B      DISK=1
```

c. Reading a File

Example:

Load file PGM1*B from disk drive No. 1 into RAM:

```
{L} OFFSET=0000 IN=F FILE=PGM1*B      DISK=1
```

6.4.2 Using the AIM 65/40 Editor

The Editor List (L) function can be used to output ASCII text from the Editor Text Buffer in RAM to a disk file while the Read (R) function can be used to read the file into the Text Buffer (see Sections 5.4.9 and 5.4.1, respectively, in the AIM 65/40 Systems User's Manual).

a. Writing a File

Example:

Write all the text in the Text Buffer to file PGM1 on disk drive No. 1:

```
={T}
={L}/. OUT=F FILE=PGM1       DISK=1
```

b. Reading a File

Example:

Read file PGM1 from disk drive No. 1 into the Text Buffer:

```
={R} IN=F FILE=PGM1       DISK=1
*END*
```

6.4.3 Using the AIM 65/40 Assembler

Source code may be read from a disk file into the AIM 65/40 assembler and/or object code may be written to a disk file from the assembler during the assembly process. If the object code output format is binary, the symbol table may also be saved on the disk file.

> **NOTE**
>
> The 8 key (Re-enter Assembler command) may not be used to assemble to/from disk.

Example 1:

Assemble source code from memory (i.e., the Text Buffer) and write the generated object code in ASCII to file PGM1*A on disk drive No. 2:


```
{7}ASSEMBLER V1.0
 FROM=1800  T0=1FFF
 IN=M
 OBJ TO MEM?N
 OUT=F FILE=PGM1*A       DISK=2
 TYPE=A
 LIST?N OUT=<RETURN>
 PASS 1
 PASS 2

 DONE
 ERRORS=0000
```

Example 2:

Assemble source code from file PGM1 on disk drive No. 1 and do not generate object code.

```
{7}ASSEMBLER V1.0
 FROM=1800  TO=1FFF
 IN=F FILE=PGM1       DISK=1
 OBJ TO MEM?N
 OUT=X
 LIST?N OUT=<RETURN>
 PASS 1
 PASS 2

 DONE
 ERRORS=0000
```

Example 3:

Assemble source code from file PGM1 on disk drive No. 1 and write the generated object code and symbol table, in binary, to file PGM1*BS on disk drive No. 1:

```
{7}ASSEMBLER V1.0
 FROM=1800  TO=1FFF
 IN=F FILE=PGM1       DISK=1
 OBJ TO MEM?N OFFSET=0000
 OUT=F TYPE=B DUMP SYMBOLS?Y FILE=PGM1*BS     DISK=1
 LIST?N OUT=<RETURN>
 PASS 1
 PASS 2

 DONE
 ERRORS=0000
```

> **NOTE**
>
> When assembling from a source file on disk and an error occurs (such as a File Not Found error), the AIM 65/40 must be reset to resume normal disk operation.

6.4.4 Using AIM 65/40 BASIC

The AIM/65/40 BASIC SAVE and LOAD functions may be used to write and read a BASIC application program, to and from a disk file, respectively (see Sections 4.3.10 and 4.3.5 in the AIM 65/40 BASIC User's Manual).

a. Saving a File

Example:

Save the BASIC program in RAM to file PGM3 on disk drive No. 1:

```
SAVE
OUT=F FILE=PGM3        DISK=1
```

b. Loading a File

Example:

Load a BASIC program into RAM file PGM3 on disk drive No. 1:

```
LOAD
IN=F FILE=PGM3         DISK=1
```

6.4.5 Using AIM 65/40 FORTH

The source code for an application program written in AIM 65/40 FORTH may be formatted to edit in the AIM 65/40 Text Editor or to input in the FORTH screen format. Refer to Sections 5.4.9

and 5.4.1 in the AIM 65/40 System User's Manual to write source code from the Text Editor to disk or to read source code from disk into the Text Editor. Refer to Section 12 in the AIM 65/40 FORTH User's Manual for FORTH screen format usage.

6.4.6 Using PL/65

The source code for an application program written in AIM 65/40 PL/65 may be read from disk into the PL/65 compiler and/or the generated object code (i.e., in 6502 assembly language) may be written to disk (see Section 2.6 in the AIM 65/40 PL/65 User's Manual).

a. Write a File

Compile source code from memory (i.e., the Text Buffer) and write the output assembler code to file PGM2L on disk drive No. 2:

```
{5}AIM 65/40 PL/65 V1.1
IN=M OUT=F FILE=PGM2L        DISK=1
PASS(1 OR 2)?2

ERRORS=00
```

b. Read a File

Compile source code from file PGM2L on disk drive No. 1 and output the generated assembly language to memory:

```
{5}AIM 65/40 PL/65 V1.1
IN=F FILE=PGM2L       DISK=1
OUT=M
PASS(1 OR 2)?2

ERRORS=00
```

6.5 FILE HANDLING UNDER PROGRAM CONTROL

Often it is desirable to store and/or retrieve data from a floppy disk entirely under program control, e.g., when collecting data in an unattended installation. While this can be easily done by writing a program which calls the primitive

routines (see Section 4), use of the primitive routines alone do not support the directory format used by AIM 65/40 DOS 1.0. DOS compatible data files written under program control allow easy examination and handling under operator control using DOS utility functions. This section describes a method to write data to, and read data from, a floppy disk in a format that is compatible with the AIM 65/40 DOS 1.0 file structure. To operate the DOS 1.0 under program control, the AIM 65/40 Monitor must be installed.

6.5.1 Writing and Reading Data Files

The AIM 65/40 DOS 1.0 file structure allows the writing and reading of data, to and from disk, independent of the data meaning (e.g., program source code, program object code, or symbol table) or data format (e.g., ASCII coding or machine code). The assembly listing in Figure 6-2 details a DOS compatible file handler. This handler contains both an output driver (to write a file to disk) and an input driver (to read a file from disk). The DOS subroutines and variables used by these drivers are listed in Tables 6-1 and 6-2, respectively.

To write a file, first set up the file name, disk number and side number, then call the write open subroutine (OPENW). Next, pass data a byte at a time to the disk file by loading each byte into the Accumulator and calling the I/O ROM OUTALL subroutine. When all data bytes have been output, call the write close subroutine (CLOSEW) to close the file. The CLOSEW subroutine automatically outputs the additional fill bytes (value=$00) to complete the last sector.

To read a file, first set up the file name, disk number and side number, then call the read open subroutine (OPENR). Next, read data from the disk file, a byte at a time, by calling the I/O ROM INALL subroutine and storing the read byte in the Accumulator into memory. When all data bytes have been received, call the read close file (CLOSER) to close the file.


```
PAGE 0001   ROUTINES TO READ AND WRITE FILES FOR AIM 65/40

ADDR OBJECT   SOURCE

                        ;
                        ; FDC ADDRESSES ( 5-18-82 )
                        DISK2=$885B
                        DISK1=$884A
                        TRKSK=$84DF
                        CLOPEN=$823A
                        FOPIN=$81A8
                        CLSOUT=$82B3
                        CLSIN=$8221
                        ; FDC VARIABLES
                        FINOUT=$522
                        DSTBUF=$D9
                        SRCBUF=$D7
                        BUFFER=$52F
                        ;
                        ; AIM 65/40 VARIABLES
                        OUTFLG=$274
                        INFLG=$273
                        ;
                              *=$4000
                        ;
                        ; TO OPEN A WRITE FILE , SET UP DISK,SIDE AND
                        ; NAME BEFORE CALLING THIS OPEN ROUTINE:
                        ;  DISK = $501 - NUMBER 0-7
                        ;  SIDE = $503 - 0 FOR FIRST SIDE
                        ;  FILENAME = $518 - 10 CHARACTERS PADDED WITH $20
                        ;  DENSITY = $505 - 0 FOR DOUBLE (OPTIONAL)
                        ;
4000 A2 01      OPENW   LDX #1              ;USE WRITE BUFFER
4002 8E 22 05           STX FINOUT
4005 20 5B 88           JSR DISK2           ;TURN ON WRITE DRIVE
4008 A9 00              LDA #0              ;SET UP DESTINATION BUFFER
400A 85 D9              STA DSTBUF
400C AC 2F 05           LDY BUFFER
400F C8                 INY                 ;WRITES USE BUFFER+1
4010 84 DA              STY DSTBUF+1
4012 20 DF 84           JSR TRKSK           ;RESTORE WITH DENSITY CHECK
4015 20 3A 82           JSR CLOPEN          ;OPEN THE FILE
4018 A9 10              LDA #$10            ;POINT OUTALL TO FLOPPY
401A 8D 74 02           STA OUTFLG
401D 60                 RTS
                        ;
                        ; TO WRITE DATA , CALL OUTALL WITH BYTE THE IN A
                        ; THE USER DRIVER WILL WRITE 128/256 BYTES AT A TIME
                        ;
                        ; TO CLOSE THE WRITE FILE
401E 4C B3 82   CLOSEW  JMP CLSOUT          ;CLOSE DISK FILE
```

Figure 6-2. Program Control File Handler

```
PAGE 0002   ROUTINES TO READ AND WRITE FILES FOR AIM 65/40

ADDR OBJECT   SOURCE

                ;
                ; TO OPEN A READ FILE , SET UP DISK,SIDE AND
                ; NAME BEFORE CALLING THIS OPEN ROUTINE:
                ;  DISK = $500 - DRIVE NO. 0-7
                ;  SIDE = $502 - 0 FOR FIRST SIDE
                ;  FILENAME = $50E - 10 CHARACTERS PADDED WITH $20
                ;  DENSITY = $504 - 0 FOR DOUBLE (OPTIONAL)
                ;
4021 A2 00      OPENR  LDX #0             ;USE READ BUFFER
4023 8E 22 05          STX FINOUT
4026 20 4A 88          JSR DISK1          ;TURN ON READ DRIVE
4029 A9 00             LDA #0             ;SET UP SOURCE BUFFER
402B 85 D7             STA SRCBUF
402D AC 2F 05          LDY BUFFER
4030 84 D8             STY SRCBUF+1
4032 20 DF 84          JSR TRKSK          ;RESTORE WITH DENSITY CHECK
4035 20 A8 81          JSR FOPIN          ;OPEN THE READ FILE
4038 60                RTS
                ;
                ; TO READ DATA , CALL INALL - BYTE RETURNED IN A
                ; CHECK FOR AN EOF CHARACTER IF NEEDED
                ;
                ; TO CLOSE THE READ FILE
4039 4C 21 82   CLOSER JMP CLSIN          ;CLOSE DISK READ FILE
                       END

ERRORS=0000
```

Figure 6-2. Program Control File Handler (Cont'd)

Table 6-1. Commonly Used AIM 65/40 DOS 1.0 Subroutines

Label	Address (Hex)	Function
CLOPEN	823C	Open the write disk file.
CLSIN	8223	Close the read disk file and turn off the drives.
CLSOUT	82BA	Close the write disk file and turn off the drives.
DISK1	884A	Set up and turn on the read drive.
DISK2	885B	Set up and turn on the write drive.
ERRLCL	84D2	Error handler for the AIM 65/40 DOS (includes FESC).
FESC	84DB	Turn off motors, reset name length and jump through FESCIV.
FOPIN	81AA	Open the read disk file.
ION	8447	Re-enable AIM 65/40 interrupts.
READIN	81ED	Read one byte into A (called through INALL).
TRKSK	84E6	Seek to the track in UCYL with verify and density checking.
WRTOUT	828F	Write out one byte from A (called through OUTALL).

Table 6-2. Commonly Used AIM 65/40 DOS 1.0 Variables

Label	Address (Hex)	Function
BUFFER	52F	MSB of pointer to DOS Buffer 1.
CURCMD	4AE	Last command executed by FDC device.
DSTBUF	0D9	Pointer to DOS Write Buffer.
ERSTAT	524	DOS error status.
ERRVEC	530	Pointer to the DOS error processing routine.
FBYTE	50A	Buffer 1 current byte (Read).
	50B	Buffer 2 current byte (Write).
FESCIV	532	Pointer to the DOS escape processing routine.
FDISK	500	Buffer 1 disk number (Read).
	501	Buffer 2 disk number (Write).
FSIDE	502	Buffer 1 side number (Read).
	503	Buffer 2 side number (Write).
FDEN	504	Buffer 1 density (Read).
	505	Buffer 2 density (Write).
FNAMES	50E-517	Buffer 1 file name (Read) - 10 characters.
	518-521	Buffer 2 file name (Write) - 10 characters.
FINOUT	522	Buffer indicator (0=Buffer 1, 1=Buffer 2).
LEN	52C	Number of remaining sectors (Read).
STFLG	4AD	FDC Device Status Register image.
SRCBUF	0D7	Pointer to DOS Read Buffer.
STORIO	55B	Disable (if Z=1) or re-enable all IRQ interrupt sources except for the FDC module.

If an error occurs during writing or reading using this handler, the IRQ interrupts are re-enabled, the disk drive motors are turned off, and control is returned to the AIM 65/40 Monitor command level. The source of the error can be determined by examining the command type (CURCMD), the FDC status register (STFLG), and the DOS error status (ERSTAT).

Note that the address of the error handler is placed in ERRVEC and the address to jump to after the error has been serviced is placed in FESCIV. If errors are to be handled under program control, these vectors must be loaded appropriately. The error handler must isolate and service the error as required. If the disk operation is to be terminated, the IRQ interrupts must be re-enabled (JSR ION) and the disk drive motors turned off (JMP FESC).

6.5.2 DOS Compatibility Considerations

The user is responsible for the meaning and coding of all data in files created under program control, including the definition and inclusion of control bytes. Sometimes the files are handled by knowing exactly how many bytes are written to a file, and therefore how many to expect upon reading it (which can be detected by logically ANDing LEN, LEN+1 and FBYTE then checking for a zero result. Any $00 pad bytes used to fill the last sector can be ignored.

Another approach is to include one or more special characters to indicate the end of a file. The end of file character(s) must not conflict with valid data values using their approach, however.

In order for a data file to be listed using the DOS list utility function (UTILITY=L, see Section 6.3.4), the data must be coded in ASCII and terminated with an ASCII End of File (EOF) character (byte value = $1A).

An example program using the handler shown in Figure 6-2 is listed in Figure 6-3. This example writes a series of ASCII characters to disk then reads the file. Since an $1A EOF terminator is used, the written file can be examined using the UTILITY=L DOS function. Constants are used for the file name, disk number and side number in this example.

6.6 DOS ERROR REPORTING

The DOS reports an error condition and value indicating the cause of the error whenever improper disk operation is detected. These errors may occur due to reasons such as improper disk drive operation, incorrect disk drive/FDC module connection, bad disk media, and operator error (e.g., wrong disk installed, wrong file name specified, wrong disk drive specified, attempted use of unformatted disk, etc.).

The error reporting format is:

```
DISK ERROR=
```

where:

XX = DOS detected errors plus seek error from the FDC device on the FDC module.

YY = The contents of the FDC device Status Register (less SEEK error) on the FDC module (see Section 4.5).

The error definitions are described in Table 6-3.

The error reporting linkage is through two vectors, ERRVEC (vector before error handling) and FESCIV (vector after error handling)--see Section 6.7. These vectors are initialized upon cold reset and may be altered to link to user-provided additional or alternative error handling.

Note that the default error handler return is to the Monitor (to ESCIN at $A32E) after reporting an error code.


