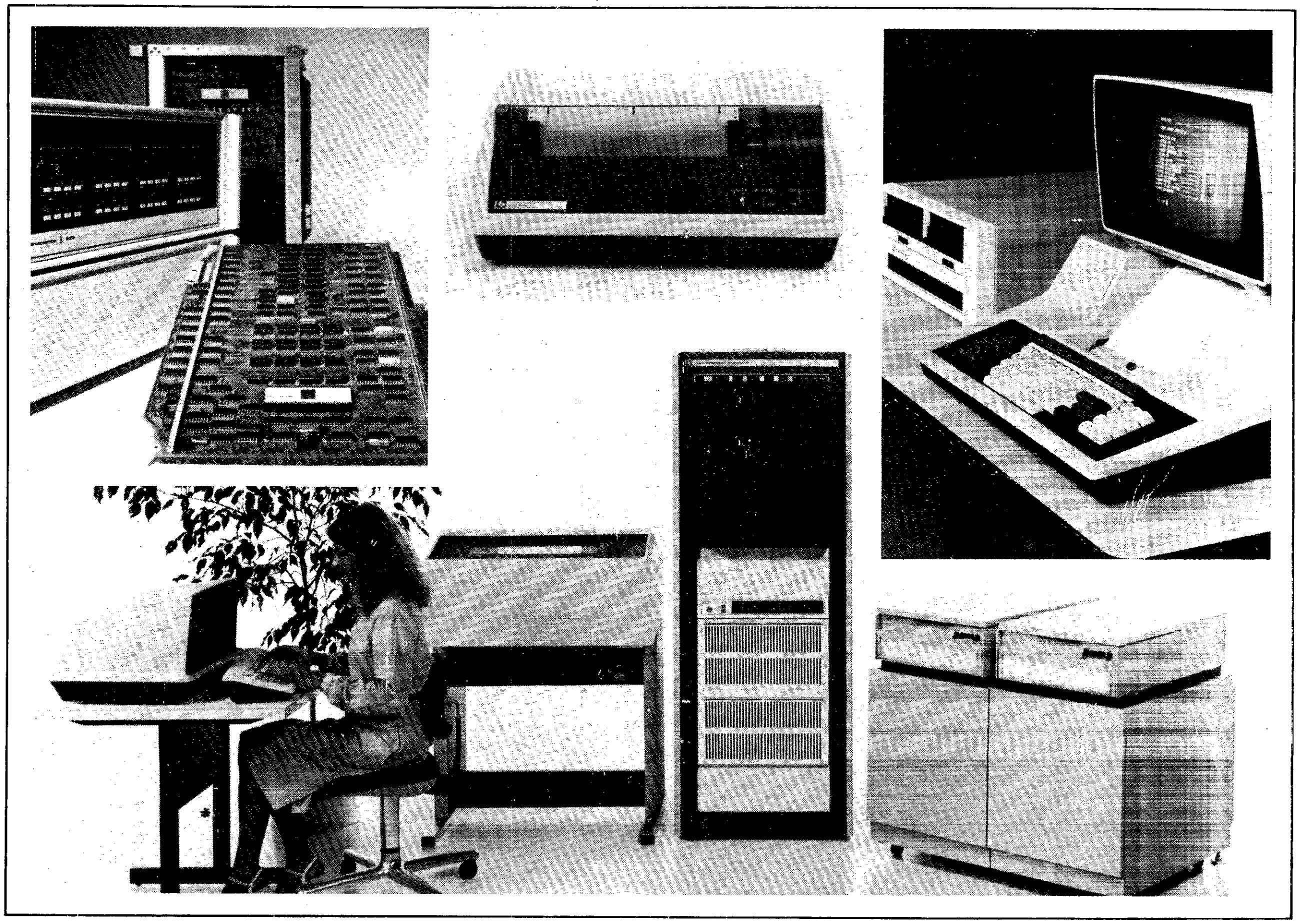
Model CD1400 Disk System Installation and Operation Manual



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Preface

This manual provides detailed instructions for installing and operating a Model CD1400 Disk System with a Model 990 Computer and TILINE data bus. Programming information for those users who wish to write their own input/output routines is also included. Information in this manual is divided into four sections as follows:

Section

1 General Description — Briefly describes the features and major components of the disk system.

2 Installation — Provides site requirements and step-by-step instructions for unpacking and installing the disk system.

3 Programming — Presents information for use by programmers in designing device service routines that interface directly with the disk system.

4 Operation — Describes system operating procedures.

The following documents contain additional information related to the Model CD1400 Disk System:

Title	Part Number
Model 990/12 Computer Hardware User's Manual	264446-9701
Model 990/10 Computer System Hardware Reference Manual	945417-9701
Model 990/5 Computer Hardware User's Manual	946294-9701
Model 990 Computer TMS 9900 Microprocessor Assembly Language Programmer's Guide	943441-9701
Model 990/12 Computer Assembly Language Programmer's Guide	2250077-9701
Model 990 Computer Family Maintenance Drawings, Volume I — Peripherals	945421-9702
Model 990 Computer Diagnostics Handbook	945400-9701
Model CD1400 Disk System Field Maintenance Instructions	945419-9701

Title	Part Number
Model CD1400 Disk System Depot Maintenance Instructions	2272082-9701
DS990 Systems Field Maintenance Instructions	2250696-9701
Control Data Cartridge Module Disk Drive Hardware Maintenance Manual	7588415

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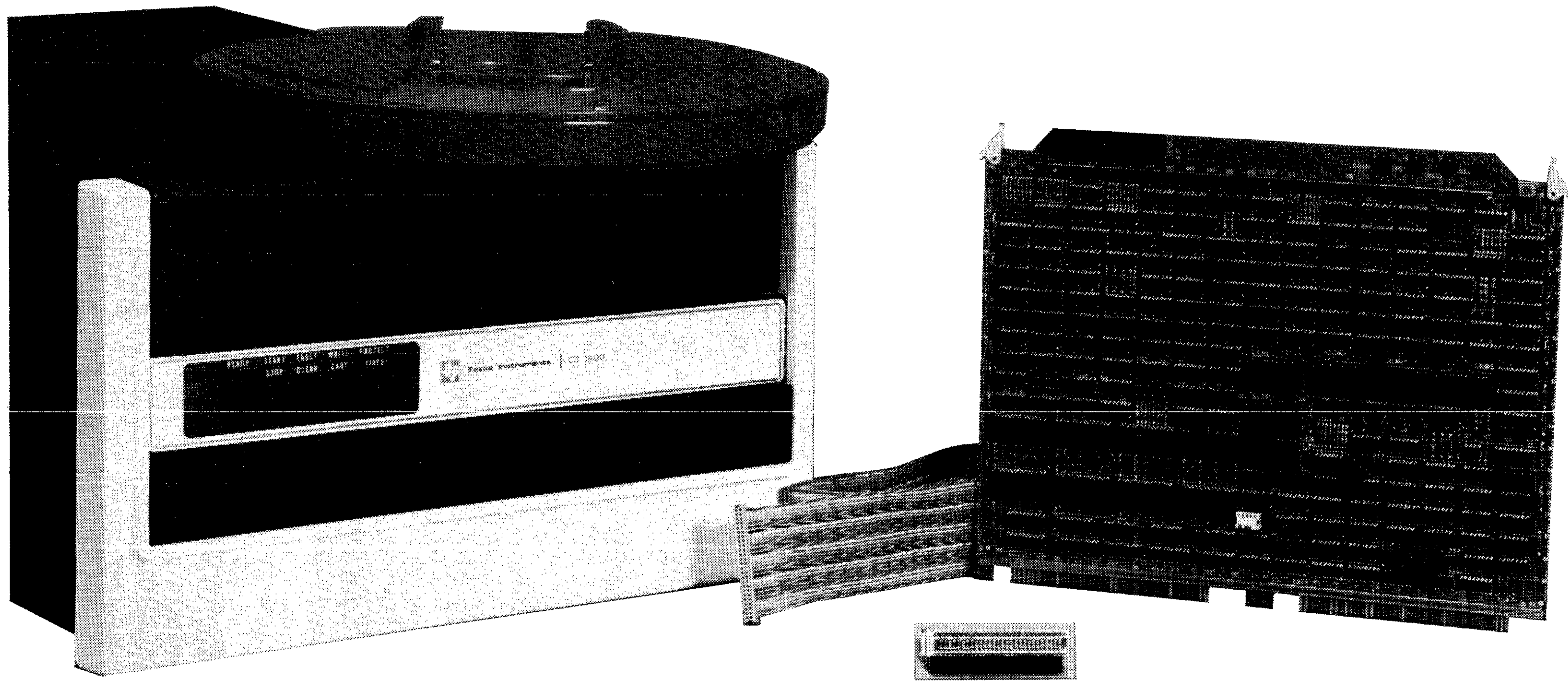

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Figure 1-1. Model CD1400 Disk System

1

GENERAL DESCRIPTION

1.1 GENERAL

The Texas Instruments Model CD1400 32-Megabyte, 64-Megabyte, or 96-Megabyte Disk System (Figure 1-1), is a random-access, mass data storage unit featuring a 16-megabyte removable front-loaded cartridge disk, and fixed platters that provide an additional 16, 48, or 80 megabytes of on-line storage. One or two disk drives may be connected in a daisy-chain configuration to the controller installed in any TI Model 990 computer with a TILINE data bus.

System features include:

- Single circuit board disk controller
- One or two disk drives (may be of different data storage capabilities) per controller
- Independent manual write protection of cartridge and/or fixed media
- Microprocessor-based controller logic
- Error checking and correction (ECC) capability
- Extended fault isolation
- Very fast average seek time (30 ms)
- 9.67 mHz bit transfer rate
- Accurate track-following servo
- Dynamic brake
- Integral power supply

1.2 SYSTEM COMPONENTS

The Model CD1400 Disk System consists of a disk controller, one or two disk drives, a terminator, and associated interconnecting cables. Major system components and parts numbers are listed in Table 1-1, and are described in the following paragraphs.

Table 1-1. Disk System Components and Part Numbers

Item	Part Number
Model CD1400 Disk System	2269887-00XX
Model CD1400 Disk Drive	2269885-00XX
Model CD1400 Disk Controller	2269405-0001
Model CD1400 Disk Terminator	2269880-0001
I/O Cables	
6-foot	937516-3
10-foot	937516-2
20-foot	937516-1
Disk Cartridge	2269886-1
Documentation:	
Model CD1400 Disk System Installation and Operation	2272081-9701
Model CD1400 Disk System Field Maintenance Instructions	945419-9706
Model CD1400 Disk System Depot Maintenance Manual	2272082-9701

1.2.1 Disk Controller

The Model CD1400 disk controller (Figure 1-2) is a full-width circuit board that occupies one slot in the 990 computer chassis or TILINE* expansion chassis. The TILINE data bus, dc power lines, and the interrupt system are accessed through connectors at the bottom of the chassis slot. All control, select, status, and data communications between the 990 computer and the disk drives are handled by the disk controller. Controller operation is initiated when the computer transmits a block of eight control words over the TILINE. These control words contain a command code and a set of parameters that completely describe the required operation. The controller acts independently during the operation, freeing the 990 processor for other tasks. All necessary record location, control/status signal interchange, memory access, data transmission, error checking, and format conversion operations are handled by the controller. Upon completion of the operation, which optionally causes an interrupt, the processor may read controller, drive, and operational status words, located at the control word addresses.

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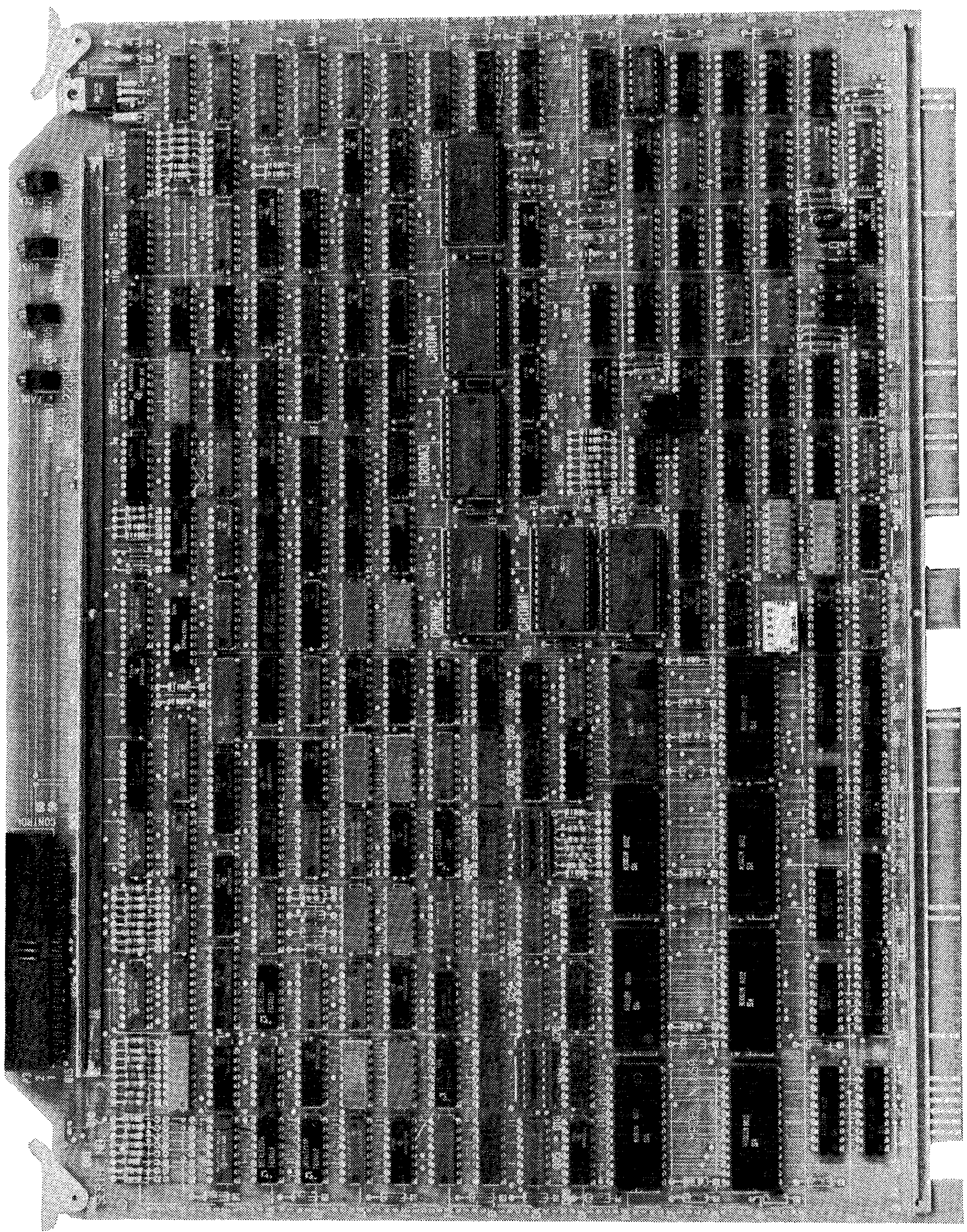

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Figure 1-2. Disk Controller

1.2.2 Disk Drive

The disk drive basic unit (Figure 1-3) contains 16 megabytes of data capacity on a removable cartridge, and 16, 48, or 80 additional megabytes of data capacity on one, two, or three fixed platters. The disk drive is completely self-contained in the drive chassis, which may be rack mounted on slides, or pedestal mounted.

A rotation speed of 3600 revolutions per minute enables the disk drive to operate at a 9.67-mHz data rate. Head positioning is performed through the use of a closed-loop proportional servo system, with both acceleration and velocity feedback. The carriage is driven by a voice-coil linear actuator that uses positioning information derived from a dedicated servo surface on the cartridge or on one of the fixed platters. Dimensional integrity necessary for the recording system is provided by a precision spindle mounted in a rigid cast aluminum deck that ensures positive registration and seating of the cartridge to the spindle.

The disk drive consists of a cartridge receiver; spindle, drive motor, and deck; fixed platters; read/write and servo heads; voice-coil head positioner; electronics module containing read/write, microprocessor, I/O, servo, and drive control electronics; a blower and absolute air filter; dc power supply; and operator control panel. The following paragraphs describe each of these components:

1.2.2.1 Cartridge Receiver. The cartridge receiver houses the front-loaded removable cartridge. After loading, the cartridge is registered onto the spindle for proper drive and head positioning.

1.2.2.2 Spindle, Drive Motor, and Deck. A rigid cast-aluminum deck, ac induction motor, and precision spindle insure positive registration, seating, and drive of the cartridge. The head positioner is also mounted directly to the deck assembly.

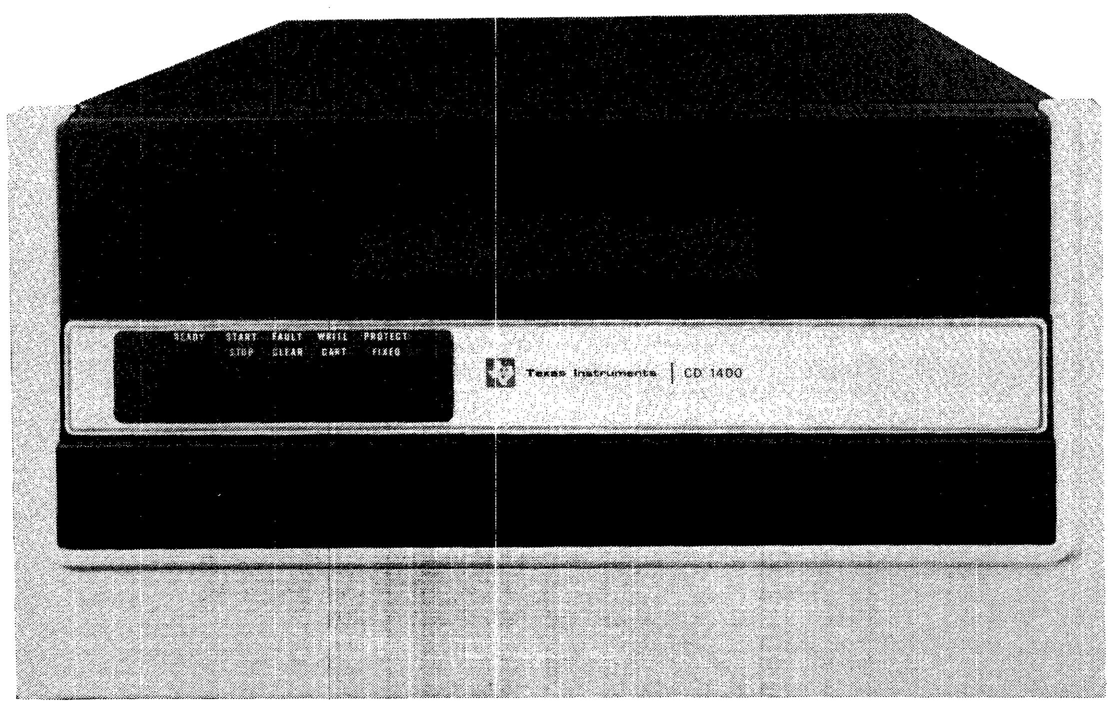

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Figure 1-3. Disk Drive

1.2.2.3 Fixed Platters. The disk drive contains up to three fixed platters that provide up to 80 additional megabytes of on-line storage, and is located under the cartridge receiver deck.

1.2.2.4 Read/Write and Servo Heads. The read/write heads record data onto and read data from the data surfaces of the fixed and removable platters; the servo heads read positioning information from the servo surfaces on the platters. One read/write head and one servo head are required for the removable cartridge; however, only one servo head is required for all fixed platters since servo information for one fixed platter is valid for all.

1.2.2.5 Voice-Coil Head Positioner. The heads are positioned by a closed-loop servosystem incorporating both acceleration and velocity feedback. A voice-coil linear actuator drives the carriage using positioning information recorded on dedicated servo surfaces on either the removable cartridge or the fixed media. The appropriate servo surface is selected prior to the start of a new positioner movement.

1.2.2.6 Electronics Module. The electronics module contains virtually all of the electronic components required to operate the disk drive and to interface with the disk controller. The majority of the logic circuits employ low-power Schottky components while ECL components are used in critical timing areas such as the read/write circuits. A microprocessor is used for a variety of tasks such as coarse seek control, spindle start/stop, and internal event monitoring. All read/write, I/O, servo, and drive control functions are controlled by the electronic module circuits.

1.2.2.7 Blower and Absolute Filter. A direct-drive blower provides cooling air to the disk drive. A 0.3-micron absolute filter cleans the air supplied to the cartridge receiver and fixed disks. The blower operates whenever ac is applied to the drive.

1.2.2.8 Dc Power Supply. The dc power supply provides all necessary dc voltages required to operate the disk drive.

1.2.2.9 Operator Control Panel. The operator control panel contains the indicator lights and switches used to control the disk drive. Controls and indicators on the front panel are the start/stop switch and indicator, fault clear switch with fault status indicator, fixed and removable write-protect switches with indicators, and the ready indicator. Refer to the operation section of this manual for instructions for using these switches and indicators.

1.3 SYSTEM OPERATIONAL DESCRIPTION

The following paragraphs describe how the TILINE data bus, disk controller, and disk drive interact with the 990 computer to provide on-line data storage functions. Figure 1-4 is a block diagram that shows system interconnections.

1.3.1 TILINE Bus

The TILINE is an asynchronous 16-bit parallel data bus that transfers data between high-speed system elements such as the 990 main memory, the 990 central processing unit (CPU), and disk drive systems. The TILINE bus architecture incorporates the disk controller directly into CPU addressable memory space, and provides reliable, high-speed I/O control. Devices on the TILINE act as either masters or slaves. Master devices may contend for access and control of the TILINE while slave devices respond only when addressed by a master device. The disk controller acts as either a master or slave.

1.3.2 Disk Controller Operations

The disk controller operates as a slave device when receiving commands from the CPU, or when the CPU reads controller status. These commands, which direct controller operations, are written into memory addresses assigned to the controller. After a controller operation has completed, the controller writes status information into these same memory locations, that can then be read by the CPU. When executing an operation, the controller functions independently of the CPU and the CPU cannot interfere, except to ascertain idle/busy status.

After a command has been initiated, the controller then may become a TILINE master. The controller contends for TILINE access on a positional priority basis by cycle-stealing with the CPU and with other active TILINE master devices. After TILINE access is obtained, the controller transfers a 16-bit parallel data word to or from the slave it has addressed, which in most cases is a computer memory board. In addition, the controller manipulates all of the disk interface data and control lines that enable data transfer between the controller and the disk drive.

When data is read from the disk, an error detecting and correcting circuit (ECC) examines the data and determines if any errors have occurred during the data storage process. Certain types of these errors can be corrected, and if these types of errors are found, corrections are made. After an operation, the CPU can read status indicators that show if errors have occurred and if corrections have been made. Although there is no guarantee that ECC provides perfect records after correction, corrections that are made offer the highest probability of data integrity.

1.3.3 Disk Drive Operations

The disk drive performs all data reading and writing functions upon operational commands exchanged solely with the disk controller. As shown in Figure 1-4, disk control commands, power sequence, data, and clock signals are fed directly to the disk drive. Status signals, data, and clock signals are returned to the disk controller when requested.

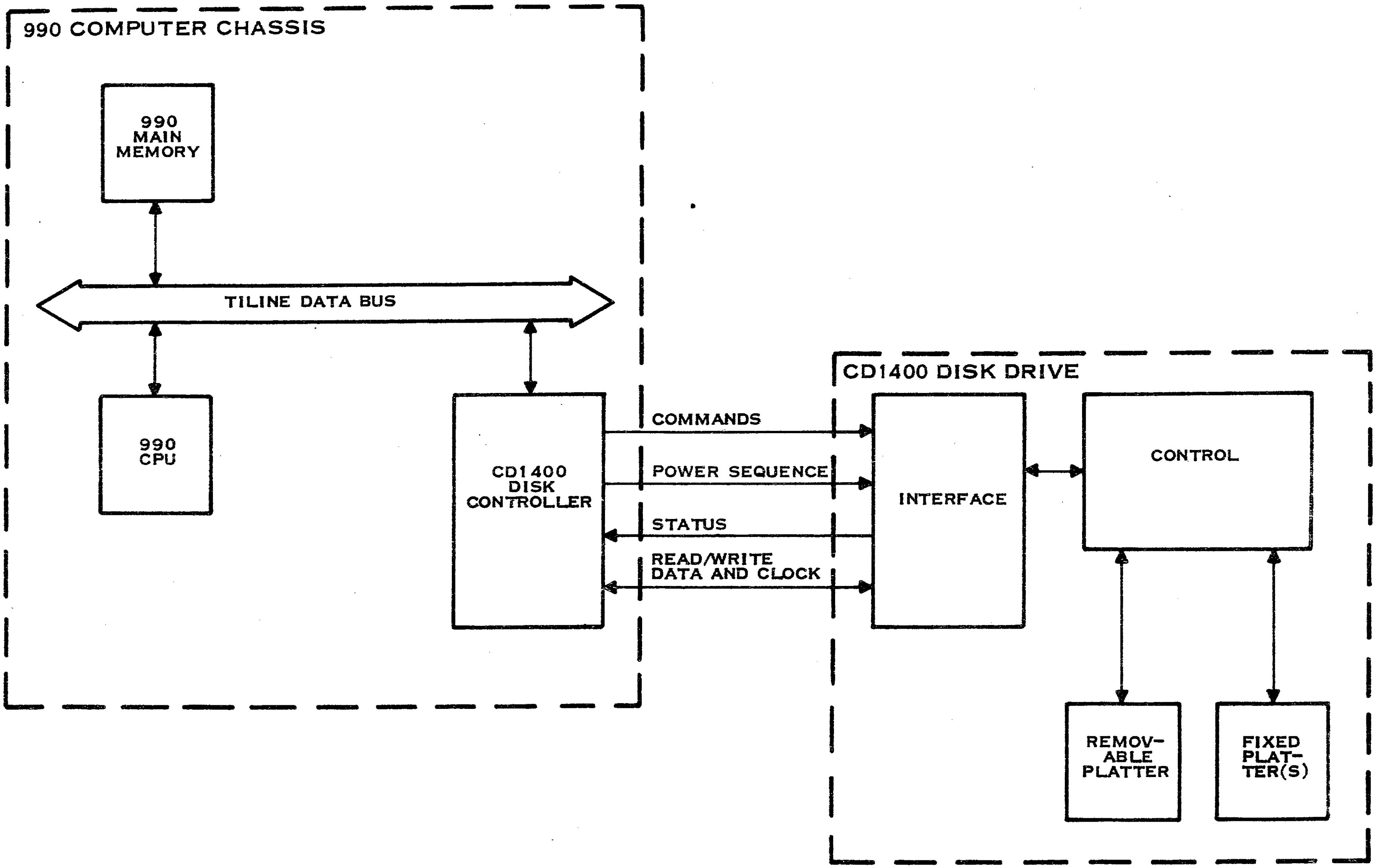

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Figure 1-4. Disk Drive System Simplified Block Diagram

1.4 SYSTEM SPECIFICATIONS

Table 1-2 lists specifications for the CD1400 disk system.

