

**RM 65 FAMILY**

**FLOPPY DISK  
CONTROLLER  
(FDC) MODULE**

**USER'S  
MANUAL**

**RM 65 FAMILY**

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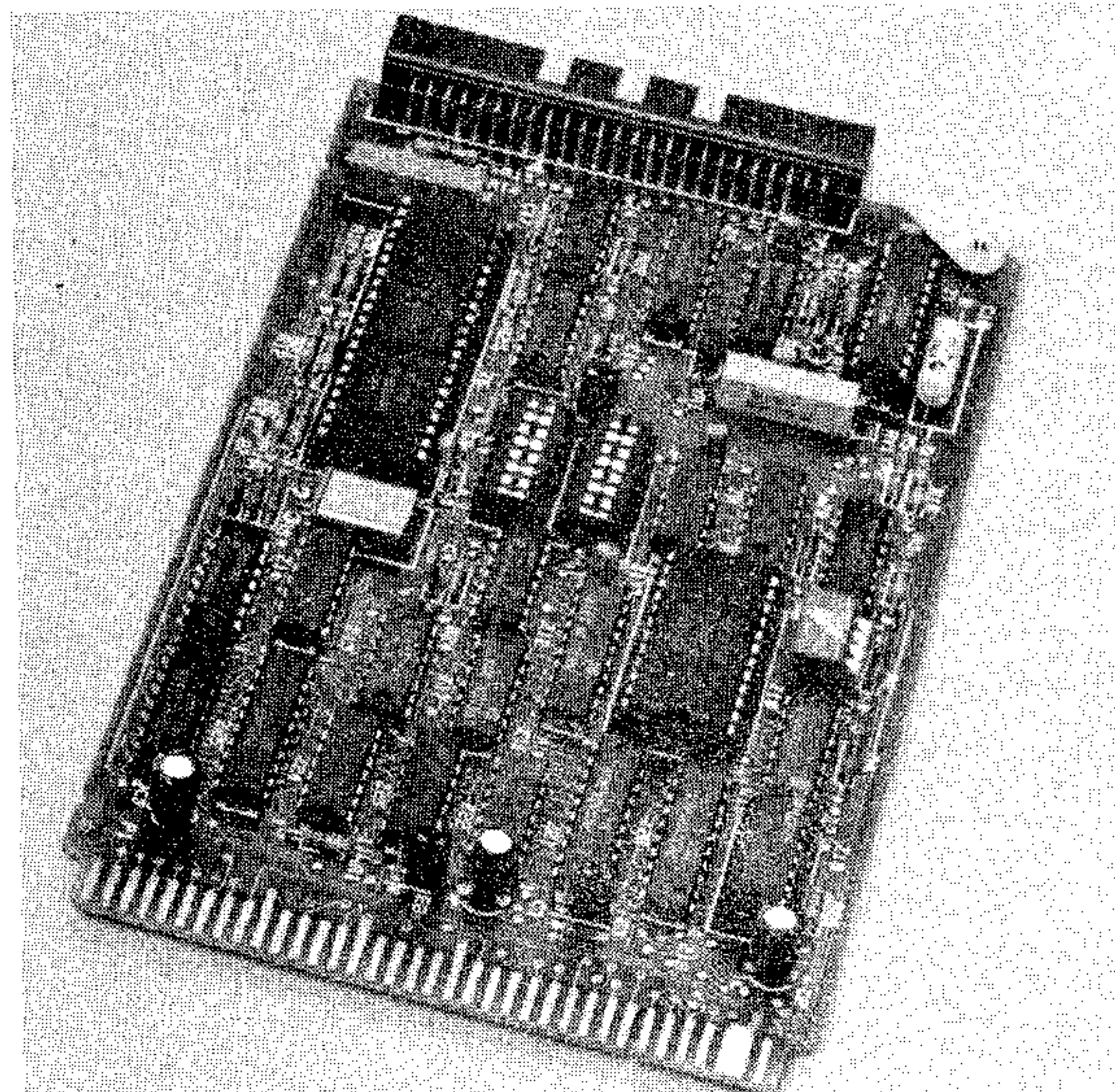
INTRODUCTION