```
PAGE 0001   TEST OF DISK FILE HANDLERS FOR AIM 65/40

ADDR OBJECT   SOURCE

                OUTALL=$F32B
                INALL=$F233
                OUTPUT=$F352
                OPENW=$4000
                OPENR=$4021
                CLOSEW=$401E
                CLOSER=$4039
                CHAR    =0
                      *=$3000
                ;
                ; THIS TEST PROGRAM WRITES OUT TWO SECTORS OF NUMBERS TO
                ; THE DISK . THE FILE IS THEN READ AND DISPLAYED , ALL
                ; UNDER PROGRAM CONTROL . THE FILE ( NAME IS FROM FNAME )
                ; IS SUITABLE TO BE LISTED FROM DOS .
                ;
                ; SET UP THE READ AND WRITE DISK PARAMETERS FIRST
                ;
3000 A9 00      TEST    LDA #0
                ; SET UP THE DRIVES
3002 8D 00 05           STA $500            ;READ DRIVE
3005 8D 01 05           STA $501            ;WRITE DRIVE
                ; SET UP THE SIDES
3008 8D 03 05           STA $503            ;READ SIDE
300B 8D 04 05           STA $504            ;WRITE SIDE
                ; DOWNLOAD FILENAME FROM FNAME
300E A2 0A      NAME    LDX #10
3010 BD 64 30   NAME1   LDA FNAME,X
3013 9D 0E 05           STA $50E,X          ;READ FILE NAME
3016 9D 18 05           STA $518,X          ;WRITE FILE NAME
3019 CA                 DEX
301A 10 F4              BPL NAME1
                ;
                ; NEXT WRITE OUT A TEST FILE
                ;
301C 20 00 40   TESTWR  JSR OPENW           ;OPEN FILE
301F A2 07      ISSUE   LDX #7
3021 A0 3C      NEWLIN  LDY #60
3023 A9 30      ZERO    LDA #'0
3025 85 00              STA CHAR
3027 A5 00      LOOP    LDA CHAR
3029 C9 3A              CMP #':
302B F0 F6              BEQ ZERO
302D 20 2B F3   WRITE   JSR OUTALL
3030 E6 00              INC CHAR
3032 88                 DEY
3033 D0 F2              BNE LOOP
3035 A9 0D              LDA #$0D            ;CR
3037 20 2B F3           JSR OUTALL
303A CA                 DEX
303B D0 E4              BNE NEWLIN
303D A9 1A      END     LDA #$1A            ;SHOULD BE EOF
303F 20 2B F3           JSR OUTALL
3042 20 1E 40   DONE    JSR CLOSEW
```

Figure 6-3. Example Program Using File Handler

```
PAGE 0002   TEST OF DISK FILE HANDLERS FOR AIM 65/40

ADDR OBJECT   SOURCE

                ;
                ; NOW READ IN THE TEST FILE
                ;
3045 20 21 40  TESTRD JSR OPENR          ;OPEN FILE
3048 20 33 F2  READ   JSR INALL          ;READ IN A CHARACTER
3048 C9 1A            CMP #$1A           ;EOF MARK
304D F0 0F            BEQ EOFOUT
304F C9 0D            CMP #$0D           ;ALWAYS SEND LF WITH CR
3051 D0 05            BNE OUTWIT
3053 20 52 F3         JSR OUTPUT
3056 A9 0A            LDA #$0A
3058 20 52 F3  OUTWIT JSR OUTPUT
305B 4C 48 30         JMP READ
305E 20 39 40  EOFOUT JSR CLOSER
3061 4C 14 A3         JMP $A314          ;COMIN1 ==>
                ;
                ; THE NAME OF THE FILE IS ...
3064 54 45      FNAME  .BYT 'TESTFILE01'
                .END

 ERRORS=0000
```

Figure 6-3. Example Program Using File Handler (Cont'd)

Table 6-3. AIM 65/40 DOS 1.0 Error Definitions

Code	Error	Definition
01YY	SEEK ERROR	The FDC device did not locate the data on the disk.
02YY	Undefined	
04YY	DISK FULL	The disk is full, thus, no more data may be written on it.
08YY	DIRECTORY FULL	The directory is full, thus, no more file names may be entered.
10YY	FILE NAME NOT FOUND	The specified file name is not in the directory.
20YY	FILE NAME EXISTS	The specified file name already exists for an active file.
80YY	DIRECTORY ERROR	The directory terminator was not found within the directory limits.
XX01	BUSY	The FDC device is busy.
XX02	Undefined	
XX04	LOST DATA	The CPU did not respond to DRQ in one byte time.
XX08	CRC ERROR	If RECORD NOT FOUND error exists, an error was found in one or more ID fields, otherwise a data field error exists.
XX10	RECORD NOT FOUND	The desired track, sector, or side were not found.
XX20	RECORD TYPE/WRITE FAULT	On read record, this bit indicates the record-type code from the data field address mark (1=Deleted Data Mark, 0=Data Mark). On a write, this bit indicates a write fault.
XX40	WRITE PROTECT ERROR	Writing was attempted to a write protected disk.
XX80	NOT READY	The drive is not ready.

6.7 DOS VARIABLES

The DOS variables, located on page zero and five are listed in Table 6-4. Some of these variables are for internal use only (to store temporary values) while others are user-alterable and constant after initialization. The default values for the user-alterable variables, initialized by a cold reset if the AIM 65/40 monitor is installed or the subroutine DOSSETT, are also shown in Table 6-4.

Table 6-4. AIM 65/40 DOS 1.0 Variables

Addr (Hex)	Label	No. Bytes	Init Value	Definition
ØD7	SRCBUF	2	-	DOS Source Buffer Vector
ØD9	DSTBUF	2	-	DOS Destination Buffer Vector
500	FDISK	1	ØØ	Buffer 1 Disk No.
501		1	ØØ	Buffer 2 Disk No.
502	FSIDE	1	ØØ	Buffer 1 Side No.
503		1	ØØ	Buffer 2 Side No.
504	FDEN	1	ØØ	Buffer 1 Density
505		1	ØØ	Buffer 2 Density
506	FTRACK	1	ØØ	Buffer 1 Track No.
507		1	ØØ	Buffer 2 Track No.
508	FSECTR	1	ØØ	Buffer 1 Sector No.
509		1	ØØ	Buffer 2 Sector No.
50A	FBYTE	1	ØØ	Buffer 1 Byte Count
50B		1	ØØ	Buffer 2 Byte Count
50C	SECLEN	1	ØØ	Buffer 1 Bytes/Sector
50D		1	ØØ	Buffer 2 Bytes/Sector
50E	FNAMES	10	ØØ -> ØØ	Buffer 1 File Name
518		10	ØØ -> ØØ	Buffer 2 File Name
522	FINOUT	1	ØØ	Buffer to use
523	CHAR	1	ØØ	Character Temporary Storage
524	ERSTAT	1	ØØ	Error Status
525	FILNM1	2	ØØ ØØ	Temporary Storage
527	FILNM2	2	ØØ ØØ	Temporary Storage
529	FILNM3	2	ØØ ØØ	Temporary Storage
52B	RETCNT	1	ØØ	Retry Count
52C	LEN	2	ØØ ØØ	Length Count for Read File
52E	INITFL	1	ØØ	Density Ask Flag*
52F	BUFFER	1	3E	Source Buffer Addr High Byte*
530	ERRVEC	2	CB 84	Before Error Handler Vector*
532	FESCIV	2	34 A3	After Error Handler Vector*
534	BEEPC	3	4C 67 F4	JMP BEEP*
537	SPACE	3	4C 7A F3	JMP BLANK*
53A	CRLFC	3	4C 5E AE	JMP CRLF*
53D	CRLOWC	3	4C 8F F3	JMP CRLOW*
540	OUTCL	3	4C 4E A5	JMP EBCRCL*

Table 6-4. AIM 65/40 DOS 1.0 Variables (Cont'd)

Addr (Hex)	Label	No. Bytes	Init Value	Definition
543	FNAMEC	3	4C 2A FA	JMP FNAME*
546	NOUTC	3	4C AC F3	JMP NOUT*
549	NUMAC	3	4C A4 F3	JMP NUMA*
54C	OUTALC	3	4C 2B F3	JMP OUTALL*
54F	OUTPUC	3	4C 52 F3	JMP OUTPUT*
552	RCHEK	3	4C 7D B0	JMP VARCHEK*
555	REDOC	3	4C 9B F2	JMP REDOUT*
558	WHERE	3	4C B9 AE	JMP WHEREO*
55B	STORIO	3	8D 80 FF	STA PRIRTY*
55E		1	60	RTS*
55F	MENUVC	2	62 80	Before UTILITY Decode Vector*
561	MENULS	2	85 80	After UTILITY Decode Vector*
563	NOVRFY	1	01	Format Disk No Verify Flag*

NOTES

*User-alterable

1. The DOS 1.0 variables are initialized by a cold reset (refer to the AIM 65/40 System User's Manual) only if the AIM 65/40 Monitor is installed.

APPENDIX A

DISK DRIVE CONFIGURATION

This appendix describes the actual configuration of some of the more popular disk drives. The drives included are:

Shugart SA400
Shugart SA450
Pertec FD200
Shugart SA800

A.1 5" DISK DRIVE CONFIGURATION

To operate the RM 65 FDC module in single- or double-density mode with these 5" drives, perform the following steps:

a. Set up switch S1 for common bank operation with both the Program ROM and I/O enabled.

S1-1 = OPEN
S1-2 = OPEN
S1-3 = CLOSED
S1-4 = CLOSED

b. Set up the jumpers for no DMA, no precompensation (which is not required for 5" double density) and the number of heads.

E1 = EITHER
E2 = EITHER
E3 = B for only single sided drives (SA400 or FD200)
A for double sided drives (SA450)

c. Set up the standard/mini-floppy headers (JB1, JB2) for mini-floppy drives (shown in Figure 2-2a).

Table 6-4. AIM 65/40 DOS 1.0 Variables (Cont'd)

Addr (Hex)	Label	No. Bytes	Init Value	Definition
543	FNAMEC	3	4C 2A FA	JMP FNAME*
546	NOUTC	3	4C AC F3	JMP NOUT*
549	NUMAC	3	4C A4 F3	JMP NUMA*
54C	OUTALC	3	4C 2B F3	JMP OUTALL*
54F	OUTPUC	3	4C 52 F3	JMP OUTPUT*
552	RCHEK	3	4C 7D B0	JMP VARCHEK*
555	REDOC	3	4C 9B F2	JMP REDOUT*
558	WHERE	3	4C B9 AE	JMP WHEREO*
55B	STORIO	3	8D 80 FF	STA PRIRTY*
55E		1	60	RTS*
55F	MENUVC	2	62 80	Before UTILITY Decode Vector*
561	MENULS	2	85 80	After UTILITY Decode Vector*
563	NOVRFY	1	01	Format Disk No Verify Flag*

NOTES

*User-alterable

1. The DOS 1.0 variables are initialized by a cold reset (refer to the AIM 65/40 System User's Manual) only if the AIM 65/40 Monitor is installed.

APPENDIX A

DISK DRIVE CONFIGURATION

This appendix describes the actual configuration of some of the more popular disk drives. The drives included are:

Shugart SA400
Shugart SA450
Pertec FD200
Shugart SA800

A.1 5" DISK DRIVE CONFIGURATION

To operate the RM 65 FDC module in single- or double-density mode with these 5" drives, perform the following steps:

a. Set up switch S1 for common bank operation with both the Program ROM and I/O enabled.

S1-1 = OPEN
S1-2 = OPEN
S1-3 = CLOSED
S1-4 = CLOSED

b. Set up the jumpers for no DMA, no precompensation (which is not required for 5" double density) and the number of heads.

E1 = EITHER
E2 = EITHER
E3 = B for only single sided drives (SA400 or FD200)
A for double sided drives (SA450)

c. Set up the standard/mini-floppy headers (JB1, JB2) for mini-floppy drives (shown in Figure 2-2a).

d. Ensure that the FDC module has both +5 VDC and +12 VDC. The +5 VDC can be verified by reading the Program ROM ($8000) and comparing this with the Program Listing. The +12 VDC can be verified by reading the FDC device registers ($8F00 - $8F03). If these four locations are $FF, +12 VDC is not reaching the module.

The 5" disk drives must also be prepared as described in the following sections.

A.1.1 Shugart SA400

The Shugart SA400 is a single-sided 5" drive. As factory configured, the SA400 is ready to operate as the only drive. If additional drives are used, make the following changes to each:

> **CAUTION**
>
> Refer to the SA400 user instructions accompanying your drives to confirm this setup.

a. Install the termination resistor pack only in the last drive on the Floppy Disk cable.

b. Open the MX shunt.

c. Short the HL shunt and open the MH shunt.

d. Short only one--1, 2 or 3 (Drive select 4 is not available) and open the remaining two positions to assign a unique number to each drive.

Ensure that both +5 VDC and +12 VDC are present at power connector J2.

A.1.2 Shugart SA450

The Shugart SA450 is a double-sided 5" drive. As factory configured, this drive is ready to operate as the only drive. If additional drives are used, make the following changes to each:

> **CAUTION**
>
> Refer to the SA450 user instructions accompanying your drives to confirm this setup.

a. Install the termination resistor pack only in the last drive on the Floppy Disk cable.

b. Open the MX shunt.

c. Open the MM and the MS shunts.

d. Short only one--1, 2, 3 or 4 and open the remaining three positions to assign a unique number to each drive.

Ensure that both +5 VDC and +12 VDC are present at power connector J2.

A.1.3 Pertec FD200

The Pertec FD200 is a single-sided 5" drive (although this drive allows the front and back side of the disk to be used, this is a non-standard format that is only compatible with Pertec drives).

If additional drives are used, the following changes must be made to each:

> **CAUTION**
>
> Refer to the FD200 user instructions accompanying your drives to confirm this setup.

a. Install the termination resistor pack only in the last drive.

b. Cut the PC etch between the pads at DC.

c. Short only one--1, 2, 3 or 4 and open the remaining three switch positions to assign a unique number to each drive.

d. Leave the head-load option in the standard configuration with W2 installed and W1 removed.

Ensure that both +5 VDC and +12 VDC are present on the power connector J3.

A.2 8" DISK DRIVE CONFIGURATION

To operate the RM65 FDC module in single- or double-density mode with 8" drives, perform the following steps:

a. Set up switch S1 for common bank operation with both the Program ROM and I/O enabled.

S1-1 = OPEN
S1-2 = OPEN
S1-3 = CLOSED
S1-4 = CLOSED

b. Set up the jumpers for no DMA, no precompensation and the number of heads.

E1 = EITHER
E2 = EITHER
E3 = B for only single sided drives (SA800)
A for double sided drives (SA850)

c. Set up the standard/mini-floppy headers (JB1, JB2) for standard floppy drives (shown in Figure 2-2b).

d. Ensure that the FDC module has both +5 VDC and +12 VDC (refer to Section A.1.d).

A.2.1 Shugart SA800/801

The Shugart SA800 is a single-sided 8" drive. Configure each SA800 drive as follows to use with the FDC module:

> **CAUTION**
>
> Refer to the SA800 user instructions accompanying your drives to confirm this setup.

a. Short only one of the DS1, DS2, DS3 or DS4 jumpers and leave the other three open to assign a unique number to each drive.

b. If only one drive is used, install jumpers at T3, T4, T5 and T6. If additional drives are used, remove jumpers at T3, T4, T5 and T6 from all drives except for the last one on the Floppy Drive cable.

c. Remove jumper at 801.

d. Install jumpers at A, B, HL, I, L, R, RI, RR, S, T1, WP, X, Z, 32 and 800.

e. Leave all remaining positions open.

Ensure that +5, +24 and -5 VDC are all present at connector J5, and 11Ø VAC is applied to connector J4.

A.3 DMA Configuration

The RM 65 FDC module will operate in all modes--5" or 8", single- or double-density--with the RM 65 DMA Controller module (RM65-5104). To operate in the 8" double-density mode this module is required, but all modes will show performance improvement when the DMA module is used. For an operating description and complete configuration details, refer to the RM 65 DMA Controller User's manual. To configure the DMA module for operation, perform the following steps:

a. Set up switches S1-1 to S1-8 for the desired base address of the DMA module. This module address can be any page of the RM 65 memory map not being used, where the switches reflect the selected page. Thus, for a typical base address of $7FØØ;

    S1-1 to S1-7 = CLOSED
    A1-8 = OPEN

b. Set up switches S1-9 and S1-1Ø for common bank operation for use with AIM 65 and AIM 65/4Ø single bank systems;

    S1-9 = OPEN
    S1-1Ø = OPEN

c. Set up the DMA interrupt request to be sent over the BIRQ/ interrupt line;

    E1 = A

The DMAC module requires RAM that is directly addressable from the RM 65 bus--such as an RM 65 8K Static RAM module--to supplement the AIM 65 or AIM 65/4Ø on-board RAM. To configure the 8K RAM module for operation, perform the following steps:

a. Set up switches S1-1 to S1-8 for the desired base address of the RAM module. This module address can be any two 4K byte blocks of the RM 65 memory map, with each of the four switches assigning a block. Thus, for typical base addresses of $1ØØØ and $2ØØØ;

    S1-1 = CLOSED
    S1-2 to S1-5 = OPEN
    S1-6 = CLOSED
    S1-7 to S1-8 = OPEN

b. Set up switches S2-1 and S2-2 for common bank operation;

    S2-1 = OPEN
    S2-2 = OPEN

c. Set up the RAM for no write protection;

    S2-3 = OPEN
    S2-4 = OPEN

The FDC module does not have any special configuration. The DMA request selection jumper can be set for either BDRQ1/ or BDRQ2/.

In addition to configuring the module, the DMA variables in the FDC firmware must also be set:

a. The DMA module address must be written into the variable DMAADR. Thus, for a typical base address of $7FØØ;

    DMAADR ($4B9) = $7F

b. The variable DMAFLG must set up with a DMA module enable (bit Ø), DMA transfer source bank address (bit 7), and DMA transfer destination bank address (bit 6). Thus, for single bank operation in Bank Ø;

    DMAFLG ($4BA) = $Ø1

When the DMA module enable bit of DMAFLG is set, many of the firmware routines make use of the module for data transfers. This use is automatic--each routine will set up the DMA module and initiate the transfers as required. No software changes are required to take advantage of the DMA module.

> NOTE
>
> When using the RM 65 DMA Controller module with the FDC module, the disk read and write buffers (RDBUF, WRBUF) must be on the supplemental RM 65 RAM module. For file management, the source and destination buffers (set up from BUFFER) must be on the supplemental RM 65 RAM module.

APPENDIX B

FORTH AND THE RM 65 FDC MODULE

This appendix describes the actual code used to interface the RM 65 FDC module with AIM 65 and AIM 65/40 FORTH. This example uses a single 5" drive with one side and double density recording. The example is entered into the text editor and compiled using the SOURCE word. For a detailed description of the code words, refer to the AIM 65/40 FORTH User's Manual, Section 12. There are seven major words created which supplement the use of the FDC module:

INIT

Initializes the FDC module and turns on drive one, side one in single density mode.

MOTORON

Turns on the drive from SRCDSK, side from SRCSID, and density from SRCDEN.

MOTOROFF

Turns off the selected drive.

FORMAT

Initializes the disk in the selected drive. A formatted disk will have all sectors filled with $E5, which on the AIM 65 is displayed as a blank, and printed as"%". On the AIM 65/40, this is displayed as a blinking "E.", and printed as "e".

WIPE n ---

Clears screen n by filling it with null characters ($00).

LIST n ---

Lists screen n as 16 numbered lines (0 to F) with 64 characters each.

When the DMA module enable bit of DMAFLG is set, many of the firmware routines make use of the module for data transfers. This use is automatic--each routine will set up the DMA module and initiate the transfers as required. No software changes are required to take advantage of the DMA module.

> NOTE
>
> When using the RM 65 DMA Controller module with the FDC module, the disk read and write buffers (RDBUF, WRBUF) must be on the supplemental RM 65 RAM module. For file management, the source and destination buffers (set up from BUFFER) must be on the supplemental RM 65 RAM module.

APPENDIX B

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Turns on the drive from SRCDSK, side from SRCSID, and density from SRCDEN.

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Initializes the disk in the selected drive. A formatted disk will have all sectors filled with $E5, which on the AIM 65 is displayed as a blank, and printed as"%". On the AIM 65/40, this is displayed as a blinking "E.", and printed as "e".

WIPE n ---

Clears screen n by filling it with null characters ($00).

LIST n ---

Lists screen n as 16 numbered lines (0 to F) with 64 characters each.

P n ---

Places the text following EDIT (up to 64 characters) into line n on the current screen (i.e., the last screen accessed with LIST or WIPE).

Other words that are present in FORTH and are also useful in the creation and execution of source code include:

LOAD n ---

Compiles source code into the dictionary starting at screen n , line 0 and continuing until a ;S is encountered. The ;S should be within 4 lines of the last line of source code. More than one sequential screen is loaded by using --> to point to the next screen.

EMPTY-BUFFERS

Marks all RAM block buffers as empty.

FLUSH

Writes out any updated RAM block buffers to the disk.

Figure B-1 lists the FDC interface program for AIM 65 FORTH.

Figure B-2 lists the AFDC interface program for AIM 65/40 FORTH.