Table 1-2. Model CD1400 Disk System Specifications

Characteristic	Specification		
PHYSICAL			
Dimensions:			
Height	267 mm (10.5 in)		
Width	483 mm (19.0 in)		
Length	762 mm (30.5 in)		
Weight:	77 kg (170 lbs)		
	32MB	64MB	96MB
Number of fixed platters:	3	3	3
Read/write heads:	2	4	6
Servo heads:	2	2	2
Bytes per drive:	32MB	64MB	96MB
Tracks per surface:	823	823	823
Track density tracks/millimeters (tracks/inch):	15(384)	15(384)	15(384)
Track spacing millimeters (inches):	0.0660 (0.0260)	0.0660 (0.0260)	0.0660 (0.0260)
ENVIRONMENTAL			
Temperature range:			
Transit	-40 °C to 70 °C (-40 °F to 158 °F) 20 °C/hr maximum change		
Nonoperating (storage)	-10 °C to 50 °C (14 °F to 122 °F) 15 °C/hr maximum change		
Operating	10 °C to 35 °C (50 °F to 95 °F) 10 °C/hr maximum change		
Humidity range:			
Transit	5% to 95% relative, noncondensing 10% per hour maximum change		
Storage	10% to 90% relative, noncondensing 10% per hour maximum change		
Operating	20% to 80% relative, noncondensing 10% per hour maximum change		

Table 1-2. Model CD1400 Disk System Specifications (Continued)

Characteristic	Specification		
	ENVIRONMENTAL (Continued)		
Air Cleanliness:			
Operating	Particle size (microns)		Particles per cubic meter
	>1		4 x 10^7
	>1.5		4 x 10^6
	>5		4 x 10^5
Altitude:	-305 to 1983 meters (-1000 to 6500 feet) (Maximum temperature limit must be reduced 1.0 °F for each 1000 ft. altitude.)		
	POWER REQUIREMENTS		
Ac power input (disk drive):			
	Voltage		Frequency
	100 +10,-10 V		50(+.5,-1) Hz
	100 +10,-10 V		60(+.6,-1) Hz
	120 +12,-18 V		60(+.6,-1) Hz
	220 +22,-33 V		50(+.5,-1) Hz
	240 +24,-36 V		50(+.5,-1) Hz
	Phase	Amperes (start)	Amperes (run)
	1	15 max	8.2
	1	15 max	8.2
	1	15 max	8.2
	1	7.5 max	4.0
	1	7.5 max	4.0
Dc power input (disk controller):			
	Voltage		Current (amperes)
	+5.0		6.0
	-12.0		0.10
	PERFORMANCE		
Start time:	45 seconds typical, 70 seconds maximum, from power on		
Stop time:	30 seconds typical, 35 seconds maximum, from power off		
Seek time:			
Full	55 ms, maximum		
Average	30 ms		
Single track	6 ms, maximum		

Table 1-2. Model CD1400 Disk System Specifications (Continued)

Characteristic	Specification		
	PERFORMANCE (Continued)		
Transfer rate:	1.2MBytes/second		
Rotation speed:	3600 +90,−144 rev./min.		
Bit density:	6038 bits/inch, inner track 4038 bits/inch, outer track		
Rotational latency time:			
Maximum	17.3 ms		
Average	8.33 ms		
Volume switch time:	4 ms, maximum		
Head switching time (within fixed volume):	15 μs, nominal		
Zero track seek time:	450 μs, nominal		
Phase lock synchronization:	9 μs, maximum		
Write-to-read recovery (write gate off to read gate on):	10 μs		
Read-to-write recovery (read gate off to write gate on);	0.3 μs		
Bit cell time:	103.2 ± 7.2 ns		
Bit rate (nominal):	9.677 Mhz (1.21MB/second)		
Recording mode:	Modified frequency modulation (MFM)		
Positioning error rate:	1 in 10^6 seek executions		
Audible noise power emissions:	67 dBA when idle 68 dBA when operating		
	CAPACITY		
	32MB	64MB	96MB
Number of sectors/track:	64	64	64
Number of bytes/sector:	256	256	256
Total number of tracks:	1646	3292	4938
Unformatted bytes per track:	20160	20160	20160
Number of addressable cylinders (including two diagnostic cylinders):	823	823	823
Number of tracks per cylinder:	2	4	6
Total unformatted data storage bytes, excluding diagnostic cylinders:	33.1MB	66.2MB	99.3MB

1.5 SYSTEM CABLING CONFIGURATIONS

One or two disk drives in a daisy-chain configuration may be connected to the 990 computer for access via the TILINE data bus. Refer to the installation section of this manual for details on cabling the disk system.

2

Installation

2.1 GENERAL

This section provides preparation, unpacking, mounting, and cabling information for the Model CD1400 Disk System. Site requirements and initial verification procedures are also detailed.

The user should read this entire section before beginning since unusual circumstances may require that procedures be performed in an order different from that described.

CAUTION

Do not connect or disconnect any plug or circuit board when power is applied to the system since voltage transients may damage electronic parts.

2.2 SITE REQUIREMENTS

Refer to Section 1 for environmental conditions and limits. Particular attention must be paid to temperature, humidity, and air cleanliness specifications. The disk drive should be located away from smoking, food consumption, and high traffic areas. Carpets and drapes should be avoided since they produce lint, collect dust, and increase static discharge problems. Also, the drive should be located away from printers, card punching machines, paper tape perforators and similar equipment since paper, carbon, and ink particles reduce the life of the drive air filter and increase chance of drive failure.

Cooling air is drawn in at the front of the disk drive and exhausted through the rear. The disk drive must be mounted in either a deep cabinet or special pedestal to insure proper air flow.

The disk drive mounts on drawer slides in an EIA standard 19-inch rack (36-inches deep), and requires 264-millimeters (10.5-inches) panel height and 806-millimeters (31.75-inches) depth behind the front panel. The disk drive may also be mounted on a pedestal.

2.3 PREPARATION FOR USE

The following paragraphs detail instructions for preparing the disk drive for use. These instructions include unpacking, inspection, shipping hardware removal, printed wiring board preparation, disk controller preparation, CPU preparation, disk drive mounting, cabling, grounding, and verification before applying power.

A checklist is provided on the following page to assist the user in ascertaining that all necessary preparations have been made prior to using the disk system.

PREPARATION FOR USE CHECKLIST

	Task	Initials
1.	Unpacking and parts inventory complete (paragraph 2.3.1)	________
2.	Inspection complete (paragraph 2.3.2)	________
3.	Shipping hardware removed (paragraph 2.3.3)	
	a. Carriage lock	________
	b. Rear shipping bolt	________
	c. Base pan shipping screws	________
	d. Deck hold-down bolts	________
4.	Disk drive printed wiring board preparations (paragraph 2.3.4)	
	a. Interface (I/O) board power sequencing switch, interface inhibit switch, unit number switches, and drive capacity switches all set (paragraph 2.3.4.1)	________
	b. Servo-coarse board sector pulse switches set (paragraph 2.3.4.2)	________
5.	Disk controller TILINE address switches set (paragraph 2.3.5)	________
6.	990 computer chassis preparations (paragraph 2.3.6)	
	a. Slot selected and controller installed	________
	b. Access granted jumper installed	________
	c. Interrupt connected	________
7.	Slide or pedestal mounting complete (warning label installed on slide mounted drive) (paragraph 2.3.7)	________
8.	Cabling and connections (paragraph 2.3.8)	
	a. I/O cables installed and routed	________
	b. Terminator board installed in last drive	________
9.	System grounding checked (paragraph 2.3.9)	________
10.	Verification before applying power (paragraph 2.3.10)	
	a. Logic boards firmly seated	________
	b. Connectors firmly seated	________
	c. Cables checked	________
	d. Overall inspection complete	________
	e. Air filter checked	________
	f. Ac power cord checked	________

2.3.1 Unpacking
The disk drive is shipped attached to a skid and packaged as shown in Figure 2-1. The disk controller and accessories are packed in an accessory carton with the disk drive. Inspect packaging for evidence of abuse immediately upon receipt. After preliminary inspection and opening, perform a parts inventory.

NOTE

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

CAUTION

To avoid equipment damage, exercise care using tools during unpacking.

Unpack the disk drive according to the following procedure:

WARNING

All personnel should stand clear when the steel straps holding the crate together are cut. Flying loose ends can cause injury.

1. Remove the steel strapping and slide the shell casing up and off of the unit.
2. Remove accessory carton.
3. Lift off the corrugated box from around the disk drive and remove packing materials, using care not to scratch chassis finish.

WARNING

At least two people are required to lift the disk drive, which weighs 77 kg (170 lbs). To avoid backstrain or other injury, use extreme care when lifting the unit.

4. Lift the disk drive off the skid and place on a convenient working surface.

2.3.2 Inspection
Inspect the disk drive by removing the top cover. Check interior items such as printed wiring boards, carriage assembly, and read/write heads for shipping damage. Contact carrier immediately upon discovery of shipping damage.

CAUTION

The front door of the disk drive cannot be opened until power has been applied. Do not attempt to open the door and remove the cartridge. Do not connect the ac power cord.

2.3.3 Shipping Hardware Removal
Remove the carriage lock, shipping bolt, and deck hold-down bolts by performing the following procedure:

CAUTION

Use care not to drop any hardware into drive chassis as removal is difficult. Any dropped hardware must be removed from chassis before operating.

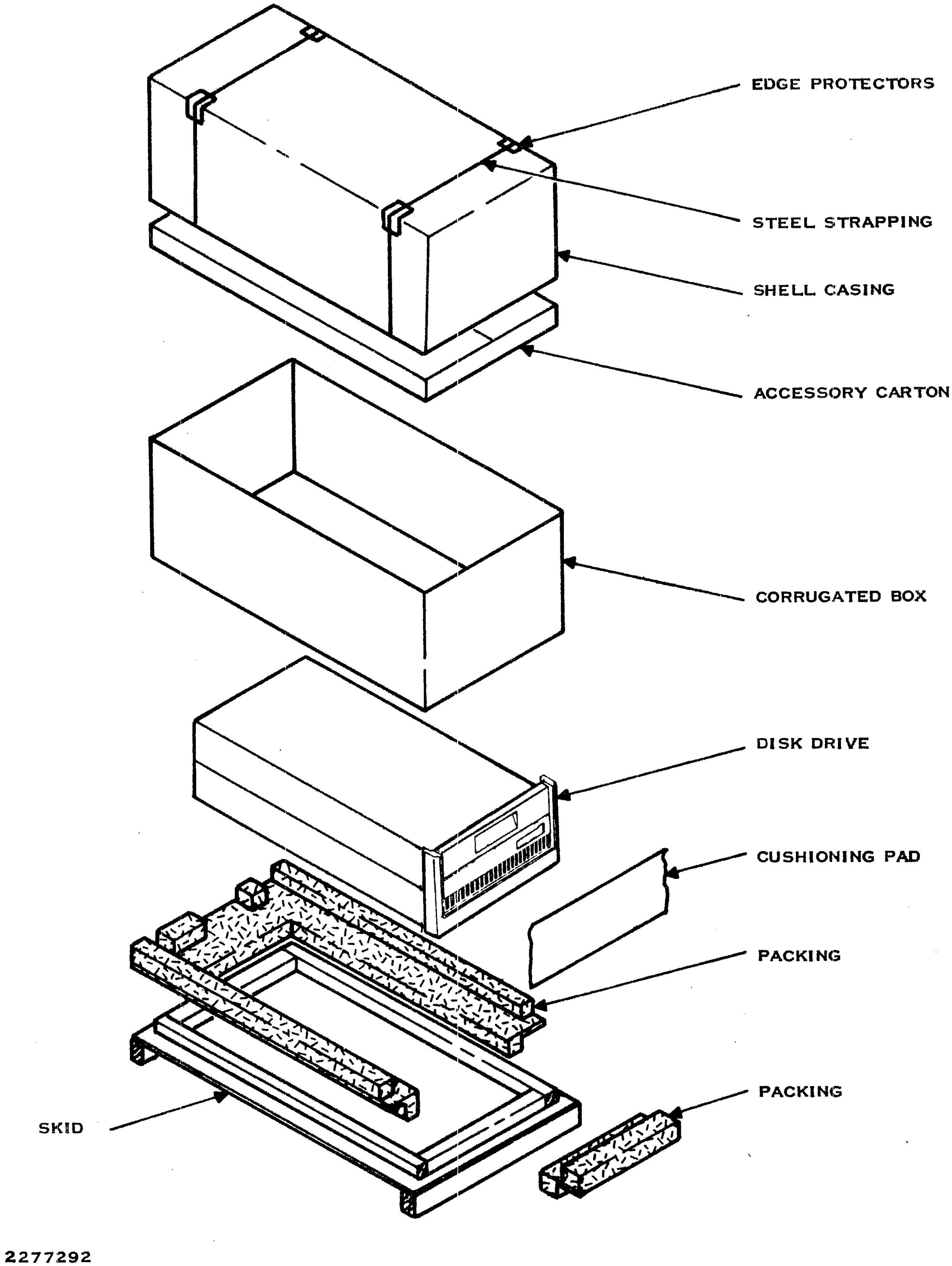


Figure 2-1. Disk Drive Shipping Configuration

1. Remove the carriage lock as follows:

   a. Refer to Figure 2-2. Remove the screw (4) that secures the carriage locking tool (1). Lift the locking tool to remove the pin (2) from the hole in the carriage.

   b. Rotate the locking tool one-half turn and swing tool around to the operating position (B), shown in Figure 2-2.

   c. Reinstall the screw to secure the locking tool to the magnet in the operating position.

CAUTION

Do not position the carriage manually. Such action could cause the read/write heads to load and to cause damage to the platters and heads. The unit should never be shipped or even moved any significant distance without the carriage lock pin in place to prevent head loading and head or platter damage.

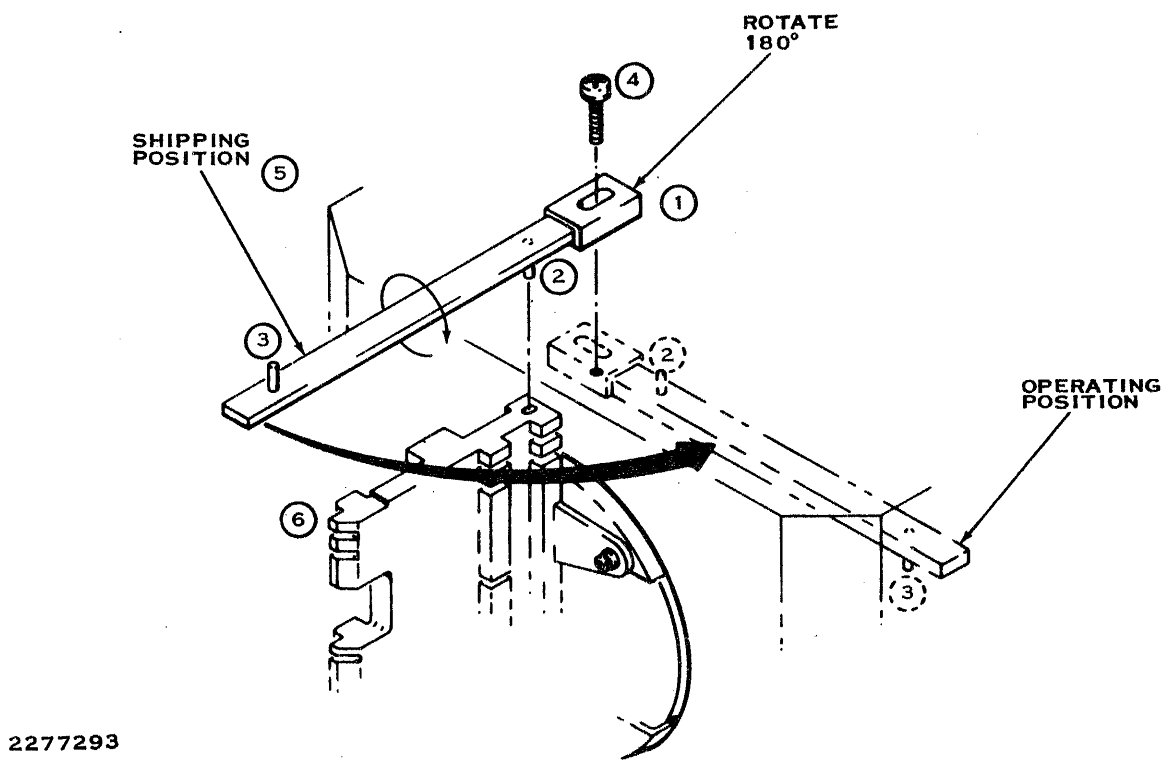


Figure 2-2. Carriage Locking Tool

2. Remove shipping bolt as follows:

   a. Remove rear shipping bolt (C), shown in Figure 2-3, using a 3/16-inch hex driver, and remove spacer from under tie-down tab.

   b. Install removed bolt and spacer in hole (D) as shown in the figure.

   c. Remove and discard screws (F) that secure the electronics module to the base pan as shown in Figure 2-3.

NOTE

Do not remove screws (E) except to access the bottom of the electronics module.

3. Remove deck hold-down bolts using the following procedure:

   a. Remove the air filter from the front panel by grasping the filter housing and pulling straight out, away from the disk drive.

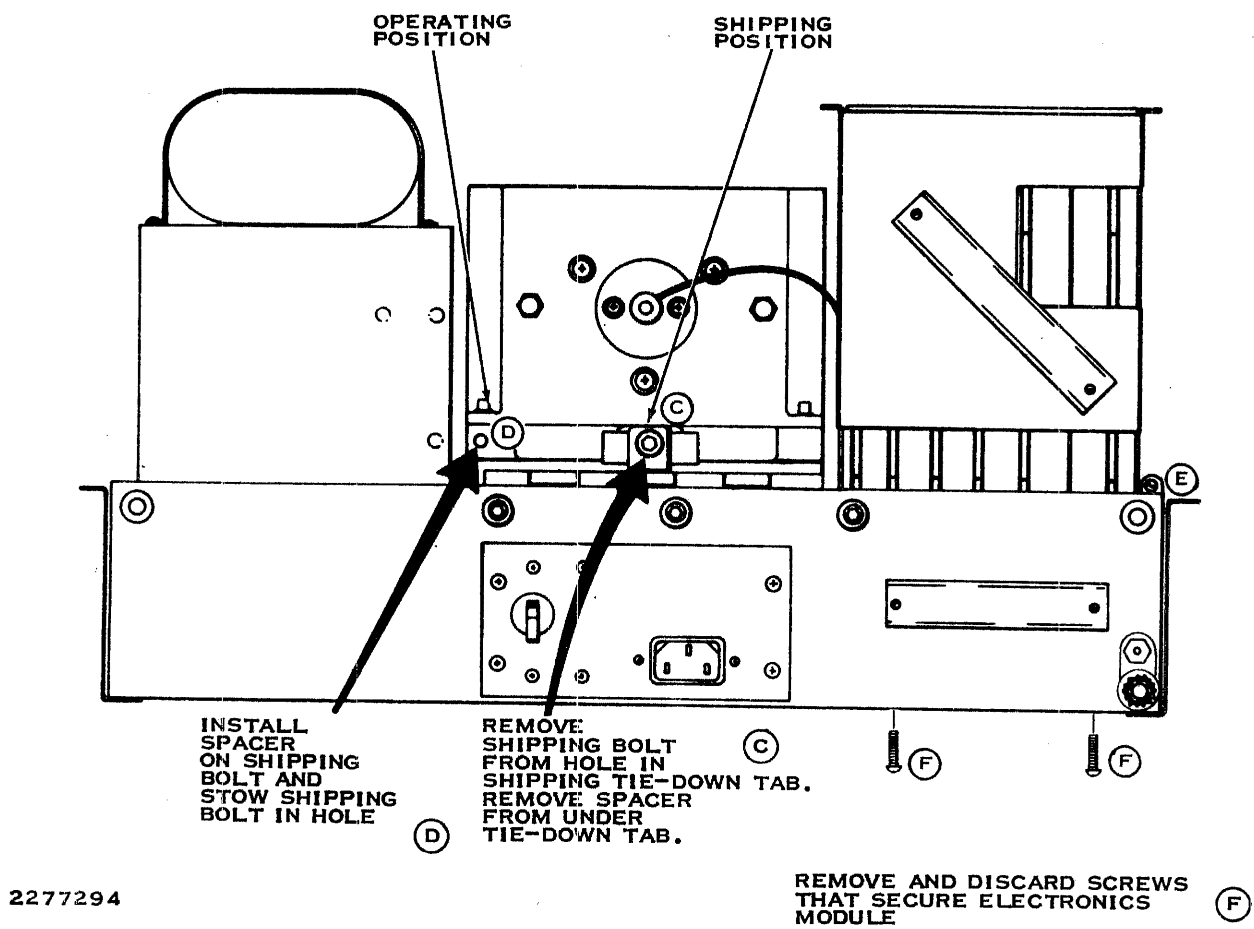


Figure 2-3. Rear Shipping Bolt Locations

b. Remove the front panel. Screws are accessible on each side of the air filter opening.

c. Using an open-end wrench, loosen both lock nuts attached to each hold-down bolt. An access hole is provided at the front right side of the chassis above the air filter for this purpose

d. Remove both hold-down bolts and all attaching hardware using care not to drop any hardware into the disk drive chassis.

e. Restack hardware and reinstall as shown in Figure 2-4, sheet 2.

f. Insure that shipping bolts in the operating position cannot touch deck during operation as dc and ac ground isolation will be lost.

g. Reinstall front panel and air filter in reverse order of removal.

4. Insure deck hold-down bolts (A) shown in Figure 2-4, sheet 1 are securely installed.

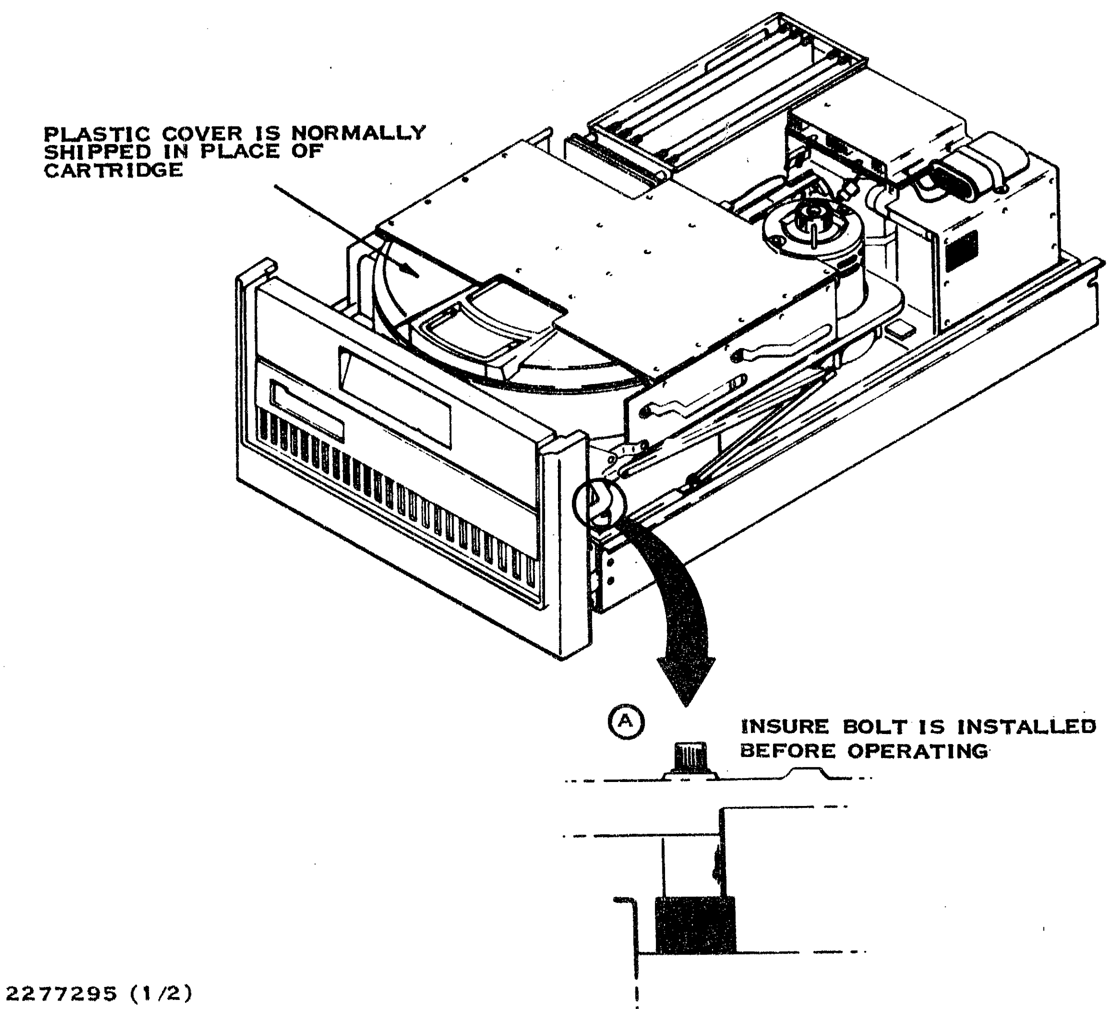


Figure 2-4. Deck Hold-Down Bolts (Sheet 1 of 2)

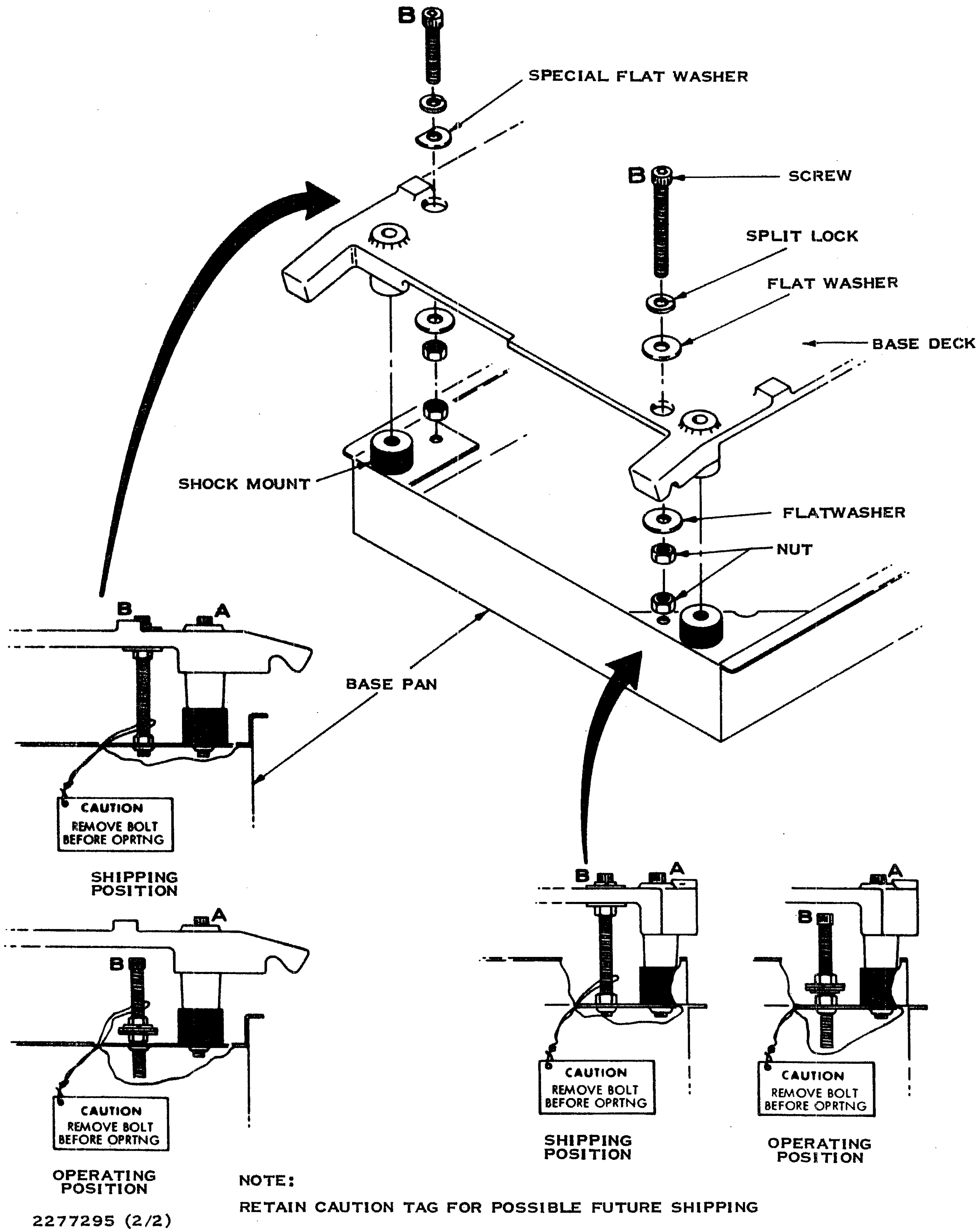


Figure 2-4. Deck Hold-Down Bolts (Sheet 2 of 2)

2.3.4 Disk Drive Printed Wiring Board Preparations

Two printed wiring boards, located in the electronics module of the disk drive, contain option switches that must be set properly prior to operation. These switches were preset at the factory, however, each should be checked prior to placing the unit in service. Locations of these boards are shown in Figure 2-5.

2.3.4.1 Interface (I/O) Board. The disk drive interface board (I/O board) contains two toggle switches S1 and S2, an eight-section DIP switch S3, and a four-section DIP switch S4. Verify switch positions according to the following paragraphs:

Remote/Local Power Sequencing. Since power up of a disk drive requires a relatively high current draw during the first few seconds of operation, disk drives in multiple drive systems should be powered up one at a time to avoid tripping the circuit breaker. After ac power has been applied to a system with all drive START switches on, the controller sequences power to each drive one at a time. Toggle switch S1 on the drive interface (I/O) board selects remote (initial power sequencing by the controller) or local (power sequencing controlled only from the disk drive front panel) control of the power sequence lines. For normal operation, switch S1 should be set to the REM position as shown in Figure 2-6. Once initial power sequencing is complete, drives start immediately upon pressing the START/STOP switch. No more than one drive at a time should be started to avoid tripping circuit breakers.

Drive Interface Inhibit. Toggle switch S2 provides manual capability of inhibiting drive interface signals. For normal operation, switch S2 should be set to the NORM position as shown in Figure 2-6.