1.1 PURPOSE/FUNCTION

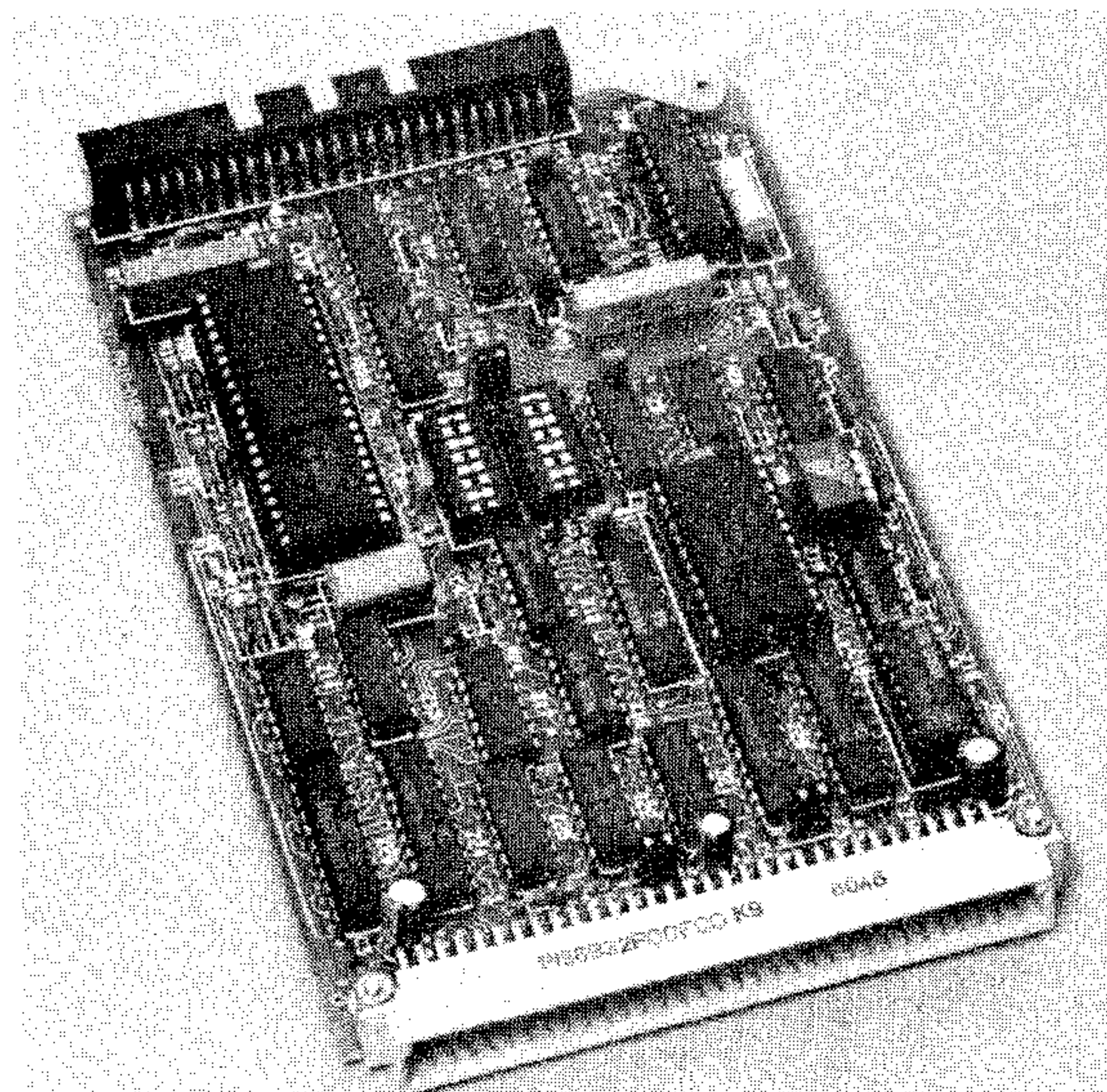
The RM 65 Floppy Disk Controller (FDC) module supports an AIM 65, AIM 65/40 or RM 65 SBC based system with floppy disk mass storage capability. The FDC module controls up to four standard (8") or mini-(5-1/4") floppy disk drives, single- or double-sided, soft sectored with either single-density (FM) 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
<b>Dimensions (see Figure 1-2)</b>	
<b>Edge Connector Version</b>	
Width	3.9 in. (100 mm)
Length	6.5 in. (164 mm)
Height	0.56 in. (14 mm)
Weight	4.8 oz. (130 g)
<b>Eurocard Version</b>	
Width	3.94 in. (100 mm)
Length	6.30 in. (160 mm)
Height	0.56 in. (14 mm)
Weight	5.2 oz. (140 g)
<b>Environment</b>	
Operating Temperature	0°C to 70°C
Storage Temperature	-40°C to 85°C
Relative Humidity	0% to 85% (without condensation)
<b>Power Requirements</b>	
	+5 Vdc ± 5%
	600 mA (3.2 W) - typical
	900 mA (4.8 W) - maximum
	+12 Vdc ± 5%
	60 mA (0.76W) - typical
	100 mA (1.26W) - maximum
<b>Interface Connector P1</b>	
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)
<b>Module I/O Interface J1</b>	
	50-pin mass terminated (0.100 in. centers). Mates with T&B/Ansley Part No. 609-5001M or equivalent.
<b>NOTES</b>	
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.	