```
( AIM 65 - FORTH DOUBLE DENSITY DISK EXAMPLE )
(  USE WITH FDC FIRMWARE DOS V1.0 - 5/26/82  )
HEX FORGET TASK 500 ALLOT ( MOVE ABOVE FDC AND DOS RAM )
1 CONSTANT S# ( ONLY 1 SCREEN NEEDED )
100 UB/BUF ! ( 256 FOR DOUBLE DENSITY )
4 UB/SCR !  ( 4  FOR DOUBLE  DENSITY )
LIMIT B/BUF 4 + B/SCR * S# * - UFIRST ! ( TOP OF RAM )
0 OFFSET ! ( OFFSET NOT NEEDED WITH 1 DRIVE)
FIRST DUP USE ! PREV !  ( SET UP FIRST BUFFER )
EMPTY-BUFFERS ( CLEAR OUT THE BUFFER AREA )
CODE INIT1 XSAVE STX, 886C JSR, ( CALL INIT )
 ( SET DRIVE PARAMETERS IN UDRV,USIDE, & UDEN )
 0 # LDA, 484 STA, ( DRIVE ONE INTO UDRV )
 0 # LDY, 482 STY, ( SIDE ONE INTO USIDE )
 0 # LDX,  480 STX, ( DOUBLE DENSITY INTO UDEN  )
 8C53 JSR,  ( MOTON ) XSAVE LDX, NEXT JMP, END-CODE
: INIT 8BED A400 ! ( SET UP IRQHAN ) INIT1 ;
: SIZEOK OVER 230 < , ( 16 SECTOR * 35 TRACK )
: BBUF DUP 4F1 ( RDBUF ) ! 4F3 ( WRTBUF ) ! ;
: T&S SWAP 10 /MOD ; ( LEAVE TRACK & SECTOR )
: DERROR CR ." DISK ERROR - " ; ( PRINT ERROR MESSAGE )
CODE SEEK XSAVE STX, TOP LDA, 8938 JSR, ( CALL SEEK )
 XSAVE LDX, 99 # AND, PUSH0A JMP, END-CODE
CODE DREAD XSAVE STX, TOP LDA, 8D29 JSR, ( CALL RDSEC )
 XSAVE LDX, 80 # AND, PUSH0A JMP, END-CODE
CODE DWRITE XSAVE STX, TOP LDA, 8D61 JSR, ( CALL WRTSEC )
 XSAVE LDX, FD # AND, PUSH0A JMP, END-CODE
: DATA ( FETCH A BYTE ) ROT BBUF T&S SEEK DUP
  IF DERROR ." SEEK A="    ( SEEK ERROR )  ELSE DROP
    THEN DROP 1+ ( SECTOR 1 TO 16 ) SWAP
  IF DREAD DUP   IF DERROR  " READ A=" .  ( READ ERROR )
      ELSE DROP   THEN ( DO NOTHING )
    ELSE DWRITE DUP   IF DERROR ." WRITE A=" .  ( ERROR )
      ELSE DROP   THEN ( DO NOTHING )   THEN DROP ;
: DISK SIZEOK   IF DATA
   ELSE CR  " BLOCK TOO LARGE ERROR " ABORT     THEN ;
' DISK CFA UR/W ! ( STORE INTERFACE WORD )
( UTILITIES THAT MUST BE AVAILABLE TO USER )
CODE FORMAT XSAVE STX, 890D JSR, ( CALL FORMAT )
 XSAVE LDX, NEXT JMP, END-CODE
CODE MOTOROFF XSAVE STX, 8CF7 JSR, ( CALL MOTOFF )
 XSAVE LDX, NEXT JMP, END-CODE
CODE MOTORON XSAVE STX, 8CF7 JSR, ( CALL MOTOFF )
 484 LDA, ( UDRV ) 482 LDY, ( USIDE )
 480 LDX, ( UDEN ) 8C53 JSR, ( CALL MOTON )
 XSAVE LDX, NEXT JMP, END-CODE
: P SCR @  (LINE)  OVER SWAP BLANKS ( CLEAR OUT LINE )
 0 WORD ( PARSE TEXT ) HERE COUNT 40 MIN ( 64 CHAR LINES )
 ROT SWAP CMOVE ( MOVE TEXT ) UPDATE ( MARK BUFFER ) ;
: LIST  DUP CR ." SCR # " .  ( PRINT SCREEN AND SAVE ) SCR !
 10 0 DO CR I 3 .R SPACE I SCR @  .LINE  LOOP  CR ;
: WIPE  B/SCR * B/SCR BOUNDS ( SCREEN # TO BLOCK RANGE )
 DO  I BLOCK  B/BUF BLANKS UPDATE  LOOP  FLUSH ;
: TASK ; ( THROUGH WITH CODE ) FINIS
```

Figure B-1. AIM 65 FORTH Floppy Disk Example