Disk Drive Unit Number. For addressing purposes, the controller treats the fixed platters of the disk drive as a separate drive unit from the removable cartridge platter. Switch S3 on the drive interface (I/O) board sets drive unit numbers for both the fixed platters and the removable platter. In single drive systems set at the factory, drive unit 0 refers to the fixed platters and drive unit 1 refers to the removable platter. Each drive unit in a system must be assigned a different unit number. Assign Unit numbers for fixed and removable platters are assigned by setting switch S3 as follows:

Removable Cartridge Unit Selection

Unit Number	S3 Section Number/Position 1	2	3	4
0	OFF	ON	ON	ON
1*	ON	OFF	ON	ON
2	ON	ON	OFF	ON
3	ON	ON	ON	OFF

Note:

* Typical unit select setting for single drive systems.

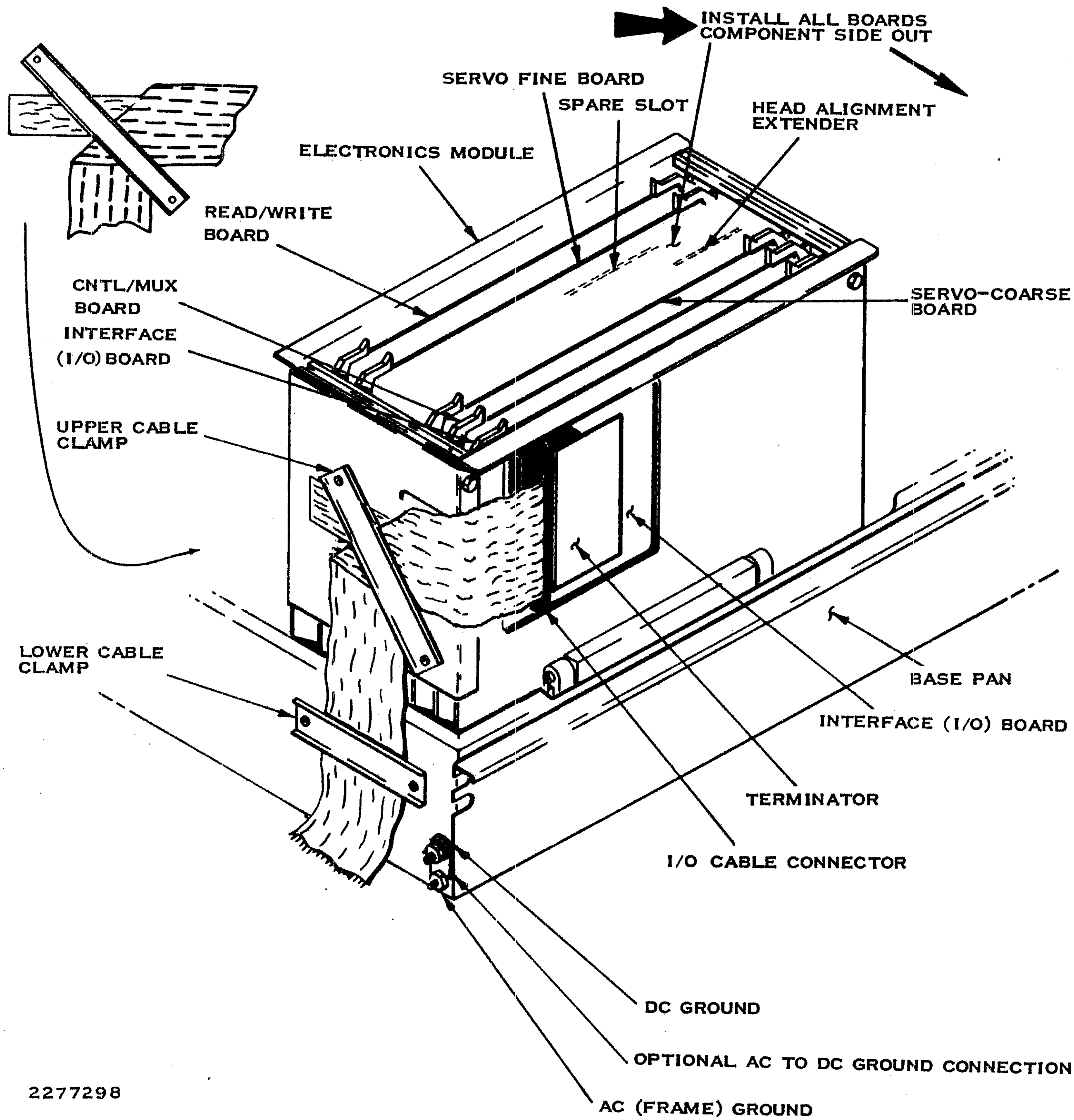


Figure 2-5. Printed Wiring Board Locations

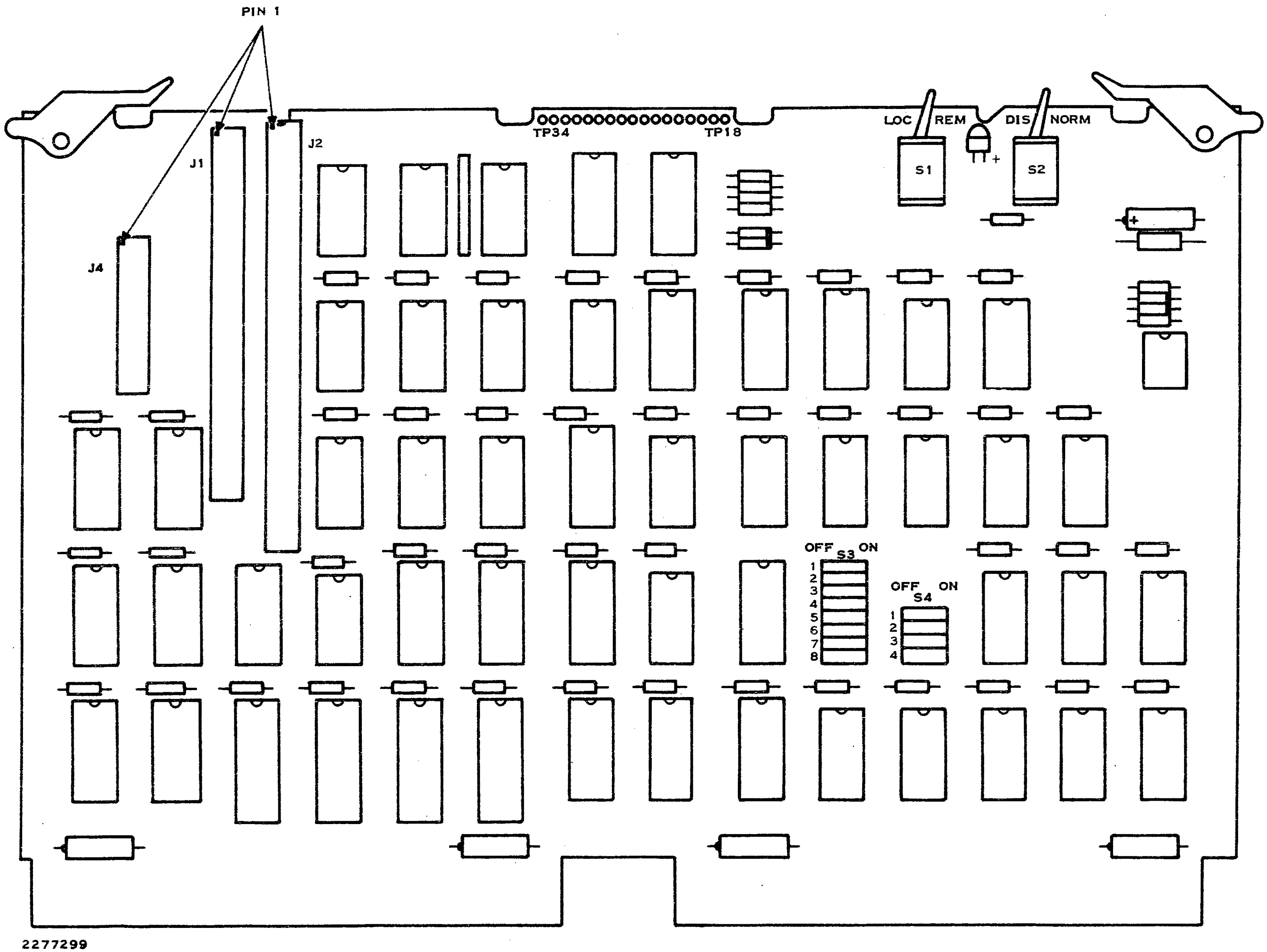


Figure 2-6. Disk Drive Interface (I/O) Board

Fixed Platter Unit Selection

Unit Number	S3 Section Number/Position 5	6	7	8
0*	OFF	ON	ON	ON
1	ON	OFF	ON	ON
2	ON	ON	OFF	ON
3	ON	ON	ON	OFF

Note:

* Typical unit select setting for single drive systems.

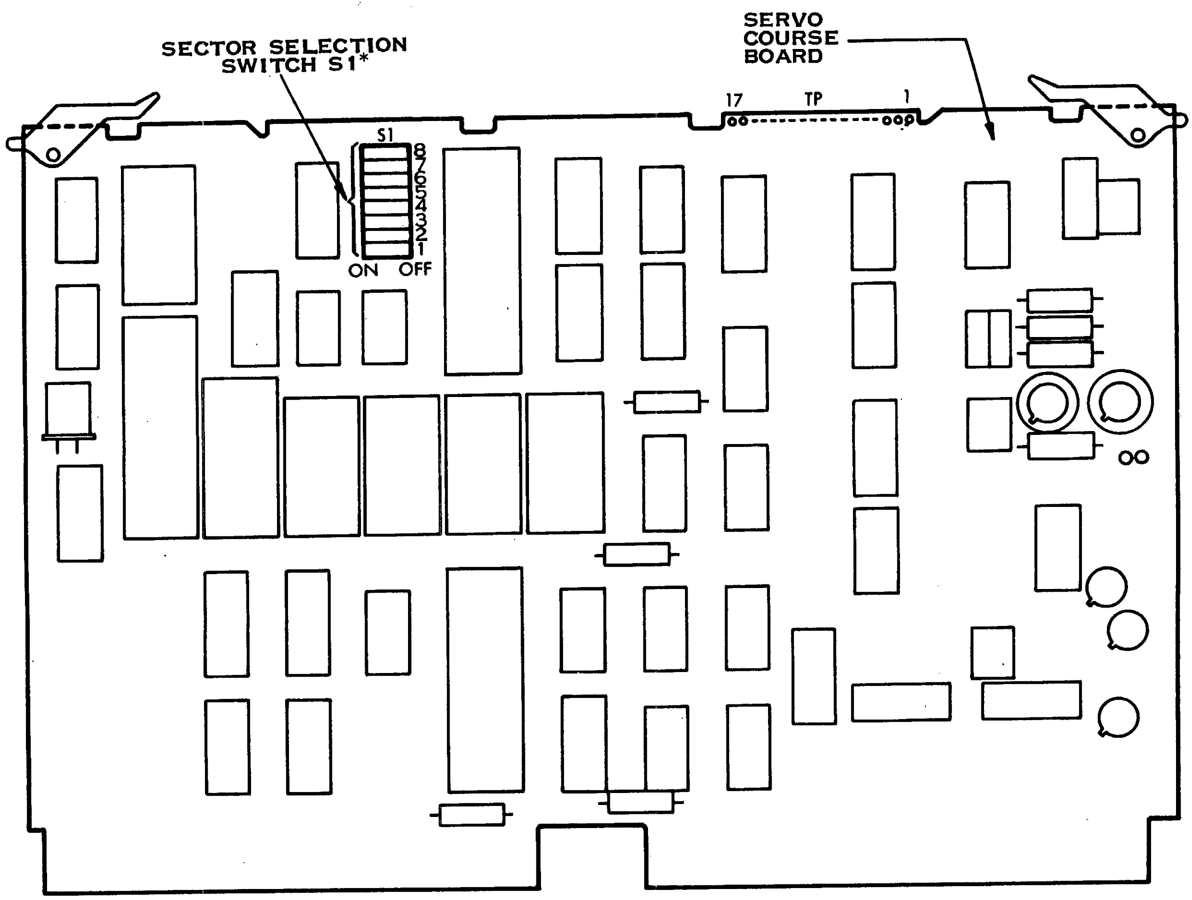
Disk Drive Capacity. DIP switch S4, shown in Figure 2-6, should be preset to the capacity of fixed media in the disk drive. Set the switches according to the capacity of the disk drive fixed media as follows. Note that only sections 1 and 2 of the switch are used.

Disk Size	S4 Switch Section/Position 1	2
32MB (16MB Fixed)	ON	ON
64MB (48MB Fixed)	OFF	ON
96MB (80MB Fixed)	ON	OFF

2.3.4.2 Servo-Coarse Board. The servo-coarse board (Figure 2-7) contains an eight-section DIP switch. Seven of these sections set the number of sector pulses per revolution, which is 64, and the eighth section is used for maintenance. This switch must be set to the following positions:

Sector Selection Switch — Servo-Coarse Board

Switch S1 Section Number	Position
1	ON
2	ON
3	ON
4	ON
5	ON
6	ON
7	OFF
8	ON



2277300 *PUSH IN LEFT SIDE FOR ON , PUSH IN RIGHT SIDE FOR OFF .

*Section 6.9.1 discusses the use of S1-8.

Figure 2-7. Servo-Coarse Board

2.3.5 Disk Controller Preparations

The CPU incorporates the disk controller into addressable memory space for access via the TILINE. Switches on the disk controller determine the TILINE base memory address and must be correctly set prior to use. If the disk drive system was shipped as part of a complete system, these switches have already been set, but should be verified prior to operation. The following paragraphs describe this procedure.

Figure 2-8 shows the disk controller and switch locations. Figure 2-9 lists the TILINE addresses, CPU byte addresses, and corresponding switch positions for each of these addresses. The standard main 990 computer chassis slot assignment for the disk controller is slot 7 for the 13-slot chassis and slot 11 for the 17-slot chassis. The CPU byte address is >F800 (all switches in the off position).

If these switches need setting, determine the proper TILINE address according to the operating system software, and set the switches as shown in Figure 2-9. This completes disk controller preparations.

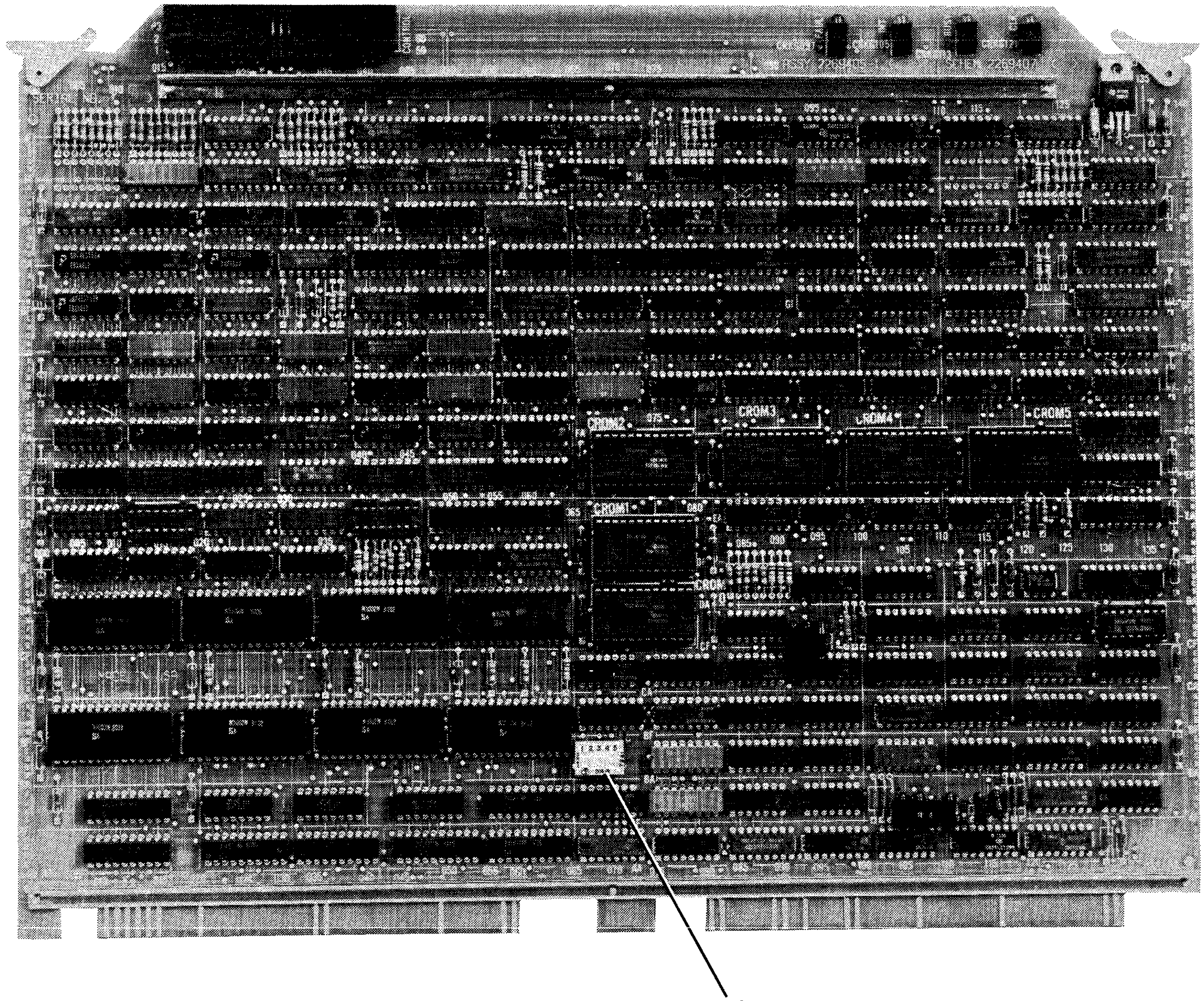
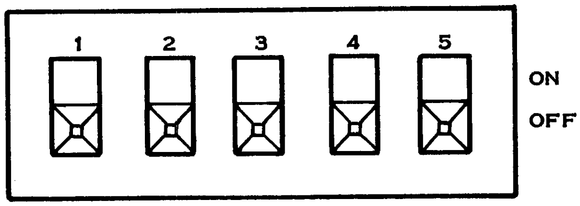


Figure 2-8. Disk Controller



SWITCHES SHOWN SET AT CPU BYTE ADDRESS $F800_{16}$

TILINE WORD ADDRESS (HEXA-DECIMAL)	CPU BYTE ADDRESS (HEXA-DECIMAL)	SWITCHES					
		1	2	3	4	5	
FFC00	F800	OFF	OFF	OFF	OFF	OFF	DISK CONTROLLERS
FFC08	F810	OFF	OFF	OFF	OFF	ON	
FFC10	F820	OFF	OFF	OFF	ON	OFF	
FFC18	F830	OFF	OFF	OFF	ON	ON	
FFC20	F840	OFF	OFF	ON	OFF	OFF	
FFC28	F850	OFF	OFF	ON	OFF	ON	
FFC30	F860	OFF	OFF	ON	ON	OFF	
FFC38	F870	OFF	OFF	ON	ON	ON	
FFC40	F880	OFF	ON	OFF	OFF	OFF	OTHER TILINE SLAVES
FFC48	F890	OFF	ON	OFF	OFF	ON	
FFC50	F8A0	OFF	ON	OFF	ON	OFF	
FFC58	F8B0	OFF	ON	OFF	ON	ON	
FFC60	F8C0	OFF	ON	ON	OFF	OFF	
FFC68	F8D0	OFF	ON	ON	OFF	ON	
FFC70	F8E0	OFF	ON	ON	ON	OFF	
FFC78	F8F0	OFF	ON	ON	ON	ON	

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Figure 2-9. TILINE Address Switch Configurations

NOTE

If the disk drive system was purchased as part of a complete Texas Instruments 990 computer system, computer chassis preparation (paragraphs 2.3.6 through 2.3.6.4) is not necessary. In this case, proceed to paragraph 2.3.7.

2.3.6 990 Computer Chassis Preparation for the Disk Controller

The following paragraphs describe 990 computer preparations unique to the Model CD1400 Disk System. This material is abstracted from the chassis preparation instructions in the computer hardware reference manuals. See the preface for formal titles and part numbers of hardware reference manuals for the 990/5, 990/10, and 990/12 computers.

If the disk controller is shipped as part of a 990 computer system, computer chassis preparation is done at the factory. The controller is assigned a slot location, the interrupt jumpers are installed, and the TILINE access-granted (TLAG) jumpers/switches are correctly set. In this case, after the controller switch settings are verified, the hardware is compatible with the supplied software.

2.3.6.1 Selecting a Chassis Slot for the Controller. Chassis slot selection is based upon interrupt level and TILINE priority considerations. Each of the DS990 package systems already incorporate a planned growth path that specifies preferred slot locations, interrupt levels, and TILINE base addresses for standard peripheral controllers.

Interrupt assignments and TILINE address switch settings must be coordinated with the operating system software by system generation (SYSGEN) procedures. Refer to

SYSGEN instructions in operating system documentation upon completion of hardware installation.

2.3.6.2 TILINE Philosophy. The TILINE is a common data path that is connected to all slot positions in the 990 chassis. Users of this bus fall into two major types, masters and slaves. Slave devices are addressed by master devices and commanded to accept or transmit data. Some TILINE peripherals, including the cartridge disk controller, have both master logic and slave logic.

In order to resolve conflicts between multiple masters contending for TILINE control, a positional priority scheme is used. The TLAG signal that establishes positional priority among masters is wired along the P2 side of the computer chassis. The TILINE master installed in the highest numbered slot has the highest priority, with priority decreasing with each slot toward the central processor location (slot 1).

The TLAG signal from a higher priority master enters each master on P2, pin 6. The signal leaves the master on P2, pin 5. Logic on the master allows it to block the output to lower priority masters. Jumpers are installed on the backpanel to assure line continuity across slots not occupied by masters. Additional masters may be inserted at slot positions of higher or lower priority by opening the jumper between P2-5 and P2-6 (TLAG) for the selected slot location. Installing a board with TILINE master logic, such as the disk controller, requires that:

- The TLAG jumper (P2-5 to P2-6) be opened for the chosen slot. Opening a TLAG jumper consists of either:

  — Physically pulling out a jumper (current 6-slot, 13-slot chassis)

  — Cutting a jumper wire or etch (older 6-slot, 13-slot chassis)

  — Setting a jumper switch to OFF (17-slot chassis)

- Continuity of the TLAG lines between the highest priority master and the central processor board must be preserved. This means that if an intermediate slot is assigned to a TILINE master, that master must be installed to preserve continuity and to allow the priority system to function. It also means that the jumpers must be in place (or jumper switches ON) for all slots not occupied by TILINE couplers or TILINE device controllers.

2.3.6.3 Preparing a 990 Chassis Slot Location for the Disk Controller. Jumper locations and modification procedures differ between versions of the 990 chassis, as described in the following paragraphs.

Slot Preparation — Current production, 6-slot and 13-slot Chassis. Current production units have the TLAG jumpers accessible from the connector side of the motherboard, as shown in Figures 2-10 (6-slot) and 2-11 (13-slot). For these units, the following steps should be performed:

1. Turn off power and unplug the ac line cord.

2. Remove any circuit boards necessary for access by rocking firmly on the plastic ejector tabs. Note the locations and orientation of the boards so they may be properly reinstalled.

3. Remove the access-granted jumper plug for the selected location.

4. If interrupt levels are to be changed, refer to paragraph 2.3.6.4.

5. Reinstall the circuit boards in the proper locations. The configuration label on the chassis should be checked to assure that the boards are installed in the correct slots.

6. Record the new slot assignment on the configuration chart affixed to the chassis.

Slot Preparation — Early Production, 6-Slot and 13-Slot Chassis. If the chassis is an early production version (i.e., it does not have jumpers as shown in Figure 2-10 or 2-11), remove the back cover and power supply to gain access to the TLAG jumpers. For these chassis, the following steps should be followed:

1. Turn off power and unplug the ac line cord.

WARNING

Lethal voltages are exposed when the access cover is removed. The power supply capacitor may retain charges long after ac power is removed.

2. Remove the left access cover (as viewed from the front of the chassis). The cover is fastened by four or six hex-head machine screws.

3. If the chassis is a 13-slot unit with a 20-ampere power supply, slots 1-6 are visible above the power supply. In this case, proceed to step 5.

4. Remove the power supply as follows:

   a. Disconnect color-coded connectors from the component side of the power supply board.

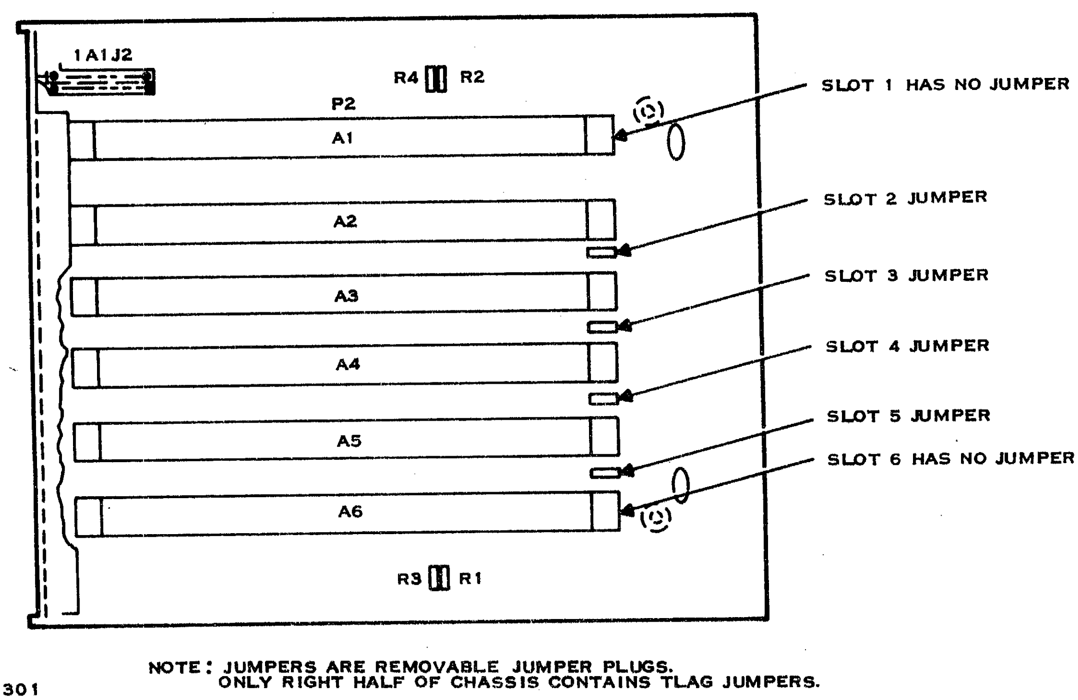


Figure 2-10. TLAG Jumper Locations for 6-Slot Chassis (Current Production)

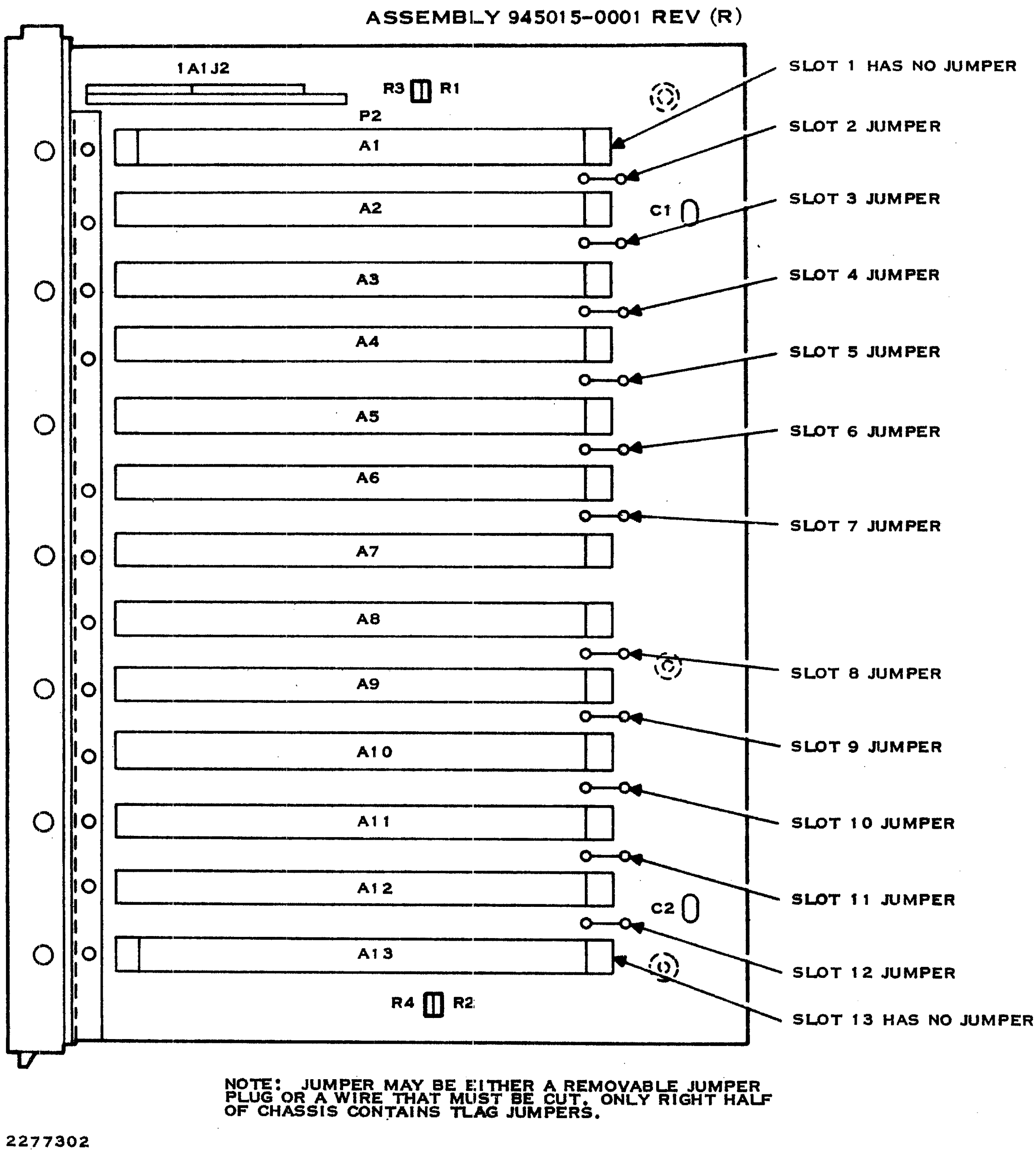


Figure 2-11. TLAG Jumper Locations for 13-Slot Chassis (Current Production)

b. Unscrew the machine screws and standoffs that secure the power supply and RF shield to the frame and to the motherboard.

c. Carefully pull the power supply board straight forward until the connector at the bottom center of the power supply board is disengaged from the pins protruding from the motherboard. Lift the power supply board out of the chassis.

d. Remove the RF shield.