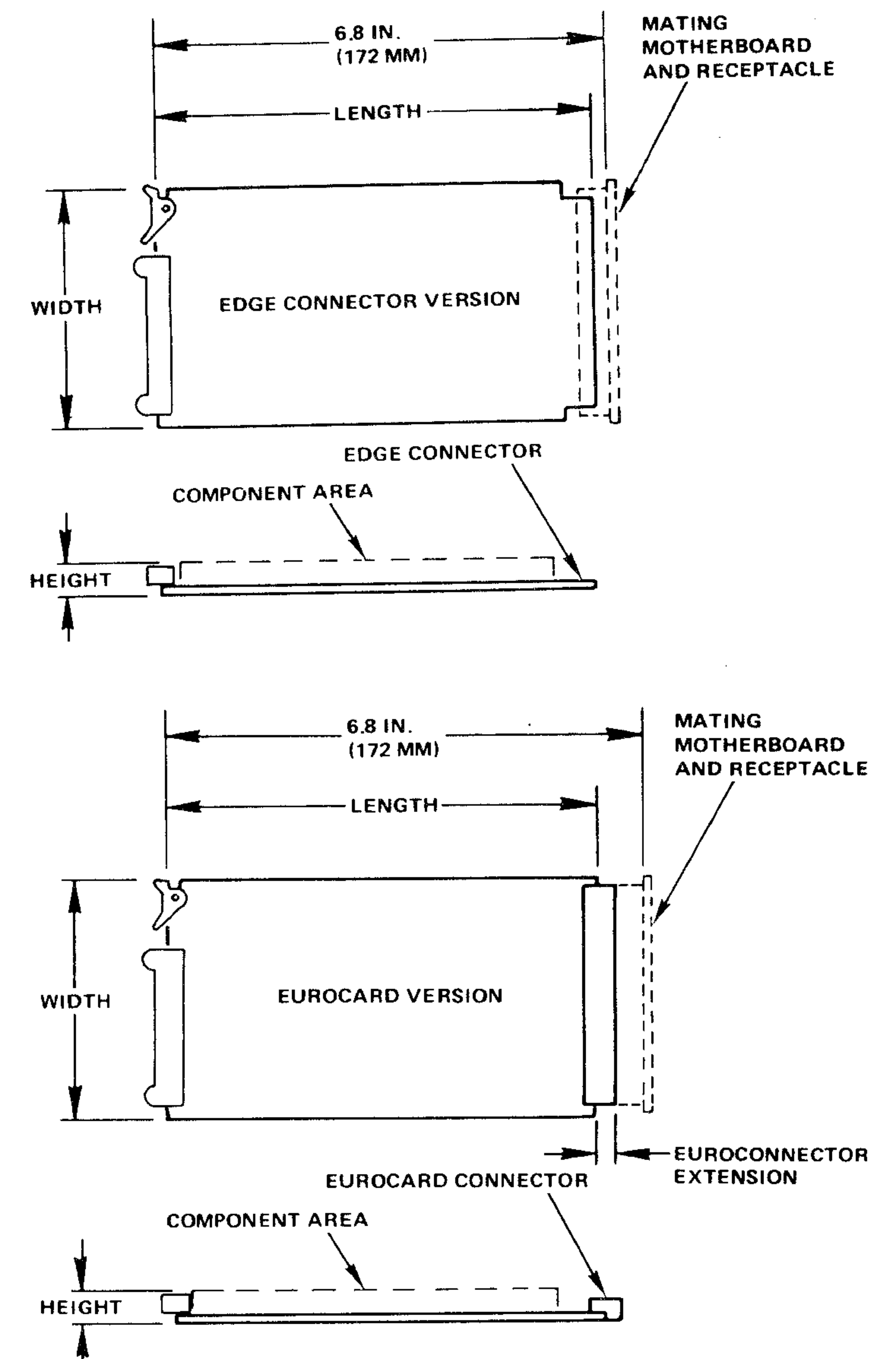


Figure 1-2. FDC Module Outline

#### 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	Section 2.2.3 Table 2-4
	S1-3	I/O Selection	
	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