```
( AIM 65/40 -- FORTH  DOUBLE DENSITY DISK ROUTINES )
(  USE WITH RM 65 FDC FIRMWARE DOS V1.0 - 5/18/82  )
HEX FORGET TASK ( FDC AND DOS RAM $4A0-$563 )
4 CONSTANT S# ( ONLY 1 SCREEN NEEDED )
100 UB/BUF ! ( 256 FOR DOUBLE DENSITY )
4 UB/SCR !  ( 4  FOR DOUBLE  DENSITY )
LIMIT 200 - DUP ULIMIT ! B/BUF 4 + B/SCR * S# * - UFIRST ! ( 16K OF RAM )
0 OFFSET ! ( OFFSET NOT NEEDED WITH 1 DRIVE)
FIRST DUP USE ! PREV !  ( SET UP FIRST BUFFER )
EMPTY-BUFFERS ( CLEAR OUT THE BUFFER AREA )
CODE INIT1 XSAVE STX, 886C JSR, ( CALL INIT )
 ( SET DRIVE PARAMETERS IN UDRV, USIDE, & UDEN )
 0 # LDA, 4B4 STA, ( DRIVE ONE INTO UDRV )
 0 # LDY, 4B2 STY, ( SIDE ONE INTO USIDE )
 0 # LDX,  4BC STX, ( DOUBLE DENSITY INTO UDEN )
 8C53 JSR,  ( MOTON ) XSAVE LDX, NEXT JMP, END-CODE
: INIT FD46 4A0 ! ( UIRQBM ) IRQOUT ) 8BED 22B
 !  ( SET UP IROHAN) INIT1 ;
: SIZEOK OVER 230 < ; ( 16 SECTOR * 35 TRACK )
: BBUF DUP 4C9 ( RDBUF ) ! 4CB ( WRTBUF ) ! ;
: T&S SWAP 10 /MOD ; ( LEAVE TRACK & SECTOR )
CODE SEEK XSAVE STX, TOP LDA, 8938 JSR, ( CALL SEEK )
 XSAVE LDX, 99 # AND, PUSH0A JMP, END-CODE
CODE DREAD XSAVE STX, TOP LDA, 8D29 JSR, ( CALL RDSEC )
 XSAVE LDX, 80 # AND, PUSH0A JMP, END-CODE
CODE DWRITE XSAVE STX, TOP LDA, 8D61 JSR, ( CALL WRTSEC )
 XSAVE LDX, FD # AND, PUSH0A JMP, END-CODE
: INTDIS FF FF80 C! ( MASK OUT ALL IRQ BUT FDC ) ;
: INTENB 00 FF80 C! ( RESTORE THE IRQ MASK ) ;
: DERROR INTENB CR ." DISK ERROR - " ; ( RECOVER & PRINT)
: DATA ( FETCH A BYTE ) ROT BBUF T&S SEEK DUP
  IF DERROR ." SEEK A=" .  ( SEEK ERROR ) INTDIS ELSE DROP
    THEN DROP 1+ ( SECTOR 1 TO 16 ) SWAP
  IF DREAD DUP   IF DERROR ." READ A=" .  ( READ ERROR )
     ELSE DROP   THEN ( DO NOTHING )
   ELSE DWRITE DUP   IF DERROR ." WRITE A=" .  ( ERROR )
     ELSE DROP   THEN ( DO NOTHING )   THEN  DROP ;
: DISK SIZEOK   IF INTDIS DATA INTENB
  ELSE CR ." BLOCK TOO LARGE ERROR " ABORT      THEN ;
' DISK CFA UR/W ! ( STORE INTERFACE WORD )
( UTILITIES THAT MUST BE AVAILABLE TO USER )
CODE FORMAT XSAVE STX, 890D JSR, ( CALL FORMAT )
 XSAVE LDX, PUSH0A JMP, END-CODE
: FORMAT INTDIS FORMAT INTENB ;
CODE MOTOROFF XSAVE STX, 8CF7 JSR, ( CALL MOTOFF )
 XSAVE LDX, NEXT JMP, END-CODE
CODE MOTORON XSAVE STX, 8CF7 JSR, ( CALL MOTOFF )
 4B4 LDA, ( UDRV ) 4B2 LDY, ( USIDE )
 4BC LDX, ( UDEN ) 8C53 JSR, ( CALL MOTON )
 XSAVE LDX, NEXT JMP, END-CODE
: P SCR @  (LINE)  OVER SWAP BLANKS ( CLEAR OUT LINE )
 0 WORD ( PARSE TEXT ) HERE COUNT 40 MIN ( 64 CHAR LINES )
 ROT SWAP CMOVE ( MOVE TEXT ) UPDATE ( MARK BUFFER ) ;
: LIST  DUP CR ." SCR # " .  ( PRINT SCREEN AND SAVE ) SCR !
 10 0 DO CR I 3 .R SPACE I SCR @  .LINE  LOOP  CR ;
: WIPE  B/SCR * B/SCR BOUNDS ( SCREEN # TO BLOCK RANGE )
 DO  I BLOCK  B/BUF BLANKS UPDATE  LOOP  FLUSH ;
: TASK ; ( THROUGH WITH CODE )  FINIS
```

Figure B-2. AIM 65/40 FORTH Floppy Disk Example

APPENDIX C

FDC FIRMWARE PROGRAM LISTING

```
                ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                ;                                   ;
                ;         RM 65 FDC FIRMWARE        ;
                ;                                   ;
                ;           REVISION 2.0            ;
                ;           MAY 18, 1982            ;
                ;                                   ;
                ;                                   ;
                ;                                   ;
                ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

                ;ROCKWELL INTERNATIONAL
                ;ELECTRONIC DEVICES DIVISION
                ;P.O. BOX 3669
                ;3310 MIRALOMA AVENUE
                ;ANAHEIM CAL. U.S.A. 92803
```



```
                ;MODULE REGISTER EQUATES

8F00            FCOMR   =       $8F00       ;COMMAND REG
8F00            FSTAR   =       FCOMR       ;STATUS REG
8F01            FCYLR   =       FCOMR+1     ;CYLINDER NBR
8F02            FSECR   =       FCOMR+2     ;SECTOR NBR
8F03            FDAR    =       FCOMR+3     ;DATA REG
8F04            DSTAR   =       FCOMR+4     ;DRIVE STATUS REG
8F04            DCONR   =       FCOMR+4     ;DRIVE CONTROL REG
8F15            FSTOP   =       FCOMR+$15   ;STOP CPU

                ;COMMAND CODES

                ;TYPE 1:
0000            RECOD   =       $00         ;RESTORE
0010            SKCOD   =       $10         ;SEEK A CYL
                ;TYPE 2:
0080            RSCOD   =       $80         ;READ A SECTOR
00A0            WSCOD   =       $A0         ;WRITE A SECTOR
                ;TYPE 3:
00C4            RACOD   =       $C4         ;READ AN ID FIELD
00E4            RTCOD   =       $E4         ;READ A TRACK
00F4            WTCOD   =       $F4         ;WRITE A TRACK
                ;TYPE 4:
00D0            FICOD   =       $D0         ;FORCE AN INTERRUPT

                ;COMMAND FLAGS

0004            V       =       $04         ;VERIFY AFTER COMMAND
0010            M       =       $10         ;MULTPL SECTORS(TO END OF TRK)
0008            S       =       $08         ;2ND SIDE SELECT
0002            C       =       $02         ;SIDE COMPARE ENABLE
0004            E       =       $04         ;15 MS DELAY FOR HEAD SETTLING

                ;DMA REG ADDRESSES

9000            DMASRC  =       $9000       ;SOURCE CONTROL
9001            DMASR1  =       $9001       ;MS SOURCE ADDR
9002            DMASR2  =       $9002       ;LS SOURCE ADDR
9004            DMADST  =       $9004       ;DEST CONTROL
9005            DMADS1  =       $9005       ;MS DEST ADDRESS
9006            DMADS2  =       $9006       ;LS DEST ADDRESS
9008            DMACNT  =       $9008       ;BYTE CNT CONTROL
9009            DMACT1  =       $9009       ;MS BYTE COUNT
900A            DMACT2  =       $900A       ;LS BYTE COUNT
900C            DMACMD  =       $900C       ;CMD/STATUS
```

```
0067 0000                       *=$DB

0069                    ;PAGE ZERO INDIRECTS

0071 00DB               PTR     *=*+2
0072 00DD               DMAPTR  *=*+2

0074 00DF                       *=$4A0

0076 04A0               IRGOUT  *=*+2           ;IRQ EXIT ADDRESS
0077 04A2               FLAG    *=*+1           ;FLAG=ERR DETECT FLAG1= RD/WRT
0078 04A3               CNTR    *=*+1           ;COUNTER
0079 04A4               TEMP    *=*+2           ;TEMP STORAGE
0080 04A6               TEMP2   *=*+1           ;TEMP STOR
0081 04A7               MSC     *=*+1
0082 04A8               LSC     *=*+1
0083 04A9               NCYL    *=*+1
0084 04AA               NSEC    *=*+1
0085 04AB               CURSEC  *=*+1           ;CURR SECT NBR
0086 04AC               LSECR   *=*+1           ;LAST SECT TO READ OR WRITTEN
0087 04AD               STFLG   *=*+1           ;STATUS FLG
0088 04AE               CURCMD  *=*+1           ;CURRENT CMD BEING EXECUTED
0089 04AF               WRTFLG  *=*+1           ;WRITE CMD FLAG
0090 04B0               SELFLG  *=*+1
0091 04B1               MDFLG   *=*+1
0092 04B2               USIDE   *=*+1           ;SIDE
0093 04B3               UCYL    *=*+1           ;CYLINDER
0094 04B4               UDRV    *=*+1           ;DRIVE
0095 04B5               CURCYL  *=*+4           ;CURR CYL FOR EACH DRV (0-3)
0096 04B9               DMAADR  *=*+1           ;DMA MSB I/O ADDR
0097 04BA               DMAFLG  *=*+1           ;DMA FLAG
0098 04BB               FORFLG  *=*+1           ;WRITE TRACK FLAG
0099 04BC                       *=*+2

0101                    ;THE FOLLOWING MUST BE IN ORDER--SEE INIT
0102 04BE               DBLCNT  *=*+1           ;DOUBLE DENSITY CTR (255)
0103 04BF               SNGLCT  *=*+1           ;SINGLE DENSITY CTR (127)
0104 04C0               NBYTE   *=*+1           ;128
0105 04C1               NHEAD   *=*+1           ;1
0106 04C2               CYL5    *=*+1           ;35
0107 04C3               CYL8    *=*+1           ;77
0108 04C4               SECTK5  *=*+1           ;16
0109 04C5               SECTK8  *=*+1           ;26
0110 04C6               HDEL    *=*+1           ;DELAY FOR HEAD LOAD(30)
0111 04C7               SFLAG   *=*+1           ;SIDE CMP & DATA MARK (C+E)
0112 04C8               TUNDEL  *=*+1           ;DELAY FOR NON-SHUGART TUNNEL
0113 04C9               RDBUF   *=*+2           ;USER BUFR FOR READ (1000)
0114 04CB               WRBUF   *=*+2           ;USER BUFR FOR WRT (2000)
0115 04CD               RATE    *=*+1           ;STEPPING RATE (03)
0116 04CE               RETRY   *=*+1           ;NBR OF RETRIES
0117 04CF               PADB    *=*+1
0118 04CF               TABLE5=*-1;SECTOR       INTERLEAVING TABLE
0119 04D0                       *=*+16
0120 04DF               TABLE8=*-1;FOR          5 AND 8 INCH RESPECTIVELY
0121 04E0                       *=*+26
```



```
0122                    ;END OF ORDER
```

INITIALIZE VARIABLES AT STARTUP

```
0124 04FA

                        *=$886C

0126 886C  AD 00 8F  INIT   LDA   FSTAR      ;INIT STATUS REG UPON PWR UP
0127 886F  AD 04 8F         LDA   DSTAR
0128 8872  A9 00            LDA   #00
0129 8874  A2 1B            LDX   #DBLCNT-FLAG-1
0130 8876  9D A2 04  INIT1  STA   FLAG,X     ;CLEAR RAM BUT NOT IRQOUT
0131 8879  CA               DEX
0132 887A  10 FA            BPL   INIT1
0133 887C  A2 3B            LDX   #SETUP-INTTBL-1
0134 887E  BD 88 88  INIT3  LDA   INTTBL,X   ;TABLE OF DEFAULT VALUES
0135 8881  9D BE 04         STA   DBLCNT,X   ;AREA WHERE VARIABLES ARE LOC
0136 8884  CA               DEX               ;NEXT VALUE
0137 8885  10 F7            BPL   INIT3
0138 8887  60               RTS
0139 8888                INTTBL
0140 8888  FF               .BYT  255,127,128,1,35,77,16,26,30
0141 8891  06               .BYT  C+E
0142 8892  64               .BYT  100
0143 8893  00 3E            .WOR  $3E00,$3F00
0144 8897  07               .BYT  7,5,$E5
0145 889A  06            T5 .BYT  6,7,8,9,10,11,12,13,14,15,16,0,2,3,4,5
0146 88AA  06            T8 .BYT  6,7,8,9,10,11,12,13,14,15,16,17,18
0147 88B7  13               .BYT  19,20,21,22,23,24,25,26,0,2,3,4,5
```


CK IF MOTOR ON & DRV SELECTED

```
0150 88C4  78        SETUP  SEI            ;DISABLE INTERRUPTS
0151 88C5  D8               CLD            ;MAKE SURE DECIMAL MODE CLEAR
0152 88C6  A9 00            LDA   #00      ;RESET DRIVE STATUS FLAG
0153 88C8  8D BB 04         STA   FORFLG   ;ZERO FOR NON-FORMAT COMMAND
0154 88CB  8D AD 04         STA   STFLG
0155 88CE  AD B1 04         LDA   MOFLG    ;IS MOTOR ON?
0156 88D1  F0 2B            BEQ   ERCOND   ;MOTOR NOT ON
0157 88D3  AD B0 04         LDA   SELFLG   ;HAS DRIVE BEEN SELECTED?
0158 88D6  F0 26            BEQ   ERCOND   ;NO, DRIVE MUST BE SELECTED
0159 88D8  20 16 8C         JSR   FORM5    ;MAKE SURE IT'S OFF
0160 88DB  20 04 89         JSR   SETIRQ   ;ENABLE FDC IRQ & CPU STOP
0161 88DE  A9 80            LDA   #128     ;BYTES/SECT FOR FM
0162 88E0  AE C2 04         LDX   CYL5     ;NBR CYL/DRV
0163 88E3  AC C4 04         LDY   SECTK5   ;SECTORS/TRACK FOR 5"
0164 88E6  2C 04 8F         BIT   DSTAR    ;CK DENSITY(BIT 7) & DRV (B6)
0165 88E9  10 01            BPL   STUP1    ;FM
0166 88EB  0A               ASL   A        ;MAKE 256
0167 88EC  8D C0 04  STUP1  STA   NBYTE
0168 88EF  70 06            BVS   INIT0    ;5" DRIVE
0169 88F1  AE C3 04         LDX   CYL8
0170 88F4  AC C5 04         LDY   SECTK8
0171 88F7  8C AA 04  INIT0  STY   NSEC
0172 88FA  8E A9 04         STX   NCYL
0173 88FD  60               RTS

0175 88FE  A9 80     ERCOND LDA   #$80      ;MOTOR-NOT-ON ERROR
0176 8900  8D AD 04         STA   STFLG
0177 8903  60               RTS

0179 8904  AD B1 04  SETIRQ LDA   MOFLG
0180 8907  09 40            ORA   #$40     ;ENABLE FDC IRQ LATCH
0181 8909  8D 04 8F         STA   DCONR    ;ENABLE CPU STOP
0182 890C  60               RTS
```

FORMAT A PARTICULAR SIDE OF A DISK