5. The rear of the motherboard is now exposed. The P2 connectors are at the left side, closest to the fan. Figure 2-12 gives detailed views of the left end of the P2 connector in a 13-slot and 6-slot chassis.

   In a 13-slot chassis, the TLAG jumpers (P2-5 to P2-6) are wire loops soldered to the connector. Pins 1 and 2 are concealed by the ground plane.

   To remove a jumper in the 13-slot chassis, clip the wire loop in two places and remove the excess wire. To remove a jumper in the 6-slot chassis, cut the jumper etch at two points with a sharp knife and lift or scrape away the excess conductor.

   To install a jumper, solder a short length of #26 AWG wire between P2-5 and P2-6.

6. To reinstall the power supply, proceed as follows:

CAUTION

The male pins protuding from the lower center of the motherboard are subject to bending if the mating connector on the power supply is not properly aligned with these pins.

a. Slip the power supply over the cable harness and into the side of the chassis. The metal shell jumper connector (for the standby power supply) should appear at the bottom center of the power supply board.

b. Align the power supply circuit boards on the two alignment pins and carefully slide the board straight back so that the pins protruding from the motherboard slip into the connector on the power supply circuit board. View of these pins is blocked by the power supply board.

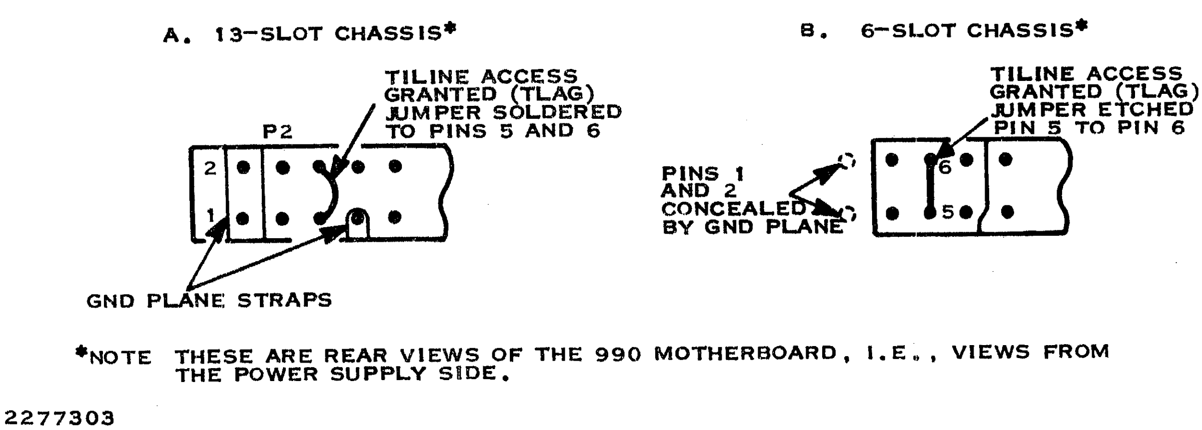


Figure 2-12. TLAG Jumpers on Early Production 6-Slot and 13-Slot Chassis

c. Reinstall the machine screws and standoffs that hold the power supply and RF shield in place. Do not omit the lockwashers, as both mechanical and electrical connections are made by the machine screws and standoffs.

d. Reconnect the power supply to the wiring harness by installing the color-coded plastic connectors.

7. Replace the access cover and secure with machine screws.

8. Record the new slot assignment on the configuration chart affixed to the chassis.

9. Refer to paragraph 2.3.6.4 for interrupt connections.

Slot Preparation — 17-Slot Chassis. Continuity of the TLAG jumpers in the 17-slot chassis is controlled by two socket-mounted DIP switches, each with eight individual switch sections. These switches are accessible from the rear of the 17-slot chassis, as shown in Figure 2-13. To check or set these switches, the following steps should be performed.

1. Turn off power and unplug the chassis ac line cord. Allow about 30 seconds for the power supply bleeders to discharge the power supply capacitors.

WARNING

Opening the chassis rear cover (power panel) exposes high voltages if the ac line cord is installed in a power socket. Do not contact the large filter capacitors on the power module.

CAUTION

The wire hinges on the chassis rear cover do not allow the cover to pivot beyond 90 degrees. Attempts to open the chassis rear cover beyond 90 degrees may damage the hinge mountings.

2. Using a coin or flat-bladed screwdriver, release each of the 11 quarter-turn latches on the chassis rear cover. Pull the cover straight back 38 millimeters (1.5 inches) to extend the wire hinges, and then open the cover to the 90-degree position. The hinges are on the right as viewed from the rear of the chassis.

3. Figure 2-14 shows the correspondence between switch sections and chassis slots. Set the appropriate switch segment OFF for any slot that is assigned to a TILINE master device, such as the disk controller. All other switch segments should be ON.

4. Refer to paragraph 2.3.6.4 if interrupt assignments are to be changed.

CAUTION

There is a possibility of interference between heat sinks in the chassis and modules mounted inside the rear access cover as the door is closed. Do not force the door closed if resistance is felt.

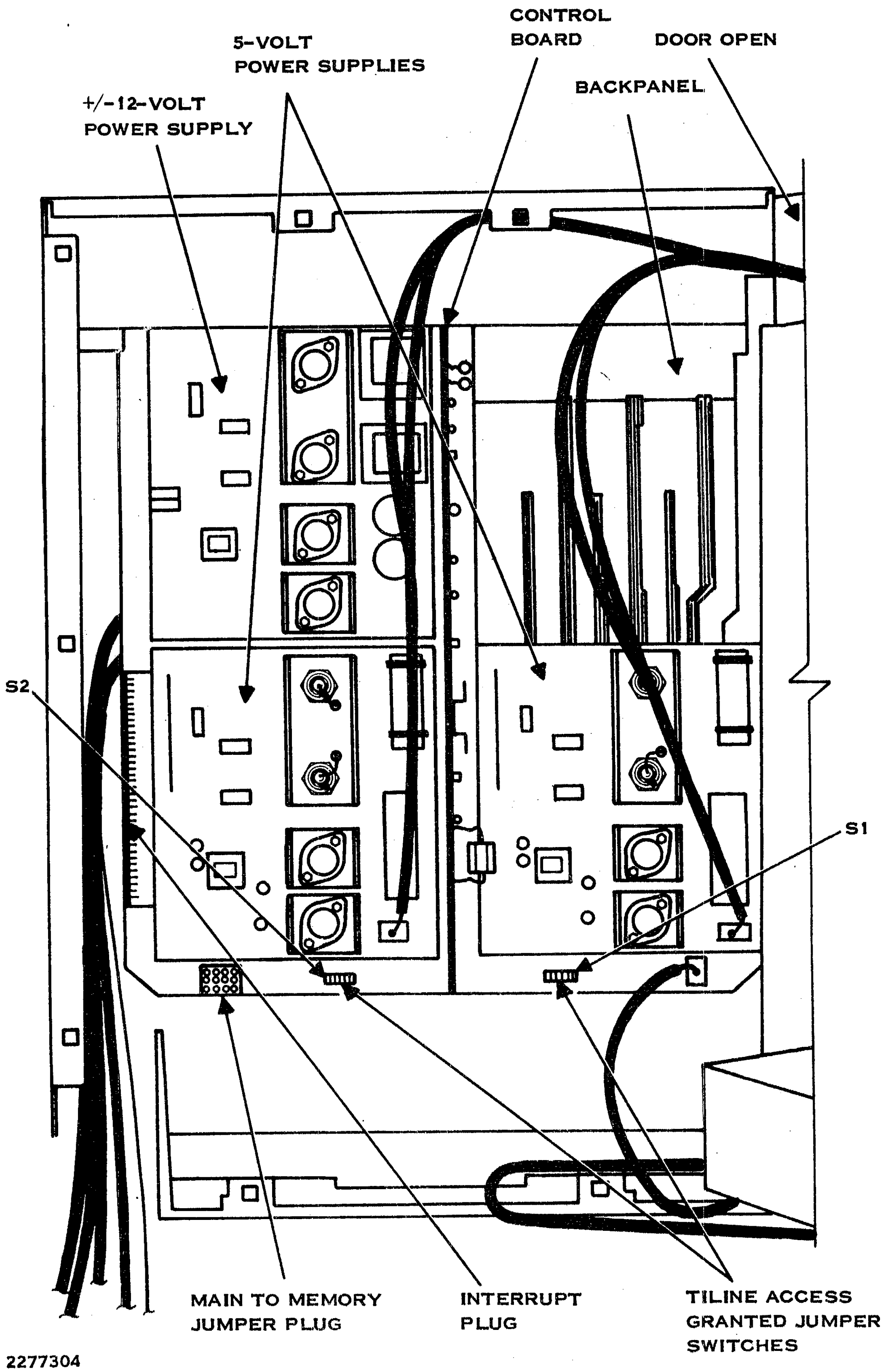


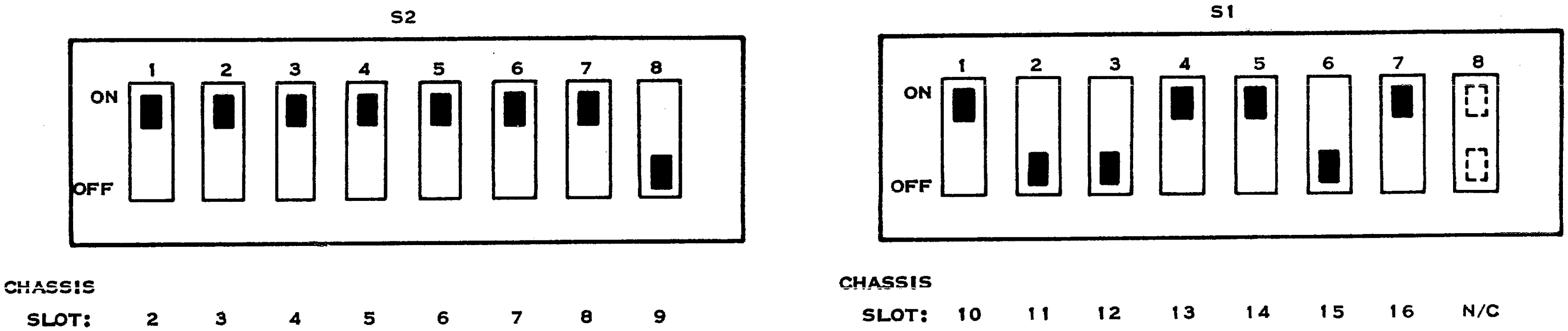
Figure 2-13. Interrupt Plug and TLAG Jumper Switches in the 17-Slot Chassis

17 – SLOT CHASSIS

TILINE ACCESS GRANTED (TLAG) JUMPER SWITCHES

ON = TLAG JUMPERED ACROSS SLOT (P2-6 TO P2-5)

OFF = TLAG NOT JUMPERED – CONTINUITY REQUIRES TILINE CONTROLLER



NOTES: 1. SWITCHES ARE SHOWN SET FOR:

FCCC	– SLOT 9
SYSTEM DISK CONTROLLER	– SLOT 11
979A TILINE MAGNETIC TAPE CONTROLLER	– SLOT 12
FD1000 TILINE FLEXIBLE DISK CONTROLLER	– SLOT 15

2. EACH SWITCH SECTION MUST BE ON UNLESS A TILINE MASTER CONTROLLER IS INSTALLED IN THE CORRESPONDING CHASSIS SLOT. TILINE PRIORITY SYSTEM WILL NOT WORK IF SWITCHES ARE SET INCORRECTLY.

3. SLOT 17 DOES NOT REQUIRE A SWITCH.

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Figure 2-14. 17-Slot Chassis TLAG Jumper Switch Settings

5. Rotate the door to fully extend hinges and to a position parallel to the rear of the chassis. Grasp the rear access cover at the left and right sides and push straight back to mounting position against the chassis.

6. Using a coin or screwdriver, lock the 11 quarter-turn latches that hold the access cover in position.

2.3.6.4 Interrupt Connections. Interrupt connections to interface peripheral equipment to the 990 processor are usually made before the system is delivered to the customer. The planned growth path for the DS990 systems avoids the necessity for the customer to modify interrupt levels, except under very unusual circumstances. Preassigned slot assignments do not require modification of the factory prewired interrupt levels. Note, however, that adding a controller to a previously existing installation requires a SYSGEN operation to coordinate hardware and software operation.

The information in the following paragraphs is provided for users who must modify existing interrupt assignments.

The 990 processor has 16 interrupt levels, numbered 0–15. Interrupt level 0, which is internal to the processor, has the highest priority. Interrupt levels 3, 4, and 6–15 are external inputs that are available for assignment to peripheral controllers installed in the chassis. The interrupt input lines are wired from chassis slot 1 to an interrupt header adjacent to slot 1.

Each of the remaining chassis slots (numbered 2 and above) has two interrupt output lines wired to the same interrupt header. Interrupt level to device assignments are made by jumper connections at the interrupt header.

Interrupt Connections for 6-Slot and 13-Slot Chassis. Figure 2-15 shows the location of the interrupt jumper header and interrupt jumper plugs in a 6-slot or 13-slot chassis.

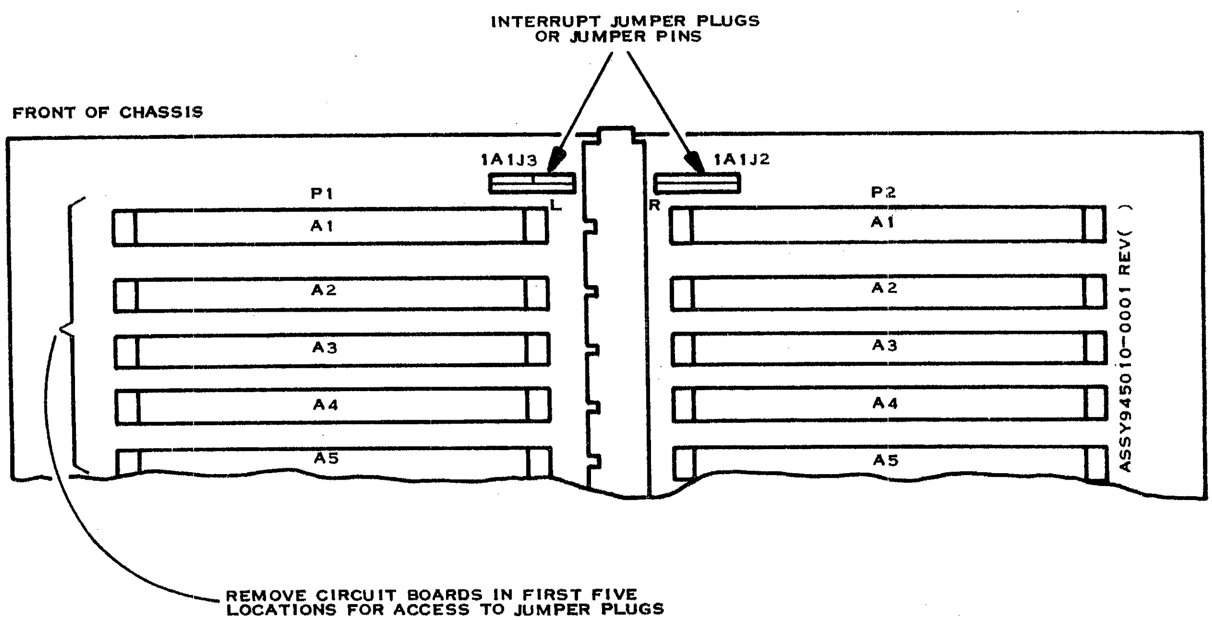

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Figure 2-15. Location of Interrupt Jumpers, 6-Slot and 13-Slot Chassis

Early versions of the chassis use direct pin-to-pin jumpers without jumper plugs.

There are two rows of pins in the header. The top row has 15 pins connected through the motherboard to the 15 interrupt levels of the processor. Additional pins on the top row are provided in the 13-slot chassis for special configurations, such as CRU expansion. The bottom row contains 48 pins in a 13-slot chassis or 20 pins in a 6-slot chassis. Two of these pins are wired to each of the possible circuit board interrupt outputs. This allows multiple interrupts to be connected to one interrupt level.

Interrupt pin assignments are shown in Figures 2-16 and 2-17, which are views of the jumper plugs as seen from the jumper wire side. The X marks identify jumper plug positions that have no corresponding pins on the header. The O marks identify jumper plug positions that have no corresponding pins on the early production header.

The configuration chart on top of the chassis details the interrupt level and chassis slot assignments. Any modifications should be recorded on the chart.

The detailed procedure for assigning and changing interrupt levels is presented in the hardware reference manual for the 990 computer. The information presented here is a brief summary of that procedure.

CAUTION

Do not remove or install any circuit board or modify any jumper while power is applied to the 990 chassis.

To gain access to the interrupt jumpers, remove the circuit boards installed in slots 1-5. The interrupt jumpers will be visible on the motherboard just above the slot 1 connectors. The interrupt output of a full-sized

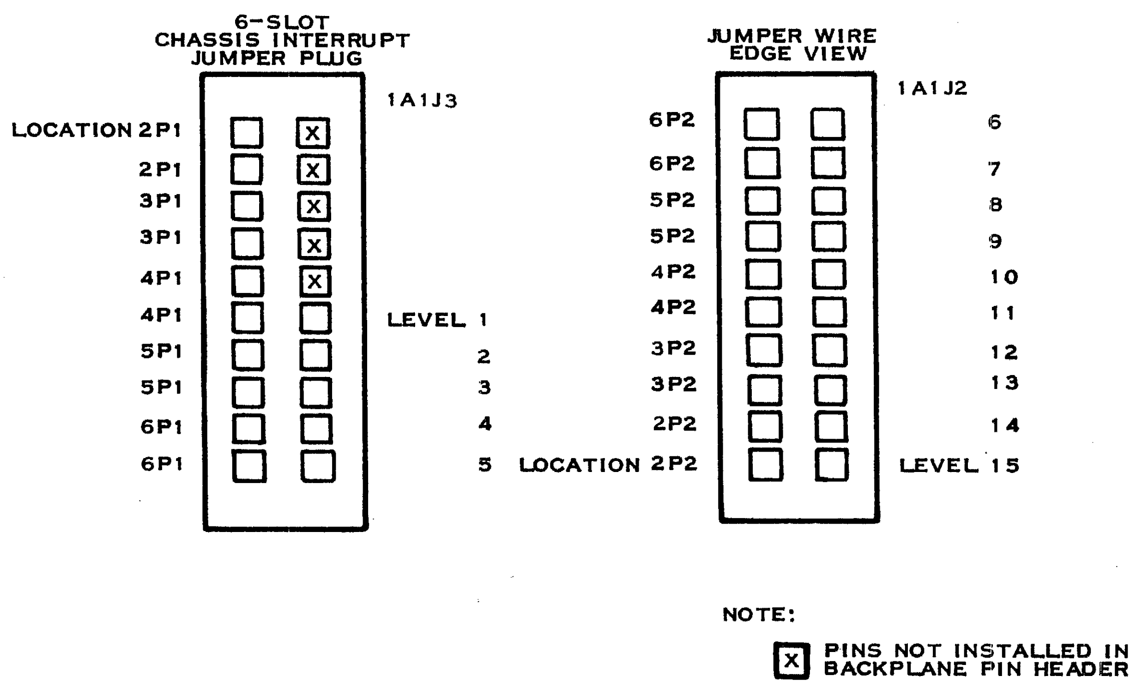

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Figure 2-16. 6-Slot Chassis Interrupt Jumper Plugs

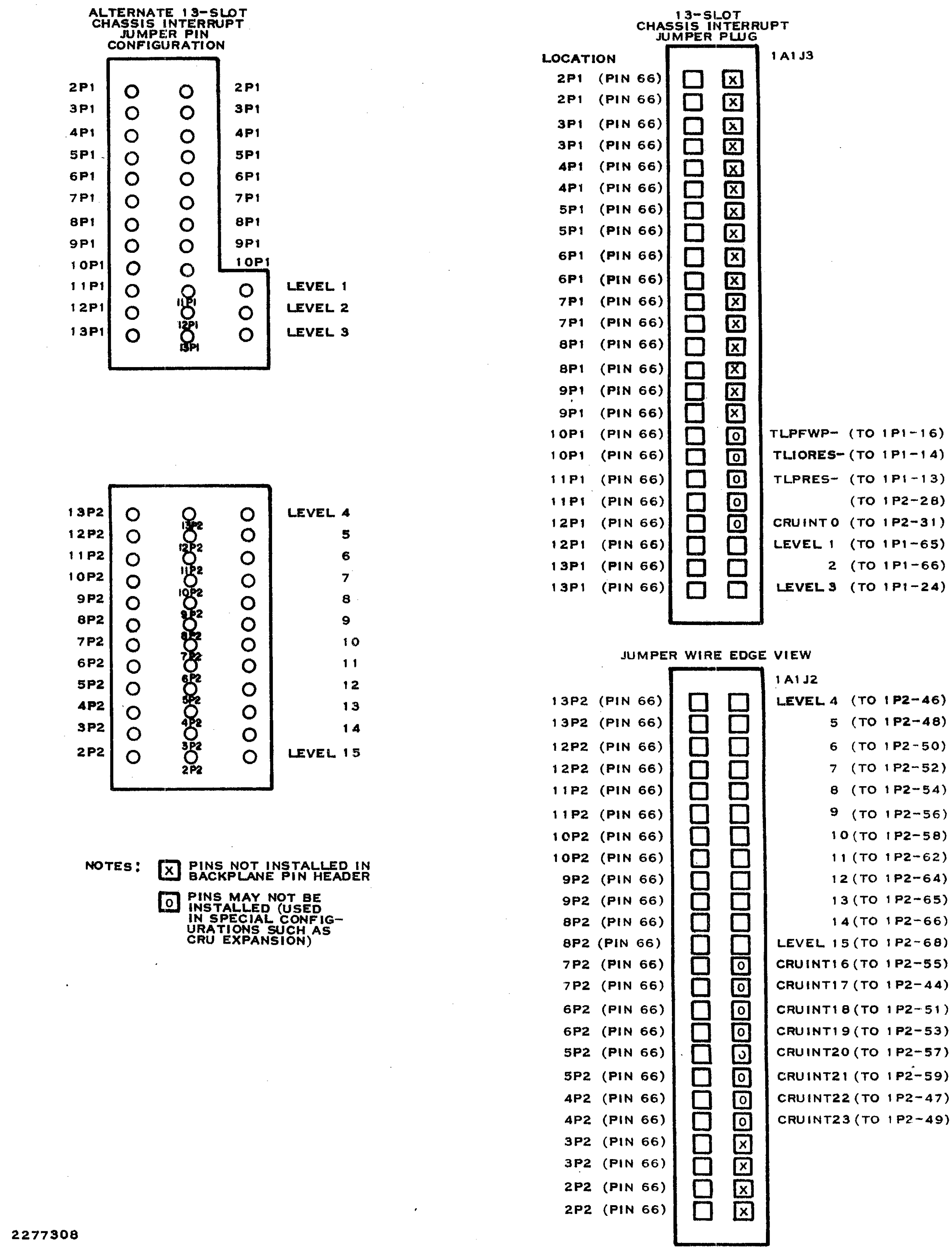


Figure 2-17. 13-Slot Chassis Interrupt Jumper Plugs

board is on P2 of the assigned slot location. Therefore, if slot 8 is chosen for the disk controller, the interrupt will be found at 8P2 of the wire-wrap pin header. A single jumper should be run from the 8P2 pin to the selected interrupt level input to the processor.

After completing any interrupt jumper modifications, carefully reinstall the removed circuit boards (component side up) according to the configuration chart attached to the top of the computer. Update the configuration chart to correspond to the interrupt jumper modifications.

Interrupt Connections for 17-Slot Chassis. Interrupt lines in the 17-slot chassis are wired to a 70-pin connector accessible from the rear of the chassis. A jumper assembly is plugged into the connector to make the interrupt level to chassis slot connections. This assembly appears at the lower right of the chassis backplane as shown in Figure 2-13.

The jumper assembly supplied with a standard DS990 system is a printed wiring board, so it should not be necessary to alter the standard interrupt level assignments. If it should become necessary to change interrupt levels, the customer may purchase a special variable jumper assembly, or modify the fixed jumper card. Figure 2-18 shows the pin assignments on the interrupt connector.

To gain access to the interrupt jumper assembly, open the chassis rear cover. Remove the interrupt jumper assembly by gently rocking it up and down to loosen the connector and then pulling straight back. When reinstalling the assembly, make sure the pins are properly aligned before applying mating force.

CAUTION

It is possible to install the interrupt jumper assembly upside down. Note that pin 1 is at the bottom of the interrupt connector.

2.3.7 Disk Drive Mounting

The following procedures describe mounting the disk drive either on slides in a standard 914-mm (36-inch) cabinet, or on a pedestal.

WARNING

The disk drive weighs 77 kg (170 lbs). At least three people are required to perform slide mounting. Use extreme care when lifting and positioning the drive to avoid backstrain or other injury.

2.3.7.1 Cabinet Mounting the Disk Drive. Mount slides and install the disk drive into the cabinet using the following procedure. Detailed dimensions of the disk drive are shown in Figure 2-19.

WARNING

When the disk drive is mounted on slides and fully extended, additional weight on the top of the drive can cause the entire cabinet to tip over. When extending the drive, insure that all other equipment mounted in the cabinet is fully retracted. Do not lean on the drive. Do not place any heavy tools or test equipment on top of the drive. Insure that the warning label is properly installed on the top of the drive chassis (step 1 following). Also insure that the levelers have been properly installed on the bottom of the cabinet and are extended sufficiently to allow the casters to swivel freely.

1. Install the warning label supplied with the slide kit to the top of the drive chassis so that it can be easily seen and read when the drive is mounted on slides and extended only a few inches (to the first detent).

