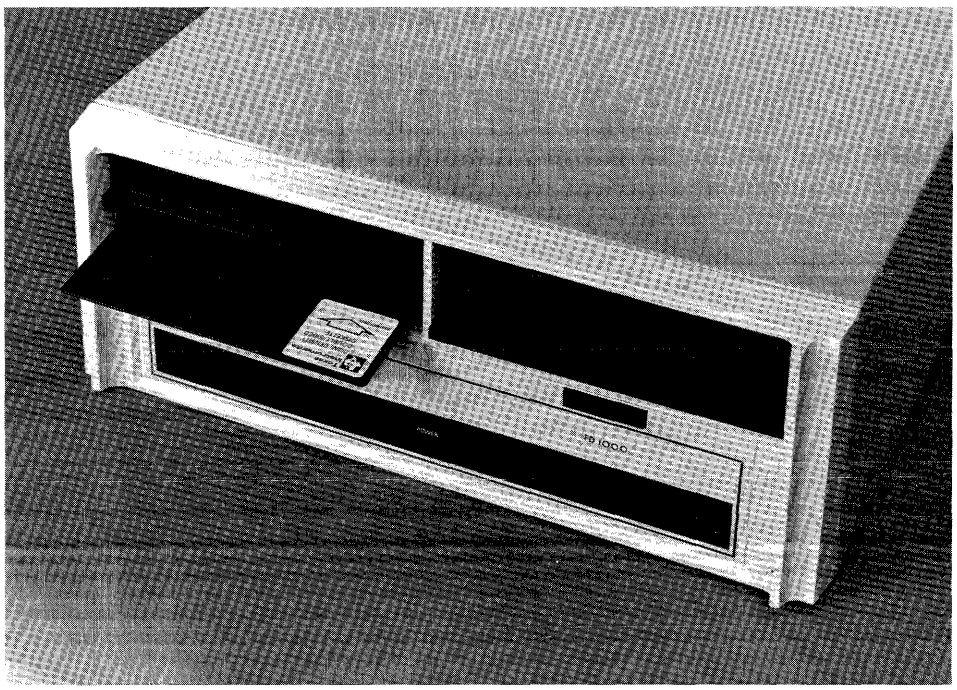
Model FD1000
Flexible-Disk System



TEXAS INSTRUMENTS.

Model FD1000 Flexible-Disk System

The Texas Instruments Model FD1000 Flexible-Disk System provides the TI Model 990 computer user with an economical, random-access, mass-storage peripheral with exceptional utility and reliability.

The FD1000 operates in double-sided, double-density (DSDD) or single-sided, single-density (SSSD) mode. The DSDD mode is selected automatically in the controller when a DSDD IBM Diskette 2D-type diskette is installed. This mode provides direct compatibility with TI hard-disk, file-support software. DSDD diskettes require a high quality, high performance, TI-approved media.

The SSSD mode is selected automatically in the controller when a single-sided IBM Diskette 1-type diskette is installed. This mode provides data exchange with IBM 3740 formats through utilities, and interchange with TI FD800 flexible-disk systems.

The double-sided, double-density, certified diskette stores 1.1 megabytes (formatted) on 77 cylinders of two tracks each. Separate read/write heads are provided for the upper and lower surfaces, so no manual inversion of the diskette is required. Burst transfer rate with the DSDD diskette is 500 kilobits per second.

The standard single-sided diskette stores 256 kilobytes of data (formatted) on 77 tracks of 3328 bytes each. The burst transfer rate is 250 kilobits per second. Single-sided diskettes are interchangeable between the FD1000 and FD800 systems used in the FS990 diskette-based computer systems.

With either diskette type, adjacent track step time is 3 milliseconds, head settling time is 15 milliseconds, and head load time is 35 milliseconds.

The FD1000 flexible-disk is available in a single or dual configuration that mounts in a 178-mm (7-in.) panel, EIA standard 483-mm (19-in.) rack. The FD1000 interfaces with any 990 computer that includes the TILINE high-speed data bus. The controller occupies one slot in the computer chassis and can handle up to four flexible-disk drives (two 178-mm chassis). A dual drive system with controller and cabling is shown in figure 1.