```
0184 890D  20 CA 8D   FORMAT JSR   SETIT     ;CK MOTOR ON & SETUP PARAMETER
0185 8910  A9 00              LDA   #00
0186 8912  8D B3 04           STA   UCYL
0187 8915  20 82 89   FORMO  JSR   SEEKNV    ;SEEK TO DESIRED CYL
0188 8918  29 99              AND   #$99
0189 891A  D0 1B              BNE   FORERR    ;MUST BE ZERO OR ELSE ERROR
0190 891C  20 94 89           JSR   WRTRK     ;WRITE A TRACK
0191 891F  29 FD              AND   #$FD
0192 8921  D0 14              BNE   FORERR
0193 8923  20 3B 89           JSR   FMTSK     ;SEEK CURRENT CYL
0194 8926  29 99              AND   #$99
0195 8928  D0 0D              BNE   FORERR
0196 892A  EE B3 04           INC   UCYL
0197 892D  AD B3 04           LDA   UCYL      ;CURRENT CYL
0198 8930  CD A9 04           CMP   NCYL      ;HAVE ALL CYL'S BEEN DONE?
0199 8933  D0 E0              BNE   FORMO     ;CONT TO FORMAT
0200 8935  A9 00              LDA   #00
0201 8937  60         FORERR RTS
```


SEEK TO A TRACK

```
0203                          ;ENTER WITH TRACK NBR IN ACC 'A'

0205 893B  8D B3 04   SEEK   STA   UCYL      ;SAVE THE CYL NBR
0206 893B  20 CA 8D   FMTSK  JSR   SETIT     ;MOTOR ON & SETUP PARAMETERS
0207 893E  AE B4 04          LDX   UDRV
0208 8941  BD B5 04          LDA   CURCYL,X  ;CURR CYL FOR DRV
0209 8944  8D 01 8F          STA   FCYLR
0210 8947  AD B3 04          LDA   UCYL      ;DESIRED CYL
0211 894A  9D B5 04          STA   CURCYL,X  ;SV CURR CYL FOR DRV
0212 894D  8D 03 8F          STA   FDAR      ;PUT CYL INTO DATA REG
0213 8950  F0 04             BEQ   RSTOR     ;SEEK TO CYL 0
0214 8952  A9 10             LDA   #SKCOD    ;SEEK TO A CYL
0215 8954  D0 05             BNE   REST      ;EXECUTE
0216                         ;     ***
0217 8956  A0 01      RSTOR  LDY   #01       ;RESET SECTOR TO ONE
0218 8958  8C 02 8F          STY   FSECR     ;A ALREADY CONTAINS RESET CODE
0219 895B  0D CD 04   REST   ORA   RATE      ;STEPPING RATE
0220 895E  8D AE 04          STA   CURCMD    ;SAVE CURR CMD
0221 8961  AD AF 04          LDA   WRTFLG    ;WAS LAST CMD A WRITE?
0222 8964  10 0B             BPL   RESTEE    ;NO
0223 8966  4E AF 04          LSR   WRTFLG    ;CLEAR WRT FLAG
0224 8969  AD C8 04          LDA   TUNDEL    ;IS DRIVE A SHUGART?
0225 896C  F0 03             BEQ   RESTEE    ;YES
0226 896E  20 D9 8E          JSR   MICROD    ;DELAY FOR TUNNEL ERASE
0227 8971  AD AE 04   RESTEE LDA   CURCMD
0228 8974  20 D6 88          JSR   EXEC04

0230 8977  A9 01      RESTED LDA   #1
0231 8979  2C 00 8F          BIT   FSTAR
0232 897C  D0 F9             BNE   RESTED
0233 897E  AD AD 04   LSTFLG LDA   STFLG      ;GET ERROR FROM INTERRUPT
0234 8981  60                RTS

0236                          ;SEEK WITHOUT VERIFY

0238 8982  AD CD 04   SEEKNV LDA   RATE
0239 8985  48                PHA
0240 8986  29 FB             AND   #$FB
0241 8988  8D CD 04          STA   RATE
0242 898B  20 3B 89          JSR   FMTSK
0243 898E  68                PLA
0244 898F  8D CD 04          STA   RATE
0245 8992  D0 EA             BNE   LSTFLG     ;ALWAYS GOES
```

```
0247                            .MACRO W1 BYTE
0248                    LDA #BYTE
0249                    BIT FSTOP ;STOP CPU
0250                    STA FDAR
0251                            .ENDM

0253                            .MACRO W2 BYTE,BCNT
0254                    LDX #BCNT-1
0255                    LDA #BYTE
0256                    BIT FSTOP ;STOP CPU
0257                    STA FDAR ;WRITE THE BYT
0258                    DEX
0259                    BNE *-7
0260                    BIT FSTOP
0261                    STA FDAR
0262                            .ENDM

0264                            .MACRO SW2 BYTE,BCNT
0265                    LDX #BCNT
0266                    LDA #BYTE
0267                    BIT FSTOP
0268                    STA FDAR
0269                    DEX
0270                    BNE *-7
0271                            .ENDM

0273                            .MACRO W3 BYTE,COUNT,DATA
0274                    LDX #COUNT
0275                    LDA #DATA
0276                    BIT FSTOP ;STOP CPU
0277                    STA FDAR ;WRITE THE BYTE
0278                    LDA BYTE
0279                    BIT FSTOP
0280                    STA FDAR
0281                    DEX ;COUNT IT
0282                    BNE *-7
0283                    BIT FSTOP
0284                    STA FDAR
0285                            .ENDM
0286                            .MACRO SW3 BYTE,COUNT,DATA
0287                    LDX #COUNT
0288                    LDA #DATA
0289                    BIT FSTOP
0290                    STA FDAR
0291                    LDA BYTE
0292                    BIT FSTOP
0293                    STA FDAR
0294                    DEX
0295                    BNE *-7
0296                            .ENDM

0298                            .MACRO WA BYTE
0299                    LDA BYTE ;PICK UP VALUE
0300                    BIT FSTOP ;STOP CPU
0301                    STA FDAR ;WRITE BYTE
```



```
0302                            .ENDM

0304                            .MACRO WY
0305                    BIT FSTOP ;STOP CPU
0306                    STY FDAR ;WRITE BYTE
0307                            .ENDM
```

```
0309                        ;SEEK MUST HAVE BEEN COMPLETED PRIOR
0310                        ;TO CALLING THIS ROUTINE.

0312 8994   20 CA 8D    WRTRK  JSR    SETIT      ;MOTOR ON & SETUP PARAMETERS
0313 8997   A2 04       WRTRK1 LDX    #>TABLE8
0314 8999   2C 04 8F           BIT    DSTAR
0315 899C   70 04              BVS    FIVE       ;FIVE INCH DRIVE
0316 899E   A9 DF              LDA    #<TABLE8   ;INTERLEAVE TABLE
0317 89A0   D0 02              BNE    FPUT
0318                        ;      ***
0319 89A2   A9 CF       FIVE   LDA    #<TABLE5
0320 89A4   85 DB       FPUT   STA    PTR
0321 89A6   86 DC              STX    PTR+1
0322 89A8   38                 SEC                ;SET WRT FLAG
0323 89A9   6E AF 04           ROR    WRTFLG
0324 89AC   A9 F4       WRTRK3 LDA    #WTCOD
0325 89AE   8D BB 04           STA    FORFLG     ;LET INTERRUPTS KNOW IT'S A WR
0326 89B1   A0 01              LDY    #01        ;SECTOR CTR
0327 89B3   2C 04 8F           BIT    DSTAR
0328 89B6   8D AE 04           STA    CURCMD
0329 89B9   8D 00 8F           STA    FCOMR
0330 89BC   30 03              BMI    WTMFM      ;1=DOUBLE DENSITY
0331 89BE   4C 04 8B           JMP    WTFM       ;0=SINGLE DENSITY

0333                        ;DOUBLE DENSITY
0334 89C1   70 41       WTMFM  BVS    WT5MFM     ;5" DRV DOUBLE DENSITY
0335                        ;8" DRV DOUBLE DENSITY ----- NEED DMA !!!!!!
0336 89C3                      W2     $4E,80
0337 89D6                      W2     00,12
0338 89E9                      W2     $F6,3
0339 89FC                      W1     $FC
0340 8A04               WT5MFM W2     $4E,50     ;GAP 1
0341                        ;LOOP FOR EACH SECT
0342 8A17   A2 0B              LDX    #$B
0343 8A19   A9 00              LDA    #00
0344 8A1B   2C 15 8F    WSMFM  BIT    FSTOP      ;STOP CPU
0345 8A1E   8D 03 8F           STA    FDAR       ;WRITE THE DATA
0346 8A21   CA                 DEX
0347 8A22   D0 F7              BNE    *-7
0348 8A24   2C 15 8F           BIT    FSTOP
0349 8A27   8D 03 8F           STA    FDAR
0350 8A2A                      W2     $F5,3
0351 8A3D                      W1     $FE
0352 8A45                      WA     UCYL       ;TRACK
0353 8A4E                      WA     USIDE      ;SIDE
0354 8A57                      WY                ;SECTOR NBR
0355 8A5D                      W1     1          ;LENGTH
0356 8A65                      W1     $F7
0357 8A6D                      W2     $4E,22
0358 8A80                      W2     00,12
0359 8A93                      W2     $F5,3
0360 8AA6                      W3     PADB,$FF,$FB   ;256 BYTES/SECT
0361 8AC2                      W1     $F7
0362 8ACA                      W2     $4E,54     ;GAP 3
0363 8ADD   B1 DB              LDA    (PTR),Y    ;GET NEXT SECTOR
```



```
0364 8ADF   F0 18              BEQ    WTDOND     ;YES, ALL SECTORS DONE
0365 8AE1   2C 15 8F           BIT    FSTOP
0366 8AE4   8E 03 8F           STX    FDAR
0367 8AE7   A8                 TAY
0368 8AE8   A2 09              LDX    #9
0369 8AEA   A9 00              LDA    #00
0370 8AEC   2C 15 8F           BIT    FSTOP
0371 8AEF   8D 03 8F           STA    FDAR
0372 8AF2   4C 1B 8A           JMP    WSMFM      ;NO

0374 8AF5   A0 FF       WTDONS LDY    #$FF
0375 8AF7   D0 02              BNE    WTDON
0376 8AF9   A0 4E       WTDOND LDY    #$4E
0377 8AFB   2C 15 8F    WTDON  BIT    FSTOP
0378 8AFE   8C 03 8F           STY    FDAR
0379 8B01   4C FB 8A           JMP    WTDON

0381                        ;SINGLE DENSITY
0382 8B04   70 22       WTFM   BVS    WT5FM      ;5" DRV
0383                        ;       8" DRV
0384 8B06                      SW2    $FF,40
0385 8B13                      SW2    00,6
0386 8B20                      W1     $FC
0387 8B28               WT5FM  SW2    $FF,26     ;GAP 1
0388                        ;LOOP TO FORMAT EACH SECT
0389 8B35               WSFM   SW2    00,6
0390 8B42                      W1     $FE
0391 8B4A                      WA     UCYL       ;TRACK
0392 8B53                      WA     USIDE      ;SIDE
0393 8B5C                      WY                ;SECT NBR
0394 8B62                      W1     0          ;LENGTH
0395 8B6A                      W1     $F7
0396 8B72                      SW2    $FF,11
0397 8B7F                      SW2    00,6
0398 8B8C                      SW3    PADB,$80,$FB   ;128 BYTES OF DATA
0399 8BA2                      W1     $F7
0400 8BAA                      SW2    $FF,27     ;GAP 3
0401 8BB7   B1 DB              LDA    (PTR),Y    ;GET NEXT SECT #
0402 8BB9   A8                 TAY
0403 8BBA   F0 03              BEQ    WSFMO      ;YES, ALL SECT DONE
0404 8BBC   4C 35 8B           JMP    WSFM

0406 8BBF   4C F5 8A    WSFMO  JMP    WTDONS

0408                        ;5" INTERLEAVED SECTOR ORDER
0409                        ;1,6,11,16,5,10,15,4,9,14,3,8,13,2,7,12

0411                        ;8" INTERLEAVED SECTOR ORDER
0412                        ;1,6,11,16,21,26,5,10,15,20,25,4,9,14,19
0413                        ;24,3,8,13,18,23,2,7,12,17,22
```

```
0415                        ;EXECUTE TYPE 2 COMMAND

0417                        ;NOTE: SELECTED SIDE MUST BE PUT INTO CMD FOR PROPER
0418                        ;      HEADER SIDE VERIFICATION....

0420 8BC2  8D AE 04     EXEC02 STA    CURCMD     ;TYPE 2 ENTRY
0421 8BC5  AD 04 8F            LDA    DSTAR      ;GET SELECTED SIDE
0422 8BC8  4A                  LSR    A          ;SIDE INTO CARRY
0423 8BC9  AD AE 04            LDA    CURCMD     ;RESTORE CMD
0424 8BCC  B0 02               BCS    EXEC01     ;SIDE 1
0425 8BCE  09 08               ORA    #S         ;SIDE 2
0426 8BD0  0D C7 04     EXEC01 ORA    SFLAG      ;ONLY FOR TYPE 2
0427 8BD3  8D AE 04     EXEC03 STA    CURCMD     ;ENTRY FOR TYPE 3 COMMANDS
0428 8BD6  8D 00 8F     EXEC04 STA    FCOMR      ;EXECUTE CMD TYPES 1 & 4
0429 8BD9  A0 00               LDY    #00        ;INIT DATA XFER POINTER

0431                        ;THE FDC CHIP REQUIRES A DELAY AFTER BEING
0432                        ;ISSUED A COMMAND.  STOPPING THE CPU BEFORE
0433                        ;THIS DELAY IS COMPLETE WILL CAUSE ERRORS
0434                        ;   14 USEC FOR 8" DOUBLE
0435                        ;   28 USEC FOR 8" SINGLE
0436                        ;      AND FOR 5" DOUBLE
0437                        ;   56 USEC FOR 5" SINGLE

0439 8BDB  2C 04 8F            BIT    DSTAR      ;DELAY FOR STATUS REGISTER
0440 8BDE  30 05               BMI    DOUBLD     ;GO IF DOUBLE DENSITY
0441 8BE0  A0 04               LDY    #4
0442 8BE2  88           WAITS1 DEY
0443 8BE3  D0 FD               BNE    WAITS1
0444 8BE5  50 05        DOUBLD BVC    BIGDSK     ;GO IF 8 INCH DRIVES
0445 8BE7  A0 04               LDY    #4
0446 8BE9  88           WAITS2 DEY
0447 8BEA  D0 FD               BNE    WAITS2
0448 8BEC  60           BIGDSK RTS                ;COMMAND NOW BEING EXECUTED
```



```
0451                        ;   NOTE!!!! FLOPPY DISK CANNOT BE INTERRUPTED
0452                        ;            DURING A FORMAT,WRITE OR READ OR
0453                        ;            ELSE DATA LOST WILL OCCUR !!!!!!