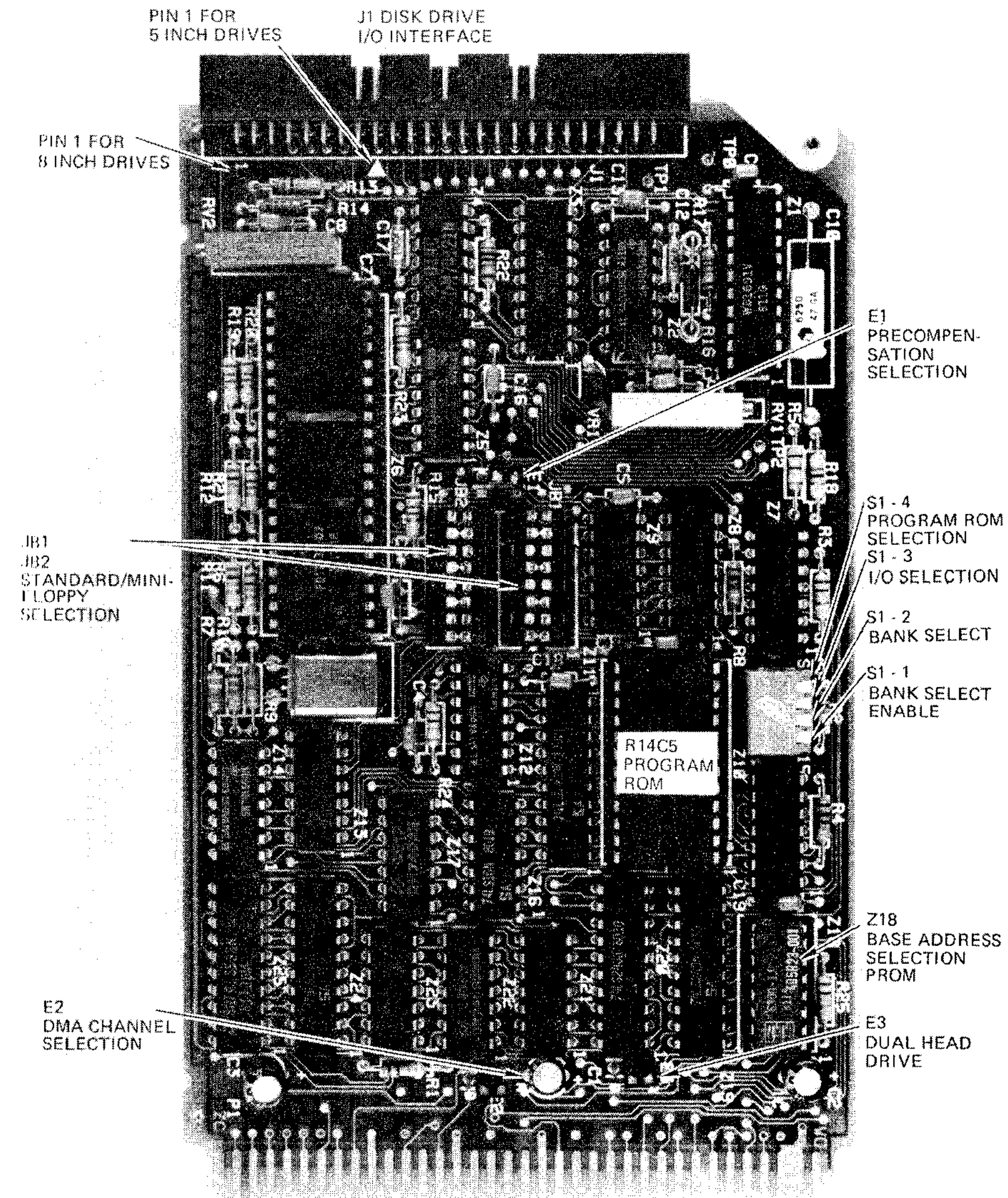


Figure 2-1. FDC Module Detail



### 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
0	0	X	X	X	X	X	X	1	1	X	X
0	1	0	X	X	X	X	X	1	1	X	X
0	1	1	0	X	X	X	X	1	1	X	X
0	1	1	1	0	0	0	0	0	1	X	X
0	1	1	1	0	0	0	1	1	0	X	X
0	1	1	1	0	1	X	X	1	0	X	X
0	1	1	1	1	X	X	X	1	0	X	X
1	X	X	X	X	X	X	X	1	1	X	X

NOTES

- X is a don't care level.
- PROM inputs A to H correspond to RM 65 signals BA8/ to BA15/, respectively.
- PROM outputs D1 and D2 correspond to device selects  $\overline{\text{FDC}}$  and  $\overline{\text{ROM}}$ , respectively.
- PROM outputs D3 and D4 are not used.
- 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 0 and Bank 1) or to be dedicated to a selected memory bank (either Bank 0 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 0 and Bank 1, or dedicated to Bank 0.

Table 2-3. Bank Select Switch Positions

Memory Bank Selected	Switch Position	
	Bank Select Enable Switch S1-1	Bank Select Switch S1-2
Bank 0 and 1	OPEN	EITHER
Bank 0 (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