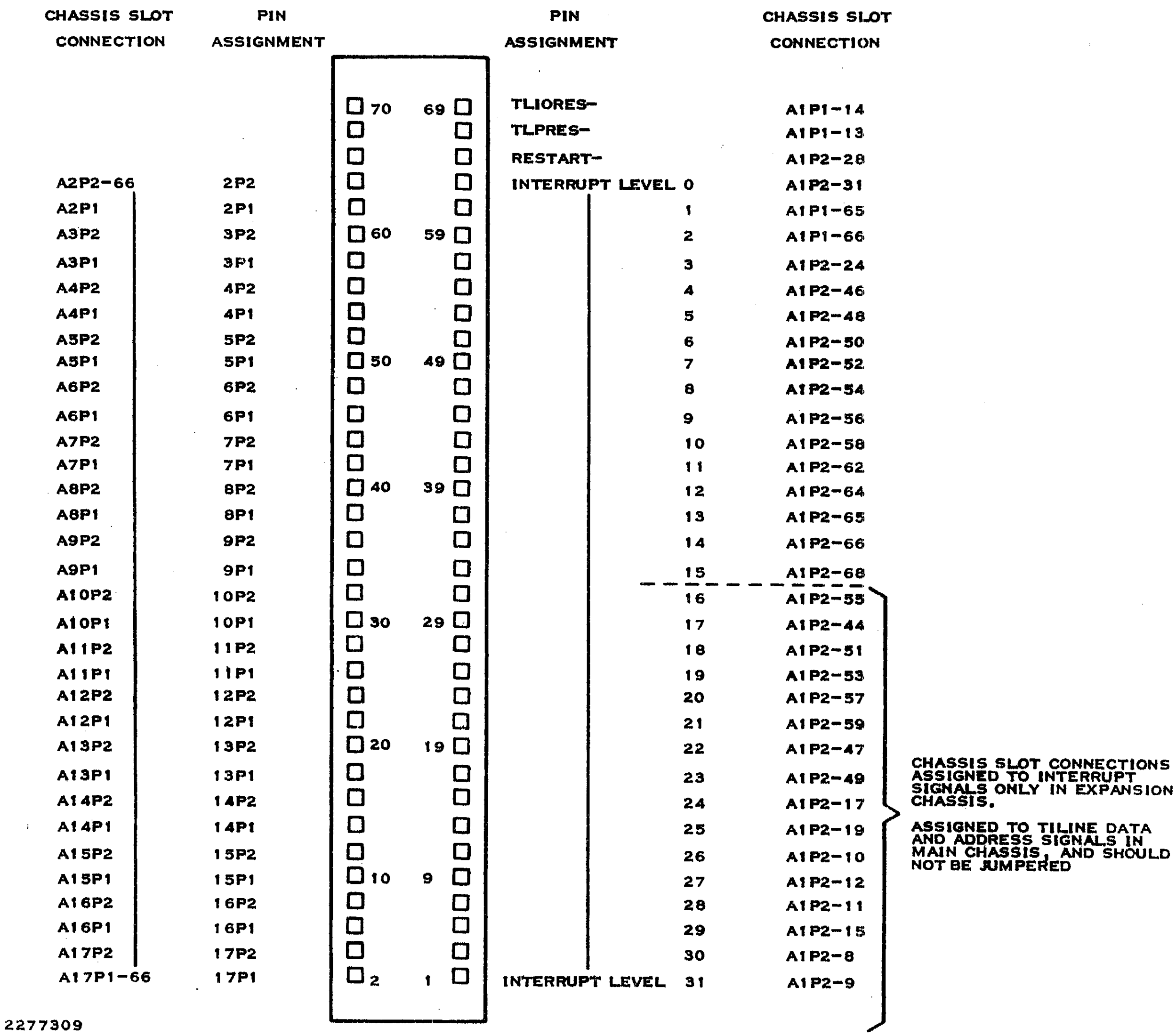
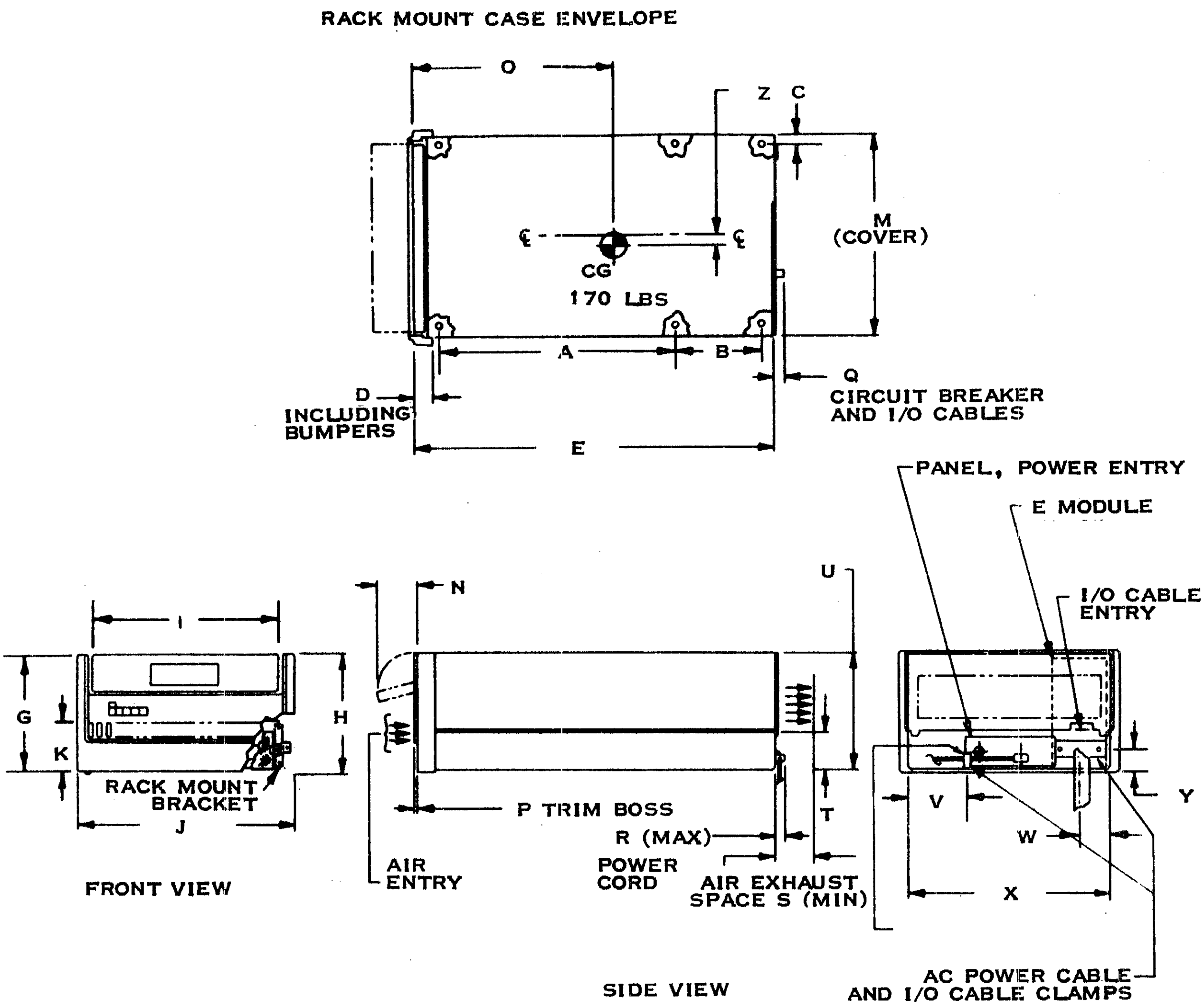


Figure 2-18. 17-Slot Interrupt Jumper Connector

2. Adjust the rack rails (22) front-to-back separation dimension or the slide length or both so that the slide fixed member can be mounted to the front and back rack rails as shown in details A and B of Figure 2-20. Refer to Figure 2-21 for dimensions.

3. Adjust the side-to-side separation of the rails (if possible) so that the width specification is met as shown in Figure 2-21.



DIMENSION	INCHES	MILLIMETERS
A	17.76	451.1
B	10.0	254.0
C	0.38	9.7
D	1.50	38.1
E	30.50	774.7
G	10.28	261.1
H	10.34	262.7
I	17.0	431.8
J	18.94	481.1
K	4.4	111.8
M	17.50	444.5

DIMENSION	INCHES	MILLIMETERS
N	4.25	108.0
O	17.25	438.2
P	0.38	9.7
Q	0.75	19.1
R	1.25	31.7MAX
S	1.25	31.7MIN
T	3.38	85.9
U	10.15	257.8
V	5.5	139.7
W	2.80	71.1
X	16.70	424.2
Y	1.7	43.5
Z	0.90	0.23

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Figure 2-19. Disk Drive Detailed Dimensions

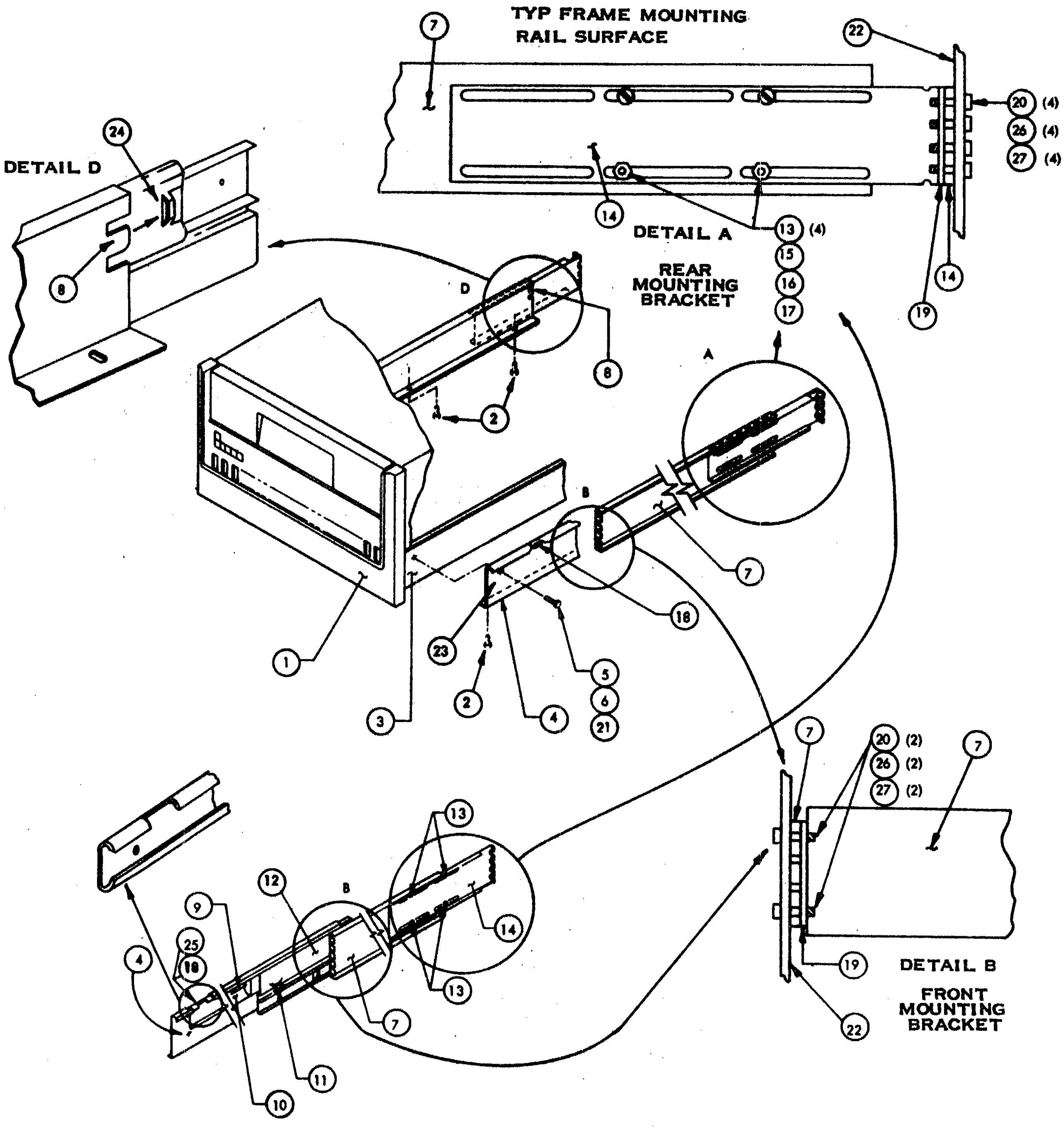

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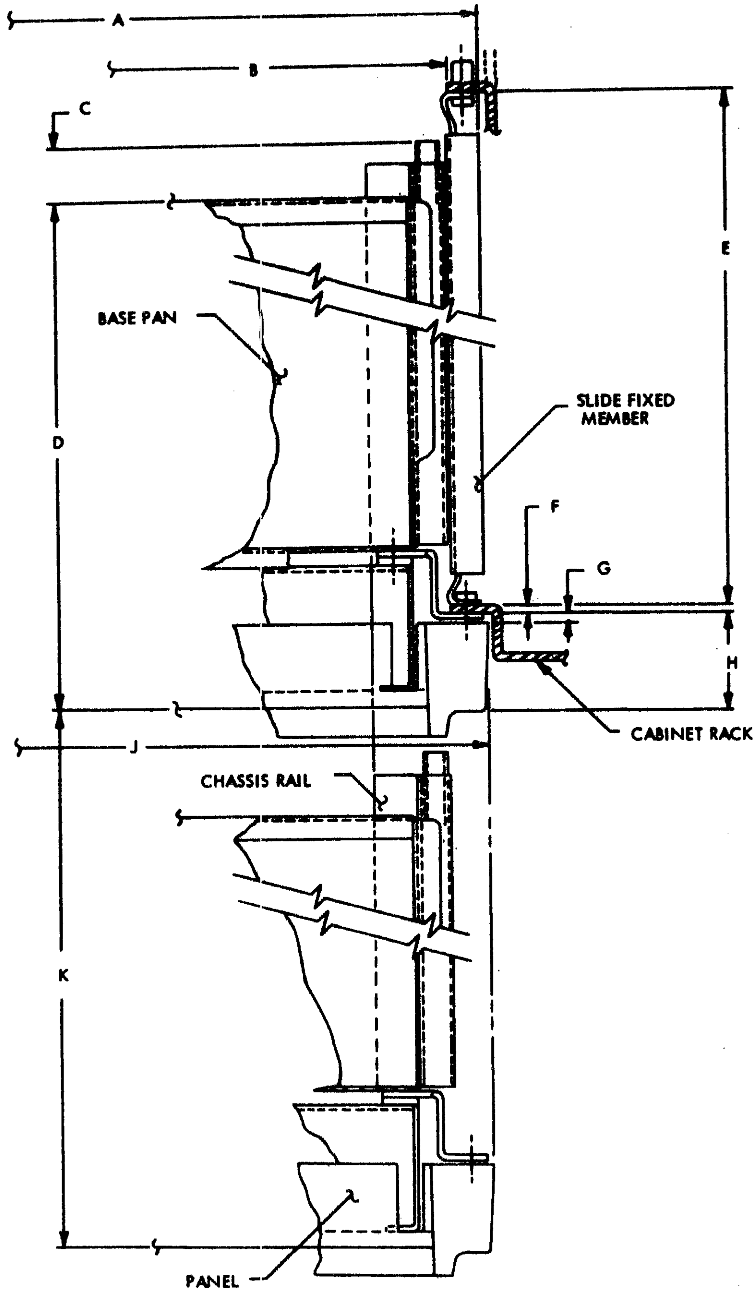
Figure 2-20. Slide Mounting Details



DIMENSION	INCHES	MILLIMETERS	REMARKS
A	18.82	478.0	MIN ALLOWABLE CABINET CLEARANCE FOR FIXED SLIDE MEMBER
B	17.75	450.9	MIN ALLOWABLE CABINET OPENING FRONT AND REAR
C	1.18	30.0	
D	30.50	774.7	CASE
E	28.00 33.75	711.2THRU 857.25	SLIDE ADJUSTMENT LIMITS
F	0.12	3.1	REFERENCE
G	0.12	3.1	BUMPER
H	1.50	38.1	
J	19.00	483.6	MAXIMUM
K	33.00	838.2	TRAVEL MAINTENANCE POSITION

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Figure 2-21. Rack Mounting Details

4. If the chassis mounting rail (4) and the slides are shipped attached, remove the screw (5) holding the two together. The hex nut removed with the screw (5) can be discarded but save the flatwasher, split lockwasher, and screw.

5. Disengage the mounting tooth (8) from its slot (24) in the mounting rail thus separating the slides and mounting rail. Separate both slide sets from the mounting rails.

6. Using three 10-32 x 3/8 inch screws, attach the chassis mounting rail (4) to the base pan (3) of the disk drive.

7. Install the slides into the rack cabinet at the desired location. Loosen the adjusting screws, nut, and washers (13, 15, 16, and 17) to adjust the length of the fixed slide member (7). Position the slides so that the inside edges of the fixed slide members are 452.7 millimeters (17.82 inches) apart. Insure that the slides are horizontal and equidistant from the base of the cabinet. To mount the slides, use one #10 flatwasher (27) on each #10-32 mounting screw (2). Insert the screw (2) through the cabinet mounting rail holes and the slots on the slide mounting surfaces, and then into the holes in the nut plates as illustrated in Figure 2-20, details A and B. Tighten all screws.

8. Press the full extension release (11) (see arrow in Figure 2-20) on each side and pull the slides out to their full extension, approximately 740 millimeters (29 inches). The slides lock at full extension.

CAUTION

Placing the disk drive on the slides requires at least three persons. Use extreme care when lifting the disk drive to avoid backstrain or other injury.

WARNING

When the disk drive is fully extended on slides, additional weight on the unit can cause the entire cabinet to tip over. Insure that any other equipment mounted in the cabinet (flexible disk drives, etc.) is fully retracted. Do not place test equipment or tools on the disk drive.

9. Place the disk drive on the slides. Note detail D in Figure 2-20 that shows the mounting tooth (8) on the chassis mounting rail and the slot (24) into which the tooth fits.

10. Position the disk drive so that each chassis mounting rail rests on the top of the slides. Slide the disk drive to the rear of the rack until the mounting tooth (8) engages the slot (24) and the mounting block (25) on each chassis mounting rail (4) fits into the slot (18) on each side. If one or both of the chassis mounting rails (4) does not sit properly on the slides, slightly loosen the hardware that mounts the slides to the rack rail and adjust the distance between the slides to allow each chassis mounting rail to sit properly on the top of each set of slides.

11. Place flatwasher (21) and lockwasher (6) on screw (5) and install into hole (23). The matching hole in the base pan should be in line with the hole (23). If not, loosen the three screws (2) and slightly move the disk drive until the hole (23) lines up with the base pan.
12. Insert screw (5).
13. Tighten screws (2) and (5) on both sides. Tighten screws (20), if previously loosened.
14. Unlock the slides by simultaneously pushing the spring locks (9) inward and push the disk drive into the rack.

2.3.7.2 Pedestal Mounting the Disk Drive. Install the disk drive on a pedestal according to the following procedure:

WARNING

The disk drive weighs 77 kg (170 lbs). At least two people are required to mount the unit on a pedestal. Use extreme care when lifting the disk drive to avoid back strain or other injury. Before extending any equipment mounted in the pedestal, insure that the levelers have been properly installed on the bottom of the pedestal and are extended sufficiently to allow the casters to swivel freely.

1. Refer to Figure 2-22. Examine the pedestal mounting deck and determine if the deck is drilled for mounting the aluminum studs. If not, drill the holes in the locations shown in Figure 2-22 using a number 9 drill.

NOTE

The aluminum studs are mounted on the pedestal mounting deck and the plastic sockets are mounted on the drive bottom plate as described in the following steps. The plastic sockets are mounted on the drive to prevent marring any working surface upon which the drive may be set during servicing.

2. Mount the four aluminum studs in the locations shown in Figure 2-22 using 10-32 nuts, washers, and lockwashers as shown in Figure 2-23.
3. Very carefully set the disk drive on its side and mount the four plastic sockets to the bottom of the disk drive in the four corner mounting holes. Use the 10-32 screws and washers supplied.
4. Carefully set the disk drive on the pedestal mating the aluminum studs with the plastic sockets.
5. When cabling the disk drive as described in the following paragraph, route the power cord and I/O cable(s) through the slot in the rear of the pedestal.
6. When all drive preparations are complete and the disk drive top cover has been installed, set the pedestal cover on the pedestal over the drive, allowing the pedestal cover locating studs to protrude through the holes in the pedestal mounting deck shown in Figure 2-22.

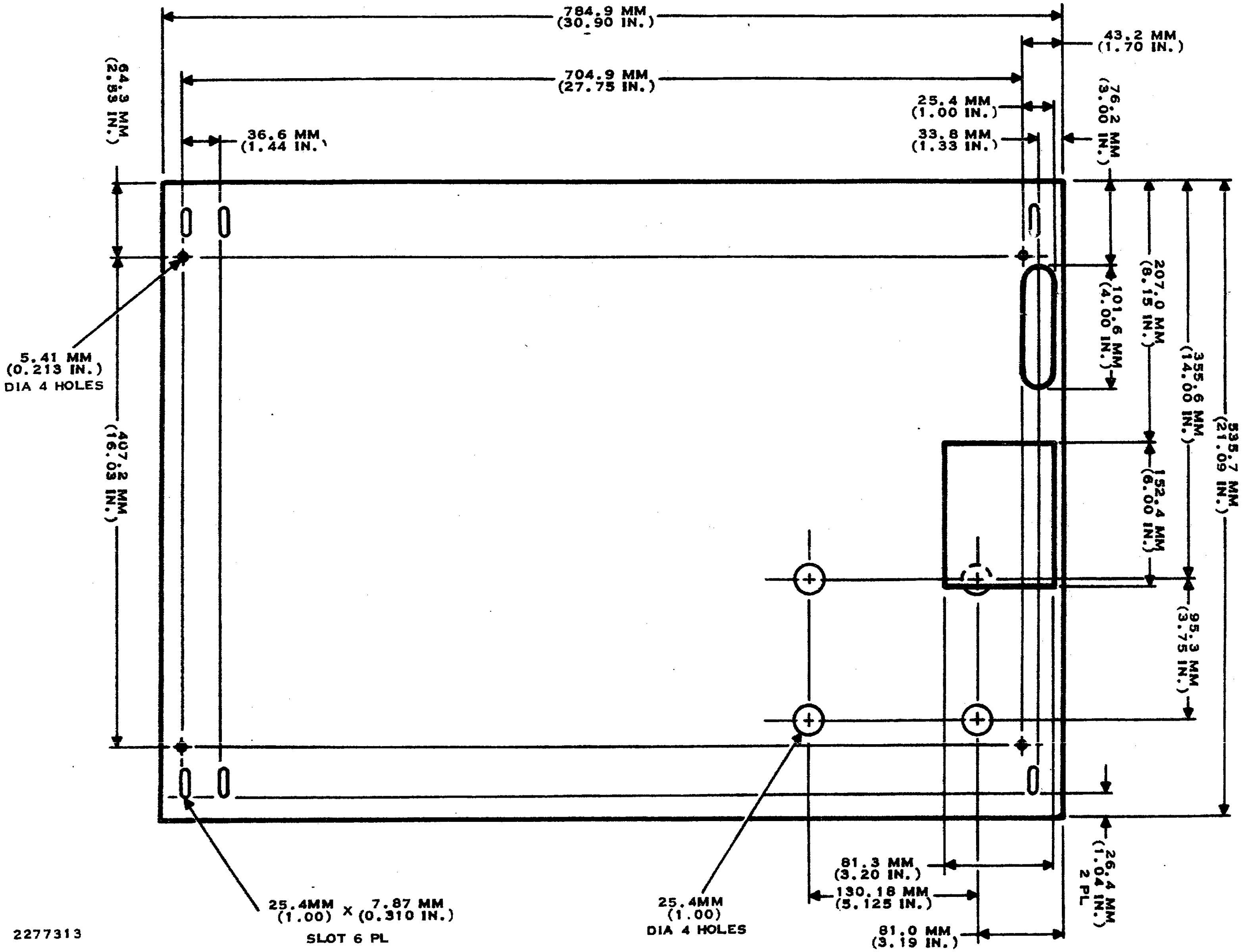

Figure 2-22. Pedestal Mounting Deck Hole Locations

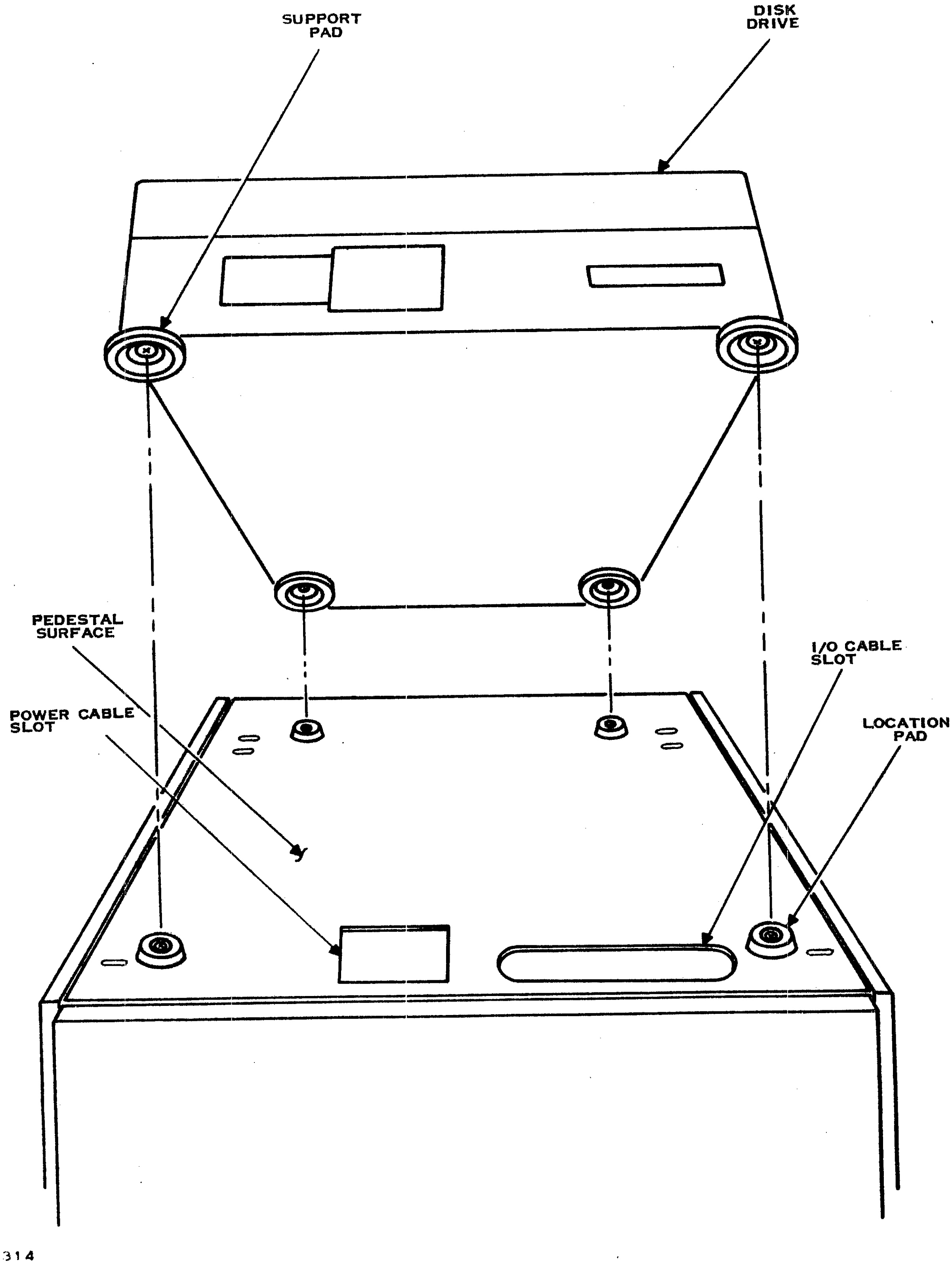

Figure 2-23. Pedestal Mounting Details

CAUTION

Do not place any heavy tools, test equipment, or other objects on top of the pedestal or disk drive. Never stack disk drives.

2.3.8 Cabling and Connections

The following paragraphs detail I/O cable installation between the CPU and the disk drive(s).

