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Model 990 Computer

Model FD800 Floppy Disc System Installation and Operation

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Note: The portion of the text affected by the changes is indicated by a vertical bar in the outer margins of the page.

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Total number of pages in this publication is 64 consisting of the following:

PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.	PAGE NO.	CHANGE NO.
Cover	1	3-13 - 3-14	1		
Effective Pages	1	4-1	0		
iii - iv	0	4-2	1		
v - viii	1	4-3 - 4-6	0		
1-1 - 1-8	1	Appendix A Div	0		
2-1 - 2-12	1	A-1	0		
3-1 - 3-4	0	A-2 - A-4	1		
3-5	1	Alphabetical Index Div	0		
3-6	0	Index-1 - Index-4	0		
3-7	1	User's Response	1		
3-8 - 3-9	0	Business Reply	1		
3-10	1	Cover Blank	0		
3-11 - 3-12	0	Cover	0		

PREFACE

This manual provides installation procedures, interface requirements, programming information, and operating instructions for the FD 800 Floppy Disc, a reliable, random access storage I/O peripheral for the Texas Instruments Model 990 Computer Family.

Texas Instruments provides personnel to install, interface, and/or maintain the Floppy Disc System. A companion manual *Model 990 Computer Floppy Disc Controller Maintenance Manual* is available for customers desiring to provide their own depot-level maintenance.

This manual is organized into four sections and one appendix including:

I General Description – Provides a general description of the FD 800 Floppy Disc System and the assemblies of the system.

II Installation – Describes details of unpacking, mounting, and cabling for installation of the Floppy Disc System.

III Programming – Provides interface data necessary for generating software for the requirements of the particular installation.

IV Operation – Describes loading, controls, and procedures for operating the Floppy Disc System.

A Diskette Formatting – Describes standard formatting of diskettes.

The following publications contain additional information related to the FD 800 Floppy Disc and Computer-Controllers.

Title	Part Number
Model 990 Computer Floppy Disc Controller Maintenance Manual	945418-9701
Model 990 Computer TMS 9900 Microprocessor Assembly Language Programmer's Guide	943441-9701
Model 990/4 Computer System Hardware Reference Manual	945251-9701
Model 990/10 Computer System Hardware Reference Manual	945417-9701
Model 990 Computer Peripheral Equipment Field Maintenance Manual	945419-9701
990 Computer Family Systems Handbook	945250-9701
Model 990/10 Program Development System Operator's Guide	945256-9701

Title	Part Number
Model 990 Computer DX10 Operating System Programmer's Guide	945257-9701
Shugart Associates SA800/801 Diskette Storage Drive Maintenance Manual (Vendor PN 50575-2)	945960-9701
Shugart Associates SA800/801 Diskette Storage Drive Original Equipment Manufacturer's Manual (Vendor PN 50574-1)	945960-9702
Shugart Associates SA800/801 Diskette Storage Drive Theory of Operations (PN 50664-0)	945960-9703
Shugart Associates SA800/801 Diskette Storage Drive Illustrated Parts Catalogue (Vendor PN 50576-3)	945960-9704

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION IV. OPERATION

APPENDIXES

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I

DESCRIPTION

1.1 GENERAL

The Texas Instruments FD 800 Floppy Disc System provides the Model 990 Computer user an economical, random access, mass storage peripheral with exceptional utility and reliability.

The FD 800 has a standard IBM-formatted capacity of 2.0 megabits in a single-side diskette with a transfer rate of 250 kilobits per second, adjacent track step time of 8 milliseconds, and average rotational latency time of 83 milliseconds. The FD 800 Floppy Disc is contained in a single or dual configuration which mounts in a 7-inch panel height, EIA standard 19-inch rack. Figure 1-1 shows the dual floppy disc with indicator panel. Up to four disc units (two 7-inch panels) can be operated from one FD 800 Floppy Disc Controller.

Some features of the FD 800 Floppy Disc System incorporated for the Model 990 Computer user are:

- Operational capability for up to four disc drives.
- Internal on-board diagnostics.
- Positive write protect (ANSI standard).

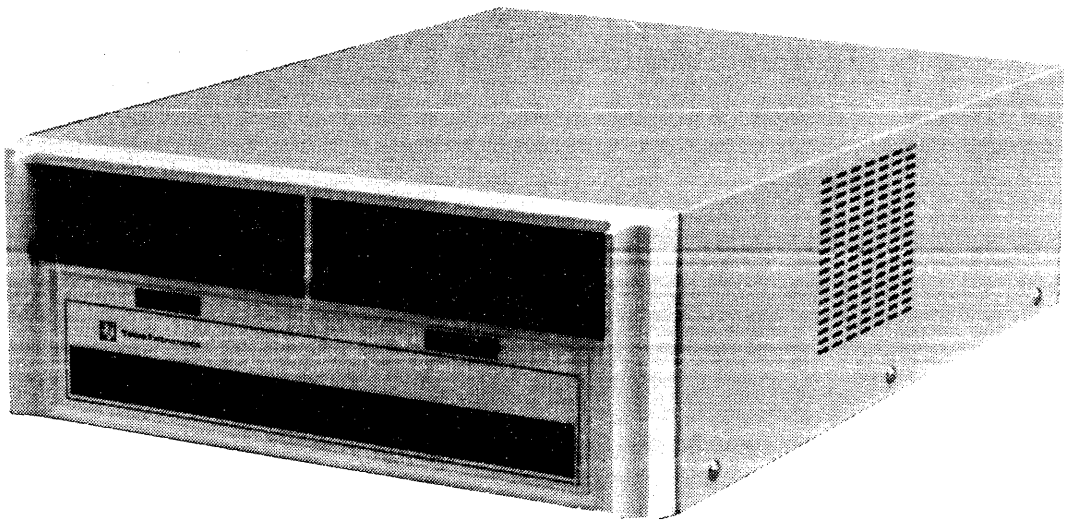

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Figure 1-1. Model FD 800 Floppy Disc

- Power failure detection to prevent data alteration.
- Cyclic redundancy error checking of sectors.
- Automatic head unloading whenever possible to minimize wear.
- IBM compatible formatting of records within tracks.
- Double sector buffering.
- Special software interface commands to allow simplified maintenance.

1.2 SYSTEM DESCRIPTION

The computer-floppy disc system configuration is illustrated by figure 1-2. The following paragraphs describe the functions of the floppy disc peripheral components.

1.3 COMMUNICATION REGISTER UNIT

The Texas Instruments Model 990 Computer is interfaced to peripheral equipment through its Communications Register Unit (CRU). Each peripheral requires a controller for data transfer between the peripheral and the computer. Status and control of the peripheral is accomplished via the CRU interface.

1.4 FLOPPY DISC CONTROLLER

The floppy disc controller handles all control, select, and status communications and data transfer between the computer and the floppy disc units. The controller is contained on a full-width printed circuit card that installs into the TI Model 990 Computer chassis. Data transfer to and from the disc is double-sector buffered (256 bytes) in the controller. See table 1-1 for floppy disc controller specifications.

1.5 FLOPPY DISC DRIVE UNIT

The floppy disc drive allows random access data storage and retrieval on a single, removable flexible disc commonly called a diskette. The media is 7.88 inches in diameter contained in an 8-inch square protective jacket. Read-write data rates of 250,000 bits per second are achieved at the 360 rpm disc drive speed. Read/write electronics, read/write head positioning, and drive control circuits are contained in the floppy disc drive assembly. See table 1-2 for a summary of floppy disc drive specifications.

1.6 FLOPPY DISC CHASSIS

The floppy disc chassis is a rack-mountable assembly in which one or two floppy disc drive units and their power supplies are mounted. Status indicators for READY, LOAD, PROTECT and POWER are located on the chassis front panel.

As indicated in figure 1-2, the FD chassis can be used either as a master chassis or an expansion chassis. Table 1-3 defines the components which make up the floppy disc peripheral system. The master floppy disc kit contains an FD chassis, dual disc-to-controller cable, status panel cable, controller and diskette(s). Figure 1-3 shows a master kit configured as a dual floppy drive system (with a secondary floppy drive unit installed alongside the primary drive unit). The expansion floppy disc kit contains FD chassis, quad disc-to-controller cable and diskette(s).

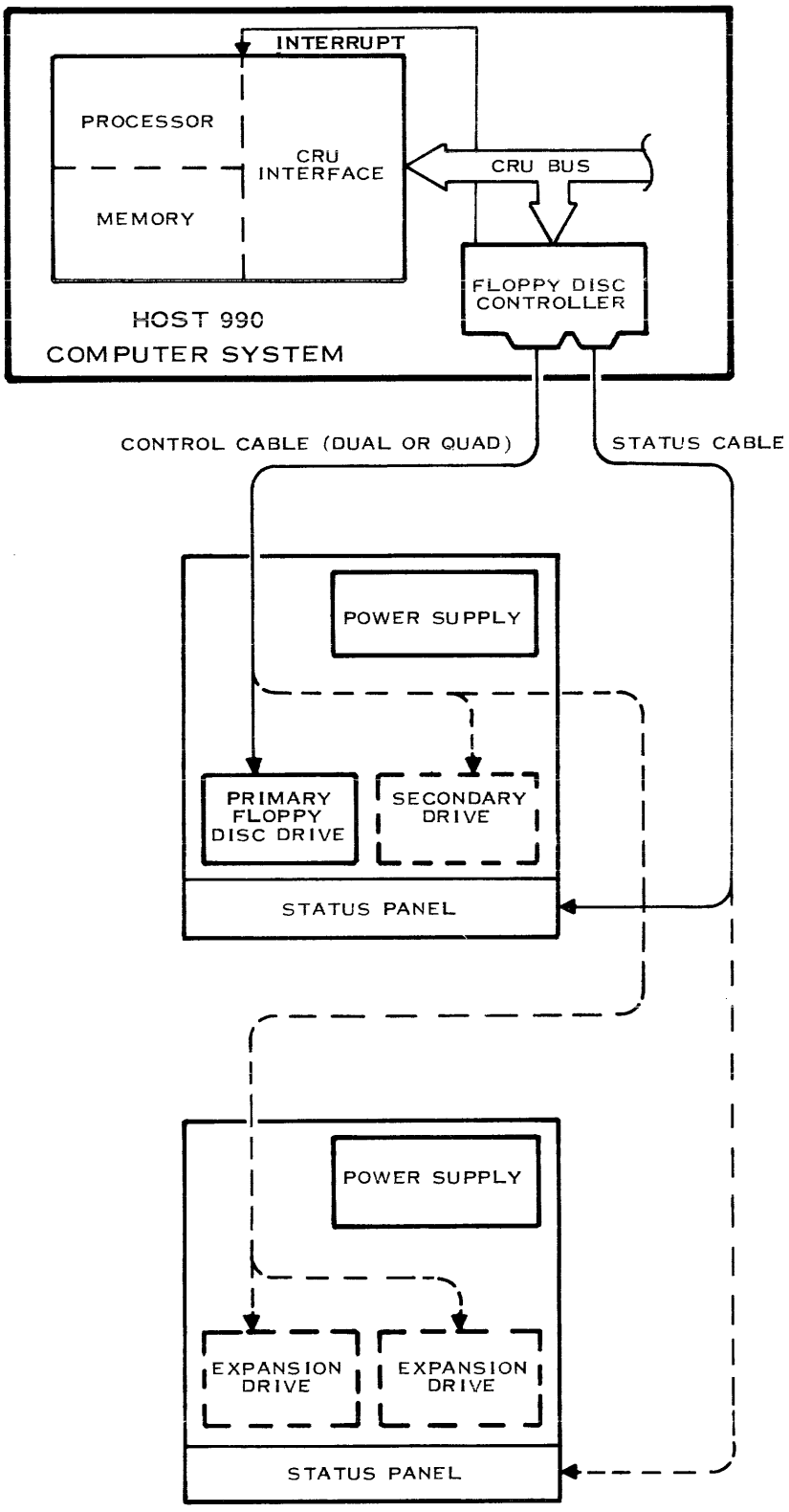

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Figure 1-2. Host Computer-Floppy Disc System Configuration

Table 1-1. Floppy Disc Controller Specifications

PHYSICAL

- Standard double width 990 PC board with ribbon cable connectors for connection to floppy units and chassis status panel
- Controls up to four flexible disc drives

FUNCTIONAL

- Features the TMS 9900 microprocessor with 512 word RAM for double sector data buffering and 2K words microprogrammed control and self-test in ROM
- On-board diagnostic LEDs for visual feedback of self-test results
- Handles 15 software commands for disc control and operation plus 8 commands for trouble-shooting and maintenance operations
- TI to IBM data format conversion utilities:
  - 128 bytes per sector
  - 26 sectors per track
  - 77 tracks per diskette
  - 3328 bytes per track
  - 256,256 bytes per diskette
- Cyclic redundancy error checking (CRC) of sector ID fields and data fields
- Write protect (ANSI standard) and power failure detection to prevent data alteration
- Firmware programmed retries for automatic error recovery
- Automatic head unloading when not accessing a drive to minimize media wear
- Serial data transfers from diskette at 500K bits per second (clocks and data in double frequency encloding) into RAM data buffer
- Serial 16 bit transfers of data, commands, and status between controller and host via the host computer CRU port