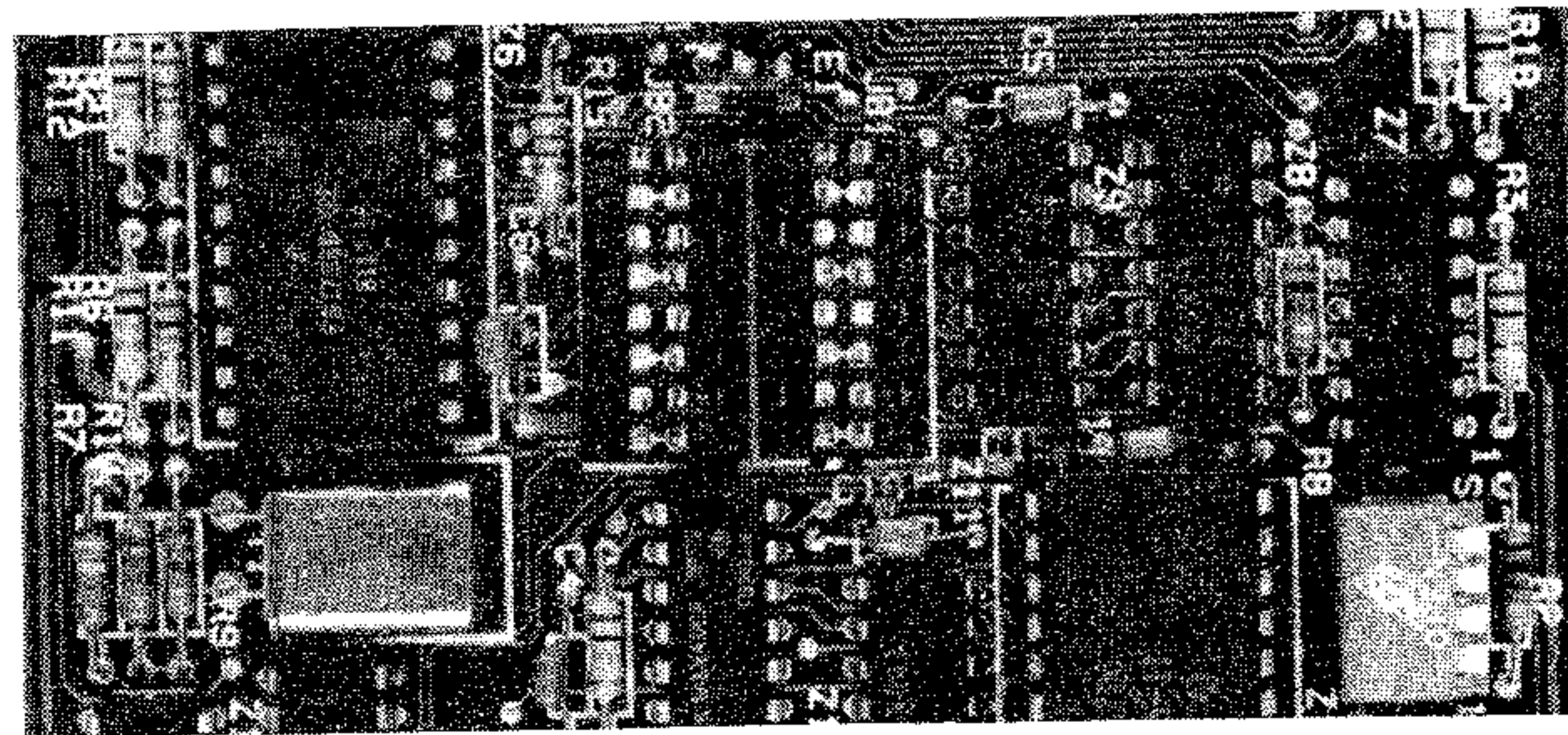
### 2.2.5 Standard/Mini-Floppy Selection

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).