0455 8BED  48           IRQHAN PHA                SAVE ACC 'A'
0456 8BEE  AD AE 04            LDA    CURCMD     ;WAS AN FDC CMD ISSUED?
0457 8BF1  F0 06               BEQ    IRQRTN     ;NO
0458 8BF3  AD 00 8F            LDA    FSTAR      ;IF IRQ IS FROM FDC
0459 8BF6  4A                  LSR    A          ;IT WOULD BE IDLE
0460 8BF7  90 07               BCC    IRQFDC     ;IRQ FROM FDC
0461 8BF9  AD 00 8F     IRQRTN LDA    FSTAR
0462 8BFC  68                  PLA               ;RESTORE ACCUM
0463 8BFD  6C A0 04            JMP    (IRQOUT)   ;DO INTERRUPT EXIT

0465 8C00  8A           IRQFDC TXA
0466 8C01  48                  PHA
0467 8C02  20 1C 8C            JSR    FORM6
0468 8C05  AD BB 04            LDA    FORFLG     ;SEE IF WRITE TRACK
0469 8C08  F0 08               BEQ    NOTFOR
0470 8C0A  68                  PLA
0471 8C0B  68                  PLA
0472 8C0C  68                  PLA
0473 8C0D  68                  PLA
0474 8C0E  68                  PLA
0475 8C0F  4C 7E 89            JMP    LSTFLG     ;EXIT WITH ERRORS IN A
0476 8C12  68           NOTFOR PLA
0477 8C13  AA                  TAX
0478 8C14  68                  PLA
0479 8C15  40                  RTI

0481 8C16  AD 00 8F     FORM5  LDA    FSTAR      ;WAIT TILL CMD ENDS
0482 8C19  4A                  LSR    A          ;HAS CMD ENDED?
0483 8C1A  B0 FA               BCS    FORM5      ;NO, STILL BUSY
0484 8C1C  AD BA 04     FORM6  LDA    DMAFLG     ;USING DMA?
0485 8C1F  F0 0A               BEQ    NODMA      ;NO
0486 8C21  98                  TYA
0487 8C22  48                  PHA               ;SAVE Y
0488 8C23  A0 0C               LDY    #<DMACMD   ;COMMAND REGISTER
0489 8C25  A9 00               LDA    #00        ;HALT DMA
0490 8C27  91 DD               STA    (DMAPTR),Y
0491 8C29  68                  PLA
0492 8C2A  A8                  TAY
0493 8C2B  AD B1 04     NODMA  LDA    MOFLG
0494 8C2E  29 BF               AND    #$BF       ;DISABLE IRQ LATCH
0495 8C30  8D 04 8F            STA    DCONR      ;DISABLE CPU STOP
0496 8C33  AE AE 04            LDX    CURCMD
0497 8C36  8E A2 04            STX    FLAG       ;SAVE FOR EXTERNAL USE
0498 8C39  AD AD 04            LDA    STFLG      ;IS STATUS FLG SET?
0499 8C3C  D0 09               BNE    FORM7      ;YES, RETURN STATUS TO CALLER
0500 8C3E  AD 00 8F            LDA    FSTAR
0501 8C41  E0 20               CPX    #$20       ;TYPE 1?
0502 8C43  B0 02               BCS    FORM7      ;NO
0503 8C45  29 D9               AND    #$D9       ;YES, REMOVE BAD BITS
0504 8C47  A2 00        FORM7  LDX    #00
0505 8C49  8E AE 04            STX    CURCMD     ;CLR CURR CMD
```

FDC INTERRUPT HANDLER

```
0506 8C4C   29 FD          AND   #$FD
0507 8C4E   8D AD 04       STA   STFLG
0508 8C51   58             CLI
0509 8C52   60             RTS
```


TURN MOTOR ON AND SELECT DRIVE

```
0511                ;ENTER WITH DESIRED DRIVE (0-3) IN ACC AND
0512                ;   SET INDEX REG 'Y' TO SIDE.
0513                ;   SET INDEX REG 'X' WITH A
0514                ;       1 FOR SINGLE DENSITY
0515                ;       0 FOR DOUBLE DENSITY

0517 8C53   D8      MOTON  CLD             ;CLEAR DECIMAL MODE
0518 8C54   48             PHA
0519 8C55   A9 20          LDA   #$20
0520 8C57   2C B1 04       BIT   MOFLG     ;MOTOR ON?
0521 8C5A   D0 5F          BNE   SELCTD    ;YES, SO SELECT DRIVE
0522 8C5C   68             PLA
0523 8C5D   8D B4 04       STA   UDRV
0524 8C60   8C B2 04       STY   USIDE
0525 8C63   A9 20          LDA   #$20
0526 8C65   20 F0 8C       JSR   SETFLG    ;SET FLAGS (MOTOR ON), A=$20
0527 8C68   20 A6 8C       JSR   WAIT
0528 8C6B   20 7C 8C       JSR   MTR1
0529 8C6E   A2 00          LDX   #00       ;RESET NUMBER OF HEADS
0530 8C70   AD 04 8F       LDA   DSTAR     ;GET HEAD DATA
0531 8C73   29 20          AND   #$20      ;BIT 5 FOR # OF HEADS
0532 8C75   F0 01          BEQ   INTST
0533 8C77   E8             INX             ;TWO HEADS
0534 8C78   8E C1 04    INTST  STX   NHEAD
0535 8C7B   60             RTS

0537 8C7C   8A          MTR1   TXA
0538 8C7D   F0 08          BEQ   MTR3      ;DRIVE IS DOUBLE DENSITY
0539 8C7F   A9 80          LDA   #$80      ;YES
0540 8C81   0D B1 04       ORA   MOFLG
0541 8C84   8D B1 04       STA   MOFLG
0542 8C87   AD B2 04    MTR3   LDA   USIDE     ;SIDE
0543 8C8A   0D B1 04       ORA   MOFLG     ;SET SIDE
0544 8C8D   8D B1 04       STA   MOFLG
0545 8C90   AE B4 04       LDX   UDRV      ;DRIVE NBR
0546 8C93   E0 04          CPX   #4        ;VALID DRIVE ?
0547 8C95   30 03          BMI   MTR4      ;YES
0548 8C97   4C FE 88       JMP   ERCOND    ;BAD DRIVE #
0549                ;
0550 8C9A   BD B7 8C    MTR4   LDA   DRVTBL,X
0551 8C9D   0D B1 04       ORA   MOFLG
0552 8CA0   8D B0 04       STA   SELFLG    ;DRIVE SELECT FLAG SET
0553 8CA3   20 F0 8C       JSR   SETFLG    ;SET FLAGS
0554 8CA6   AD C6 04    WAIT   LDA   HDEL
0555 8CA9   8D A6 04       STA   TEMP2     ;DELAY ROUTINE
0556 8CAC   A9 FF       WAITO  LDA   #$FF
0557 8CAE   20 D9 8E       JSR   MICROD    ;10US DELAY
0558 8CB1   CE A6 04       DEC   TEMP2
0559 8CB4   D0 F6          BNE   WAITO
0560 8CB6   60          SELCT4 RTS
0561                ;
0562 8CB7   42          DRVTBL  BYT   $42,$44,$48,$50
```

SELECT DRIVE AND LOAD HEAD

```
0564                    ;ENTER WITH DESIRED DRIVE (0-3) IN ACC AND
0565                    ;   SET INDEX REG 'Y' TO SIDE.
0566                    ;   SET INDEX REG 'X' WITH A
0567                    ;       1 FOR SINGLE DENSITY
0568                    ;       0 FOR DOUBLE DENSITY
0569                    ;   ONLY ONE DRIVE CAN BE SELECTED AT A TIME

0571 8CBB   68          SELCTD PLA              ;ENTRY FROM MOTON

0573 8CBC   D8          SELECT CLD              ;MAKE SURE DECIMAL MODE CLEAR
0574 8CBD   CD B4 04           CMP   UDRV       ;SAME DRIVE?
0575 8CC0   D0 14              BNE   SELCT1     ;NO
0576 8CC2   CC B2 04           CPY   USIDE      ;SAME SIDE?
0577 8CC5   D0 12              BNE   SELCT2     ;NO
0578 8CC7   8A                 TXA
0579 8CC8   6A                 ROR   A
0580 8CC9   6A                 ROR   A          ;PUT DENSITY IN MSB OF A
0581 8CCA   4D B1 04           EOR   MOFLG      ;POSITIVE IF THE SAME
0582 8CCD   30 0D              BMI   SELCT3
0583 8CCF   29 20              AND   #$20
0584 8CD1   D0 E3              BNE   SELCT4     ;AND MOTOR ON!!
0585 8CD3   4C FE 88           JMP   ERCOND     ;MOTOR OFF

0587 8CD6   8D B4 04    SELCT1 STA   UDRV
0588 8CD9   8C B2 04    SELCT2 STY   USIDE
0589 8CDC   20 E2 8C    SELCT3 JSR   DESEL
0590 8CDF   4C 7C 8C           JMP   MTR1
```


DESELECT DRIVE (UNLOAD HEADS)

```
0592 8CE2   A9 20       DESEL  LDA   #$20       ;LEAVE MOTOR ON
0593 8CE4   2D B1 04           AND   MOFLG
0594 8CE7   20 F0 8C    DESEL1 JSR   SETFLG     ;SET FLAGS
0595 8CEA   A9 00              LDA   #00
0596 8CEC   8D B0 04           STA   SELFLG     ;SET SELECT FLG OFF
0597 8CEF   60                 RTS

0599 8CF0   8D 04 8F    SETFLG STA   DCONR      ;STATUS FLAG
0600 8CF3   8D B1 04           STA   MOFLG      ;MOTOR ON FLAG
0601 8CF6   60                 RTS

0603 8CF7   A9 00       MOTOFF LDA   #00
0604 8CF9   F0 EC              BEQ   DESEL1     ;ALWAYS GOES
```

```
0606                    ;ENTER WITH 'RDBUF' POINTING TO MEMORY LOCATION WHERE
0607                    ;    DATA WILL BE READ

0609 8CFB  20 CA 8D     RDTRK   JSR     SETIT       ;MOTOR ON & SETUP PARAMETERS
0610 8CFE  F0 0E                BEQ     RDT1        ;NO
0611 8D00  20 A6 8E             JSR     WHTK        ;SETUP TK COUNT
0612 8D03  20 0C 8E             JSR     RDDMA       ;YES-SETUP DMA
0613 8D06  A9 E4                LDA     #RTCOD
0614 8D08  20 D3 8B             JSR     EXECO3
0615 8D0B  4C 39 8D             JMP     RDS3        ;EXECUTE FDC
0616                    ;
0617 8D0E  20 E3 8E     RDT1    JSR     RDBPTR
0618 8D11  A9 E4                LDA     #RTCOD      ;CMD TO READ A WHOLE TRACK
0619 8D13  8D BB 04             STA     FORFLG
0620 8D16  20 D3 8B             JSR     EXECO3
0621 8D19  2C 15 8F     RDTKO   BIT     FSTOP       ;STOP CPU
0622 8D1C  AD 03 8F             LDA     FDAR        ;YES, GET THE BYTE
0623 8D1F  91 DB                STA     (PTR),Y     ;STORE IT INTO USERS BUFFER
0624 8D21  C8                   INY                 ;BUMP PTR
0625 8D22  D0 F5                BNE     RDTKO       ;PTR NOT AT END
0626 8D24  E6 DC                INC     PTR+1       ;IS L/O PART OF PTR AT END
0627 8D26  4C 19 8D             JMP     RDTKO
```



```
0629                    ;ENTER WITH 'RDBUF' POINTING TO MEMORY LOC WHERE DATA
0630                    ;    WILL BE PUT.  SET ACC 'A' WITH THE SECTOR NUMBER.
0631                    ;

0633 8D29  20 C7 8D     RDSEC   JSR     SETSEC      ;SECTOR SETUP
0634 8D2C  F0 16                BEQ     RDS1        ;NO DMA
0635 8D2E  20 BB 8E             JSR     SECCNT      ;SETUP DMA COUNT
0636 8D31  20 0C 8E             JSR     RDDMA       ;YES-SETUP DMA
0637 8D34  A9 80                LDA     #RSCOD
0638 8D36  20 C2 8B     RDS2    JSR     EXECO2
0639 8D39  20 77 89     RDS3    JSR     RESTED      ;WAIT FOR FDC INTERRUPT
0640 8D3C  20 7A 8E     RDS4    JSR     QDMA        ;DMA ACTIVE, Z=0 IF STILL
0641 8D3F  D0 FB                BNE     RDS4
0642 8D41  4C 7E 89             JMP     LSTFLG      ;LOAD WITH STFLG AND RETURN

0644 8D44  20 E3 8E     RDS1    JSR     RDBPTR      ;SET UP PTR TO READ BUFFER
0645 8D47  A9 80                LDA     #RSCOD      ;CMD TO READ A SECTOR
0646 8D49  20 C2 8B             JSR     EXECO2      ;EXECUTE THE CMD
0647 8D4C  20 52 8D             JSR     INBYTE
0648 8D4F  4C 77 89             JMP     RESTED

0650 8D52  2C 15 8F     INBYTE  BIT     FSTOP       ;STOP CPU
0651 8D55  AD 03 8F             LDA     FDAR        ;GET DATA FROM DATA REG
0652 8D58  91 DB                STA     (PTR),Y     ;STUFF IT
0653 8D5A  C8                   INY
0654 8D5B  CC C0 04             CPY     NBYTE       ;GOT ALL ?
0655 8D5E  D0 F2                BNE     INBYTE      ;NO
0656 8D60  60                   RTS
```

WRITE A SECTOR