POWER REQUIREMENTS

+5.0 ± 0.1 Vdc @2.3A
+12.0 ± .1 Vdc @0.3A
-5.0 Vdc @0.01A

ENVIRONMENTAL

Operating Temperature – 32° to 126°F (0° to 52.2°C)
Storage Temperature – Minus 40° to 212°F (-40° to 100°C)
Operating Humidity – 5% to 85% R.H., noncondensing
Storage Humidity – 5% to 95% R.H., noncondensing
Maximum Altitude – 8000 ft. (2400m)

Table 1-2. Floppy Disc Drive Specification Summary

Performance Specifications

Capacity	Single Density
Unformatted	
Per Disk	3.2 megabits
Per Track	41.7 kilobits
Transfer Rate	250 kilobits/sec
Latency (average)	83 ms
Access Time	
Track to Track	8 ms
Average	260 ms
Settling Time	8 ms
Head Load Time	35 ms

Functional Specifications

Rotational Speed	360 rpm
Recording Density	
(inside track)	3200 bpi
Flux Density	6400 fci
Track Density	48 tpi
Tracks	77
Physical Sectors	
SA800	0
Index	1
Encoding Method	FM
Media Requirements	
SA800	SA100/IBM Diskette

Physical Specifications

Environmental Limits	50°F to 100°F
Ambient Temperature	50°F to 100°F
Relative Humidity	20% to 80%
Maximum Wet Bulb	78°F
AC Power Requirements	
50/60 Hz ±0.5 Hz	
100/115 VAC Installations	90 to 127 V @ .4A typical
200/230 VAC Installations	180 to 253 V @ .2A typical

DC Voltage Requirements
- +24 VDC ±5% 1.3A typical
- + 5 VDC ±5% 0.8A typical
- - 5 VDC ±5% .05A typical (option -7 to -6 VDC)

Mechanical Dimensions
- Width = 4.50 in. (11.43 cm)
- Height = 8.55 in. (21.71 cm)
- Depth = 14.25 in. (36.2 cm)
- Weight = 13.0 lbs. (5.9 kg)

Heat Dissipation = 245 BTU/hr. typical

Table 1-2. Floppy Disc Unit Specification Summary (Continued)

Reliability Specifications

MTBF:	5000 POH* under heavy usage. 8000 POH under typical usage.
PM:	Every 5,000 POH under heavy usage. Every 15,000 POH under typical usage.
MTTR:	30 minutes.
Component LIfe:	15,000 POH.
Error Rates:	
Soft Read Errors:	1 per 10^9 bits read.
Hard Read Errors:	1 per 10^{12} bits read.
Seek Errors:	1 per 10^6 seeks.
Media LIfe:	
Passes Per Track	3.5×10^6
Insertions:	30,000+

*POH denotes "power on hours".

Table 1-3. Floppy Disc System Components

Item	Part Number		
FD Controller Assembly	945940-0001		
Dual Controller Cable Assembly	945951-0001		
Quad Controller Cable Assembly	945952-0001		
Status Cable Assembly	945958-0001		
	115V, 60 Hz	**230V, 50 Hz**	**100V, 50 Hz**
Chassis with Status Panel, P/S, two Floppy Disc Drives	945989-0002	945989-0004	945989-0006
Chassis with Status Panel, P/S, one Floppy Disc Drive	945989-0001	945989-0003	945989-0005
Rackmount Option Kit			
with brackets	945996-0001		
with slides	945995-0002		
Table Top Kit	945991-0001		

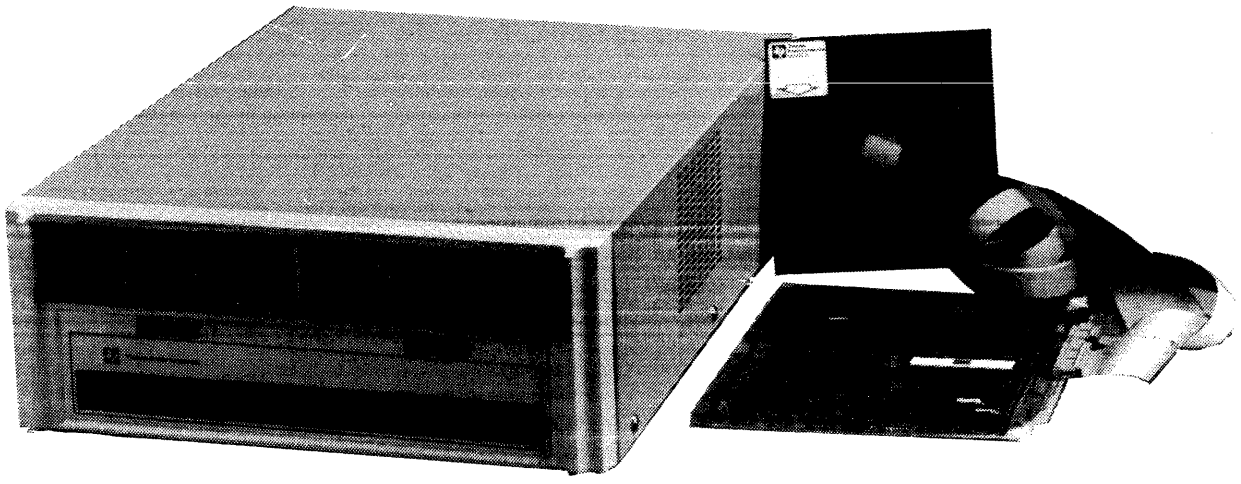

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Figure 1-3. Floppy Disc System

SECTION II

INSTALLATION

2.1 GENERAL

This section gives preparation, unpacking, mounting and cabling information for the FD 800 Floppy Disc and Controller installation. Diagnostic verification test procedures are also discussed.

2.2 PREPARATION

The FD 800 chassis mounts in an EIA standard 19-inch rack on drawer slides. It requires 7.0 inches panel height and 25 inches depth behind the panel. Shelf mounting is permissible, but alternate provision for covering the unit must be made. In either case, the rack or the shelf installation must accommodate clean, free-air flow to the chassis. These and other installation requirements are given in table 2-1.

2.3 UNPACKING

The FD 800 Floppy Disc chassis assembly is shipped on a plywood pallet in a corrugated cardboard container as illustrated by figure 2-1. The controller circuit board and interconnecting cables may be packed either in the same container or with the computer. Upon receipt of the FD 800, inspect the container for evidence of abuse during shipment. After preliminary inspection and after opening the container, visual inspection and parts inventory should be made.

Table 2-1. FD 800 Installation Requirements

Electrical, Per drive unit	90-110 VAC @ 1.2A 103-127 VAC @ 1.2A 208-253 VAC @ .6A
Dimensional	7 inches (17.8 cm) panel height 19 inches (48.3 cm) width 24 inches (61.0 cm) depth behind panel.
Weight (Dual configuration) Chassis w/power supply Floppy drive unit	45 pounds (20.4 kg) 19 pounds (8.6 kg) 13 pounds (5.9 kg)
Mounting	EIA standard 19-inch rack or table top
Environment	50°F (10° C) to 100°F (37.8°C) 20% to 80% relative humidity 78°F (25.6°C) max wet bulb.
Altitude	6000 feet (1800 meters)
Heat dissipation	340 BTU/hr (100 W) per drive (includes dc power provisions)

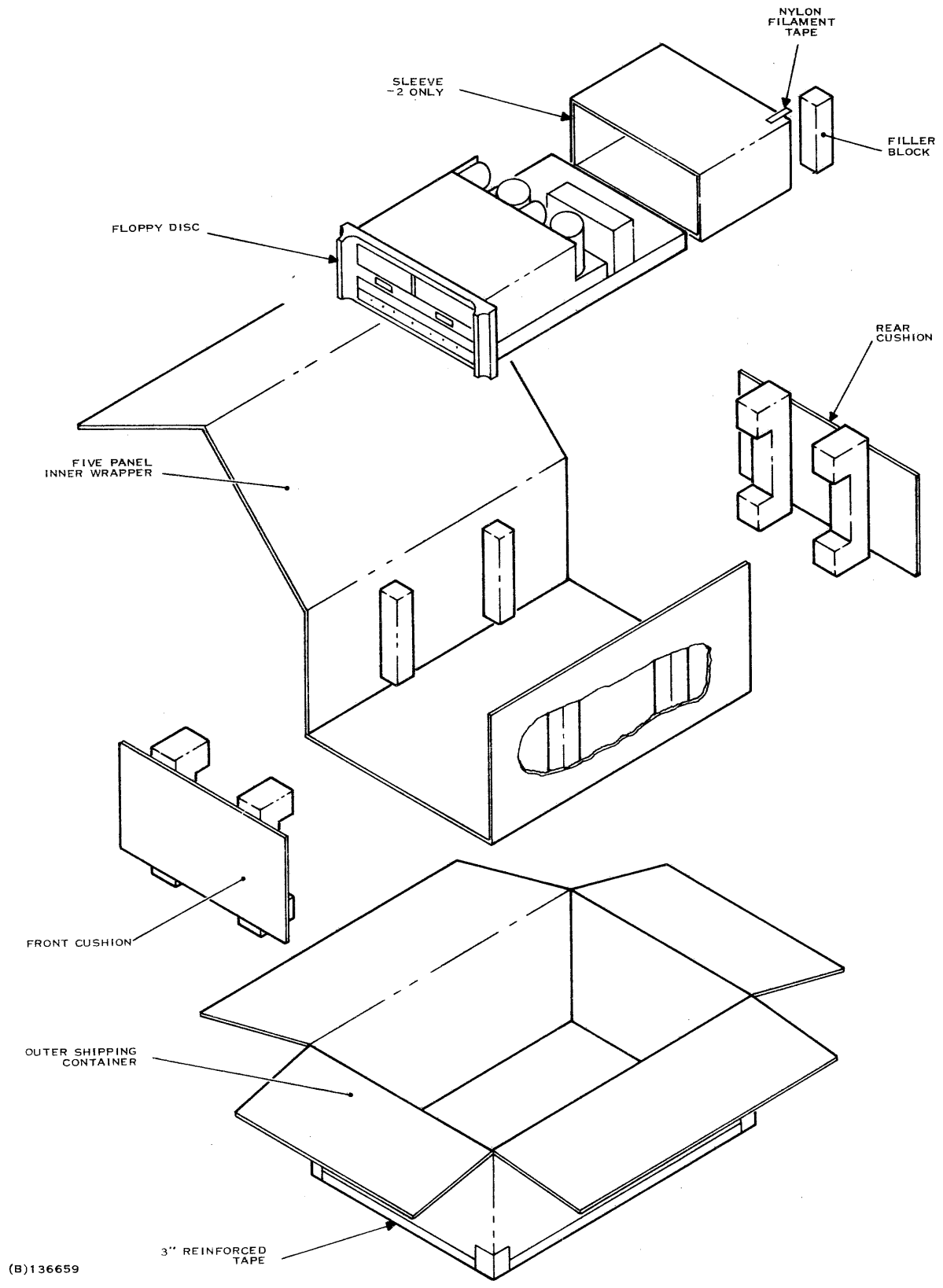

Figure 2-1. Floppy Disc Shipping Pack Illustration

WARNING

This equipment weight and form factor make it cumbersome. While following these instructions, observe proper lifting procedures to avoid back strain.

NOTE

Save the shipping cartons and packing materials for reshipment of the units, if required.

1. Position the container with address label on top side, open the top edge of the outer container, and remove the ethafoam corner pads.

2. Remove plastic bag(s) containing cables and controller circuit board, manuals and mounting hardware.

3. Open the inner box and remove inner packing sleeve and then the FD 800 mounted to its shipping pallet. The corners of the box may be slit open with a utility knife for this purpose, but take care not to scratch the finish on the unit with the knife blade.

4. Six screws attach the brackets of the shipping pallet to the unit. Remove three screws and washers on each side which attach the shipping pallet brackets and lift out the unit.

2.4 FD 800 CHASSIS MOUNTING

The following procedure is used to mount the FD 800 Chassis in an EIA standard rack.

NOTE

The dimension between the front and rear rack chassis mounting rails must be 24.25 ± 0.2 inches in order to install right angle chassis retainers.

1. The FD 800 Chassis is to be mounted on drawer slides which are provided in one of the packets from step 2 of 2.3 above. One each right-hand and left-hand drawer slide is provided.

2. Attach the drawer slides to the floppy disc chassis.

3. Install the mating slide tracks in the equipment cabinet.

4. Lift the chassis and engage the chassis drawer slides into rack drawer tracks. Then, with the FD 800 horizontally positioned, gently push the unit into place. The drawer slide retention springs should snap into place as the unit is pushed into the cabinet. Verify that the unit cannot be pulled free of the cabinet on the slide tracks.

5. The FD 800 may now be pushed into the cabinet until the front panel is against the cabinet rails. Attach the two magnetic panel edge strips to the cabinet vertically, beside the disc drive unit.

6. Install the right angle chassis retainers at the rear of the cabinet and fasten the clamp to the chassis. Refer to figure 2-2. The chassis then cannot be extended from the rack.