One or two disk drives may be connected to a single disk controller, as shown in Figure 2-24. If one disk drive is connected to the controller, the I/O cable is routed from the controller to the interface board in the disk drive and a terminator card is installed. If two disk drives are connected, an I/O cable is routed from the controller to the interface board in the first disk drive and an additional I/O cable is routed from that interface board to the interface board in the second disk

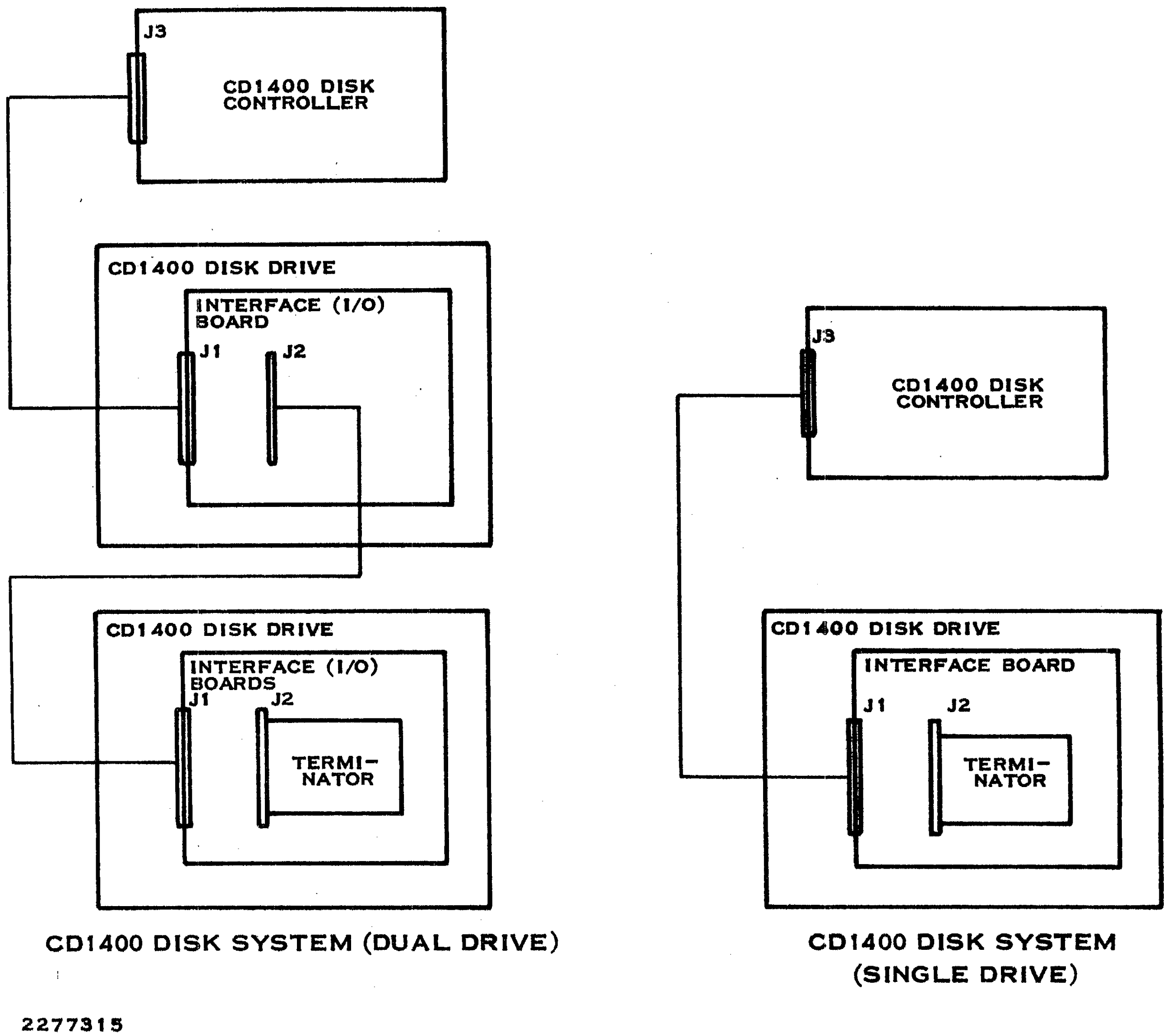

Figure 2-24. Single and Dual Disk Drive Configurations

drive. The terminator board is then installed in the second interface board. Figure 2-25 shows I/O cable installation. If rack mounted, insure that adequate I/O cable length is installed to allow the disk drive to be extended to maintenance position. Refer to the CPU installation and operation manual for I/O cable connection details to the CPU.

NOTE

> Unit selection is not determined by cable routing, but by switch settings on the disk drive interface (I/O) printed wiring board. See paragraph 2.3.4.3.

2.3.9 Grounding

The disk drive electronics (dc power, logic, and analog signals) are grounded separately from the ac or frame ground. These two grounds are connected only at grounding studs located on the rear apron of the disk drive as shown in Figure 2-26. These grounds can be isolated by disconnecting the metal ground strap between the ac and dc ground studs. If isolation is desired, the strap should be rotated away from the frame ground stud and retightened. Do not remove the strap since later use may be necessary. The following general guidelines should be followed when grounding the system.

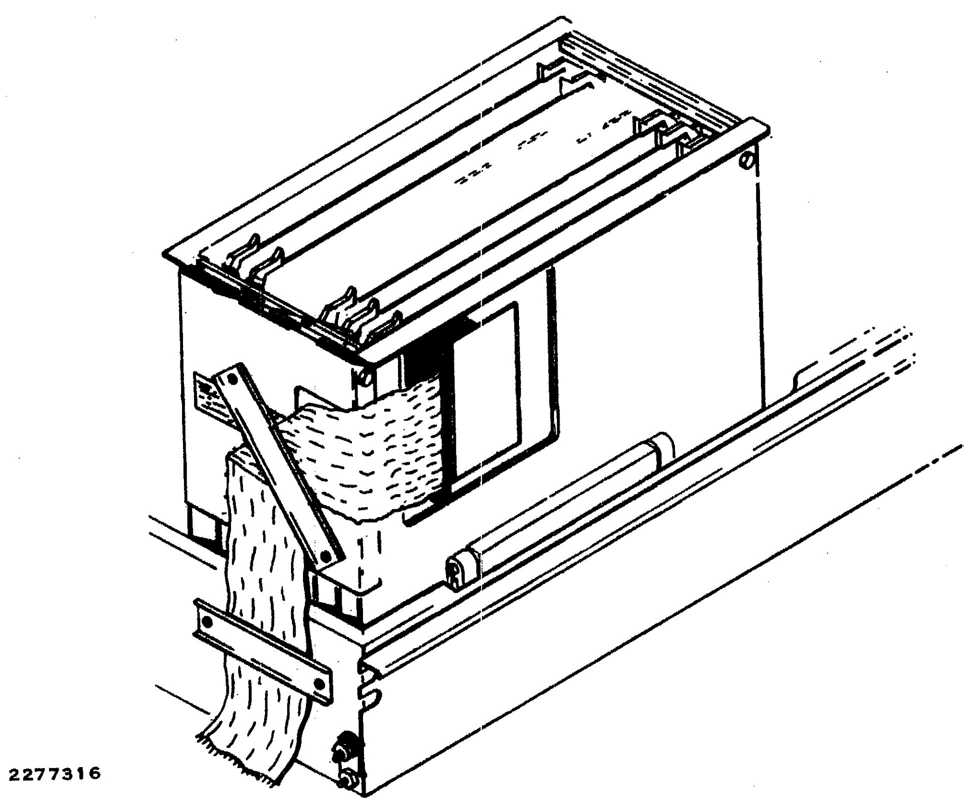

Figure 2-25. I/O Cable Installation

1. The system should have a single point ground.

2. If one device in the system is grounded, do not ground the disk drive.

3. If no other device in the system is grounded, ground the last disk drive in the daisy chain.

4. Refer to the *DS990 Systems Field Maintenance Manual,* part number 2250696-9701, for additional grounding information.

2.3.10 Verification Before Applying Power
After installation is completed, perform the following verifications prior to power on.

1. Verify that all applicable steps listed on the preparation for use checklist have been accomplished.

2. Verify that all logic cards are firmly seated in the electronics module of the disk drive and the computer chassis.

3. Verify that all connectors are firmly seated.

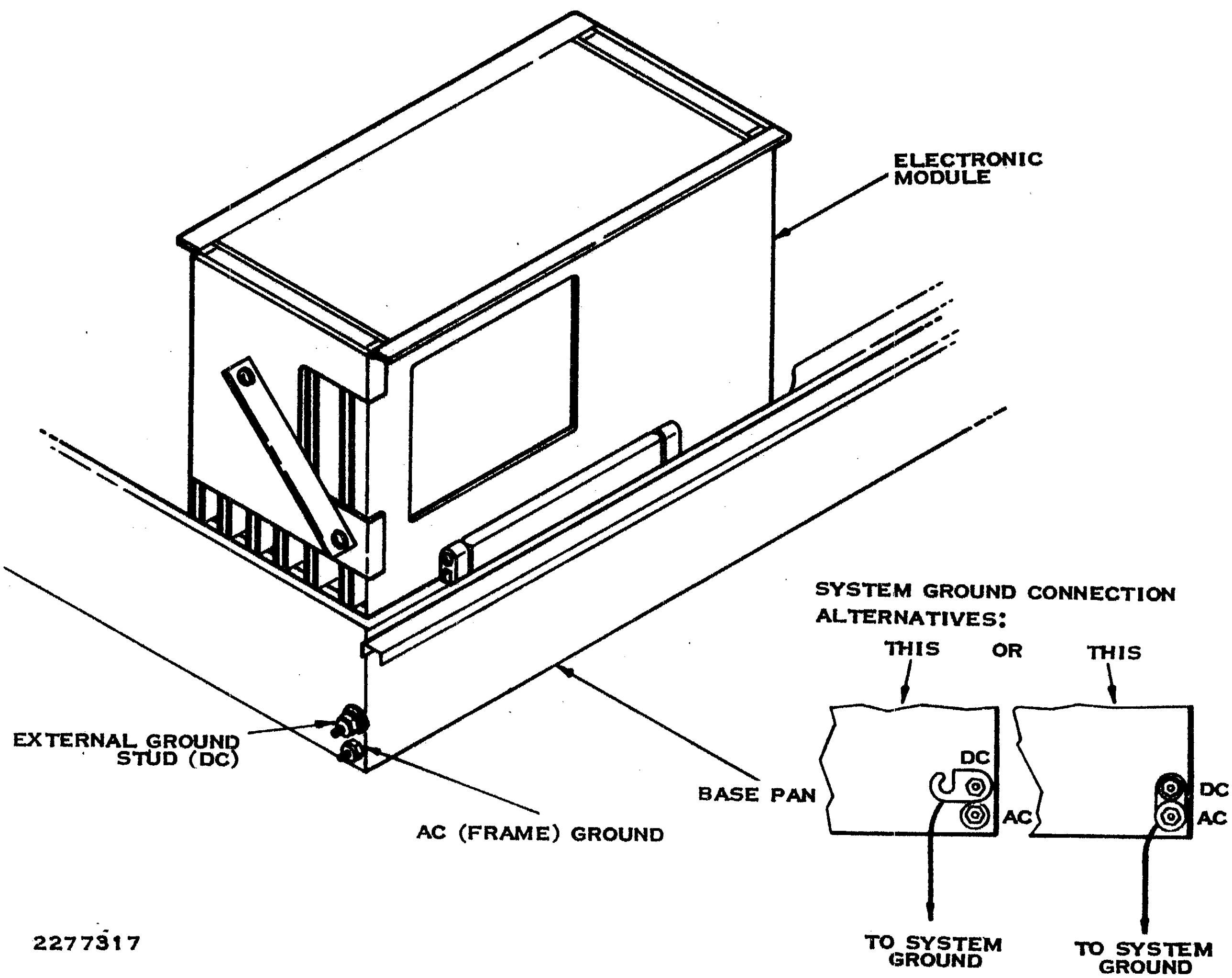

Figure 2-26. Grounding Options

4. Verify that all cabling is intact and that there are no broken or damaged wires or connectors.

5. Inspect entire disk drive for presence of foreign material that could cause an electrical short or contaminate the disk drive.

6. Verify that the inlet air filter is installed.

7. Verify that the ac power cord is installed on all disk drives.

8. Install disk cartridge using procedure found in section 4.

2.4 POWER-ON PROCEDURES

After verification is complete, apply power to the disk drive system as follows:

1. Turn off computer power. (This is necessary so that power-on sequencing to the disk drives takes place automatically when computer power is applied).

2. Disconnect plug A1P1 located in the disk drive adjacent to the voice-coil head positioner.

3. Set the CB1 main power circuit breaker on all disk drives to ON. The blower fans should start when power is applied to each disk drive. Set the drive START/STOP switch to the START position (switch in).

4. Apply power to the computer.

5. Check that the CLK and BUSY LEDs on the disk controller are lit. (These LED locations are shown in Figure 2-5.) Note that the FAULT LED lights for about one-half second after power-up.

6. After 30 seconds, verify that the drive motor on the first disk starts to run. (Allow an additional 60 seconds for the second disk drive in the system to sequence on.) If the drives fail to sequence, check the FAULT LED on the controller. If lit, the controller may be malfunctioning.

7. After all disk drives are up to speed, verify that the FAULT AND BUSY LEDs on the controller are out. If the FAULT indicator is lit, the controller may be malfunctioning. Note that with A1P1 disconnected, the heads will not load. Allow the unit to operate for 20 minutes to purge contaminants from the drive.

8. With the disk drive up to speed, verify that the FAULT/RESET indicator on each disk drive front panel is out. If this indicator is lit, press the FAULT/RESET switch and verify that the indicator goes out. If not, refer the problem to a qualified maintenance technician.

9. Set the drive START/STOP switch to the STOP position (switch out), and wait until the READY indicator quits blinking.

10. Set the CB1 main power circuit breaker to off.

11. Reconnect the voice-coil head positioner plug A1P1.

12. Set the CB1 main power circuit breaker to ON.

13. Set the drive START/STOP switch to the START position. The spindle should operate and the heads should load in a maximum of 70 seconds.

14. Set the START/STOP switch to the STOP position, and check that the heads fully unload and the spindle stops.

15. Set the CB1 main power circuit breaker to OFF, and replace the top cover.

2.5 INITIALIZING DISK MEDIA

Before operating the disk drive, the disk media may need initialization. Since initialization procedures differ according to the particular operating system in use, the operator must refer to the software reference manuals for initialization instructions. Three of the operating parameters that must be considered when initializing the media are: the physical record size, hardware interleaving factor, and bad track input.

2.5.1 Physical Record Size

In order to maximize disk use, the physical record size should be some multiple of 256 (e.g. 256, 512, 768, etc.). Further details concerning choosing this multiple are found in the software reference manual.

2.5.2 Hardware Interleaving Factor

Hardware interleaving is not supported in the CD1400 disk system. Use a factor number of 1 when initializing media.

2.5.3 Bad Track Input

Media errors must be entered into the operating system in order for bad tracks to be deallocated. TI-supplied media is preformatted and includes bad track information. However, all operating systems may not be capable of using information in this form. Refer to applicable software reference manuals for further details.

2.6 SELF-TEST

When the system is powered up or reset, the disk controller automatically conducts a self-test. During execution of the self-test, the FAULT LED on the disk controller lights. If the system passes these tests, the FAULT LED goes out after the self-test is completed successfully. If the FAULT LED does not go out, refer the problem to a maintenance technician.

Similarly, the disk drive conducts a self-test upon power-up. The front panel FAULT/RESET switch/indicator lights briefly during this self-test. If the indicator does not go out, press the FAULT/RESET switch/indicator. If the indicator remains lit, refer the problem to a maintenance technician.

2.7 POWER-OFF PROCEDURE

The power-off sequence can be started either locally at the disk drive or remotely by the controller, depending on the setting of the LOC/REM switch in the logic card cage of the disk drive. If this switch is in the LOC position, the power-off sequence starts when the START/STOP switch is set to STOP. Once the ready light extinguishes, circuit breaker CB1 may be set to OFF. If the LOC/REM switch is in the REM position, the power-off sequence starts when the sequence signal is disabled at the controller. Once the READY light is out, power can be removed by setting circuit breaker CB1 to OFF. In either case, the power-off sequence retracts the heads, stops the drive motor, and extinguishes the READY indicator. To completely power down the system, perform the following procedure:

1. Set START/STOP switch on front panel to STOP.

2. Wait for READY light to stop blinking.

3. Set circuit breaker CB1 to OFF.

4. Turn off system/CPU ac power.

3 Programming

3.1 GENERAL

This section contains information necessary for an assembly language programmer to write device service routines that communicate with the Model CD1400 Disk System. The programmer must be familiar with assembly language described in the *Model 990 Computer TMS 9900 Microprocessor Assembly Language Programmer's Guide* or the *Model 990/12 Computer Assembly Language Programmer's Guide.*

Most users prefer Texas Instruments standard operating system software that includes device service routines and features standardized file manipulation schemes that are essentially independent of I/O device type. These users should refer to the applicable operating system reference manual. Users who wish to perform direct disk I/O operations without using a standard operating system device service routine may initiate disk commands and receive disk status as described in this section.

This section is organized into four basic parts: First, communication between the disk system and the CPU using the TILINE is discussed. Second, basic programming of the controller is detailed, including command descriptions, disk operation, and command completion. Third, control and status word formats and descriptions are given. Fourth, detailed command descriptions with example command formats and status word formats are discussed.

3.2 TILINE COMMUNICATION

3.2.1 Introduction

The TILINE is an asynchronous parallel data bus that links the 990 processor, memory boards, and high-speed peripheral controllers. The disk controller is assigned a block of eight TILINE memory addresses, and the 990 processor communicates with the disk controller by writing 16-bit command words into these eight TILINE addresses. After a disk operation is completed, the disk controller replaces the control words with status words and the 990 processor can read the words in these same memory locations to determine disk drive status. Controller operations are initiated when control words, containing initialization parameters, operation parameters, and command codes, are written into the memory locations assigned to the controller. After initialization, the disk controller acts independently of the 990 processor and transfers data between specified TILINE memory locations and the disk as required by the command. Any computer instruction that reads or modifies general memory can be used to communicate with the disk controller.

3.2.2 Drive Unit Designation

The controller treats each disk drive as two independent logical drive units: the removable drive unit, and the fixed drive unit. Each drive unit is assigned a separate unit number. Thus, the disk controller can access only two disk drives (four logical drive units). Each drive unit may be assigned any unit number from 0 to 3; however, no two drive units should be assigned the same unit number. In a single disk drive installation, the removable drive unit is usually assigned unit number 1 and the fixed drive unit is usually assigned unit number 0. In a dual disk drive system, the additional removable drive unit may be assigned unit number 2 and the additional fixed drive unit may be assigned unit number 3. Drive units are assigned using switches located on the disk drive interface (I/O) board.

3.2.3 TILINE Addresses

Standard conventions built into the hardware and software of the Model 990 Computer reserve CPU byte addresses >F800 to >FBFF for control and status communication with TILINE peripheral controllers, such as the magnetic tape and disk controllers. This range is called the TILINE Peripheral Control Space (TPCS). Addresses in this range may be mapped by the processor hardware to TILINE addresses in the range >FFC00 to >FFDFF. This mapping requires the 990 processor to be operating either unmapped or in map file 0. The TPCS can also be addressed through alternate map files if the mapping bias value is chosen to yield the correct TILINE address. This programmable mapping feature is standard on some 990 CPUs and optional on others. This feature allows effective use of the entire TILINE address space, rather than just the lower 32K words. Depending on the values in the map file registers, memory may be addressed anywhere in the TILINE address space (assuming a memory board exists at that address).

The physical TILINE bus includes 20 address lines, however, each CPU byte address consists of 16 bits. When a CPU byte address falls within the TPCS, all ones are loaded automatically into the upper five bits of the TILINE address, and the least significant bit is dropped. (This least significant bit is a byte selector used only within the CPU.) The remaining 15 bits form the lower 15 bits of the TILINE address. Figure 3-1 shows the conversion of a 16-bit CPU byte address to a 20-bit TILINE word address. One way to visualize this conversion is to think of a 21-bit TILINE *byte* address of >1FF800 that loses its LSB (byte selector) to become TILINE *word* address >FFC00. The 1F comes from the 5 ones and the >F800 comes from the original CPU byte address. The only part of this address accessible to the programmer is the CPU byte address, >F800.

The eight addresses are assigned to the controller from a base address to base address +7 word addresses. The base address is dedicated to control and status word W0, base address + 1 is dedicated to W1 and continues through base address +7, dedicated to W7.

The base address is selected by a five-section switch on the disk controller board, allowing multiple controllers in one system. Base address selection must be coordinated with the operating system software. Refer to Section 2 of this manual for instructions on setting the base address switches.

The controller is capable of communicating with TILINE memory in any range of the TILINE address space; however, the TPCS is generally reserved only for CPU/controller communications.

3.3 COMMAND DESCRIPTIONS

Commands sent to the controller from the CPU cause the controller to perform any of eight basic disk system operations as follows. Detailed command descriptions and examples are deferred until later in the section since these descriptions require complete control word information.

- Store Registers. A store registers command causes the disk controller to return certain critical drive parameters, such as words per track and cylinders available per drive unit, to the CPU using status words. This operation allows the operating system software to determine these

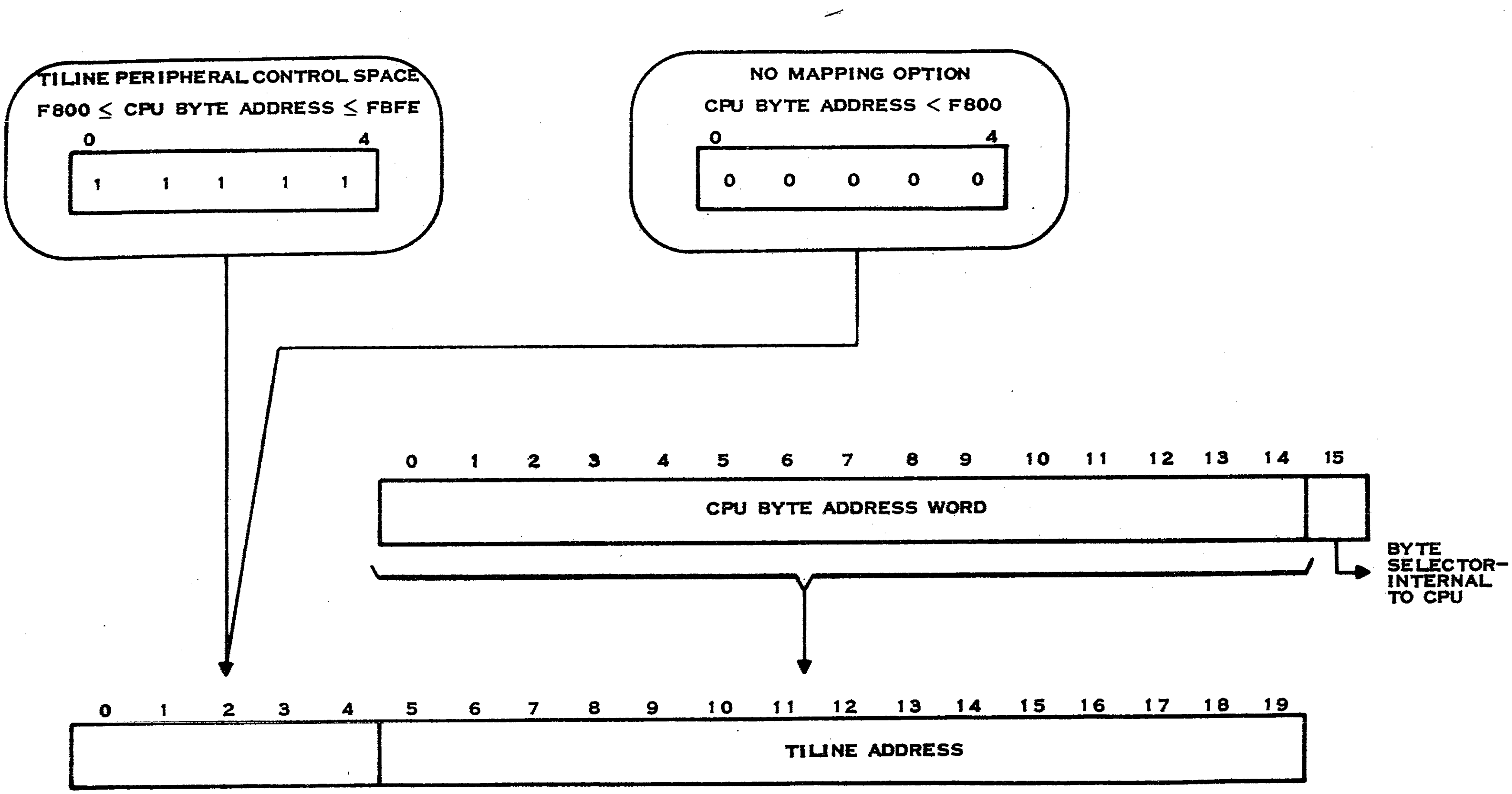

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Figure 3-1. Relationship Between TILINE Address and CPU Byte Address parameters prior to using the disk system.

- Write Format. The write format command formats a new disk, or reformats a disk already in operation with ID words, simulated data in the data field, an ECC character, and the required gaps. The write format operation is required prior to using any nonformatted disk media.

- Read Data. The read data command transfers data from a specified disk location to a specified location in TILINE memory.

- Write Data. The write data command reads data at a specified TILINE memory location and records this data on a previously formatted disk.

- Unformatted Read. There are two unformatted read command operations. The unextended unformatted read command returns certain disk drive parameters to the software in order to insure compatibility with some existing operating systems. The extended unformatted read command reads a specified number of words from the disk without regard to formatting, and is used basically for diagnostic purposes.

- Unformatted Write. The unformatted write command writes data from TILINE memory onto the disk without regard to existing record boundaries, and is used primarily for diagnostic purposes.

- Restore. The restore command reinitializes the cylinder counter and repositions the heads of the selected drive over cylinder zero, and is used to clear certain disk error conditions.

- Seek. Because of mechanical limitations using this drive, the seek command is ignored by the controller, and no operation is performed.

- Self-Test. The controller incorporates extensive self-test routines that can be used to locate many controller faults.

3.4 PROGRAMMING THE CONTROLLER

The eight control and status words the CPU uses to communicate with the controller contain the following information:

- W0 — Disk Status. Contains disk status codes for selected drive, and attention bits and attention mask bits for generating interrupts.

- W1 — Command and Head Address. Contains command codes, head address, and several control bits used during certain recovery operations.

- W2 — Sector. Specifies starting sector address and number of sectors per record.

- W3 — Cylinder Address. Contains cylinder address.

- W4 — Byte Count. Specifies number of bytes to be transferred between disk and CPU memory.

- W5 — LSB Memory Address. Contains the fifteen least significant bits of the twenty-bit TILINE memory address.

- W6 — Select and MSB Memory Address. Contains drive select codes and the five most significant bits of the twenty-bit TILINE memory address.
- W7 — Controller Status. Contains controller status codes, interrupt enable bit, and idle/busy bit.

To initiate controller operation, the program loads control words into memory addresses assigned to the controller. The order in which control words are transmitted is not important except that word W7 must be last. Controller operation is initiated immediately when bit 0 of a word is set to zero and loaded into controller location W7.

Transmitting a new set of control words to the controller wipes out the status words from the previous operation, except for the disk status fields of word W0, which are set by the disk drive and cannot be modified by overwriting with a new control word. If overwriting is attempted, the controller ignores bits placed in word W0 disk status fields.

If the CPU attempts to send a control word to the controller after operation has been initiated, the attempt completes normally, but the controller ignores the control word.

Any status word read from a busy controller is a simulated W7 word in which bit 0 is a zero (busy) and bits 1 through 15 are meaningless. This word is returned regardless of the status word requested. This feature allows the controller to be polled for idle/busy status without interference to any on-going controller operations.

Before writing a command to the controller registers, word W7, bit 0 should first be checked to verify that the controller is idle and will accept the command. If W7, bit 0 is set (controller idle), the command may be written to the controller registers.

3.4.1 Command Completion

An interrupt enable bit in W7 allows the programmer to specify whether the controller generates an interrupt to the CPU upon completion of an operation. The disk controller may be used either with an interrupt-driven or a polled device service routine. The following paragraphs discuss these options.

3.4.2 Command Completion Without Interrupts

To determine command completion or controller availability in a polled system, it is necessary to periodically read status word W7 and check bit 0 for idle status. A 0 in this position indicates the controller is busy; a 1 indicates the controller is idle and available for commands.

Usually, the program initiates a timing loop when controller operation begins, and checks the idle bit at timer expiration. If the idle bit is still zero, the timer may be restarted and the sequence repeated a preselected number of times. This method requires more program overhead than the interrupt-driven approach.

If a restore command has been initiated, the disk may not be ready after the controller has reported completion. To determine if the disk has completed a restore command, the program should check the drive status bits of word 0. If the disk drive has completed its operation, the attention line for the selected drive will be set and either the not ready bit will be inactive or the seek incomplete will be set.

3.4.3 Command Completion with Interrupts

The controller can issue two types of interrupts to the computer. One type of interrupt is issued when the controller completes any command, and the other type is issued when the disk drive completes an operation. Most disk drive operations are completed when the controller has completed a command. For restore operations, however, the controller command is completed before the disk operation has completed, and the drive completion interrupt may be used to determine when the system is again idle. Note that the seek operation is disabled on the CD1400 disk system (see paragraph 3.6.1.7) but the interrupt is still generated to insure compatibility with other disk drive systems.