```
0658                            ;ENTER WITH 'WRBUF POINTING TO MEMORY WHERE DATA
0659                            ;    WILL BE READ.  SET ACC 'A' WITH THE SECTOR NUMBER.
0660                            ;
0662 8D61   20 C7 8D    WRTSEC  JSR     SETSEC      ;SECTOR SETUP
0663 8D64   F0 0A               BEQ     WRT1        ;NO DMA
0664 8D66   20 BB 8E            JSR     SECCNT      ;SET DMA COUNT
0665 8D69   20 59 8E            JSR     WRTDMA      ;YES-SETUP DMA
0666 8D6C   A9 A0               LDA     #WSCOD
0667 8D6E   D0 C6               BNE     RDS2        ;EXECUTE FDC
0668                            ;       ***
0669                            ;
0670 8D70   20 F1 8E    WRT1    JSR     WRTPTR      ;SET UP WRT BUFR IN PTR
0671 8D73   A9 A0               LDA     #WSCOD      ;CMD TO WRITE A SECTOR
0672 8D75   20 C2 8B            JSR     EXEC02      ;EXEC THE CMD
0673 8D78   20 7E 8D            JSR     OUTBYT
0674 8D7B   4C 77 89            JMP     RESTED

0676 8D7E   B1 DB       OUTBYT  LDA     (PTR),Y     ;GET BYTE THAT IS TO BE WRITTE
0677 8D80   2C 15 8F            BIT     FSTOP       ;STOP CPU
0678 8D83   8D 03 8F            STA     FDAR
0679 8D86   C8                  INY                 ;GO TO NEXT BYTE
0680 8D87   CC C0 04            CPY     NBYTE       ;HAVE ALL BYTES BEEN READ?
0681 8D8A   D0 F2               BNE     OUTBYT      ;NO, GET MORE DATA
0682 8D8C   60                  RTS
```


READ MULTIPLE SECTORS

```
0684                            ;ENTER WITH 'RDBUF' POINTING TO MEMORY LOCATION
0685                            ;    WHERE DATA WILL BE READ.  ACC WILL CONTAIN THE
0686                            ;    SECTOR NUMBER AND INDEX REG 'X' WILL CONTAIN
0687                            ;    THE LAST SECTOR TO BE READ.
0688                            ;
0690 8D8D   20 C1 8D    RDMSC   JSR     SETMSC      ;SETUP
0691 8D90   F0 12               BEQ     RDM1        ;NO DMA
0692 8D92   20 BB 8E            JSR     BYTES       ;SETUP BYTE COUNT
0693 8D95   20 0C 8E            JSR     RDDMA       ;YES-SETUP DMA
0694 8D98   A9 90               LDA     #RSCOD+M
0695 8D9A   20 C2 8B    RDMDMA  JSR     EXEC02
0696 8D9D   20 7A 8E    RRDMA1  JSR     GDMA
0697 8DA0   D0 FB               BNE     RRDMA1
0698 8DA2   F0 15               BEQ     FORCOF      ;ALWAYS GOES

0700 8DA4   20 E3 8E    RDM1    JSR     RDBPTR      ;SET UP PTR TO READ BUFR
0701 8DA7   A9 90               LDA     #RSCOD+M    ;CMD TO READ MULTIPLE SECT
0702 8DA9   20 C2 8B            JSR     EXEC02
0703 8DAC   20 52 8D    RDM01   JSR     INBYTE      ;XFER DATA IN
0704 8DAF   20 DB 8D            JSR     TONEXT      ;BUMP PTR
0705 8DB2   B0 F8               BCS     RDM01       ;NO
0706 8DB4   A9 0D       RDM05   LDA     #13
0707 8DB6   20 D9 8E            JSR     MICROD
0708 8DB9   A9 D0       FORCOF  LDA     #FICOD      ;STOP EXECUTING
0709 8DBB   20 D6 8B            JSR     EXEC04
0710 8DBE   4C 16 8C            JMP     FORM5

0712 8DC1   8E AC 04    SETMSC  STX     LSECR       ;LAST SECTOR TO BE READ
0713 8DC4   8D AB 04            STA     CURSEC      ;CURR SECTOR
0714 8DC7   8D 02 8F    SETSEC  STA     FSECR       ;SECTOR # DESIRED
0715 8DCA   20 C4 8B    SETIT   JSR     SETUP       ;CK FLAGS & SETUP PARAMETERS
0716 8DCD   AD AD 04            LDA     STFLG       ;ANY ERRORS
0717 8DD0   10 05               BPL     ALLOK
0718 8DD2   68                  PLA                 ;REMOVE RETURN ADDRESS
0719 8DD3   68                  PLA
0720 8DD4   4C 7E 89            JMP     LSTFLG

0722 8DD7   AD BA 04    ALLOK   LDA     DMAFLG      ;DMA ?
0723 8DDA   60                  RTS

0725 8DDB   20 CA 8E    TONEXT  JSR     BUMPTR      ;BUMP PTR
0726 8DDE   A0 00               LDY     #0
0727 8DE0   EE AB 04            INC     CURSEC      ;GOTO NEXT SECT
0728 8DE3   AD AC 04            LDA     LSECR
0729 8DE6   CD AB 04            CMP     CURSEC      ;ALL SECT XFER'ED ?
0730 8DE9   60                  RTS
```

WRITE MULTIPLE SECTORS

```
0732                            ;ENTER WITH 'WRBUF' POINTING TO MEMORY WHERE DATA
0733                            ;    WILL BE READ.  ACC WILL CONTAIN THE SECTOR NBR
0734                            ;    AND INDEX REG 'X' WILL CONTAIN LAST SECTOR TO BE
0735                            ;    READ
0736                            ;

0738 8DEA   20 C1 8D    WRTMSC  JSR     SETMSC      ;SETUP
0739 8DED   F0 0B               BEQ     WRTM1       ;NO DMA
0740 8DEF   20 8B 8E            JSR     BYTES       ;SET BYTE COUNT
0741 8DF2   20 59 8E            JSR     WRTDMA      ;YES-SETUP DMA
0742 8DF5   A9 B0               LDA     #WSCOD+M
0743 8DF7   4C 9A 8D            JMP     RDMDMA      ;EXECUTE FDC
0744                            ;
0745 8DFA   20 F1 8E    WRTM1   JSR     WRTPTR      ;SET UP WRT BUFR IN PTR
0746 8DFD   A9 B0               LDA     #WSCOD+M    ;CMD TO WRITE MULTIPLE SECT
0747 8DFF   20 C2 8B            JSR     EXEC02      ;EXECUTE THE CMD
0748 8E02   20 7E 8D    WRMS0   JSR     OUTBYT      ;XFER DATA OUT
0749 8E05   20 DB 8D            JSR     TONEXT      ;BUMP PTR
0750 8E08   B0 F8               BCS     WRMS0       ;NO
0751 8E0A   90 A8               BCC     RDM05
0752                            ;       ***
```


READ DMA

```
0754                            ;NOTE!!!  A) CANT TRANSFER FROM AIM65/40 MEM TO DISK U
0755                            ;             DMA, NEED EXTERNAL MEM.....
0756                            ;          B) CPU MUST BE STOPPED BY DMA IF FIRMWARE IS
0757                            ;             EXTERNAL RAM/ROM OR ELSE CPU WILL READ BA
0758                            ;             DATA AND GET LOST.......

0760 0E06   20 01 0E    RDDMA   JSR     SETDMA      ;SET DMAADR->DMAPTR
0763 0E09   20 E3 8E            JSR     RDBPTR
0766 0E0C   A9 0F               LDA     #>FDAR      ;SOURCE=FDC DATA REG
0768 0E0E   A0 01               LDY     #1
076A 0E10   91 DD               STA     (DMAPTR),Y      ;DMASR1
076C 0E12   A9 03               LDA     #<FDAR
076E 0E14   C8                  INY
076F 0E15   91 DD               STA     (DMAPTR),Y      ;DMASR2
0771 0E17   A0 04               LDY     #4          ;A=3
0773 0E19   91 DD               STA     (DMAPTR),Y      ;DMADST
0775 0E1B   A9 3A               LDA     #$3A        ;READ DMA CMD, INH DMA INT,STO
0777 0E1D   48                  PHA
0778 0E1E   AE CA 04            LDX     RDBUF+1     ;DEST=RDBUF
077B 0E21   AD C9 04            LDA     RDBUF
077E 0E24   48          CDMA    PHA
077F 0E25   8A                  TXA
0780 0E26   A0 05               LDY     #5
0782 0E28   91 DD               STA     (DMAPTR),Y      ;DMADS1-MS DEST ADDR
0784 0E2A   C8                  INY
0785 0E2B   68                  PLA
0786 0E2C   91 DD               STA     (DMAPTR),Y      ;DMADS2-LS DEST ADDR
0788 0E2E   AD A8 04            LDA     LSC         ;LS BYTE COUNT
078B 0E31   A0 0A               LDY     #$0A
078D 0E33   91 DD               STA     (DMAPTR),Y      ;DMACT2
078F 0E35   AD A7 04            LDA     MSC         ;MS BYTE COUNT
0792 0E38   88                  DEY
0793 0E39   91 DD               STA     (DMAPTR),Y      ;DMACT1
0795 0E3B   A9 04               LDA     #04         ;DECR DMA BYTE CNT REG
0797 0E3D   88                  DEY
0798 0E3E   91 DD               STA     (DMAPTR),Y      ;DMACNT
079A 0E40   A0 0C               LDY     #$0C
079C 0E42   B1 DD               LDA     (DMAPTR),Y      ;DMACMD-CL DMA STATUS/IRQ
079E 0E44   AD BA 04            LDA     DMAFLG      ;GET BANK INFO
07A1 0E47   29 C0               AND     #$C0        ;ISOLATE IT
07A3 0E49   8D A6 04            STA     TEMP2
07A6 0E4C   68                  PLA
07A7 0E4D   0D A6 04            ORA     TEMP2
07AA 0E50   91 DD               STA     (DMAPTR),Y      ;DMACMD-ACTIVATE DMA
07AC 0E52   60                  RTS
```

```
0800 8E59  20 81 8E     WRTDMA JSR    SETDMA     ;DMAADR->DMAPTR
0801 8E5C  20 F1 8E            JSR    WRTPTR
0802 8E5F  A9 03               LDA    #03        ;INCR SOURCE ADDR REG
0803 8E61  A0 00               LDY    #0
0804 8E63  91 DD               STA    (DMAPTR),Y     ;DMASRC
0805 8E65  AD CC 04            LDA    WRBUF+1    ;SOURCE=WRBUF
0806 8E68  C8                  INY
0807 8E69  91 DD               STA    (DMAPTR),Y     ;DMASR1
0808 8E6B  AD CB 04            LDA    WRBUF
0809 8E6E  C8                  INY
0810 8E6F  91 DD               STA    (DMAPTR),Y     ;DMASR2
0811 8E71  A9 39               LDA    #$39       ;DMA WRITE CMD
0812 8E73  48                  PHA
0813 8E74  A2 8F               LDX    #>FDAR     ;DEST=FDC DATA REG
0814 8E76  A9 03               LDA    #<FDAR
0815 8E78  D0 B0               BNE    CDMA       ;DO IT
0816                    ;      ***

0818 8E7A  A0 0C        QDMA   LDY    #<DMACMD
0819 8E7C  A9 40               LDA    #$40
0820 8E7E  31 DD               AND    (DMAPTR),Y
0821 8E80  60                  RTS

0823 8E81  AD B9 04     SETDMA LDA    DMAADR
0824 8E84  85 DE               STA    DMAPTR+1
0825 8E86  A9 00               LDA    #0
0826 8E88  85 DD               STA    DMAPTR
0827 8E8A  60                  RTS
```



```
0829                    ;CALCULATE # OF BYTES FROM CURSEC TO LSECR
0830                    ;
0831 8E8B  AC AB 04     BYTES  LDY    CURSEC     ;CURRENT SECTOR
0832 8E8E  A2 00               LDX    #0         ;MS
0833 8E90  8A                  TXA               ;LS
0834 8E91  38           BYTE1  SEC
0835 8E92  CE C0 04            DEC    NBYTE      ;MAKE 0=FF
0836 8E95  6D C0 04            ADC    NBYTE      ;BYTES/SECTOR
0837 8E98  90 01               BCC    BYTE4      ;?
0838 8E9A  E8                  INX               ;MS
0839 8E9B  EE C0 04     BYTE4  INC    NBYTE      ;RESTORE OLD VALUE
0840 8E9E  CC AC 04            CPY    LSECR      ;DONE ?
0841 8EA1  F0 20               BEQ    SEC1       ;YES
0842 8EA3  C8                  INY
0843 8EA4  D0 EB               BNE    BYTE1      ;CONTINUE
0844                    ;      ***
0845                    ;
0846                    ;SET DMA CNT TO WHOLE TK
0847                    ;
0848 8EA6  AD 04 8F     WHTK   LDA    DSTAR      ;DEN/SIZE DATA
0849 8EA9  2A                  ROL    A
0850 8EAA  2A                  ROL    A          ;PUT BITS 6,7 ->0,1
0851 8EAB  2A                  ROL    A
0852 8EAC  29 03               AND    #3
0853 8EAE  AA                  TAX
0854 8EAF  BD B7 8E            LDA    TKTBL,X    ;MS
0855 8EB2  AA                  TAX
0856 8EB3  A9 00               LDA    #00
0857 8EB5  F0 0C               BEQ    SEC1
0858                    ;      ***
0859                    ;TK COUNTS EXTEND INTO TRAILER BUT S
0860                    ;STOP SHORT OF FINAL INDEX TO ALLOW
0861                    ;DMA TO COMPLETE.......
0862                    ;
0863 8EB7  14           TKTBL  BYT    $14,$0C,$27,$18    ;S8,S5,D8,D5
0864                    ;
0865                    ;SET SECTOR BYTE COUNT
0866                    ;
0867 8EBB  A2 00        SECCNT LDX    #00
0868 8EBD  AD C0 04            LDA    NBYTE      ;BYTE CNT
0869 8EC0  D0 01               BNE    SEC1       ;SINGLE ?
0870 8EC2  E8                  INX
0871 8EC3  8E A7 04     SEC1   STX    MSC
0872 8EC6  8D A8 04            STA    LSC
0873 8EC9  60                  RTS
0874                    ;INCREMENT DATA TRANSFER POINTER
0875                    ;
0876 8ECA  98           BUMPTR TYA               ;SECTORS
0877 8ECB  D0 02               BNE    BUMPER
0878 8ECD  E6 DC               INC    PTR+1      ;IF SIZE IS 256
0879 8ECF  18           BUMPER CLC
0880 8ED0  65 DB               ADC    PTR
0881 8ED2  85 DB               STA    PTR
0882 8ED4  90 02               BCC    BUMP01
0883 8ED6  E6 DC               INC    PTR+1
```

```
0884 8ED8   60          BUMP01 RTS

0886                    ;DELAY OF 10 USEC FOR EACH CNT OF 'A'
0887                    ;
0888 8ED9   8D A3 04    MICROD STA    CNTR
0889 8EDC   EA          MICR1  NOP              ;2 USEC
0890 8EDD   CE A3 04           DEC    CNTR      ;5 USEC
0891 8EE0   D0 FA              BNE    MICR1     ;3 USEC
0892 8EE2   60                 RTS

0894                    ;SET RDBUF VARIABLES INTO PTR VARIABLES.