2.5 FD 800 CONTROLLER-COMPUTER INTERFACE

Depending upon the computer configuration the FD 800 Controller circuit board may be installed either in the Model 990 Computer main chassis or in a 990 computer expansion chassis. In either case, the 990 Computer must be installed and operational.

Refer to the *Model 990/4 Computer System Hardware Reference Manual* or the *Model 990/10 Computer System Hardware Reference Manual* for computer installation and operation instructions.

When the floppy disc is a specified peripheral of an original computer system configuration, the FD Controller normally is factory-installed, and the following FD Controller installation instructions may be ignored. When the floppy disc is to be added to an existing Model 990 Computer, the following instructions are applicable.

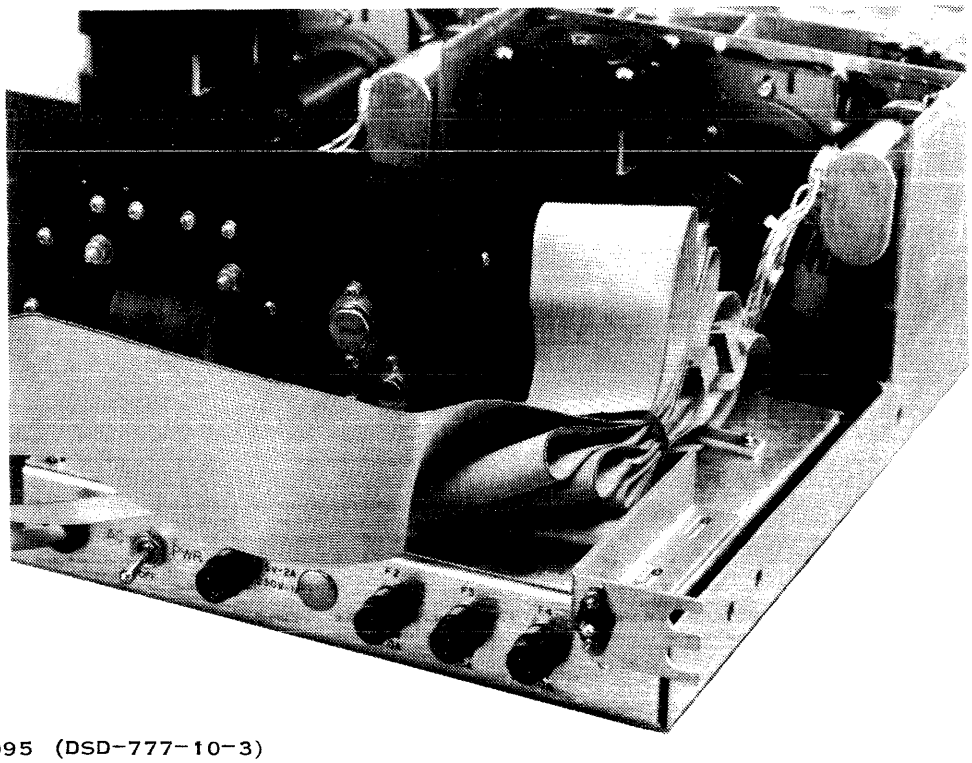

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Figure 2-2. Drawer Slide Track Mounting

NOTE

The FD 800 standard chassis locations are slot 4 for 6-slot and slot 11 for 13-slot chassis configurations of the Model 990 computers. Interrupt level 7 and CRU address 0080 are the standard assignments. If, for a specific application, locations and/or interrupt assignments are nonstandard, refer to the CRU and interrupt installations procedures of the computer system hardware reference manual. (See Preface for publications list.)

After determining its location, the controller card is installed as follows:

1. Verify that the computer chassis power is "off".
2. The card has two pivoted plastic card ejectors on the outside edge. Take hold of the card near these card ejectors, so that the component side is up.
3. Insert the card (component side up) into the card guides at the assigned location.
4. Verify that the card edge connectors will engage their mating motherboard CRU connectors and firmly press the card into place.

2.6 CONTROLLER/FLOPPY DISC CABLES

The FD 800 is connected to the FD Controller with a 50-line ribbon cable and a split 20-line ribbon cable as shown in figure 2-3. The interface cable connectors and mating controller card edge plugs are not keyed. These connectors must be installed with the polarity identified by an embossed arrowhead near one end of the connector. These arrowheads must be aligned point-to-point for the mating connector pairs. See detail as shown in figure 2-3.

NOTE

The interface cable is provided with inline "daisy chain" connectors for either two or four floppy drive units. Plan the interface cable routing so that the end floppy drive connector is attached to the last floppy drive (the one with terminating jumpers T1 and T3-T6). When fewer floppy drives are employed than provisioned by the interface cable, the unused inline ribbon connectors should be rolled up and tied back to preclude accidental shorting of the connector pins to any chassis or other metal protrusions.

Dress the controller interface cable backward along the right side of the Model 990 Computer chassis, then to the rear of the floppy disc chassis. This cable should be routed under the cable clamp at the top side of the open chassis area of the first floppy drive unit.

The in-line daisy chain connector must be mated with the floppy drive card edge plug so that the red index stripe of the ribbon cable is oriented to pin 1 (the right end when viewed from the rear). The last floppy drive unit is connected to the end connector of the daisy chain interface cable. The ribbon cable should be twisted once or twice across the chassis to the second floppy drive unit in order to orient the red index stripe to pin 1 (the right end) of the floppy drive card edge plug as shown in figure 2-4. The third and fourth floppy drives (normally mounted just above the first two floppy drives) may be accessed through the slot in the chassis just below the card edge connector. The cable is then twisted across the floppy chassis maintaining the red

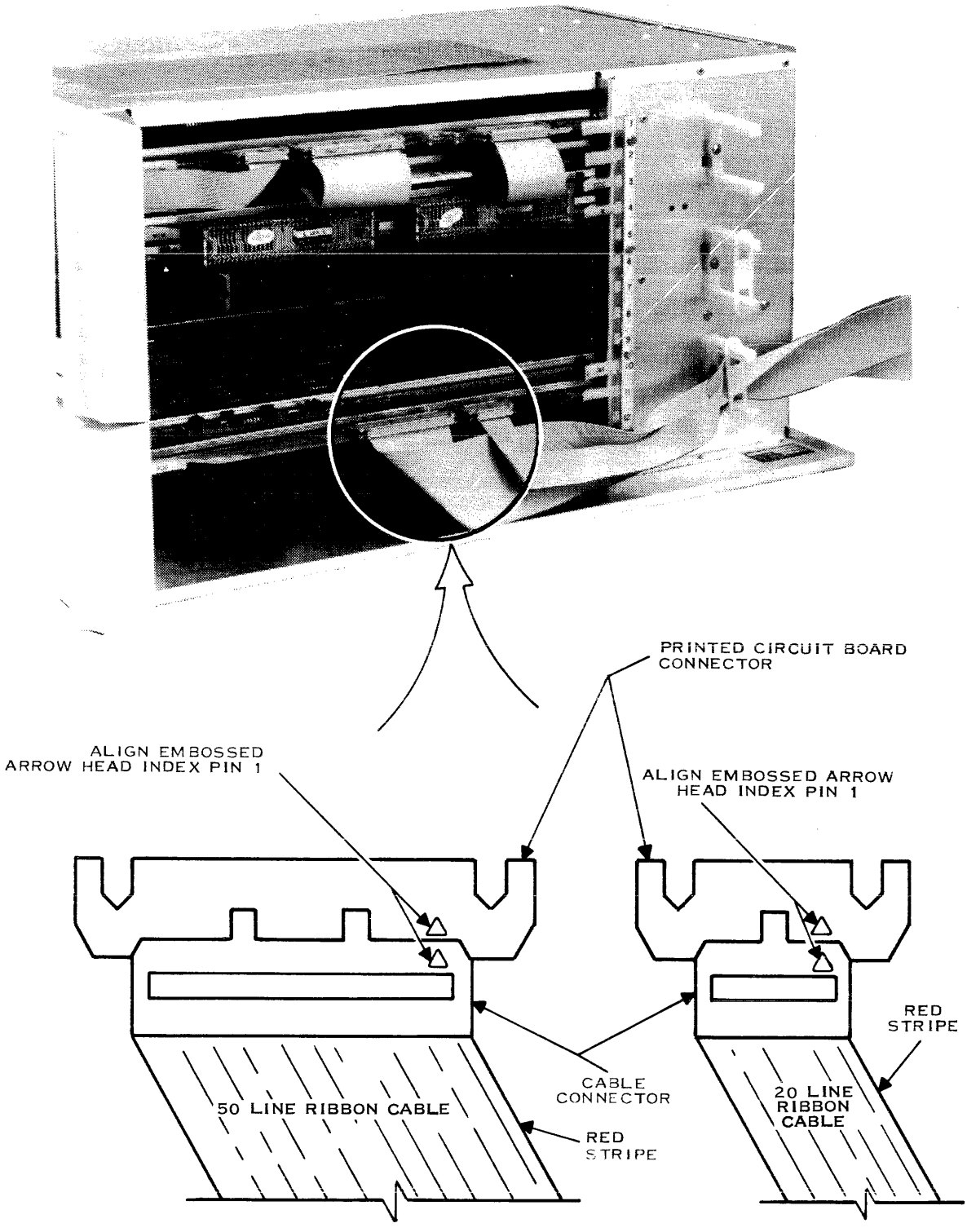

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Figure 2-3. Interface Cable Hookup to FD Controller

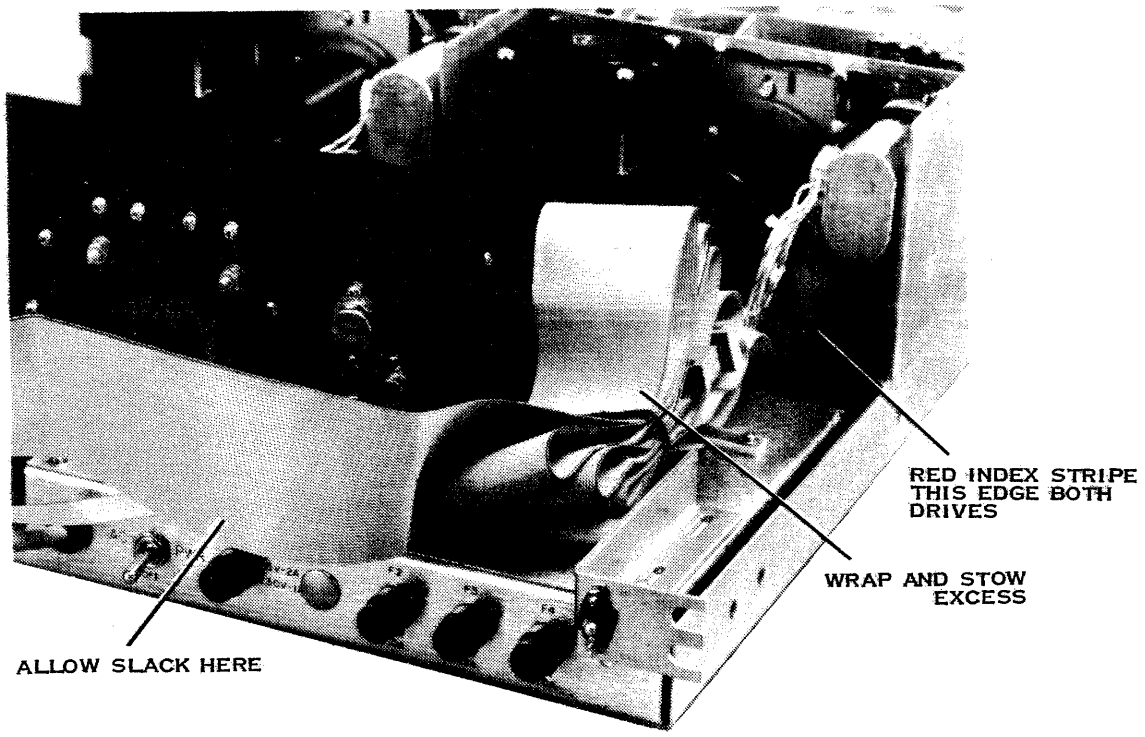

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Figure 2-4. Interface Cable Routing and Indexing to Floppy Drive Units

index stripe to the right as described above. When a fourth drive is not employed, the last connector in the control/data cable should be used, and excess cable should be rolled up and tied back as noted above.

The status cable is a split 20-line ribbon cable with a 20-pin connector which mates with the floppy disc controller and two 10-pin connectors which mate with the floppy disc status panels. This cable will accommodate up to four FD 800 disc drive units (two status panels). The status cable should be routed with the previously discussed control/data cable up to the point of the first floppy drive unit. Status cable number 1 (identified with "P2" marking on connector) is then routed through the slot under the floppy drive unit interface connector below the chassis and forward to its mating plug behind the indicator front panel. The status cable is terminated with two 10-pin connectors marked P2 and P3. The status cable # 1 terminated with connector P2 supplies the status panel below floppy drives #1 and # 2. The status cable terminated with connector P3 supplies the status panel below floppy drives #3 and #4.