3.4.3.1 Command Completion Interrupts. In order to have the controller issue an interrupt to the 990 processor upon command completion, the interrupt enable bit in W7 must be set when the operation is initiated. When the controller returns to idle, the interrupt is issued to the CPU. This interrupt is cleared by resetting the interrupt enable bit, or the appropriate completion bit in W7.

3.4.3.2 Drive Completion Interrupts. Control word 0 contains four attention lines (one for each of the four disk drive unit addresses) and four attention mask lines. Each attention line is set when the disk drive is either ready, or a seek error has occurred. When the attention bits and mask bits for any disk drive unit are both set, the interrupt line to the computer is also set.

The programmer can set or reset the mask bits by using any of the computer memory instructions. However, the attention bits and disk status bits are set only by the controller to indicate current disk operation status.

To use the drive completion interrupts during a restore operation, first issue the restore command to the controller; then after the controller reports command completion (by a controller idle or command completion interrupt), set the mask bit corresponding to the desired drive. When that drive finishes the restore operation, and the controller is idle, an interrupt is issued to the CPU. This interrupt may be cleared by resetting the mask bit corresponding to the interrupting drive. All disk controller interrupts are reset when the controller switches from an idle to a busy condition.

3.5 CONTROL AND STATUS WORD FORMATS

Control and status words described in this section are used for both operating the controller as well as reporting disk system status. As described earlier, the CPU can write control words into controller memory space to initiate operation, and can read status words in these same memory spaces to determine disk status after an operation has completed. Some bits in the words are used only for disk operation control, some only for status reporting, and some for both control and status. The following paragraphs describe functions of each of the bits in these control and status words, represented in Figure 3-2.

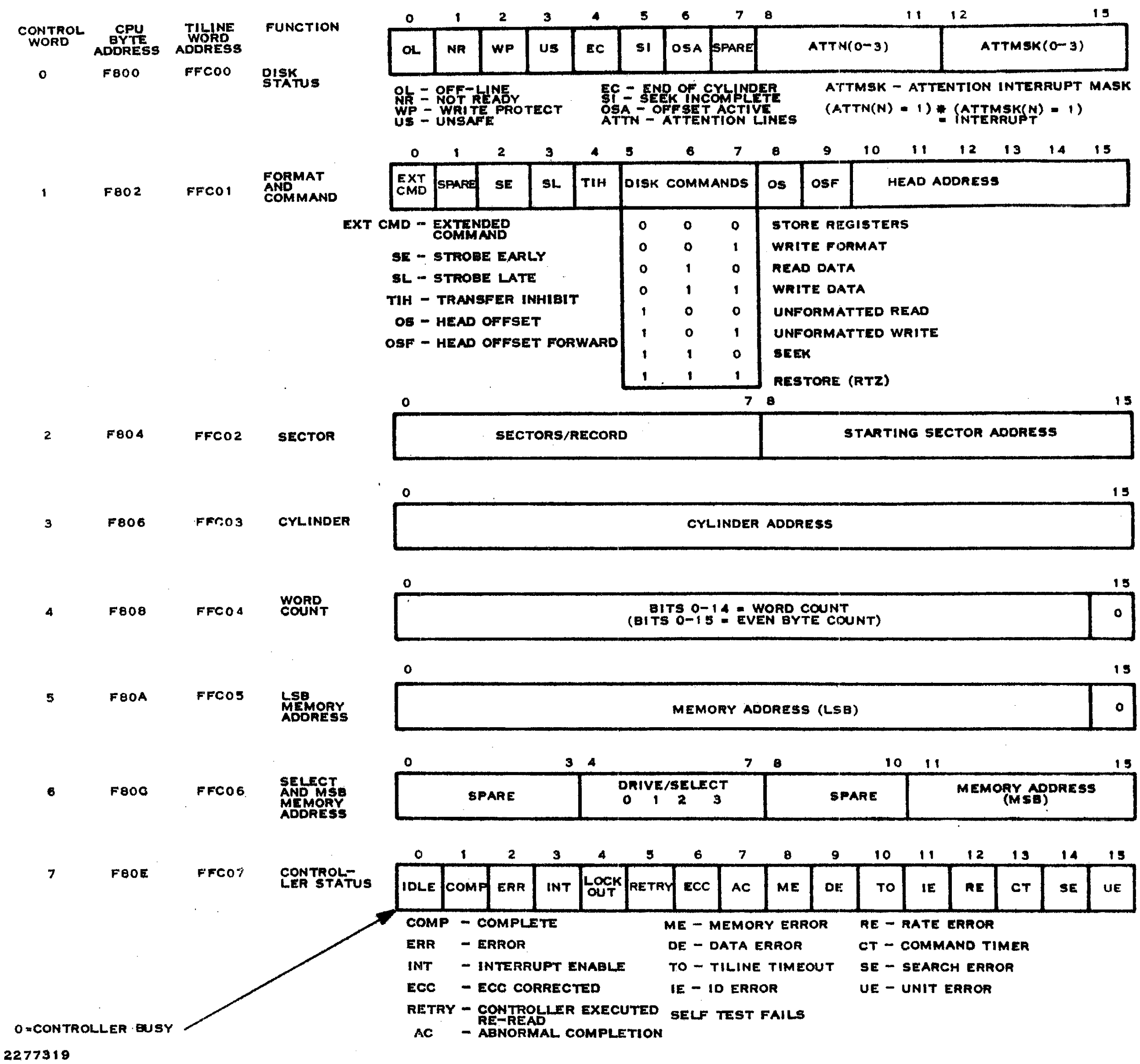

Figure 3-2. Control and Status Word Formats

3.5.1 Word 0 — Drive Unit Status

Word 0 (Figure 3-3) is used to enable or inhibit the attention interrupts, to determine which drive unit initiated an attention interrupt, and to determine status of a selected drive unit. All bits in W0 are used only for status reporting except for bits 12 through 15, which are used only by the CPU to set the attention mask bits.

Bits 0-6 contain individual status indicators for a selected drive unit. Bits 8-11 contain the attention line status of each drive unit, regardless of the drive unit selected. Bits 12-15 are mask bits used with the attention bits to generate interrupts. Each bit is defined as follows:

0	1	2	3	4	5	6	7	8–11	12–15
OL	NR	WP	US	EC	SI	OSA	SPARE	ATTN(0–3)	ATTMSK(0–3)

OL – OFF-LINE
NR – NOT READY
WP – WRITE PROTECT
US – UNSAFE

EC – END OF CYLINDER
SI – SEEK INCOMPLETE
OSA – OFFSET ACTIVE
ATTN – ATTENTION LINES

ATTMSK – ATTENTION INTERRUPT MASK

(ATTN(N) = 1) * (ATTMSK(N) = 1) = INTERRUPT

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Figure 3-3. Control and Status Word 0 Format

3.5.1.1 Offline — W0, Bit 0. Bit 0 is set to indicate that the selected drive unit is not powered-up, not at the proper speed, not loaded with a cartridge, or that an unsafe condition exists.

3.5.1.2 Not Ready — W0, Bit 1. Bit 1 is set when the selected drive unit is offline, or is performing a restore operation.

3.5.1.3 Write Protect — W0, Bit 2. Bit 2 is set when the write protect status (WRITE PROTECT switch) of the selected unit is on.

When activated, the write protect circuit inhibits disk drive write logic and neither format information nor data can be written on the disk.

3.5.1.4 Unsafe — W0, Bit 3. The drive unsafe condition indicates that a fault condition exists that prevents a disk operation (except for a restore operation) from being executed. This bit is set if the controller determines that more than one drive unit is selected, no drive unit is selected, no terminator board is installed, or a disk drive fault has been reported, such as a dc voltage fault or head select fault. This bit is also set if a command is issued for a drive unit that has not been previously identified to software by a store registers command or if there has been some parameter change since the last store registers command. For example, a cartridge change or a power-down cycle results in unsafe status the next time the drive unit is selected. A restore and store registers command clears unsafe status if the unsafe condition no longer exists. (Note that the store registers command required to clear unsafe status is included to insure compatibility with other disk systems.) After an unsafe status, the volume information should be checked to verify that the desired volume has been installed.

3.5.1.5 End of Cylinder — W0, Bit 4. This bit is not generated by the controller and is always zero.

3.5.1.6 Seek Incomplete — W0, Bit 5. The seek incomplete bit is set if the head carriage has failed to locate the specified cylinder. For example, if the word address is out of range, the operation fails and seek incomplete status is reported. Some seek incomplete error may be due to an error in the disk drive positioning logic. The system may recover from these errors by a restore operation and reperforming the desired operation.

3.5.1.7 Offset Active — W0, Bit 6. Head offset, W0, bit 6 will be set if data was read from the disk using a head offset. If data on a selected track is unrecoverable using normal head position, the CPU can command the controller to attempt data recovery with the head slightly offset, either toward the center of the disk (forward offset) or toward the outer edge of the disk (reverse offset).

3.5.1.8 Unused — W0, Bit 7. Bit 7 is not used.

3.5.1.9 Attention Lines (0–3) — W0, Bits 8–11. The attention bit for a particular disk drive unit is set if the unit is either ready or a seek error has occurred. The bit is used to indicate if a disk operation, generally a seek or restore, has completed. Since seek and restore commands are relatively slow electromechanical operations, overlapped, independent seek and restore capabilities are included in the device services routine to speed system throughput. However, since the disk drive heads are mounted on a single carriage assembly for the two logical units in a CD1400 disk drive, overlapped seek operations cannot be performed. Therefore, the seek command is ignored by the controller. The attention lines (combined with interrupt mask bits 12-15) interrupt the 990 processor when seek and restore operations are completed. Read, write, or other operations may proceed on any disk drive not actively executing a seek or restore command.

3.5.1.10 Attention Interrupt Mask (0-3) — W0, Bits 12-15. Bits 12-15 form a position-coded attention interrupt mask. An interrupt to the 990 processor is generated if the attention mask bit and the corresponding attention bit are both set.

If operations are to be overlapped, the control words for subsequent operations must not erase the attention mask, or the interrupt will not occur. Instead of using a move (MOV) instruction to write a whole new value into W0, the programmer should use a set ones corresponding (SOC) or set zeros corresponding (SZC) instruction to modify bits of W0 as needed.

Note that since there are two possible causes for an interrupt to the CPU, it is not sufficient to assume that the first interrupt after initiating a restore command is an attention interrupt.

3.5.2 Word 1 — Command Code and Surface Address

Control word W1 (Figure 3-4) contains the command code that specifies the desired controller operation and the head address. Bits 0-9 control requested operations; bits 11-15 contain the surface address. This word is generally used only for a control word, however, the head address is incremented as disk operations are performed, and the head address at the end of an operation can be read for diagnostic purposes, if desired. Bit functions are described in the following paragraphs:

3.5.2.1 Extended Mode — W1, Bit 0. The three command code bits (word 1, bits 5-7) allow up to eight unique commands. The extended mode bit (bit 0) is interpreted as an additional command code bit, increasing the number of possible command codes to 16. If this extended mode bit is zero, bits 5-7 are interpreted as normal commands. These are the most commonly used commands, such as read data, write data, and store registers. If the extended mode bit is one, bits 5-7 are interpreted as extended mode commands. Refer to paragraph 3.7 for more information concerning extended mode commands.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EXT CMD	SPARE	SE	SL	TIH	DISK COMMANDS			OS	OSF	HEAD ADDRESS					

5	6	7	Command
0	0	0	STORE REGISTERS
0	0	1	WRITE FORMAT
0	1	0	READ DATA
0	1	1	WRITE DATA
1	0	0	UNFORMATTED READ
1	0	1	UNFORMATTED WRITE
1	1	0	SEEK
1	1	1	RESTORE (RTZ)

EXT CMD – EXTENDED COMMAND
SE – STROBE EARLY
SL – STROBE LATE
TIM – TRANSFER INHIBIT
OS – HEAD OFFSET
OSF – HEAD OFFSET FORWARD

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Figure 3-4. Control and Status Word W1 Format

3.5.2.2 Unused — W1, Bit 1. Bit one is not used, and should be set to zero.

3.5.2.3 Strobe Early (SE) — W1, Bit 2. When bit 2 is set, the controller advances the data strobe. This bit is used with the read data and the unformatted read commands in an attempt to recover data that yields errors when read with normal strobe setting.

3.5.2.4 Strobe Late (SL) — W1, Bit 3. When bit 3 is set, the controller retards the data strobe. This bit is used with the read data and the unformatted read commands in an attempt to recover data that yields errors when read with normal strobe settings.

3.5.2.5 Transfer Inhibit (TIH) — W1, Bit 4. When transfer inhibit is set, data is read from the disk, but not transferred on the TILINE. The transfer inhibit function allows the operating system software to check data integrity of a record without having to provide a memory buffer area to hold the data. When data is read by the controller, the ECC is generated and compared with the ECC generated when the record was written on disk. ECCs that agree indicate a high probability of data integrity. If the ECC character recorded with the data does not correspond with the ECC character calculated during the read operation, the controller reattempts to read the data. If, after a predetermined number of retries, the controller is still unable to read a sector and obtain equal ECCs, the data error status bit is set.

3.5.2.6 Command Codes — W1, Bits 5–7. Table 3-1 lists the normal and extended mode codes and the command names. Detailed command word descriptions and examples are given in paragraph 3.6.

Table 3-1. Command Codes

Extended Mode Bit 0	Command Code Bit 5	6	7	Command
0	0	0	0	Store Registers
0	0	0	1	Write Format
0	0	1	0	Read Data
0	0	1	1	Write Data
0	1	0	0	Read Unformatted[1]
0	1	0	1	Write Unformatted
0	1	1	0	Seek[2]
0	1	1	1	Restore
1	0	0	0	Store Registers[3]
1	0	0	1	Write Format[3]
1	0	1	0	Read Data[3]
1	0	1	1	Write Data[3]
1	1	0	0	Read Unformatted
1	1	0	1	Write Unformatted[3]
1	1	1	0	Seek[2]
1	1	1	1	Self-Test

Table 3-1. Command Codes (Continued)

Notes:

[1] This command does not actually read unformatted data. Refer to text for operation.

[2] The seek operation is ignored by the controller. See paragraph 3.6.1.7.

[3] For compatibility with other disk drives, do not use these particular extended commands. Use only normal commands that perform identical operations.

3.5.2.7 Head Offset — W1, Bit 8. Bit 8 of W1 is set if data is to be read from the disk with the head offset, either forward or reverse.

3.5.2.8 Head Offset Forward — W1, Bit 9. If bit 8 has been set, bit 9 is set if data is to be read from the disk with the head offset forward, and is not set if data is to be read with the head offset reverse.

3.5.2.9 Head Address — W1, Bits 10–15. Bits 10–15 select a read/write head and associated platter surface, as shown in Table 3-2.

Table 3-2. Head Selection Codes

	Head Select Bits					
Head Number	10	11	12	13	14	15
0	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0

3.5.3 Word 2 — Sectors per Record and Sector Address

Control word 2 (Figure 3-5) determines the number of sectors per record and the address of each sector. Normally, this word is used only for commands, however, the sector address is updated during disk drive operations, and can be read for diagnostic purposes. Bit functions are described in the following paragraphs.

3.5.3.1 Sectors per Record — W2, Bits 0–7. Since the recording format is always one sector per record, these bits are ignored by the controller. However, these bits should always be set to >01 to insure compatibility with other TI disk systems.

3.5.3.2 Starting Sector Address — W2, Bits 8–15. These bits select the starting sector for any read or write operation except write format, which does not require a starting sector address. The valid range for sector addresses is >00 to >3F.

A starting sector address larger than the maximum sector address causes a command time-out status because the controller can-

0 — 7	8 — 15
SECTORS/RECORD	STARTING SECTOR ADDRESS

2277322

Figure 3-5. Control and Status Word W2 Format

not locate a starting sector address at which to start executing the command.

W2 may also contain a self-test failure code as a result of self-tests initiated by CPU command, upon power-up, or by a CPU I/O reset. In any case, a self-test failure causes all ones (FF) to be reported in the right byte of W7, and a 16-bit failure code in W2.

3.5.4 Word 3 — Cylinder Address

Word 3 (Figure 3-6) selects the cylinder address to which the disk seeks for a read or write operation. The valid number range is >0000 through >0334. This field is also used during self-tests to specify test numbers. Normally, this word is used only for control, however, the cylinder address is updated during disk operations and can be read for diagnostic purposes.

The head address in W1, the sector address in W2, and the cylinder address of W3 forms a complete address that locates a record on the disk.

An invalid cylinder address results in a termination, and the unit error (UE) controller status (control word 7) will be set. The disk status (control word 0) then indicates seek incomplete (SI) status.

0 — 15
CYLINDER ADDRESS

2277323

Figure 3-6. Control and Status Word W3 Format

3.5.5 Word 4 — Transfer Byte Count

Word 4 (Figure 3-7) selects the number of eight-bit data bytes that will be transferred between the disk and the TILINE. Since the least significant bit, bit 15, must be 0, only even byte counts can be specified. The byte count range is limited by available TILINE memory and the 64K byte maximum specified in this control word. An attempt to transfer from nonexistent TILINE memory results in TILINE time-out (TT) controller status.

NOTE

If a read with transfer inhibit is selected, the transfer byte count specifies the number of logically sequential bytes to be read from the disk and checked by ECC for data integrity. However, no data is transferred to CPU memory.

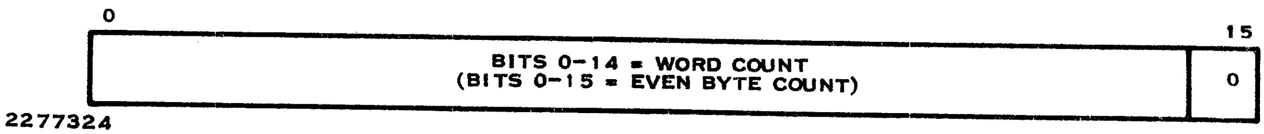

Figure 3-7. Control and Status Word W4 Format

3.5.6 Word 5 — Memory Address (LSB)

The TILINE starting address is 20 bits in length. The 15 LSBs occupy bits 0–14 of word W5 (Figure 3-8). The five MSBs are located in word W6. Bit 15 of word W5 must be held to zero. Normally, this word is used only as a control word, however, the complete TILINE starting address is incremented during disk drive operations and can be read for diagnostic purposes. If no faults occur, the address in these words should be the ending TILINE memory address. If a memory error causes termination of an operation, the address in this word indicates the byte address of the memory error + 2, because the TILINE address is incremented once before the memory error terminates the operation.

During read or write operations, the controller acts as a TILINE master and can store data in or read data from a buffer area in 990 memory. This word specifies the 15 LSBs of the 20-bit TILINE address for the start of the TILINE memory buffer address space. The controller accesses memory starting at the specified TILINE address and increments for the specified word count.

For a read operation, the software must allocate a contiguous area in TILINE memory large enough to accept the data transfer without overwriting other regions of memory.

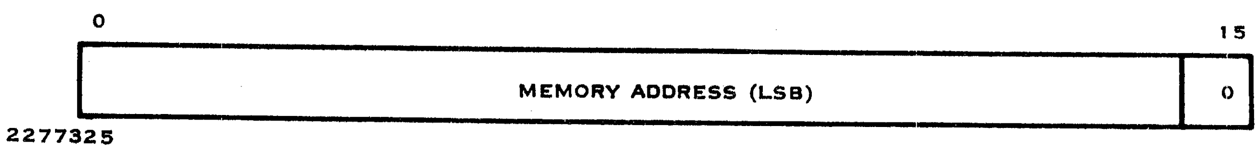

Figure 3-8. Control and Status Word W5 Format

3.5.7 Word 6 — Unit Select and Memory Address (MSB)

Word 6 (Figure 3-9) contains the unit select bits and the MSBs of the TILINE buffer memory as described in the previous paragraph. Bits 0–3 and 8–10 are reserved and should be set to 0.

3.5.7.1 Drive Select — W6, Bits 4–7. Bits 4–7 are a position-coded unit-select field. Only one bit position in this field should be set to one. Any code with two or more ones results in an offline status report, and no drive operation will be performed. The valid unit select codes are:

Word 6 Bit 4	5	6	7	Unit Selected
1	0	0	0	0
0	1	0	0	1
0	0	1	0	2
0	0	0	1	3

0–3	4–7	8–10	11–15
SPARE	DRIVE/SELECT 0 1 2 3	SPARE	MEMORY ADDRESS (MSB)

2277326

Figure 3-9. Control and Status Word W6 Format

3.5.7.2 Memory Address (MSB) — W6, Bits 11–15. The five MSBs of the 20-bit TILINE memory buffer starting address occupy bits 11–15. Refer to the word W5 description for additional information.

3.5.8 Word 7 — Controller Status

Word W7 (Figure 3-10) is used as a control word to set the interrupt enable bit, if desired, and set the idle/busy bit that initiates controller operation. Controller status is held in this word at the end of an operation. If bits 8–15 are all set, a self-test failure has been detected.

3.5.8.1 Idle/Busy Control/Status — W7, Bit 0. The controller must be in the idle mode (bit 0 = 1) for the processor to write control words into the controller, or to read any status other than the idle/busy status bit. This prevents interference to the operation in progress.

After verifying that the controller is idle, control words W0-W6 may be sent to the controller. Controller operation is initiated when a word with a zero in bit 0 is transmitted to controller word W7.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IDLE	COMP	ERR	INT	LOCK OUT	RETRY	ECC	AC	ME	DE	TO	IE	RE	CT	SE	UE

COMP – COMPLETE
ERR – ERROR
INT – INTERRUPT ENABLE
ECC – ECC CORRECTED
RETRY – CONTROLLER EXECUTED RE-READ
AC – ABNORMAL COMPLETION
ME – MEMORY ERROR
DE – DATA ERROR
TO – TILINE TIMEOUT
IE – ID ERROR
RE – RATE ERROR
CT – COMMAND TIMER
SE – SEARCH ERROR
UE – UNIT ERROR

2277327

Figure 3-10. Control and Status Word W7 Format

3.5.8.2 Complete — W7, Bit 1. The complete bit is set by the controller upon error-free completion of a command. The programmer may reset this bit as part of the interrupt service or status checking routine, or may leave it alone until the next block of control words is sent to the controller.

3.5.8.3 Error — W7, Bit 2. W7, bit 2 is set if an error is detected. The programmer may obtain more detailed error information by examining W7, bits 7-15 and W0, bits 0-5.

3.5.8.4 Interrupt Enable — W7, Bit 3. Bit 3 may be set to enable the controller to generate an interrupt on normal completion (W7, bit 1) or error termination (W7, bit 2). Command completion interrupt occurs upon the following logical condition:

IDLE and [(COMPLETE and INTERRUPT ENABLE) or (ERROR and INTERRUPT ENABLE)]

Note that if the enable interrupt bit is set while the controller is idle and the complete or error bit is set, an interrupt is generated immediately. The interrupt should always be selected simultaneously with resetting the idle bit when controller operation is initiated.

The attention interrupts (described with W0, bits 8-11 and 12-15) are independent of the interrupt enable bit. The attention interrupts are associated with completion of a disk drive operation that may be overlapped with operations involving different drives. The program must read and test the controller status words to determine the cause of an interrupt.

3.5.8.5 Lock Out — W7, Bit 4. Bit 4 is set by the controller when control word 7 is first read. This bit is reset upon power up and at the end of a command sequence. This bit is used for multiple CPU applications.

3.5.8.6 Retry — W7, Bit 5. Bit 5 is set by the controller to indicate that the controller performed a reread of the data during the last operation because of a data error detected during one or more read operations.

3.5.8.7 ECC Corrected — W7, Bit 6. When bit 6 is set, the ECC routine has corrected bits somewhere in the data or header of the sector just read, or during the last operation for multiple sector operations.

3.5.8.8 Controller Status — W7, Bits 7-15. These bits are used to report controller status after a command has been executed. Valid error information is contained when the error bit (W7, bit 2) is set. Bits 8-15 are all on in the event of a self-test failure. If the next command after a self-test failure involves a drive operation, bits 8-15 will not clear and the operation will be inhibited. An I/O reset or power reset clears the controller logic and performs a self-test.

Abnormal Completion — W7, Bit 7. Bit 7 is set if a disk operation is terminated because an I/O reset, TILINE power failure warning pulse, or TILINE power reset has been detected.

Memory Error (ME) — W7, Bit 8. Memory error is set if a TILINE memory error is detected during a disk write command. If a memory error (ME) is detected during a write data or write format operation (normal or extended), bad data may have been read from memory and recorded on the disk. All data transfer operations are terminated after ME is encountered. Any remaining data counts are not transferred.

Data Error (DE) — W7, Bit 9. W7, bit 9 is set during a read operation if the calculated ECC character detected an error but was unable to detect a correctable pattern in the data stream.

TILINE Time-out (TT) — W7, Bit 10. In order to prevent an error from indefinitely hanging the TILINE, all TILINE peripheral controllers incorporate a timer that allots up to 12 microseconds for a TILINE operation. If the timer expires before completion of the TILINE cycle, the TILINE cycle as well as controller operation is terminated. The TT bit is then set.

The most common cause for a TILINE time-out is a controller attempt to read or write to a nonexistent memory location. A restore operation cannot cause a TILINE time-out.

ID Error (IE) — W7, Bit 11. This bit is set when an ID word comparison error occurs during the ID verification of a read data or write data command. Verification includes comparison of ID words 1, 2, and 3 and ECC checking. If bit 9 is also set, it indicates the ECC has detected an error in the sector. IE causes command termination.

Rate Error (RE) — W7, Bit 12. The data transfer rate from the disk during a read operation is fixed, while the TILINE data transfer rate from controller to memory is determined by bus activity and priority. Under severe TILINE overload, the TILINE may not be able to keep up with the disk interface. This condition corrupts data transfer, and sets the rate error bit.

In a similar manner, a TILINE overload during a write data operation corrupts the data recorded on the disk and causes a rate error.

All data transfer operations are terminated after RE is encountered.

Command Time-out (CT) — W7, Bit 13. The controller is allotted a predetermined amount of time for each command. If the controller fails to complete the operation before the timer expires, command time-out is set and the operation is terminated. The timer is restarted each time a seek operation is executed, a head address is set or incremented, the controller is at the beginning of the idle routine, or during execution of the disk drive power up sequence. This bit is also set if a byte count greater than 510 is given for any unformatted command.

Search Error (SE) — W7, Bit 14. Bit 14 is set if the controller does not detect a sync character within one physical sector while attempting to read from the disk. SE causes command termination. No controller retries are attempted after a search error.

Unit Error (UE) — W7, Bit 15. Bit 15 is set when an operation is terminated because of a disk drive error. Causes of a unit error depend upon the command being executed when the error condition is encountered, as follows:

Command	Causes
Restore	Offline
Unextended read unformatted	Offline, not ready, unsafe, seek incomplete, or offset active
Write data, write formatted, write unformatted	Offline, not ready, unsafe, seek incomplete, offset active, or write protect
Read data, extended read unformatted	Offline, unsafe, seek incomplete, offset active*
Seek (Seek here does not refer to the seek command, which is nonoperable, but seek operations performed as part of other read or write commands.)	Offline, unsafe, seek incomplete, offset active
Store Registers	Offline, not ready, unsafe, offset active, seek error

Note:

* During read commands, offset active creates a unit error only during command initialization and termination.

3.6 DETAILED COMMAND DESCRIPTIONS AND EXAMPLES

3.6.1 Normal Commands

The normal or nonextended commands are the eight commands for which the extended mode bit (W1, bit 0) is not set. These commands are store registers, write format, read data, write data, unformatted read, unformatted write, seek, and restore. These basic commands are used for most normal data storage and retrieval.

3.6.1.1 Store Registers Command. The store registers command provides a means for the operating system software to interrogate a disk system to determine critical parameters such as words per track and cylinders available per drive unit. This command causes the controller to send one, two, or three words to the 990 memory, starting at the memory address specified in words W5 and W6, and specified by the word count in word W4. The three words contain the following information:

- Word 1 — Word 1 is >2000, which is the total number of formatted words that can be recorded on a disk track.
- Word 2 — Word 2 is >4000. Bits 0-7 specify the number of sectors per track, which is >40; and bits 8-15 specify the number of bytes of overhead per record, which is >00.
- Word 3 — Word 3 is >0B35 for the removable drive unit; >0B35 for the 16 MB fixed drive unit; >1B35 for the 48 MB fixed drive unit; and >2B35 for the 80 MB fixed drive unit. Bits 0-4 specify the number of tracks per cylinder and bits 5-15 specify the number of cylinders per drive as follows:

	Word 3 (Bits 0-4)	Tracks/ Cylinder	Cylinders/ Drive (Bits 5-15)
Removable Drive Unit:	>0B35	1	>0335
32 MB Fixed Drive Unit:	>0B35	1	>0335
64 MB Fixed Drive Unit:	>1B35	3	>0335
96 MB Fixed Drive Unit:	>2B35	5	>0335

An example of control words used to initiate a store registers operation is given in Table 3-3. Refer to Figure 3-2 for control word formats.