0896 8EE3   AD C9 04    RDBPTR LDA    RDBUF     ;SET UP READ BUFR IN PTR
0897 8EE6   85 DB              STA    PTR
0898 8EE8   AD CA 04           LDA    RDBUF+1   ;H/O
0899 8EEB   85 DC              STA    PTR+1
0900 8EED   4E AF 04           LSR    WRTFLG    ;CLEAR WRITE FLAG
0901 8EF0   60                 RTS

0903 8EF1   AD CB 04    WRTPTR LDA    WRBUF     ;SET UP WRT BUFR IN PTR
0904 8EF4   85 DB              STA    PTR
0905 8EF6   AD CC 04           LDA    WRBUF+1
0906 8EF9   85 DC              STA    PTR+1
0907 8EFB   38                 SEC
0908 8EFC   6E AF 04           ROR    WRTFLG    ;SET WRT FLAG
0909 8EFF   60                 RTS
```



```
0911 8F00   43                 .BYT   'COPYRIGHT 1982 '
0912 8F0F   52                 .BYT   'ROCKWELL '
0913 8F18   49                 .BYT   'INTERNATIONAL'
0914                           .END             FDC

ERRORS = 0000 <0000>
```

SYMBOL TABLE

```
ALLOK   8DD7    0717 #0722
BIGDSK  8BEC    0444 #0448
BUMPER  8ECF    0877 #0879
BUMPTR  8ECA    0725 #0876
BUMP01  8ED8    0882 #0884
BYTES   8E8B    0692  0740 #0831
BYTE1   8E91   #0834  0843
BYTE4   8E9B    0837 #0839
C       0002   #0051  0141
CDMA    8E2A   #0774  0815
CNTR    04A3   #0078  0888  0890
CURCMD  04AE   #0088  0220  0227  0328  0420  0423  0427  0456  0496  0505
CURCYL  04B5   #0095  0208  0211
CURSEC  04AB   #0085  0713  0727  0729  0831
CYL5    04C2   #0106  0162
CYL8    04C3   #0107  0169
DBLCNT  04BE   #0102  0129  0135
DCONR   8F04   #0028  0181  0495  0599
DESEL   8CE2    0589 #0592
DESEL1  8CE7   #0594  0604
DMAADR  04B9   #0096  0823
DMACMD  900C   #0065  0488  0818
DMACNT  9008   #0062
DMACT1  9009   #0063
DMACT2  900A   #0064
DMADST  9004   #0059
DMADS1  9005   #0060
DMADS2  9006   #0061
DMAFLG  04BA   #0097  0484  0722  0792
DMAPTR  00DD   #0072  0490  0764  0767  0769  0777  0780  0783  0786  0789
                0791  0797  0804  0807  0810  0820  0824  0826
DMASRC  9000   #0056
DMASR1  9001   #0057
DMASR2  9002   #0058
DOUBLD  8BE5    0440 #0444
DRVTBL  8CB7    0550 #0562
DSTAR   8F04   #0027  0127  0164  0314  0327  0421  0439  0530  0848
E       0004   #0052  0141
ERCOND  88FE    0156  0158 #0175  0548  0585
EXEC01  8BD0    0424 #0426
EXEC02  8BC2   #0420  0638  0646  0672  0695  0702  0747
EXEC03  8BD3   #0427  0614  0620
EXEC04  8BD6    0228 #0428  0709
FCOMR   8F00   #0022  0023  0024  0025  0026  0027  0028  0029  0329  0428
FCYLR   8F01   #0024  0209
FDAR    8F03   #0026  0212  0336  0337  0338  0339  0340  0345  0349  0350
                0351  0352  0353  0354  0355  0356  0357  0358  0359  0360
                0361  0362  0366  0371  0378  0384  0385  0386  0387  0389
                0390  0391  0392  0393  0394  0395  0396  0397  0398  0399
                0400  0622  0651  0678  0762  0765  0813  0814
FICOD   00D0   #0044  0708
FIVE    89A2    0315 #0319
FLAG    04A2   #0077  0129  0130  0497
FMTSK   893B    0193 #0206  0242
FORCOF  8DB9    0698 #0708
```


SYMBOL TABLE

```
FORERR  8937    0189  0192  0195 #0201
FORFLG  04BB   #0098  0153  0325  0468  0619
FORMAT  890D   #0184
FORMO   8915   #0187  0199
FORM5   8C16    0159 #0481  0483  0710
FORM6   8C1C    0467 #0484
FORM7   8C47    0499  0502 #0504
FPUT    89A4    0317 #0320
FSECR   8F02   #0025  0218  0714
FSTAR   8F00   #0023  0126  0231  0458  0461  0481  0500
FSTOP   8F15   #0029  0336  0337  0338  0339  0340  0344  0348  0350  0351
                0352  0353  0354  0355  0356  0357  0358  0359  0360  0361
                0362  0365  0370  0377  0384  0385  0386  0387  0389  0390
                0391  0392  0393  0394  0395  0396  0397  0398  0399  0400
                0621  0650  0677
HDEL    04C6   #0110  0554
INBYTE  8D52    0647 #0650  0655  0703
INIT    886C   #0126
INIT0   88F7    0168 #0171
INIT1   8876   #0130  0132
INIT3   887E   #0134  0137
INTST   8C78    0532 #0534
INTTBL  8888    0133  0134 #0139
IRQFDC  8C00    0460 #0465
IRQHAN  8BED   #0455
IRQOUT  04A0   #0076  0463
IRQRTN  8BF9    0457 #0461
LSC     04A8   #0082  0781  0872
LSECR   04AC   #0086  0712  0728  0840
LSTFLG  897E   #0233  0245  0475  0642  0720
M       0010   #0049  0694  0701  0742  0746
MICROD  8ED9    0226  0557  0707 #0888
MICR1   8EDC   #0889  0891
MOFLG   04B1   #0091  0155  0179  0493  0520  0540  0541  0543  0544  0551
                0581  0593  0600
MOTOFF  8CF7   #0603
MOTON   8C53   #0517
MSC     04A7   #0081  0784  0871
MTR1    8C7C    0528 #0537  0590
MTR3    8C87    0538 #0542
MTR4    8C9A    0547 #0550
NBYTE   04C0   #0104  0167  0654  0680  0835  0836  0839  0868
NCYL    04A9   #0083  0172  0198
NHEAD   04C1   #0105  0534
NODMA   8C2B    0485 #0493
NOTFOR  8C12    0469 #0476
NSEC    04AA   #0084  0171
OUTBYT  8D7E    0673 #0676  0681  0748
PADB    04CF   #0117  0360  0398
PTR     00DB   #0071  0320  0321  0363  0401  0623  0626  0652  0676  0878
                0880  0881  0883  0897  0899  0904  0906
QDMA    8E7A    0640  0696 #0818
RACOD   00C4   #0040
RATE    04CD   #0115  0219  0238  0241  0244
RDBPTR  8EE3    0617  0644  0700  0761 #0896
```

SYMBOL TABLE

```
RDBUF  04C9    #0113  0772  0773  0896  0898
RDDMA  8E0C     0612  0636  0693 #0760
RDMDMA 8D9A    #0695  0743
RDMSC  8D8D    #0690
RDMO1  8DAC    #0703  0705
RDMO5  8DB4    #0706  0751
RDM1   8DA4     0691 #0700
RDSEC  8D29    #0633
RDS1   8D44     0634 #0644
RDS2   8D36    #0638  0667
RDS3   8D39     0615 #0639
RDS4   8D3C    #0640  0641
RDTKO  8D19    #0621  0625  0627
RDTRK  8CFB    #0609
RDT1   8D0E     0610 #0617
RECOD  0000    #0034
REST   895B     0215 #0219
RESTED 8977    #0230  0232  0639  0648  0674
RESTEE 8971     0222  0225 #0227
RETRY  04CE    #0116
RRDMA1 8D9D    #0696  0697
RSCOD  0080    #0037  0637  0645  0694  0701
RSTOR  8956     0213 #0217
RTCOD  00E4    #0041  0613  0618
S      0008    #0050  0425
SECCNT 8EB8     0635  0664 #0867
SECTK5 04C4    #0108  0163
SECTK8 04C5    #0109  0170
SEC1   8EC3     0841  0857  0869 #0871
SEEK   8938    #0205
SEEKNV 8982     0187 #0238
SELCTD 8C8B     0521 #0571
SELCT1 8CD6     0575 #0587
SELCT2 8CD9     0577 #0588
SELCT3 8CDC     0582 #0589
SELCT4 8CB6    #0560  0584
SELECT 8CBC    #0573
SELFLG 04B0    #0090  0157  0552  0596
SETDMA 8E81     0760  0800 #0823
SETFLG 8CF0     0526  0553  0594 #0599
SETIRQ 8904     0160 #0179
SETIT  8DCA     0184  0206  0312  0609 #0715
SETMSC 8DC1     0690 #0712  0738
SETSEC 8DC7     0633  0662 #0714
SETUP  88C4     0133 #0150  0715
SFLAG  04C7    #0111  0426
SKCOD  0010    #0035  0214
SNGLCT 04BF    #0103
STFLG  04AD    #0087  0154  0176  0233  0498  0507  0716
STUP1  88EC     0165 #0167
SW2    MACR
SW3    MACR
TABLE5 04CF    #0118  0319
TABLE8 04DF    #0120  0313  0316
TEMP   04A4    #0079
```


SYMBOL TABLE

```
TEMP2  04A6    #0080  0555  0558  0794  0796
TKTBL  8EB7     0854 #0863
TONEXT 8DDB     0704 #0725  0749
TUNDEL 04C8    #0112  0224
T5     889A    #0145
T8     88AA    #0146
UCYL   04B3    #0093  0186  0196  0197  0205  0210  0352  0391
UDRV   04B4    #0094  0207  0523  0545  0574  0587
USIDE  04B2    #0092  0353  0392  0524  0542  0576  0588
V      0004    #0048
WA     MACR
WAIT   8CA6     0527 #0554
WAITS1 8BE2    #0442  0443
WAITS2 8BE9    #0446  0447
WAITO  8CAC    #0556  0559
WHTK   8EA6     0611 #0848
WRBUF  04CB    #0114  0805  0808  0903  0905
WRMSO  8E02    #0748  0750
WRTDMA 8E59     0665  0741 #0800
WRTFLG 04AF    #0089  0221  0223  0323  0900  0908
WRTMSC 8DEA    #0738
WRTM1  8DFA     0739 #0745
WRTPTR 8EF1     0670  0745  0801 #0903
WRTRK  8994     0190 #0312
WRTRK1 8997    #0313
WRTRK3 89AC    #0324
WRTSEC 8D61    #0662
WRT1   8D70     0663 #0670
WSCOD  00A0    #0038  0666  0671  0742  0746
WSFM   8B35    #0389  0404
WSFMO  8BBF     0403 #0406
WSMFM  8A1B    #0344  0372
WTCOD  00F4    #0042  0324
WTDON  8AFB     0375 #0377  0379
WTDOND 8AF9     0364 #0376
WTDONS 8AF5    #0374  0406
WTFM   8B04     0331 #0382
WTMFM  89C1     0330 #0334
WT5FM  8B28     0382 #0387
WT5MFM 8A04     0334 #0340
WY     MACR
W1     MACR
W2     MACR
W3     MACR
 NARG  ****
```

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE / APPROVED
	A	1. IN TITLE BLOCK, WAS... DISC ℄ MICROFLEX...	3-8-82 GRAHAM, RLG 4-14-82

NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE 1/4W ±5%
2. ALL CAPACITORS ARE ±20%
(5) SELECT FROM: FOLLOW: NO. 66.5K, 69.8K, 73.2K, 76.8K, 80.6K.

4. JUMPERS (E1, E2, E3) & SHUNTS (JB1 & JB2) ARE SHOWN IN FACTORY INSTALLED CONFIGURATION.
(5) Z10 (R2332) NOT USED ON -021 & -031 CONFIGURATION.

REF. DES.	PART NO.	+5V	GND
Z1	WD1691	20	10
Z2	74LS629	16	8
Z3	WD2143	18	9
Z4	74121	14	7
Z5	7416	14	7
Z6	FD1793	21	20
Z7	74LS03	14	7
Z8	74LS15	14	7
Z9	74LS74	14	7
Z10	R2332	24	12
Z11	74LS273	20	10
Z12	7416	14	7
Z13	74LS74	14	7
Z14	74LS00	14	7
Z15	74LS32	14	7
Z16	74LS10	14	7
Z17	7404	14	7
Z18	63S140	16	8
Z19	74LS240	20	10
Z20	74LS240	20	10
Z21	74LS04	14	7
Z22	74LS74	14	7
Z23	74LS74	14	7
Z24	74LS240	20	10
Z25	74LS533	20	10

PARTS LIST								
QTY REQD	QTY REQD	QTY REQD	QTY REQD	QTY REQD	MEAS UNIT	ITEM NO.	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .XX = ± .03, .XXX = ± .010; ANGLES ± 30'

MATERIAL:
HEAT TREAT
FINISH

AUTHORIZATION NO.
DR BY Robert Schmoyer
CHK BY
APPD BY
APPD BY 6-16-81

ROCKWELL INTERNATIONAL CORPORATION
ELECTRONIC DEVICES DIVISION — MICROELECTRONIC DEVICES
3310 MIRALOMA AVE., ANAHEIM, CA 92803

SCHEMATIC - FLOPPY DISK CONTROLLER RM65

SIZE	CODE IDENT NO.	DRAWING NO.
F	34576	PA10-X401

SCALE | SHEET 1

DASH NO.	NEXT ASSY	USED ON
	APPLICATION	