2.7 LINE TERMINATION AND DRIVE SELECTION

Termination jumpers must be installed on the last floppy drive unit (most remote from the controller). The FD 800 Drive Unit has provisions for terminating five input lines (Direction, Step, Write Data, Write Gate, and Head Load) by jumpering terminals T1 and T3 through T6 on the drive unit printed circuit board. Install these five jumpers on the last floppy drive unit and remove them from all other floppy drive units. Stow the jumpers on one pin of the jumper pair for possible future use. Each drive unit must have a termination jumper on terminal T2 for the Drive Select input line. Figure 2-5 shows the jumpers as installed on a system with drive units that are located as shown in figure 2-6.

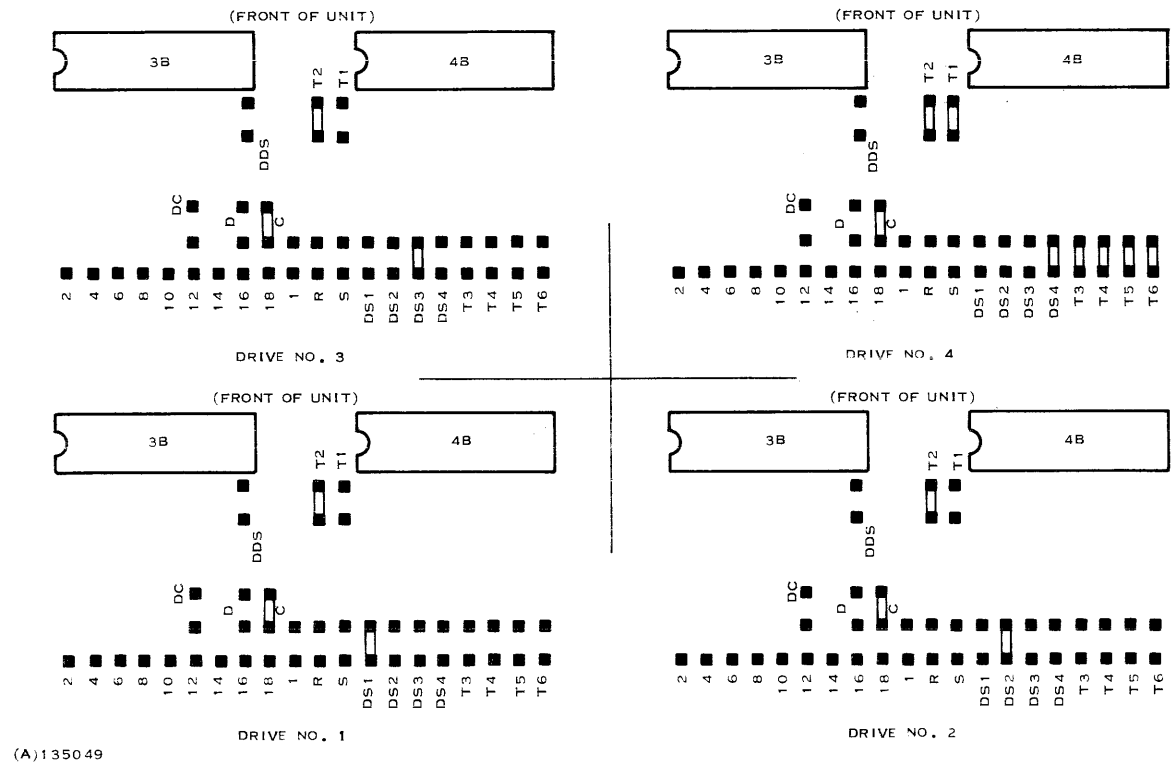


Figure 2-5. Line Termination and Drive Select Jumpers

The drive select (DS) function is jumpered on the floppy drive unit printed circuit board in the same manner as the terminator jumpers just described. The drive select jumpering is predicated on the floppy drive location relative to the status cable. Refer to figure 2-6 (illustration shows portions of the printed circuit board underneath each drive unit). When viewed from the front, the lower-numbered floppy is to the left. A maximum of four floppy drive units may be connected to the FD controller. Each floppy drive unit must be jumpered uniquely, corresponding to its location. No two units may have the same DS jumper number connection. Other jumpers used on all drives include: A, B, C, DS, Z, and one of the drive select positions (DS1, DS2, DS3, or DS4). Some drives may also come equipped with a jumper at L and at 800.

2.8 FD 800 POWER CONNECTION

Before proceeding with power application, a visual inspection should be made to verify that all power terminations and connections are properly made, and that wiring is intact and not damaged.

Power Connection Procedure:

1. Turn off the ac power switch on the rear of the FD 800 Chassis.

2. Verify that specified ac power voltage and frequency are available. The standard configuration is 60 Hz, 115 Vac, 3-wire grounded receptacle. (Options for 220 Vac and 50 Hz power are available. See equipment specifications.)

3. Untie the ac power cord bundled at the rear of the chassis and plug the cord into the provisioned ac outlet.

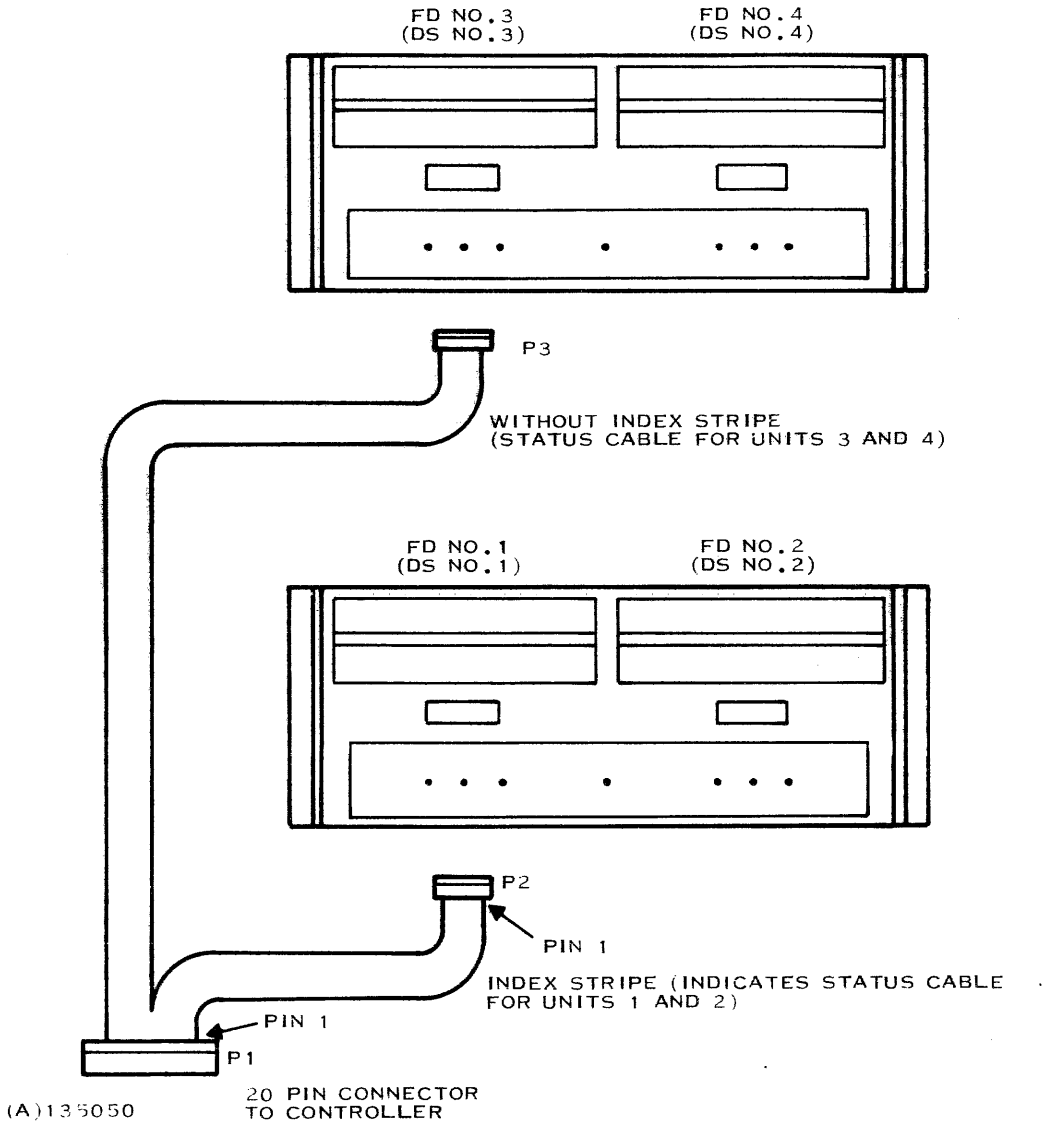


Figure 2-6. Drive Select Position Related to Status Cable Connection

2.9 SYSTEM POWER UP

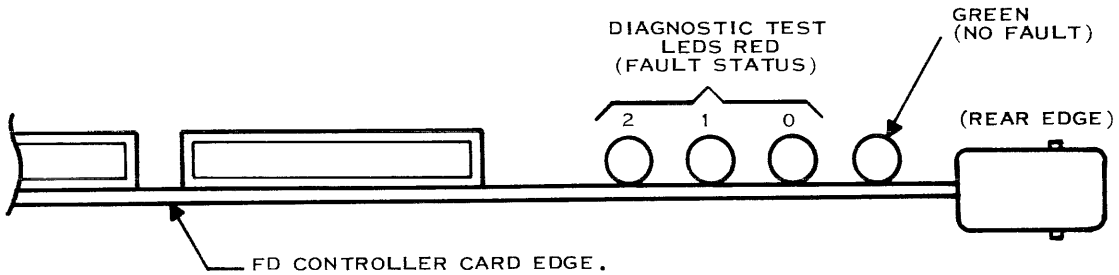
Check that all connections have been properly made between the FD controller and the FD 800 Drive Units, and that the interrupt functions have been provided by the computer interrupt programming plug as specified in the section on controller programming and in the referenced computer manuals. See Sections 1 and 3.

The line power key switch at the front of the Model 990 Computer and the line power switch at the rear chassis of the FD 800 Chassis may now be turned on.

2.10 FD CONTROLLER CHECKOUT

The controller has a diagnostic self-test program. The diagnostics are initiated by any one of four actions: 1) initial computer power-up, 2) I/O reset button on the Model 990 Computer panel (for those 990 computers so equipped), 3) software initiation of the RESET command, or 4) software initiation of power-up simulation. When the diagnostic tests are satisfied, the green OP COMPLETE LED is illuminated. Any failure of a diagnostic test will halt the test and display the failure mode on the three red LEDs as illustrated by figure 2-7.

If after power application, a fault status is indicated, turn the computer line power key switch off and back on. If the fault remains, the controller is inoperable and repair or replacement is required. Consult the nearest Texas Instruments Field Service office or refer to the *Model 990 Floppy Disc Controller Maintenance Manual.*



RED LED NO. 2	RED LED NO. 1	RED LED NO. 0	GREEN LED	FAULT STATUS
OFF	OFF	OFF	OFF	BOARD POWER, CLOCK, ROM, OR OTHER FAULT
OFF	OFF	OFF	ON	NO FAULT
OFF	OFF	ON	OFF	RAM FAILURE
OFF	ON	OFF	OFF	I/O CONTROL FAILURE
OFF	ON	ON	OFF	CRC DEVICE FAILURE
ON	OFF	OFF	OFF	BAD CRC ON WRITE
ON	OFF	ON	OFF	MARK DETECTION FAILURE
ON	ON	OFF	OFF	WRITE CIRCUIT FAILURE
ON	ON	ON	OFF	STATUS PORT OR MPU FAILURE

(A)135051

Figure 2-7. FD Controller Diagnostic Test Indicators

SECTION III

PROGRAMMING

3.1 GENERAL

This section describes the interface between the FD 800 Floppy Disc Controller and the 990 Computer and provides information that a programmer needs in order to generate software for a particular requirement. This presentation assumes that the reader is familiar with the programming section of the *Model 990 Computer Assembly Language Programmer's Guide;* therefore, only basic programming requirements are given here.

3.2 FLOPPY DISC INTERFACE

The CRU interfaces 32 addressable input bits and 32 addressable output bits between the floppy disc controller and the computer. When issuing any command or transferring any data word to the controller, a full 16 bits must be transferred, the first byte first and the second byte second. The 16 bits of status information are bit-addressable.

3.2.1 INPUT INTERFACE. The addressable input interface provides a two-byte (16-bit) READ data interface (data port) and a 16-bit status interface (status port) from the controller and disc drives. Figure 3-1 and table 3-1 define the computer input interface signals.

3.2.2 OUTPUT INTERFACE. The addressable output interface provides a two-byte (16-bit) parallel output WRITE data interface (data port) and a 16-bit command interface (command port). Figure 3-2 and table 3-2 define the computer output interface signals.

3.3 OPERATING MODES

Controller servicing can be accomplished in either an interrupt-driven mode or on a demand mode. The interrupt-driven mode is usually employed in multiprogramming monitors and operating systems. The demand mode with interrupts masked is often used in diagnostic and standalone programs. Data read from the disc (Read Data) is internally buffered by the controller, and data is not lost by failure to service interrupts or failure to check the status word.