NOTE

A drive must be selected (word 6). If no drive is selected, the disk status after the command is complete will have the not ready and off-line status bits set, the controller will have the error and unit error bits set, and no data will be transferred to memory.

Table 3-3. Example of Control Words in a Store Registers Command

Word Number	Word	Comments
0	>0000	Clear attention mask bits
1	>0000	Store registers command
2	>0000	Not used
3	>0000	Not used
4	>0006	Byte count = 6
5	>1000	Write three words in memory beginning with TILINE byte address >001000
6	>0800	Select drive unit 0; TILINE address MSB = 0
7	>0000	Reset status bits; initiate controller operation

3.6.1.2 Write Format Command. The write format command formats a new disk or reformats a disk already in service. One complete track is formatted per command. After receiving all command words, the controller verifies correct disk status (offline, not ready, unsafe, write protect, offset active, multisel, or seek incomplete), seeks to the specified cylinder, and sets the specified head address. The controller assembles the ID words from its internal registers and counters and records the word(s) on the disk at the specified disk track address. The controller then fills the entire data field following the ID words by repeating the data word fetched from the specified TILINE memory address. The ECC is then appended to the data field. Each sector on the track is formatted in this manner with ID words, data, ECC, and required gaps. Table 3-4 shows an example of the control words used to initiate a write format operation.

3.6.1.3 Read Data Command. The read data command words identify a record location, specify the number of bytes to be transferred from this location, and give the starting address for the TILINE memory address buffer area to receive data from the disk.

After initialization, the controller performs the following operations:

1. Checks for unit errors by examining disk status (offline, offset active not ready, unsafe, and seek incomplete)

2. Seeks to the specified cylinder

3. Sets the specified head address

4. Reads the ID words for the first sector that passes under the read head

Table 3-4. Example of Control Words in a Write Format Command

Word Number	Word	Comments
0	>0000	Clear attention mask bits
1	>0101	Write format command; head address = 1
2	>0100	One sector/record, starting sector address not required
3	>00CA	Cylinder address = >CA
4	>0000	Not used (Variable record lengths are not supported)
5	>1000	TILINE memory byte address of formatting data word = >001000
6	>0800	Selected drive unit 0; TILINE address MSB = 0
7	>1000	Reset status bits, set interrupt enable, initiate controller operation.

5. Verifies the contents of ID words 1, 2, and 3
6. Waits for the correct starting sector
7. Assembles 16-bit words from the data fields
8. Transfers these words to the specified TILINE address, if transfer inhibit is not set
9. Verifies the 32-bit ECC character for data field and header for the sectors from which data is being transferred

A failure to verify an ID word results in an ID error status (bit 11) and termination of the read data operation. If the ECC is incorrect for the sector from which data is being read, data error status (bit 9) is also set. When the controller encounters the end of a sector but the remaining transfer word count is nonzero, the controller automatically continues reading data on the next sequential logical sector, if it exists. The controller automatically switches heads and/or cylinders if necessary to access the next logical cylinder.

When the remaining transfer word count is zero but the controller has not encountered the end of a sector, the controller discontinues transmitting data words across the TILINE but continues to read data from the disk until the end of the sector is encountered so that the ECC character can be checked before loading status.

When the controller encounters the end of a track and the remaining transfer word count is nonzero, the controller automatically increments the head address to the next track, reads the ID words for the first sector to pass under the read head, verifies the contents of ID words 1, 2, and 3, verifies the ECC character, waits for sector zero, and continues to read words from the disk and to transfer them to the TILINE, if transfer inhibit is not specified.

When the controller encounters the end of a cylinder, and the remaining transfer word count is nonzero, and head offset is not specified, the controller automatically seeks to the next cylinder, selects head address zero for the new track, reads the ID words for the first sector to pass under the read head, verifies the contents of ID words 1, 2, and 3, waits for sector zero and continues normal read operation.

Table 3-5 shows an example of the command word used to execute a read data operation.

3.6.1.4 Write Data Command. The write data command causes the controller to record data on a previously formatted track, or to write over a previously recorded sector. After initialization, the disk controller performs the following operations:

1. Checks for unit errors by examining disk status (off-line, not ready, unsafe, write-protect, offset active, or seek incomplete)
2. Seeks to the specified cylinder
3. Selects the specified head address
4. Reads the ID words from the first sector that passes under the heads
5. Verifies ID words 1, 2, and 3, and ECC at end of sector
6. Waits for the correct starting sector to pass under the head
7. Writes appropriate header at beginning of sector
8. Writes data from the specified memory location

Table 3-5. Example of Control Words in a Read Data Command

Word Number	Word	Comments
0	>0000	Clear attention mask bits
1	>0200	Read data command; head address 0
2	>0100	One sector/record; starting sector 0
3	>0000	Cylinder address = 0
4	>2000	Transfer >2000 bytes
5	>0000	TILINE memory byte address = >1F0000
6	>041F	Select drive 1; TILINE address MSB = 1F
7	>0000	Reset status bits, interrupts not used; initiate controller operation

If the ID words in step 5 do not compare, the write operation is terminated with an ID status error.

Data is written on the disk until the specified number of words have been transferred unless a terminate condition is encountered. When the number of words is greater than the words per sector, the controller continues to the next sequential sector.

When the transfer word count is less than the sector word count, the controller fills the remainder of the sector with zeros until the sector word count has been decremented to zero.

The controller assembles the ID words from its internal registers and records the words on the disk at the specified sector address. The data words are then written on the disk. After the last data word of the sector is written, the controller records the ECC characters that pertain to the data. ID words are written for each sector on the disk.

When the controller encounters the end of a track for a cylinder and the remaining transfer word count is nonzero, the controller automatically increments the head address to the next track, starts reading ID of the first sector that passes under the head, verifies the contents of ID words 1, 2, and 3, and continues the write data operation at sector zero.

When the controller encounters the end of a cylinder and the remaining transfer word count is nonzero, the controller automatically seeks to the next cylinder, selects head address zero for the new cylinder, starts reading the first sector that passes under the heads, verifies the ID words, and continues the write operation at sector zero.

Table 3-6 is an example of the command words that execute a write data operation.

Table 3-6. Example of Control Words in a Write Data Command

Word Number	Word	Comment
0	>0000	Resets attention mask bits
1	>0304	Write data command; select head number 4
2	>013F	One sector per record; start writing at sector address >3F
3	>0300	Cylinder address = >300
4	>0300	Transfer byte count = >300
5	>9700	Starting TILINE memory address = >009700
6	>0400	Select drive unit 1; TILINE address MSB = 0.
7	>1000	Reset status bits; set interrupt enable; initiate controller operation

Table 3-7 is an example of the status words returned to word locations W0–W7 after a typical write data operation has been performed. Note that cylinder, head, and sector information have been updated, as well as TILINE memory address. Also note that the word count has decremented to zero. This example is typical for any read or write operation.

3.6.1.5 Unformatted Read Command. In order to insure compatibility with Texas Instruments device service routines, the unformatted read command (nonextended) does not actually read any data from the disk. Instead, three words are returned to the CPU after this command is executed. Word one of the three returned words contains the head and cylinder addresses; the second word contains the sectors per record number, which is >01, and the sector address; and the third word contains the record word count, which is >80. If an unformatted read operation is desired, use the extended unformatted read command words.

3.6.1.6 Unformatted Write Command. An unformatted write command transfers up to 510 bytes of data from a specified TILINE address to a specified disk address. After initialization, the controller seeks to the specified cylinder, selects the specified head address, detects the beginning of sector, generates the correct lead gap, and writes data on the disk. All data is written consecutively without regard to existing sector boundaries until the specified number of words has been transferred or until a termination condition is encountered. The controller adds a sync character to the beginning of the data and an ECC character at the end.

Table 3-7. Example of Status Words After Write Operation

Word Number	Word	Comments
0	>00C0	Attention bit for drive unit 0 and 1 is set; no unit errors occurred
1	>0300	Head address has been updated to head 0
2	>0101	Sector address has updated to ending sector address of >1
3	>0301	Cylinder address has been updated to >0301
4	>0000	Word count has decremented to 0
5	>9A00	TILINE memory address has been incremented to >9A00
6	>0400	TILINE MSB memory address remains >0
7	>D000	Controller idle; operation complete; interrupt enabled; no errors detected

NOTE

The maximum transfer count is 510 bytes.

3.6.1.7 Seek Command. Since the heads are located on a common carriage assembly, independent seek operations would result in the head assembly moving all heads to the next track in a multiple location sequence only to have to return to the original track to finish an operation that has already begun. This head thrashing is eliminated by ignoring (NOP) any command from the software to preseek to a defined track.

3.6.1.8 Restore Command. The restore command reinitializes the cylinder counter and repositions the heads of the selected disk drive unit over cylinder zero. The restore command is generally used to clear an unsafe condition at the disk drive. This command is required if seek incomplete or unsafe status is detected. Before executing the restore operation, the controller determines if a unit error exists by examining offline disk status. Completion of the operation is determined by enabling a disk drive completion interrupt (attention bit interrupt) or monitoring the attention bit for the selected drive unit. If a unit error is encountered before the restore command is initiated, the unit error bit in W7 is set.

3.7 EXTENDED MODE COMMANDS

The extended mode commands are those commands for which the extended mode bit (word 1, bit 0) is set. The extended mode bit allows the command code field (word 1, bits 5–7) to select from an additional set of commands. These are the commands that are less commonly used during the course of data storage and retrieval operations.

Refer to Table 3-1 for the complete set of nonextended and extended mode commands. Except for the extended read unformatted and extended self-test commands, extended mode commands perform identical functions as the nonextended commands.

3.7.1 Read Unformatted (100 – Extended)

The extended unformatted read command allows the programmer to read a sector and to examine a specified number of words starting immediately after the sync character without regard to ECC errors or standard sector formatting. This is primarily a diagnostic feature.

After initiation, the controller selects the proper head and seeks to the specified cylinder. When the sector is located, the controller transfers the specified number of words to TILINE memory, starting with the first word after the sync character.

The ID words, data fields, ECC words, and trailing gap are read and transferred to memory as though they were all data words. There are normally glitches in the trailing gap due to write head turn-on and turn-off transients, and differing write clock phases recorded during formatting and write operations. These glitches may cause apparent shifting of word boundaries.

An ECC check is performed at the end of the operation, and data error status is reported if the ECC check shows an error. However, no ECC correction is attempted.

Word transfer count is limited to 510 bytes. Command time-out occurs if too many bytes are requested. An example of the command words used to initiate an extended read unformatted operation is given in Table 3-8.

Table 3-8. Example of Control Words in an Extended Unformatted Read Command

Word Number	Word	Comment
0	>0000	Resets attention mask bits
1	>8401	Extended read unformatted command; select head 1
2	>0101	One sector per record; starting sector address = 1
3	>00CA	Select cylinder >CA
4	>0006	Transfer three words (6 bytes)
5	>1000	TILINE memory byte address = 001000
6	>0400	Select drive unit 1; TILINE memory address MSB = 0
7	>1000	Enable interrupt; initiate controller operation

3.7.2 Self-Test Commands (111 - Extended) This command causes the controller to execute one of the self-test routines, as specified by a value in word W3. These tests are described in the depot maintenance manual.

Certain of these extended test commands hang the controller in a test loop until an I/O reset or power reset aborts the test. Refer to the depot maintenance manual for a complete description of the self-test routines.

4

Operation

4.1 GENERAL

This section describes normal operating procedures for the Model CD1400 Disk System, including:

- Power-up, stop, and power-down
- Cartridge handling, installation, and replacement
- Fault operation

The TILINE disk controller requires no operator intervention after installation. Onboard controls and indicators are intended only for installation and maintenance use. The controller should be serviced only by qualified personnel. Before operating, read and observe all of the following listed precautions.

OPERATING PRECAUTIONS

To prevent damage, the following precautions must be observed when operating the disk drive.

1. Do not remove ac power from the disk drive or switch the MAIN AC BREAKER circuit breaker to OFF until the platters have stopped rotating. Failure to observe this precaution results in unfiltered air being sucked in by the rotating platters.

2. A removable cartridge must be kept in the unit at all times whether operating or not. If a removable cartridge is not in place, the shroud area will not seal out atmospheric contaminants.

3. Keep the access door closed at all times to prevent entry of atmospheric contaminants.

4. If a pinging or scratching sound (caused by head-to-disk contact) is heard and persists, stop the unit by following the stop and power-down procedures found in this section, then call maintenance personnel. If a head crash is suspected, do not place another cartridge into the drive until the system can be checked or else further damage can result to the disk and the disk drive.

5. If the disk drive is cabinet-mounted on slides, never extend the drive unless all other cabinet-mounted equipment is fully retracted. Never set any test equipment or other objects on top of an extended drive. Never lean on an extended drive. If these precautions are not followed, the entire cabinet may tip over.

6. If the disk drive is pedestal-mounted, do not place heavy test equipment or other heavy objects on top of the pedestal. Do not sit on the pedestal. Never stack disk drives.

OPERATING PRECAUTIONS (Continued)

7. Always carefully follow disk handling, installation, and removal procedures found in this section.
8. Use only Texas Instruments supplied disk cartridges.
9. Never attempt to override any interlocks in the system.

4.2 CONTROLS AND INDICATORS

All operator controls and indicators are located on the front panel except for the MAIN AC BREAKER circuit breaker, located on the rear panel. Figure 4-1 shows locations of these controls and indicators; Table 4-1 describes their functions.

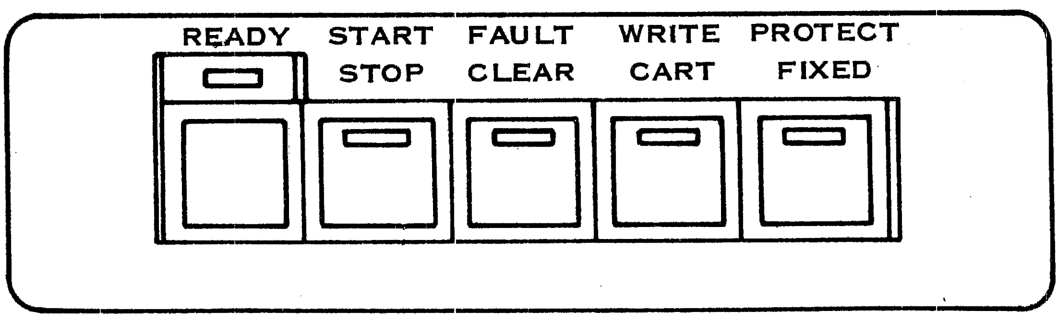

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Figure 4-1. Controls and Indicators

Table 4-1. Controls and Indicators

Control or Indicator	Function
START/STOP Alternate action switch:	When energized (in), starts spindle motor and initiates the first seek mode, provided the following conditions are met: 1. The drive MAIN AC BREAKER circuit breaker is ON. 2. The disk cartridge loading door is closed and latched with a cartridge in place. 3. The drive FAULT light is off. When deenergized (out), removes power from spindle motor, and halts all drive operation.
Indicator:	Lights when the START/STOP switch has been energized.

Table 4-1. Controls and Indicators (Continued)

Control or Indicator	Function
READY indicator:	Lights when unit is up to speed, heads are loaded, and no fault exists requiring manual intervention. The READY indicator blinks throughout the spindle start and stop procedure.
FAULT	
Switch:	When pressed, clears certain drive fault conditions.
Indicator:	Lights to indicate a fault condition. If pressing the FAULT switch clears the fault, light goes out.
WRITE PROTECT FIXED	
Switch:	Alternate action switch. When actuated, the write driver for the fixed volumes is disabled, preventing data from being written on any fixed volumes.
Indicator:	Lights to indicate that the WRITE PROTECT FIXED switch is actuated.
WRITE PROTECT CART.	
Switch:	Alternate action switch. When actuated, the write driver for the removable cartridge is disabled, preventing data from being written on the removable cartridge.
Indicator:	Lights to indicate that the WRITE PROTECT CART. switch is actuated.
MAIN AC BREAKER ON/OFF Circuit breaker (located on rear panel):	Applies primary ac power to disk drive. Trips on overload.

4.3 DISK CARTRIDGE PURCHASE, HANDLING, INSTALLATION, AND REMOVAL

The following paragraphs discuss removable disk cartridge purchase, handling, installation, and removal procedures.

CAUTION

Procedures in this section must be carefully followed to prevent damage to the disk drive or cartridge as well as to protect data written on the cartridge.

4.3.1 Disk Cartridge Purchase

The disk cartridge used in the CD1400 disk system must meet the following quality criteria. For these reasons, Texas Instruments supplied disk cartridges must be used in the system since standard disk cartridges do not meet these critical specifications.

1. Tracks 0 and 1 must be error free to insure reliable operating system performance.
2. Unmapped track errors cannot exceed seven bits in length in order to insure reliable error correction in these areas.
3. An error map must be included in order for software to deallocate bad track areas.
4. Surface finish must be superior in order to minimize possibility of head crashing.

4.3.2 Disk Cartridge Handling Procedures

The cartridge consists of a platter, and top and bottom dust covers. The platter is contained within these plastic dust covers for protection from contaminants that can cause damage. The top dust cover is permanently attached to the platter and is installed with the platter into the drive unit. The bottom dust cover is removed prior to inserting the cartridge into the disk drive. After detaching, set the bottom dust cover upside down to prevent dust from collecting inside the cover.

The bottom dust cover should always be on the cartridge when not installed in the drive unit to protect the cartridge from damage and contaminants.

Cartridge can be stored flat or on the edge, but stacking should be avoided. Do not lay objects on top of cartridges.

Never touch the recording surface on the cartridge. Always lift the cartridge by the handle on the top dust cover.

4.3.3 Disk Cartridge Installation

The disk cartridge must be stored in the same environment as the disk drive for at least 60 minutes prior to installation. Refer to Figure 4-2 while performing the following cartridge installation procedure.

1. Release latch under lip of access door recess and pull down cartridge access door.

NOTE

Power must be on, the START/STOP switch out, and READY and FAULT lamps must be off to release lock on cartridge door.

2. To separate bottom dust cover from the cartridge, push cover release button toward center of cartridge.
3. Disengage bottom dust cover from the cartridge and set the bottom dust cover upside down to prevent dust from collecting within the cover.
4. Slide cartridge into the receiver track, ensuring that the head opening is toward the rear of the disk drive.
5. Push handle down, then push cartridge fully to the rear.
6. Close cartridge access door and press the door closed until latched. The cartridge slides into place on the spindle and automatically engages as the access door is latched.
7. Engage the START/STOP switch (switch in) to apply power to the spindle motor.

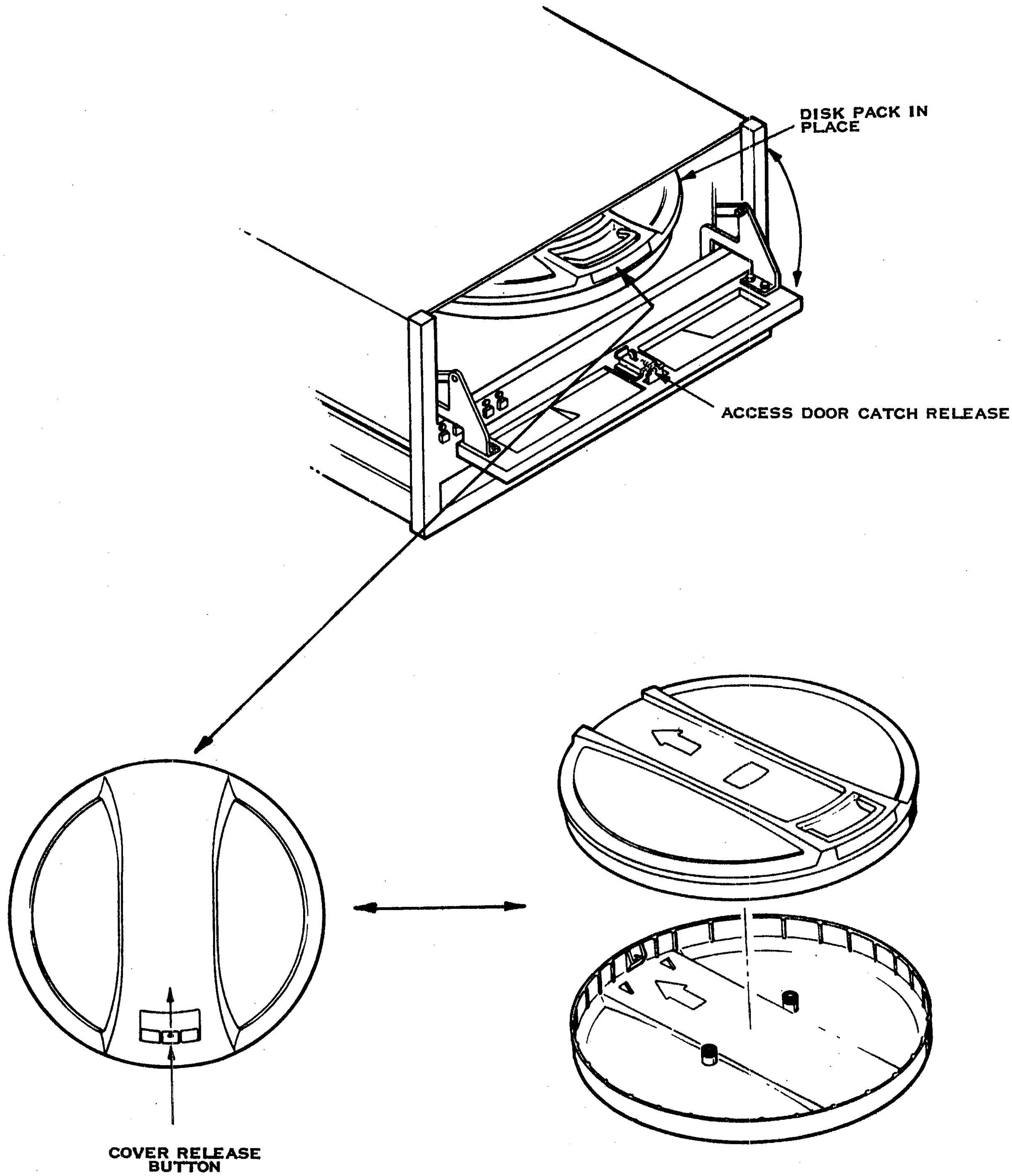

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Figure 4-2. Cartridge Installation and Removal

NOTE

If the spindle motor does not rotate, the cartridge access door may not be completely closed, the cartridge may not be properly seated on the spindle chuck, or the cartridge receiver/base may not be fully seated on the lower chassis.

4.3.4 Disk Cartridge Removal

The following procedure details cartridge removal under normal conditions. If for any reason the door cannot be opened, check that power is on, the START/STOP switch is out, and the READY and FAULT lamps are off. If these conditions are met and the door cannot be opened, refer the problem to a qualified service technician. Do not attempt to force the door or defeat interlocks. Do not attempt to remove cartridge during a power failure. Refer to Figure 4-2 during the following procedure:

1. Disengage the START/STOP switch (switch out).
2. Wait until the READY indicator ceases blinking and goes out.
3. Pull down the cartridge access door.
4. Pull the cartridge out of the receiver with sufficient force to overcome the detent action.
5. Place the bottom dust cover on the cartridge and fold over the top handle.

NOTE

Swing out the handle to carry the cartridge but do not push the cover release button while transporting.

6. Install another cartridge as described in the preceding procedure. Always keep a cartridge in the receiver to insure that the shroud remains sealed and contaminants do not enter the drive unit.

4.4 OPERATING PROCEDURES

The following paragraphs detail disk drive normal operation including power-up, write-protect, stop, and power-down procedures.

4.4.1 Power-Up for Online Operation

Since the disk drive draws a high amount of current upon start-up, disk drives in multiple drive systems should be powered up one at a time to prevent circuit breakers from tripping due to start-up overload. Under normal conditions, the disk controller supervises application of power and start-up of the disk drive. To allow the controller to perform this power application sequencing, insure that the MAIN AC BREAKER circuit breakers are ON on all disk drives and the front panel START/STOP switches are in the energized position prior to applying power to the CPU. When power is applied to the CPU, the controller automatically sequences power to all drives in the system. If the disk drive(s) in single or multiple drive installations are not powered-up and the CPU is powered-up and online, perform the following procedure to power-up the drive(s):

1. Insure that START/STOP switch is in STOP position (switch out and indicator unlit).
2. Set the MAIN AC BREAKER circuit breaker on the rear panel to ON.
3. Install cartridge into disk drive using disk cartridge installation procedures detailed above.

4. Actuate the START/STOP switch, and verify that the indicator is lit.

5. Verify that the READY indicator ceases blinking and remains constantly lit. This occurs after the disk drive is up to speed and the heads are loaded (approximately 60 seconds).

6. Verify that the FAULT indicator is not lit.

7. Repeat this procedure one at a time for all drives in the system.

4.4.2 Write-Protect
To insure that data is not inadvertently written on either a fixed platter or the removable platter, the write-protect feature may be activated. Actuate the WRITE PROTECT FIXED switch to protect the fixed media in the disk drive. Actuate the WRITE PROTECT CART. switch to protect the cartridge platter. Verify that the indicator is lit on the actuated switch. The selected platter is now write-protected. To remove write-protection, deactivate the appropriate switch and insure that the indicator is out.

4.4.3 Stop
The disk drive can be stopped whether or not a disk function is being performed. If a disk function is being performed, the operation stops, and the carriage retracts. To stop the disk drive, press the START/STOP switch. The READY indicator blinks until the platters cease rotating. The cartridge may now be removed using cartridge removal procedures.

4.4.4 Power Down
Application and removal of power is generally accomplished by the CPU as described in the power-up procedures. Power down of a single drive is generally only accomplished by maintenance personnel. If it is necessary to remove power from a disk drive, stop the unit as described, insure that the spindle has stopped rotating (READY light out) and set the MAIN AC BREAKER circuit breaker on the rear panel to OFF.

4.5 FAULT OPERATION

If the FAULT indicator lights during operation or power-up, proceed as follows:

1. Press the FAULT switch. If lamp goes out, normal operation can be resumed. If FAULT lamp does not go out, proceed with step 2.

2. Press START/STOP switch to stop and allow spindle to stop rotating (READY light out).

3. Press START/STOP switch to start. If FAULT light goes out, normal operation can resume. If FAULT light remains lit, proceed with step 4.

4. Power-down equipment in accordance with power-down procedure.

5. Power-up equipment in accordance with power-up procedure above. If FAULT light remains lit, refer problem to qualified maintenance personnel. Do not attempt to operate disk drive.

Alphabetical Index

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.
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  Tx-yy

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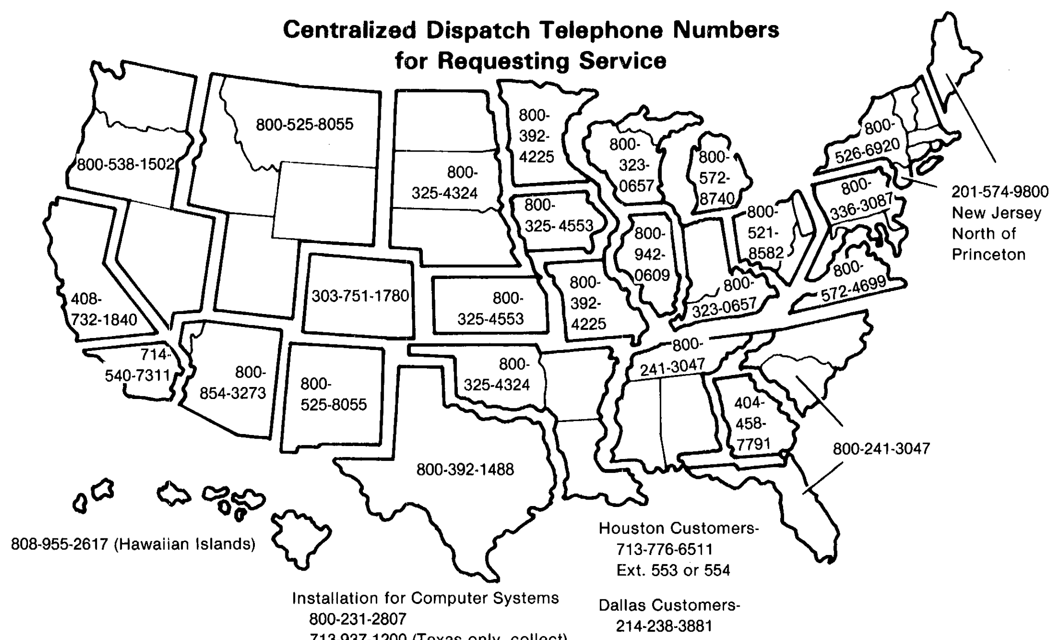

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