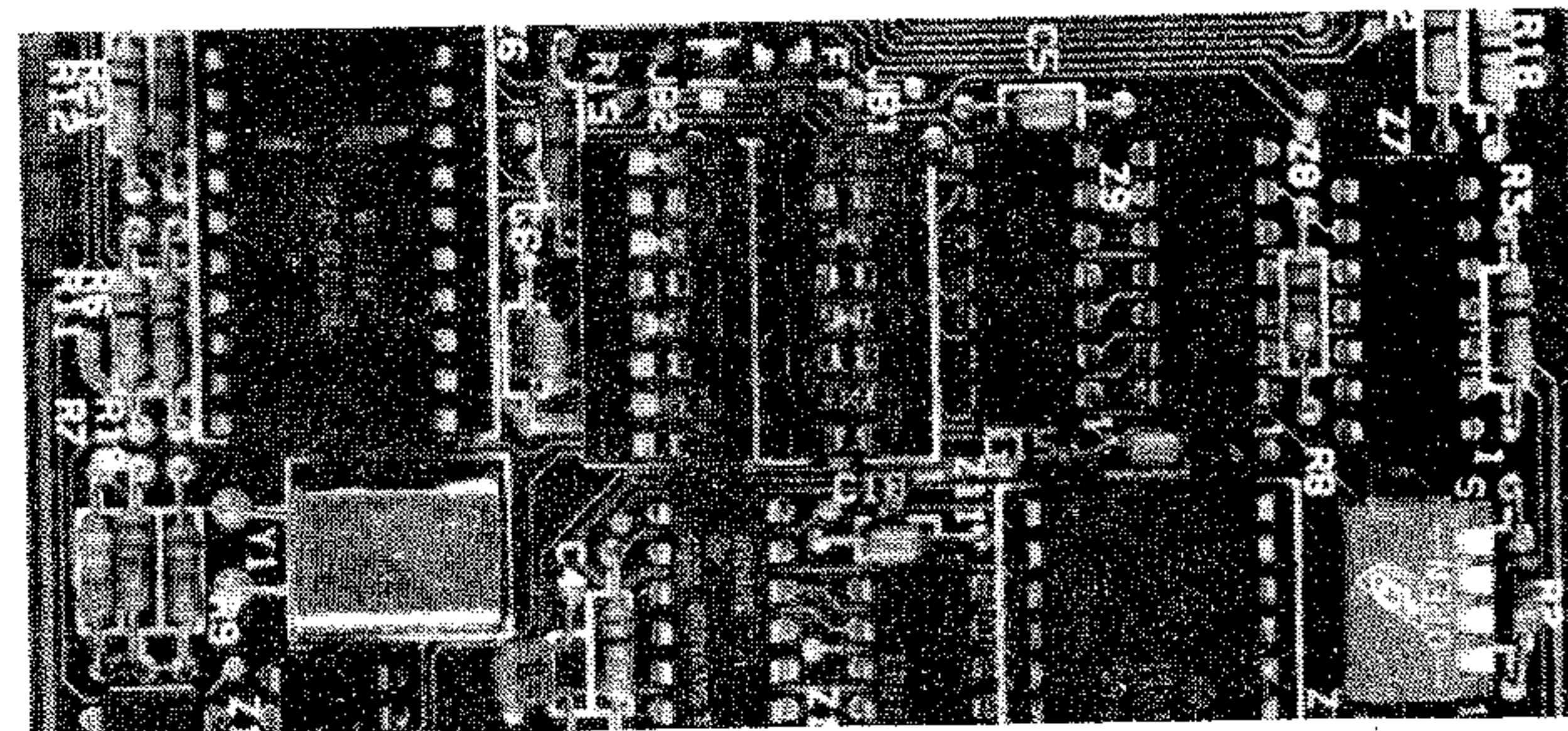
In the 5" Position (see Figure 2-2a), pins 1, 3, 5, and 7 of headers JB1 and JB2 are shunted to the opposite pins 10, 12, 14, 16, with the remaining pins left open. In this mode, the FDC module is configured for mini-floppy disk operation, with only 34 pins on the I/O connector used. Signals re-assigned 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 0).

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 50 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	
		SHUNT	OPEN	SHUNT	OPEN
JB1	1, 16	SHUNT	Drive Status Buffer - logic 0 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
JB2	7, 10	SHUNT	2nd Side Select - pin 48 (32) of J1	OPEN	2nd Side Select - pin 14 of J1
	8, 9	OPEN		SHUNT	
	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	
NOTE	5, 12	SHUNT	Drive Ready - always active	OPEN	Drive Ready - pin 22 of J1
	6, 11	OPEN		SHUNT	
	7, 10	SHUNT	Index Hole - pin 24 (8) of J1	OPEN	Index Hole - pin 20 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.

CALIBRATION TEST FOR RM 65 FDC MODULE (CONTINUED)

- 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=#8B03
FDAR=#8F03
FORFLG=#4BB
FSTOP=#8F15
*=#0000
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
    
```

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.