3.4 FLOPPY DISC CONTROLLER COMMANDS

The floppy disc controller recognizes 23 commands from the CRU as outlined in table 3-3. The following paragraphs detail these commands.

All functions except CLEAR STATUS PORT return OP COMPLETE and INTERRUPT when a command is successfully completed. During a Read or Write sequence a Clear Status Port command is treated like a STOP command, and thus will return OP COMPLETE and INTERRUPT under those conditions. All data transfer sequences continue after the initial OP COMPLETE until stopped by another command. INTERRUPT is present without OP COMPLETE if an error status has been indicated by the controller.

3.4.1 SELECT. This command selects the specified unit and replies with OP COMPLETE and INTERRUPT. DRIVE NOT READY and/or WRITE PROTECT status are returned if detected.

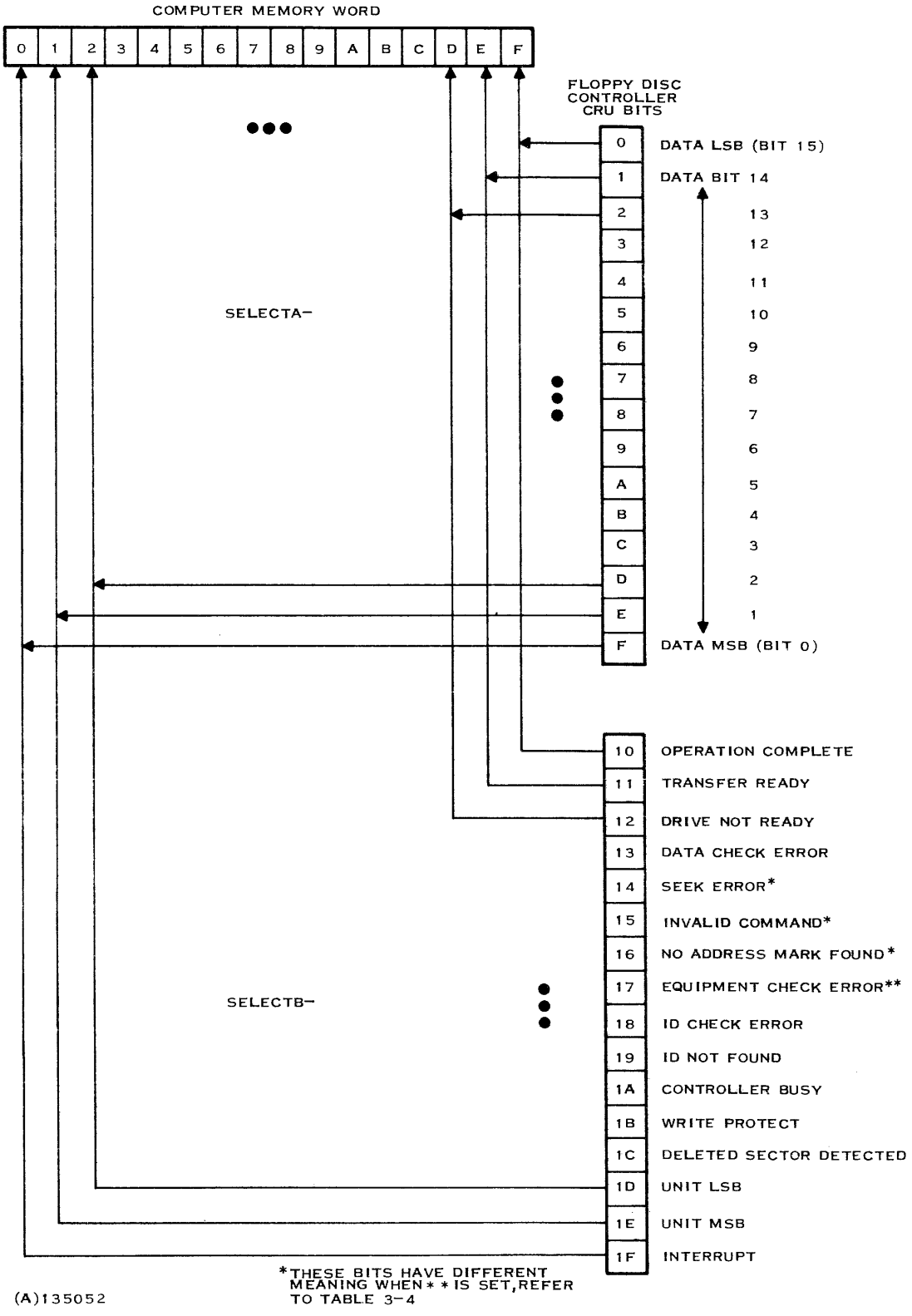


Figure 3-1. Computer Input from Controller

Table 3-1. Computer Input from Controller

Input Format Bit Number			Description
Base Sel.	CRU	Memory	
A	0	F	DATA (LSB)
– – – – through – – – –			– – – – through – – – –
A	F	0	DATA (MSB) These are the 16 bits of full-word data transfer.
B	10	F	OP COMPLETE This bit indicates a successful completion of any disc activity except for the CLEAR STATUS PORT command. It is coincident with INTERRUPT.
B	11	E	TRANSFER READY During all data transfer operations, this bit indicates that the controller is prepared to transfer a data word. It is coincident with INTERRUPT. A data or strobe command (LDCR/SBO/SBZ that affects bit F of base A or B) clears this bit.
B	12	D	DRIVE NOT READY This bit is present if the selected drive is not ready for any reason. It is coincident with INTERRUPT.
B	13	C	DATA CHECK ERROR Presence of this bit indicates that the CRC check failed on the data field. It is coincident with INTERRUPT.
B	14	B	SEEK ERROR This bit indicates that the track number could not be found during a SEEK or track switch operation. It is coincident with INTERRUPT.
B	15	A	INVALID COMMAND The controller sets this bit to indicate that it has received an invalid operation code. It is coincident with INTERRUPT.
B	16	9	ADDRESS MARK NOT FOUND The presence of this bit indicates that one of three types of address marks was not found (ID, DELETE DATA, or DATA). It is coincident with INTERRUPT.
B	17	8	EQUIPMENT CHECK ERROR This bit indicates that the controller's microprocessor has detected a controller error while running diagnostics or during command execution. It is coincident with INTERRUPT.
B	18	7	ID CHECK ERROR This bit indicates that a CRC check failed in the identification field or a valid ID is not found during an ID check. It is coincident with INTERRUPT.

Table 3-1. Computer Input from Controller (Continued)

Input Format Bit Number			Description
Base Sel.	CRU	Memory	
B	19	6	ID NOT FOUND An unsuccessful ID search after two revolutions is indicated by this bit. It is coincident with INTERRUPT.
B	1A	5	CONTROLLER BUSY This bit is set when any command is issued to the controller. It is reset immediately upon completion of all commands. A command issued when BUSY is present will terminate the previous command only when READ or WRITE is the previous command.
B	1B	4	WRITE PROTECT This bit indicates that commanded WRITE, FORMAT TRACK, or WRITE DELETED cannot be performed because the disc is write protected. It is coincident with INTERRUPT.
B	1C	3	DELETED SECTOR DETECTED This bit indicates that the last sector accessed in a READ or IPL command was found to contain a deleted sector Data Mark. If the sector occurs within a multiple sector call, data transfer is not completed. INTERRUPT is coincident with this indication.
B	1D	2	F.D. UNIT NUMBER (LSB)
B	1E	1	F.D. UNIT NUMBER (MSB) The floppy disc unit number whose status is being reported is expressed in binary format.
B	1F	0	INTERRUPT This bit indicates that an interrupt request exists in the floppy disc controller. It is set during data transfer operations to indicate that data is ready for transfer by the CPU. It is also set at the termination (complete or error) of any command activity except CLEAR STATUS PORT. It is reset by the issue of any controller command. This status bit is operational regardless of the state of the hardware interrupt mask flip/flop.

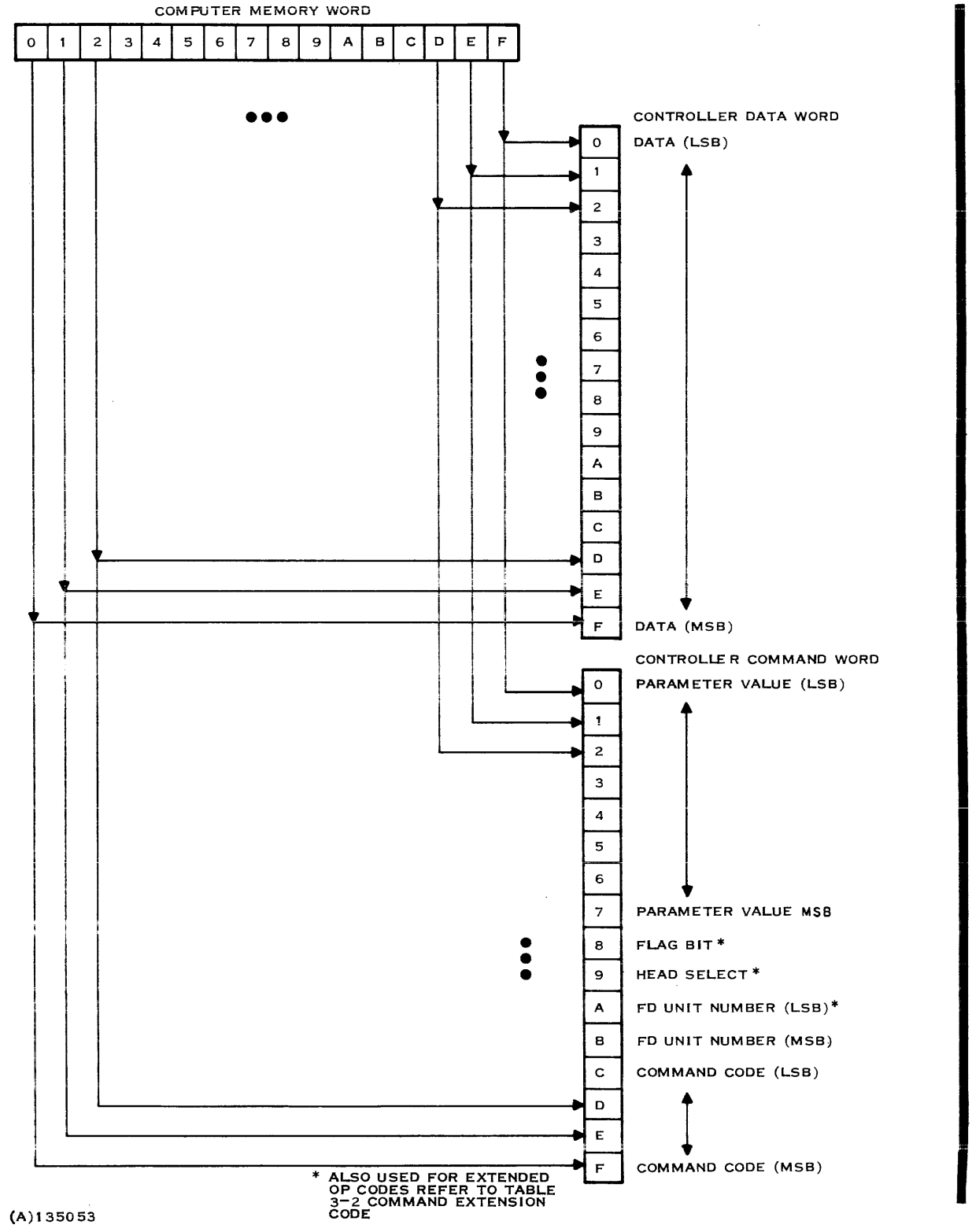


Figure 3-2. Computer Output to Controller

Table 3-2. Computer Output to Controller

Output Format Bit Number Base Sel.	CRU	Memory	Description
A	0	F	DATA (LSB)
– – – – through – – – –			– – – – through – – – –
A	F	0	DATA (MSB) This 16-bit field is the full-word data transfer.
B	10	F	PARAMETER VALUE (LSB)
– – – – through – – – –			– – – – through – – – –
B	17	8	PARAMETER VALUE (MSB) This 8-bit field conveys parameters for the various commands.
B	18	7	This bit is used to specify nonsequential sector operation for READ and IPL commands and to specify VERIFY ONLY operation in the FORMAT command.
B	19	6	This bit is used to specify the head to be used on double head disc drives for data transfer commands and SEEK and FORMAT operations.
B	1A	5	DRIVE UNIT NUMBER (LSB)
B	1B	4	DRIVE UNIT NUMBER (MSB) These two bits select the floppy disc drive unit for any command except RESET and CLEAR STATUS PORT.
B	18	7	COMMAND EXTENSION CODE (LSB)
– – – – through – – – –			– – – – through – – – –
B	1B	4	COMMAND EXTENSION CODE (MSB) This field is used for command opcode extension during the RESET primary opcode.
B	1C	3	COMMAND CODE (LSB)
– – – – though – – – –			– – – – through – – – –
B	1F	0	COMMAND CODE (MSB) Sixteen commands are coded by these four bits. Section 3.4 and table 3-3 describe these commands. Seven additional opcodes are developed using bits 18_{16} through $1B_{16}$ only during the primary opcode value 1101_2.

Table 3-3. Command Word Format

USER COMMANDS	MEMORY MSB LSB
SELECT	0000/UU00/0000/0000
SEEK	0001/UUH0/0TTT/TTTT
RESTORE	0010/UU00/0000/0000
SECT LEN	0011/UU00/0LLL/LLLL
READ	0100/UUHN/000S/SSSS
READ ID	0101/UUH0/0000/0000
READ UNF.	0110/UUH0/000S/SSSS
WRITE	0111/UUH0/000S/SSSS
WRITE DEL.	1000/UUH0/000S/SSSS
FORMAT TRACK	1001/UUHV/IIII/IIII
LD INT MASK	1010/0000/0000/000B
STOP	1011/UU00/0000/0000
STEP HEAD	1100/UU00/0TTT/TTTT
IPL	1110/UUHN/0TTT/TTTT
CLR ST PORT	1111/0000/0000/0000
MAINTENANCE COMMANDS	
RESET	1101/0000/0000/0000
RETRY INHIB	1101/0001/0000/0000
LED TEST	1101/0010/EWXY/0001
INVALID COMMAND	1101/0011/0000/0000
MEM RD	1101/0100/000M/MMMM
RAM LOAD	1101/0101/RRRR/RRR0
RAM RUN	1101/0110/RRRR/RRR0
PWR UP SIM	1101/0111/0000/0000

COMMAND TABLE KEY:

- 0 LOGIC ZERO
- 1 LOGIC ONE
- U UNIT NUMBER (0-3)
- H HEAD NUMBER (1 = UPPER)
- T TRACK NUMBER (00-4C)
- L SECTOR WORD COUNT (00-40)
- N NO SEQUENTIAL SECTORING (1 = ACTIVE)
- S SECTOR NUMBER (01-1A)
- V VERIFY ONLY (1-VERIFY,0-FORMAT, & VERIFY)
- I TRACK ID (TRACK #,FF-BAD TRACK)
- B BAD MASK FOR INTERRUPT (0 = UNMASK OR ENABLE INTERRUPT)
- E ENABLE LEDS
- W LED #4 ENABLE
- X LED #3 ENABLE
- Y LED #2 ENABLE
- M CONTROLLER MEMORY ADDRESS LEFT BYTE (MM00)
- R RAM ADDRESS OFFSET (1800+RR)

3.4.2 **SEEK.** This command will step the head of the selected drive to the specified logical track address. The controller selects the specified drive and checks its status. If the controller has a valid current address for the drive, stepping toward the new track will start. If the controller does not have a valid track address, the head is lowered and the track address is read from the first encountered header. The controller now calculates the magnitude and direction of steps toward the desired track. If the number of tracks to be crossed is greater than three, the head is unloaded until the distance from the desired track is less than three.

When the number of desired steps have been completed, the track number is read from the first header encounterered and compared to the desired track number. If the comparison fails, the head is stepped in the direction of the desired logical track. This process is repeated until a match is found or until 10 read/compare operations have been executed. Completion of the seek will be reported by OP COMPLETE and INTERRUPT. A SEEK command to track 0 is executed as a RESTORE command.

3.4.3 **RESTORE.** The selected head is stepped outward track by track seeking track zero status from the drive. If track zero is not found after 76 steps, a SEEK ERROR is generated with INTERRUPT and OP COMPLETE.

3.4.4 **SET SECTOR LENGTH.** The sector length in words is established for the selected disc drive unit. The maximum value is 64 (40_{16}), and INVALID COMMAND is generated if this limit is exceeded. The normal reply is an INTERRUPT with OP COMPLETE. Sector length of all drives is initialized to the maximum value (64) upon power up, executing the RESET command switch, or an IO RESET from the CPU.

3.4.5 **READ.** A read operation starts on the specified drive, and at the specified sector, and continues on sequential sectors to the last sector of the last track or until a STOP is received.

In the sequential mode, the controller performs the operation in the following sequence:

1. The specified drive is selected and the head is lowered.

2. The controller reads headers until the specified sector is found. Retries are performed if enabled as discussed in paragraph 4.3.

3. After the sector is found the controller transfers the data field to the controller's buffer. The data field CRC is checked and retries are performed as previously discussed. Status is reported if a good data recovery cannot be accomplished.

4. After the first buffer is filled the controller performs a search for sector N+1. When the sector is found, the controller starts transferring data from the drive into the second buffer and simultaneously makes the data in the first buffer available to the CPU by setting TRANSFER READY and INTERRUPT.

Subsequent words are then presented to CPU via the controller data port with a TRANSFER READY status. The CPU reads the data through the controller data port indicating that it has taken each word by performing an SBO or SBZ of data port bit 15. Internal reading discontinues when both buffers are filled, so that data will not be lost if the interrupt service is slow.

If nonsequential operation is specified in the command the actions are identical to a sequential read above until step #4 is reached. In the nonsequential mode each sector of data is made available to the CPU as soon as it is successfully read from the disc and the CRC check is passed. Simultaneous transfer of disk and CPU data does not occur. After the required number of words (specified by the sector length set for the specific drive) are transferred to the CPU the

controller searches for and reads the next sequential sector.

Reading continues until an error condition occurs or until a command is issued by the CPU. Stopping the READ operation is normally accomplished by issuing a STOP command which will result in OP COMPLETE and INTERRUPT (any command issued during a READ or WRITE operation is interpreted as a STOP command).

Detected errors during READ will terminate data transfer and set the error status with INTERRUPT. BUSY is also reset.

3.4.6 READ ID. The head is loaded for the selected floppy drive and ID is read from the first sector ID to pass the head. Track and sector identifications are returned via the data port in two bytes (CRU bits 0 through 7 are sector and 8 through F are track).

OP COMPLETE and TRANSFER READY with INTERRUPT complete the READ ID. If a cyclic redundancy check (CRC) error or other problem prevents successful completion within 40 attempts, ID CHECK ERROR is returned with INTERRUPT.

3.4.7 READ UNFORMATTED. The READ UNFORMATTED command provides a means of reading data from a track with a defective ID or address mark. Reading occurs at the specified sector, ignoring all IDs, and continues past the end of the data sector. Reading continues until a total of 208 words have been transferred to the controller buffers. This will include the intersector gap, next ID field, and part of the next data sector. Reading then stops and the entire 208 words are made available to the CPU via the TRANSFER READY/INTERRUPT protocol.

3.4.8 WRITE. The write command functions in a sequence similar to the READ FORMATTED command except that data transfer is in the opposite direction. TRANSFER READY and INTERRUPT are set when the controller is ready to accept the first data word. Subsequent data is transferred to the controller buffers by LDCR instructions and the TRANSFER READY signal alone. WRITE continues until terminated by any other command or until an error is detected. Note that if insufficient data is provided to completely fill the last sector started, the controller will pad the remainder of the sector with 0000_{16}.

Possible errors and their causes are: 1) ID CHECK ERROR if CRC fails on ID, 2) ID NOT FOUND if sector is not found in two revolutions, and 3) AM NOT FOUND if ID address mark is not detected. An INTERRUPT is given with the error bits.

3.4.9 WRITE DELETED SECTOR. This command executes identically with the WRITE command except that the delete code (F8) is written as the address mark for the indicated sector. Protocol for data transfer and error recognition is identical to that for the WRITE mode.

3.4.10 FORMAT TRACK. The FORMAT TRACK command initializes an entire track with a track mark, sector IDs and data fields per IBM FORMAT. The I field of the command is used as the logical track value in the new IDs. This command continues to completion regardless of other commands. An I field value of FF_{16} may be used to format a track as a bad track according to IBM format. Following formatting of a track, a track verification is performed. Error status will be reported if the format was not successful. The FORMAT COMMAND may be specified to perform a VERIFY ONLY operation by setting the appropriate bit in the command word. The value in the parameter field of the command will be used as the comparison value of the VERIFY ONLY operation.

3.4.11 **LOAD INTERRUPT MASK.** The LOAD INTERRUPT MASK command sets or resets the hardware interrupt mask F/F on the controller, depending on the value of the last bit of the command word as stored in memory. Only another LOAD INTERRUPT MASK, RESET, or POWER UP will alter the state of the F/F.

3.4.12 **STOP.** The STOP command terminates all commands except FORMAT TRACK.

3.4.13 **STEP HEAD.** If the current physical position of the head of the specified drive is unknown, the head is restored (to track 00). Then the head is mechanically stepped to the physical track specified in the command. This command is used for positioning the head for diskette formatting. OP COMPLETE is coincident with INTERRUPT.

3.4.14 **RESET, DIAGNOSTIC TEST.** This command initializes the controller hardware and initiates execution of firmware diagnostics in the microprocessor. CONTROLLER BUSY is present until the function is complete. A diagnostic failure sets EQUIP CHECK ERROR (Bit 7) in the status word. A diagnostic code is presented at the controller status port bits 4 through 7 (memory word B through 8) with OP COMPLETE and INTERRUPT. See table 3-4 for status bit definitions. In addition to status port bits indicating error conditions, three diagnostic LEDs on the controller light in a code corresponding to status port bits 4 through 6. These LEDs may provide a visible check during diagnostic testing in case the computer does not detect the status port bits correctly. See table 3-4 for definition of the LED indications.

Table 3-4. Diagnostic Status Bit Definitions

Status Word Bits					FD Controller RED LED NUMBER			
4	5	6	7	Diagnosis/Failure Indicator	2	1	0	GREEN LED
0	0	0	0	No Fault	OFF	OFF	OFF	ON
0	0	1	1	Random Access Memory Failure	OFF	OFF	ON	OFF
0	1	0	1	I/O Control Failure	OFF	ON	OFF	OFF
0	1	1	1	CRC Device Failure	OFF	ON	ON	OFF
1	0	0	1	Bad CRC on Write	ON	OFF	OFF	OFF
1	0	1	1	Mark Detection Failure	ON	OFF	ON	OFF
1	1	0	1	Write Circuit Failure	ON	ON	OFF	OFF
1	1	1	1	Microprocessor Failure	ON	ON	ON	OFF

3.4.15 **INITIAL PROGRAM LOAD.** This command is equivalent to a SEEK to the track specified and a READ FORMATTED at sector 1 of that track. Reading continues until stopped by another command. Transfers, errors, and interrupt protocol are the same as described for the SEEK and READ FORMATTED commands.

3.4.16 **CLEAR STATUS PORT.** All bits in the controller status port are set to zero. No completion or interrupt activity is associated with this command. Completion can be detected by the zero state of the status word. Note that if this command is issued during READ or WRITE commands it will be interpreted as a STOP command which will result in an INTERRUPT and OPERATION COMPLETE status.

3.4.17 **MAINTENANCE COMMANDS.** Seven maintenance commands are implemented to aid controller checkout and maintenance. Certain of these commands may be used to modify certain operating parameters of the controller for particular applications.

3.4.17.1 **RETRY INHIBIT.** This command causes the retry capabilities of the controller to be inhibited so that marginal data transfer operations can be detected. Retries are reenabled by the RESET command.

3.4.17.2 **LED TEST.** This command allows the CPU to selectively turn on the controller LED error indicators to test their operation. The status returned from this command will include the error code bits as selected by the command.

3.4.17.3 **PROGRAM ERROR.** This command returns status indicating that a program error has occurred. No other controller action is involved.

3.4.17.4 **MEMORY READ.** This command allows reading of the contents of the ROM and RAM on the controller's 9900 memory bus. The starting address for the read is specified by the parameter field of the command (starting on 128 words boundaries). Data is transferred to the CPU via the data port in exactly the same manner as in a READ command. The address of the location on the 9900 bus will automatically be incremented as each data word is transferred to the CPU. A STOP command will cause termination of the data transfer, with OPERATION COMPLETE and INTERRUPT.

3.4.17.5 **RAM LOAD.** This command can be used to transfer data from the CPU on the controller's 9900 bus to specific locations in the RAM. The starting address is automatically biased to the start of the RAM (1800_{16}). The address will be offset to any specific location in the lower half of the 256 word RAM by the value in the parameter field of the command. Data transfer to the RAM follows the convention of the transfer for the DATA WRITE command, including terminating the operation by issuing a STOP command.

NOTE

Of particular interest to the user is the possibility of varying the head unload delay after the last command is issued to a drive (this delay defaults to 400 milliseconds on power-up or on controller RESET command). The RAM LOAD command may be used to load a delay value using the command $D522_{16}$ followed by transferring a data word to the data port. The delay time achieved will be equal to 10 milliseconds times the binary value loaded.

3.4.17.6 **RAM RUN.** This command causes the microprocessor to branch its program execution into the RAM at a location specified by the command.

CAUTION

This command should be used only with extreme care and will normally never be exercised by the user. It is implemented as a maintenance aid.

3.4.17.7 **POWER UP SIMULATION.** This command causes the controller to simulate a power-up condition. Power-up results in multiple hardware clears being activated including resetting temporarily of the entire controller status word. As in an actual power-up situation, the controller will execute the self-diagnostics before returning OPERATION COMPLETE and INTERRUPT status. This will cause setting of the controller interrupt mask flip flop.

3.5 ERROR RECOVERY (RETRY PROCESS)

The FD controller is firmware programmed for automatic retrial to recover soft errors. The retry processes are discussed in the following paragraphs for each operation which employs retry for soft error recovery.

3.5.1 **SEEK ERROR RETRY.** In order to locate the correct logical track during the SEEK operation, the controller will perform up to 10 retries to verify track ID when an ID mismatch occurs between logical and physical tracks. The controller will calculate the step direction and attempt to verify ID for each retry.

3.5.2 **RESTORE ERROR RETRY.** The controller will step the head of the selected disc up to 76 times or until the track 00 status is received from the disc.

3.5.3 **READ ID ERROR RETRY.** For all operations for which ID must be read from the selected track, the controller will wait up to 350 milliseconds to detect the Address Mark (AM). If either ID field error or CRC error is found, the controller will make 40 attempts to find a readable ID field.

3.5.4 **SEARCH FOR SECTOR ERROR RETRY.** When the controller searches for a specific sector on a track, it will retry up to 54 times to retrieve the correct sector number in the ID field of the Read ID function as discussed earlier.

3.5.5 **READ DATA ERROR RETRY.** When the controller attempts to read the data field and does not detect a Data Mark within 3.7 milliseconds, it will retry reading the same sector up to 10 times or 10 revolutions. The SEARCH FOR SECTOR and READ ID will use the same retry procedure as described earlier.

3.5.6 **WRITE DATA ERROR RETRY.** During a WRITE operation, the controller must find the desired sector. The retry of SEARCH FOR SECTOR and the READ ID functions apply.

3.6 SAMPLE ROUTINES

The following paragraphs are elementary coding examples that illustrate the functions of issuing a command to the floppy disc controller, testing for data transfer/error status, and transferring READ or WRITE data.

3.6.1 **ISSUE CONTROLLER COMMAND.** This sequence presumes that a valid command word has been prepared and stored in memory at a location identified by the symbol, CMDWRD.

```
BASEB   DATA    >AO
FCBUSY  EQU     >A
OPCOMP  EQU     O
COMISU  EVEN
        MOV     @BASEB,R12      SETUP CRU BASE
        TB      FCBUSY          IF CONTROLLER BUSY,
        JEQ     CBWAIT          GO TO DELAY
        LDCR    @COMWRD,0       TRANSFER 16 BITS
```

If interrupts are used, exit here for interrupt service. Otherwise, test for completion:

```
CMPLP   TB      1               TRANSFER READY?
        JEQ     START           YES, GO TO RD/WRITE
        TB      OPCOMP          OP COMPLETE?
        JEQ     COMXIT          YES, EXIT
        STCR    @STWRD,0        ELSE READ STATUS
        LI      R1,@STWRD       R1=STATUS
        ANDI    R1,>1FFC        STRIP ERROR AND BUSY BITS
        JEQ     COMPLP          LOOP IF NO ERRORS AND NOT BUSY
```

If busy, check transfer ready and wait. If errors, decode.

```
        TB      FCBUSY
        JEQ     BSYWAT
ERRTST  EQU     $
        .
        .
COMSIT  B       *R11
```

NOTE

BSYWAT should set up a time-out loop of about 300-400 milliseconds. If transfer ready (bit 1) is detected before time-out exit to START, otherwise wait for FCBUSY to go false. If FCBUSY goes false before time-out (and transfer ready is still false), exit to CMPLP.

3.6.2 **READ/WRITE DATA TRANSFER.** This loop assumes that the initial READ or WRITE command is completed and TRANSFER READY is true:

```
STOP    DATA    >B000
BASEA   DATA    >80
WRDCNT  DATA    N
DATBUF  BSS     N
XFRDY   EQU     >11
FCBSY   EQU     >1A
START   LI      R3,DATBUF
        MOV     @BASEA,R12      MOVE BASE TO DATA
RDYWAT  EQU     $
        TB      XFRDY           WAIT HERE FOR
        JEQ     XFRWRD          READY STATE AS
        TB      FCBSY           LONG AS UNIT IS
        JEQ     RDYWAT          BUSY.
```

If busy is not true during the transfer, the controller has terminated the sequence. Test for errors:

```
        AI      R12,>20         BASE TO STATUS
        STCR    @STWRD,0        READ STATUS
```

Test individual status bits for diagnosis of error.

WRITE transfer

```
XFRWRD  LDCR    *R3+,0          TRANSFER 16 BIT DATA
        DEC     @WRDCNT         TEST FOR END OF DATA
        JGT     RDYWAT
        TB      XFRDY           WAIT FOR LAST
        JNE     $-1             WORD TAKEN BY CONTROLLER
        MOV     @BASEB,R12      SELECT COMMAND PORT
        LDCR    @STOP,0         ISSUE STOP
        BL      @CMPLP          EXIT TO AWAIT COMPLETION
```

READ

```
XFRWRD  STCR    *R3+,0          TRANSFER 16 BIT DATA
        SBO     15              CLEAR XFRDY
        DEC     @WRDCNT         TEST FOR END OF DATA
        JGT     RDYWAT          WAIT FOR NEXT WORD
        MOV     @BASEB,R12      SELECT COMMAND PORT
        LDCR    @STOP,0         ISSUE STOP
        BL      @CMPLP          EXIT TO AWAIT COMPLETION
```

SECTION IV

OPERATION

4.1 GENERAL

The Texas Instruments FD 800 Floppy Disc was designed to accommodate a wide range of applications, yet it is dedicated to operational simplicity. This section describes operating procedures for the floppy drive unit covering the following areas:

- Diskette care and loading instructions,
- Computer disc drive controls,
- Write protect feature,
- Write/read error correction procedures,
- Preventive maintenance procedures.

4.2 DISKETTE CARE AND HANDLING

The diskette is a flexible, magnetic recording media which is permanently enclosed in a protective plastic jacket. It offers an effective means for record storage, since it is inexpensive and can be compactly filed and easily handled. The jacket interior has a special liner to wipe and clean the disc as it turns. When not installed within the disc drive, the diskette should be filed in a special envelope to protect the recording surface from contamination.

To maintain serviceability, handling care for the diskette is similar to other flexible magnetic recording media, such as tape or cassette. The following precautions apply:

1. Keep the diskette away from magnetic fields or ferromagnetic materials which may have been magnetized. Magnetic fields will distort the diskette's recorded data.
2. Always return the diskette into its storage envelope when it is not installed in the drive. Replace storage envelopes and/or attached labels which have become cracked or worn.
3. Do not write on the plastic jacket or labels with a lead pencil or ballpoint pen. Use a felt-tip pen. Do not try to erase written information from the diskette jacket, since the erasure dust may contaminate the diskette surface.
4. Do not fold, bend or file the diskette in any way which will cause it to be distorted or pressed under heavy objects.
5. Do not expose the diskette to heat or direct sunlight or moisture.
6. Keep the diskette away from sticky, oily, dirty or abrasive substances.
7. Do not touch or attempt to clean the recording surface of the diskette.

8. Do not attempt to load or use a diskette which has been physically creased or warped or which is contaminated with abrasive, sticky or oily substances. Warped or contaminated diskettes may damage the read/write heads.

NOTES

Data may possibly be recovered from a diskette whose jacket may have been soiled, but only if the contaminant can be wiped off without contacting the recording surface of the diskette. After data recovery, the abused diskette should be discarded.

If a diskette has been exposed to extreme temperature (beyond 50-125°F or 10-50°C), but it is otherwise clean and dry, it is normally serviceable after about five minutes at room temperature.

4.3 DISKETTE LOADING PROCEDURE

The FD 800 Floppy Disc drive unit has a latch release just below the door. Depressing this latch release opens the door for insertion of the diskette. To load the diskette, depress the latch release, remove the diskette from its envelope, and insert the diskette into the slot with the diskette label facing up so that the read/write access slot is inserted first into the disc drive opening. See figure 4-1. Insert the diskette fully until the eject spring is latched and press downward on the door, clamping the diskette into position on the spindle. The diskette can be loaded or unloaded with power on and drive spindle rotating. When handling the diskette, always observe the precautions listed in paragraph 4.2 above.

NOTE

All diskettes must be initialized (formatted) by software prior to use. This may be accomplished under TX990 by the initialization utility (INITDSC) or under the TI Floppy Disc diagnostic PDT (PN945435) by executing verb "FD".

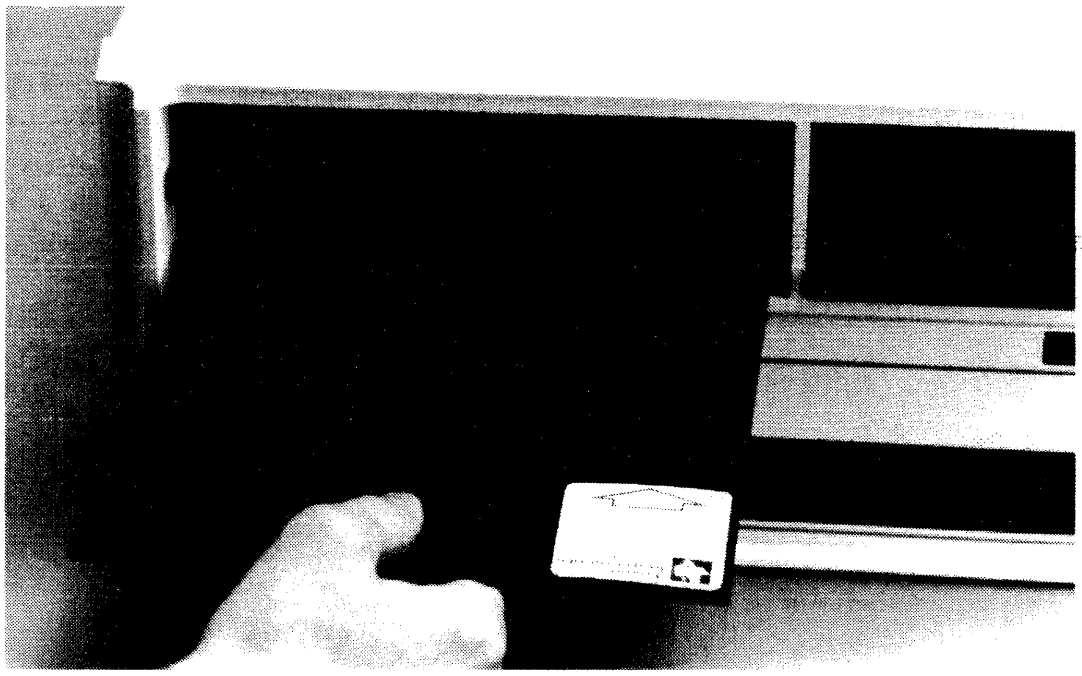


Figure 4-1. Loading the Diskette

4.4 WRITE PROTECT FEATURE

A diskette can be write protected by means of a hole or notch in the diskette jacket at the edge of the jacket near the read/write access slot as shown in figure 4-2. When this hole or notch is open, the diskette is write protected and cannot be recorded upon. This hole may be closed by placing a tab or tape over it to perform the write operation. Write protection is again provided by removing the tab or tape. IBM formatted diskettes are not supplied with write protect holds or tabs.

4.5 READ/WRITE ERROR CORRECTION

During a write operation, if an error occurs, it will be detected by a read on the next revolution. This read after write cycle is called "write check". If a successful write check is not attained after ten attempts, the read operation should be attempted on another track to determine if the media is faulty or the drive is malfunctioning. If the error persists, the diskette should be considered faulty and replaced. Should subsequent write/read errors occur on a new diskette, the drive or head or read/write electronics should be suspected. Persistent write/read errors indicate that the disc drive requires maintenance, cleaning or adjustment. See paragraph 4.6 for these procedures.

Most errors that are detected during the read operation are called "soft" errors, that is, errors that may be recovered by a repeated read process. Soft errors are usually caused by one or more of the following:

1. Airborne contaminants that pass between the read/write head and the diskette. The contaminants are generally removed by the diskette jacket self-cleaning liner.

2. Random electrical burst noise of a few microseconds duration.

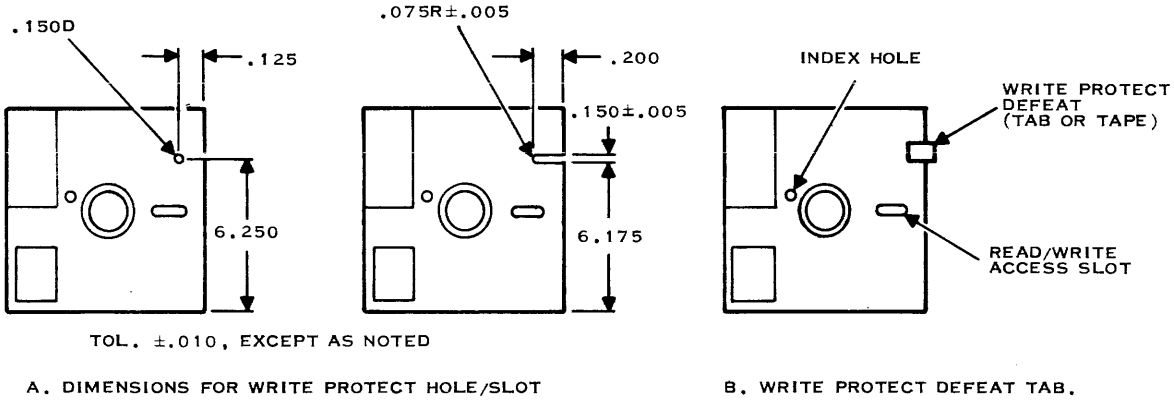


Figure 4-2. Diskette Write Protection Methods

3. Minor defects may exist in the written data and/or track which escaped detection during a subsequent write check operation. The defects may cause a soft error during read at a later time. The following procedure is used to recover from these soft errors:

   a. Reread the track (up to a maximum of ten attempts) until the data is recovered.

   b. If using step a is unsuccessful, access the next adjacent track in the same direction previously moved, then return to the desired track and repeat step a.

4. If these retries after accessing the adjacent track do not recover the error, it should be considered nonrecoverable, and the general statements on maintenance and cleaning (see paragraph 4.6) should be considered.

4.6 PREVENTIVE MAINTENANCE

The objective of preventive maintenance is to achieve maximum reliability and availability of the machine. The procedures outlined herein strive to remain simple and effective to this end. For equipment that is operating satisfactorily, no more than the required preventive maintenance is warranted. Do not perform unnecessary cleaning or replacement if the machine is functional. Replacement or alignment procedures are beyond the scope of this preventive maintenance procedure.

The preventive maintenance procedures of table 4-1 should be performed on a period of about 1500 hours operation in a dust-free, controlled-air, moderate temperature and humidity environment. Where the environment is more severe, the maintenance schedule should be adjusted accordingly.

On a routine basis or when the need arises, the Floppy Disc Diagnostic Program should be run. The diagnostic can be executed without retries. This will allow the user to detect any degrading performance which would normally be corrected by retries in the controller firmware. The diagnostic can also perform a read-only test, which allows the user to maintain a master written diskette for a standard reference. This master can be created upon installation of the system. Used later, it can determine if errors are due to write or read circuitry or due to mechanical misalignment. The diagnostic is a useful tool, which should be used in a routine preventive maintenance procedure of the system.

Table 4-1. Preventive Maintenance Procedures

CAUTION

When inspecting and cleaning the read/write head, care must be taken not to misalign the head or warp the head load mechanism.

Unit	Inspection	Action
Head Load Button	Check for wear.	Replace if necessary. Refer to maintenance manual.
Read/Write Head	Check for oxide buildup, dust or contaminants.	Clean only if necessary. Use only denatured alcohol and cotton swab.
Read/Write Head	Check for proper alignment.	Alignment acquires special tooling. Refer to maintenance manual.
Stepper Motor and Lead Screw	Inspect for oil and dust, and nicks and burs.	Clean off oil and dirt.
Spindle Belt	Check for frayed, cracked or weakened spots.	Replace if necessary. Refer to maintenance manual.
Base	Inspect for loose screws, connectors and switches.	Clean base of dust or oil with denatured alcohol and lint-free cloth.
Controller	Check for broken, burned or loose components and dirt or dust.	Clean with dry brush. Reseat components. Run diagnostics.

APPENDIX A

DISKETTE FORMATTING

APPENDIX A

DISKETTE FORMATTING

The FD 800 disc system records data on the diskette per the IBM prescribed record format for 128 byte data sectors. Sectors of longer length (256 or 512 bytes) are not supported by the controller firmware. Track allocation and use is a function of the operating software. The Texas Instruments supplied software does not allocate tracks per the IBM convention, but does format the tracks per the IBM format. IBM format conversions are provided in special conversion utilities which are part of the operating software system.

IBM track formatting of the diskette is illustrated in figure A-1. The diskette is initialized with 77 tracks (00 to 76), each segmented into 26 sectors (1 to 26) of 128 bytes of data. Basic IBM data exchange normally uses tracks 1 through 73, providing 1898 sectors of 242,944 bytes. Track 00 is the index track; track 74 and 76 are not normally used, and tracks 75 and 76 are reserved for alternate track assignment to cover possible faulty tracks in the data field. Track 00 (the index track) contains the diskette content descriptors, such as file nomenclature, owner, data, error, or security fields. This index track is organized by the FD 800 software.

As illustrated by the figure, sector 1 is preceded by preambles and track address mark synchronized from the light detected mark through the index hole. Each sector contains identification (ID) mark, track/sector ID, ID checksum, data field, data field checksum, data mark, and gaps which total a 188-byte composite. Sector 26 is followed by a nominal 241-byte postamble.

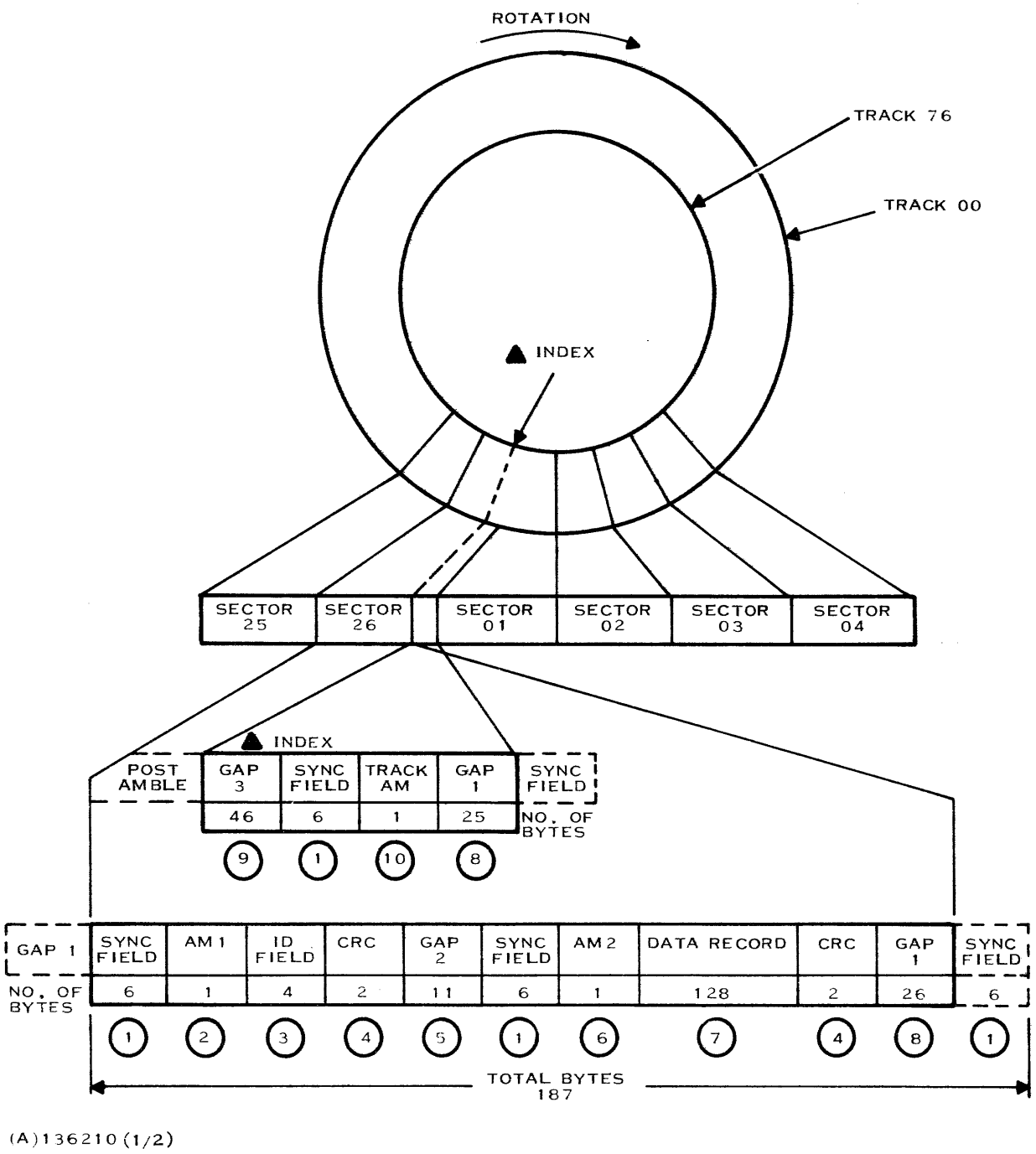


Figure A-1. Track Format (Sheet 1 of 2)

LEGEND:

(1) SYNC FIELD – EACH SYNC FIELD CONTAINS SIX BYTES OF 0'S (X'00'). THIS FIELD SYNCHRONIZES THE DISKETTE CONTROLLER CIRCUITRY TO THE INFORMATION BEING READ FROM THE DISKETTE.

(2) AM1 (ADDRESS MARKER 1) – AM1 IS ALWAYS X'FE' AND IDENTIFIES THE INFORMATION THAT FOLLOWS AS THE ID FIELD.

ID FIELD – THE ID FIELD CONSISTS OF FOUR BYTES OF INFORMATION IDENTIFYING THE ADDRESS AND SIZE OF THE SECTOR.

FIRST BYTE: TRACK NUMBER
X'00' THROUGH X'4C' (00 THROUGH 76)

SECOND BYTE: HEAD NUMBER
ALWAYS X'00'

THIRD BYTE: RECORD NUMBER
128 BYTE PER SECTOR FORMAT.
X'01' THROUGH X'1A' (1 THROUGH 26)

FOURTH BYTE: PHYSICAL RECORD LENGTH
X'00' = 128 BYTES
X'01' = 256 BYTES
X'02' = 512 BYTES

NOTE (256, 512 BYTE RECORDS ARE NOT SUPPORTED BY FD800)

(4) CRC (CYCLIC REDUNDANCY CHECK) – THE TWO CRC BYTES ASSOCIATED WITH THE ID FIELD ARE GENERATED DURING INITIALIZATION. THE TWO CRC BYTES FOLLOWING THE DATA RECORD ARE GENERATED DURING A WRITE OPERATION. THE CONTENTS OF THE TWO BYTES DEPENDS ON THE CONTENTS OF THE FIELDS FOLLOWING EACH SYNC FIELD. CHECK BYTES ARE CONSTRUCTED FROM THE SAME FIELDS DURING A READ OPERATION. THE CHECK BYTES ARE COMPARED WITH THE CRC BYTES; WHEN EQUAL, THE RECORD WAS READ CORRECTLY.

(5) GAP 2 – GAP 2 CONSISTS OF 2 BYTES OF ZEROS (X'00') AND 9 BYTES OF BINARY 1'S (X'FF')

(6) AM2 (ADDRESS MARKER 2) – AM2 IS EITHER X'FB' OR X'F8'. X'FB' IDENTIFIES THE FIELD THAT FOLLOWS AS A DATA RECORD. X'F8' IDENTIFIES THE FIELD THAT FOLLOWS AS A CONTROL RECORD.

(7) DATA RECORD OR CONTROL RECORD – A DATA RECORD CONTAINS 128 BYTES AVAILABLE FOR DATA. IN A CONTROL RECORD THE FIRST BYTE IS USED TO INDICATE DEFECTIVE OR DELETED RECORDS AS FOLLOWS:

• = DEFECTIVE RECORD (ALTERNATE PHYSICAL RECORD RELOCATION)
D = DELETED RECORD
F = DEFECTIVE RECORD (SEQUENTIAL PHYSICAL RECORD RELOCATION)

(8) GAP 1 – GAP 1 CONSISTS OF 2 BYTES OF ZEROS (X'00') FOLLOWED BY A VARIABLE NUMBER OF BINARY 1'S DEPENDING ON THE DISKETTE SPEED AND RECORD LENGTH.

(9) GAP 2 – GAP 3 IS THE INDEX GAP WHICH CONSISTS OF A VARIABLE NUMBER OF BINARY 0'S FOLLOWED BY 32 BYTES OF FF'S. NOMINAL 46 BYTES TOTAL.

(10) TRACK AM – TRACK AM IS ALWAYS X'FC', ALWAYS FOLLOWS THE INDEX MARK, AND IDENTIFIES THE START OF A TRACK.

(A)136210 (2/2)

Figure A-1. Track Format (Sheet 2 of 2)

ALPHABETICAL INDEX

ALPHABETICAL INDEX

INTRODUCTION

The following index lists key words and concepts from the subject material of the manual together with the area(s) in the manual that supply major coverage of the listed concept. The numbers along the right side of the listing reference the following manual areas:

- Sections - References to Sections of the manual appear as "Section x" with the symbol x representing any numeric quantity.
- Appendixes - References to Appendixes of the manual appear as "Appendix y" with the symbol y representing any capital letter.
- Paragraphs - References to paragraphs of the manual appear as a series of alphanumeric or numeric characters punctuated with decimal points. Only the first character of the string may be a letter; all subsequent characters are numbers. The first character refers to the section or appendix of the manual in which the paragraph is found.
- Tables - References to tables in the manual are represented by the capital letter T followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the table). The second character is followed by a dash (-) and a number:

  Tx-yy

- Figures - References to figures in the manual are represented by the capital letter F followed immediately by another alphanumeric character (representing the section or appendix of the manual containing the figure). The second character is followed by a dash (-) and a number:

  Fx-yy

- Other entries in the Index - References to other entries in the index are preceded by the word "See" followed by the referenced entry.

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