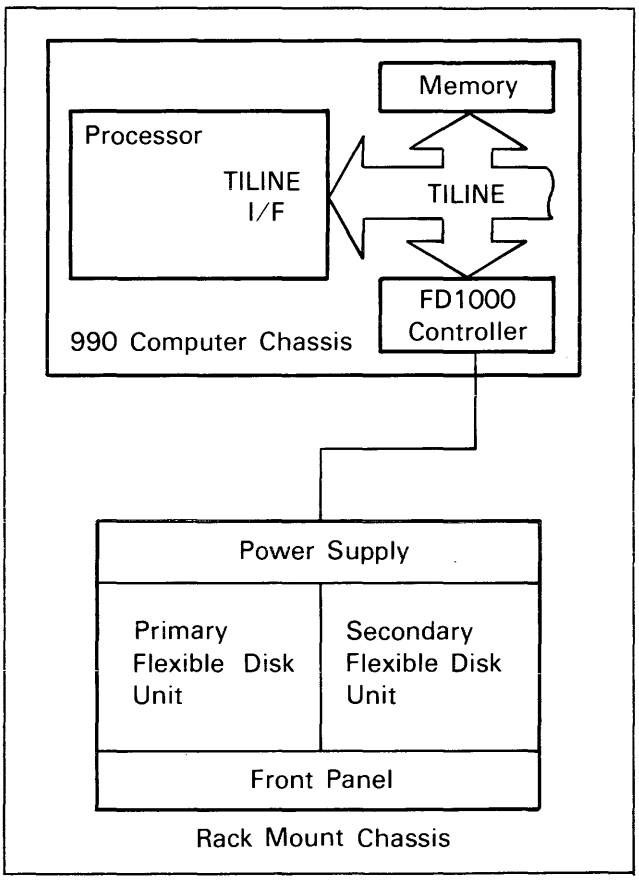


Figure 1. Flexible-Disk System Configuration

System Configuration

The FD1000 system configuration is shown in figure 1. The FD1000 controller mounts in the Model 990 computer chassis and interfaces to the TILINE bus. One cable, providing control/data and status functions, connects the controller to the FD1000 chassis. Flexible-disk drives are installed in the rackmountable chassis which contains a power supply that can support up to two flexible-disk drives. A single flexible-disk drive can be installed in the master chassis with a removable back panel for the addition of a second drive later. Another chassis may be added (via daisy-chain cable to the master chassis) to increase the system capacity to four flexible-disk drives.

System Features

Features of the FD1000 include:

- Operates with double-sided, double-density diskette, or with single-sided, single-density diskette
- Automatic diskette-type detection and operating mode selection
- Operating capability for up to four diskette drives with any mix of single and double-sided diskettes
- Interlacing capability that allows the response characteristics of the diskette system to be optimized to system software
- Overlapped seek capability
- Positive write protect (ANSI standard)
- Power failure detection to prevent data alteration
- Cyclic redundancy error-checking of all data retrieved from diskette
- Firmware-programmed retries for automatic error recovery
- Internal on-board diagnostics with other programmed maintenance aids
- Gentle head loading for prolonged media life, and head-load latching for minimizing head load delays
- Automatic head unloading when not accessed to minimize wear
- IBM-3740 formatting for single-sided diskettes
- Long-life ceramic read/write heads
- Simple diskette loading with spindle power on
- Convenient flat file storage media.

FD1000 Controller

The FD1000 controller handles all control, select and status communications, and data transmissions between the computer's memory and flexible-disk drive units (DMA-type interface). The controller is a full-width printed circuit board that installs in a TILINE chassis slot of the 990 computer.

Controller Command and Status Words

The command and status word organization of the TILINE flexible-disk controller is the same powerful and versatile organization used by the controllers for the DS10, DS25, DS50, and DS200 hard disk systems. The 990 processor initiates a controller operation by transmitting a block of eight control words over the TILINE. These control words contain a command code and a set of parameters which completely describe the desired operation. The controller acts independently during the operation, freeing the 990 processor to work on other tasks. The controller manages all memory-to-diskette drive or diskette drive-to-memory data transfers and all required control signal interchanges. Upon completion of the operation, the 990 processor may read back one or all of the control word addresses, which now contain controller, diskette drive, and operation status information.

The FD1000 control and status word formats are shown in figure 2. The second word (W1) contains the basic command codes which specify the controller operation. There are seven "normal mode" commands and eight less-frequently used "extended mode" commands. These commands are briefly described as follows:

- STORE REGISTERS reads a three-word group from the controller which identifies the storage characteristics of the system and the installed diskette to the operating system software. These characteristics are the total word capacity of a track, the number of sectors per track, overhead words per record, tracks per cylinder, and cylinders per drive unit. The operating system software uses this information to organize records for most efficient storage.
- WRITE FORMAT writes the TI format on a double-density diskette or the IBM format on a single-density diskette. As supplied by the manufacturer, diskettes can be totally blank. The formatting operation organizes the diskette surfaces into efficient record storage partitions for later recording and reproduction of data.
- READ DATA begins reading data on the track, surface, and sector specified and reads until the specified number of words have been moved to 990 memory. Error checking and automatic retries provide a high level of confidence in the data integrity.
- WRITE DATA moves data from the 990 memory over the TILINE and records it on the diskette, starting from the specified track, surface, and sector. Error checking codes are automatically recorded in each sector.
- READ supplies data based on diskette type to the operating system, and provides compatibility with the hard disk systems.
- SEEK moves the read/write heads to the specified cylinder. Seek may be used in advance of a read or write operation to speed up data transfers. The controller can direct independent, overlapped, seek operations to four diskette drives at once, with attendant improvement in system throughput.
- RESTORE is a diskette drive calibration operation which moves the read/write heads to a standard position. Other tracks are located by cumulative forward and reverse steps since the last Restore operation.
- WRITE INTERLACED SECTOR FORMAT is an extended mode version of WRITE FORMAT. The extended version allows diskette sectors to be interlaced so that sequentially recorded sectors are not physically adjacent on the disk. Careful selection of an interlace factor allows the response of the diskette storage system to be optimized for the user's system software.

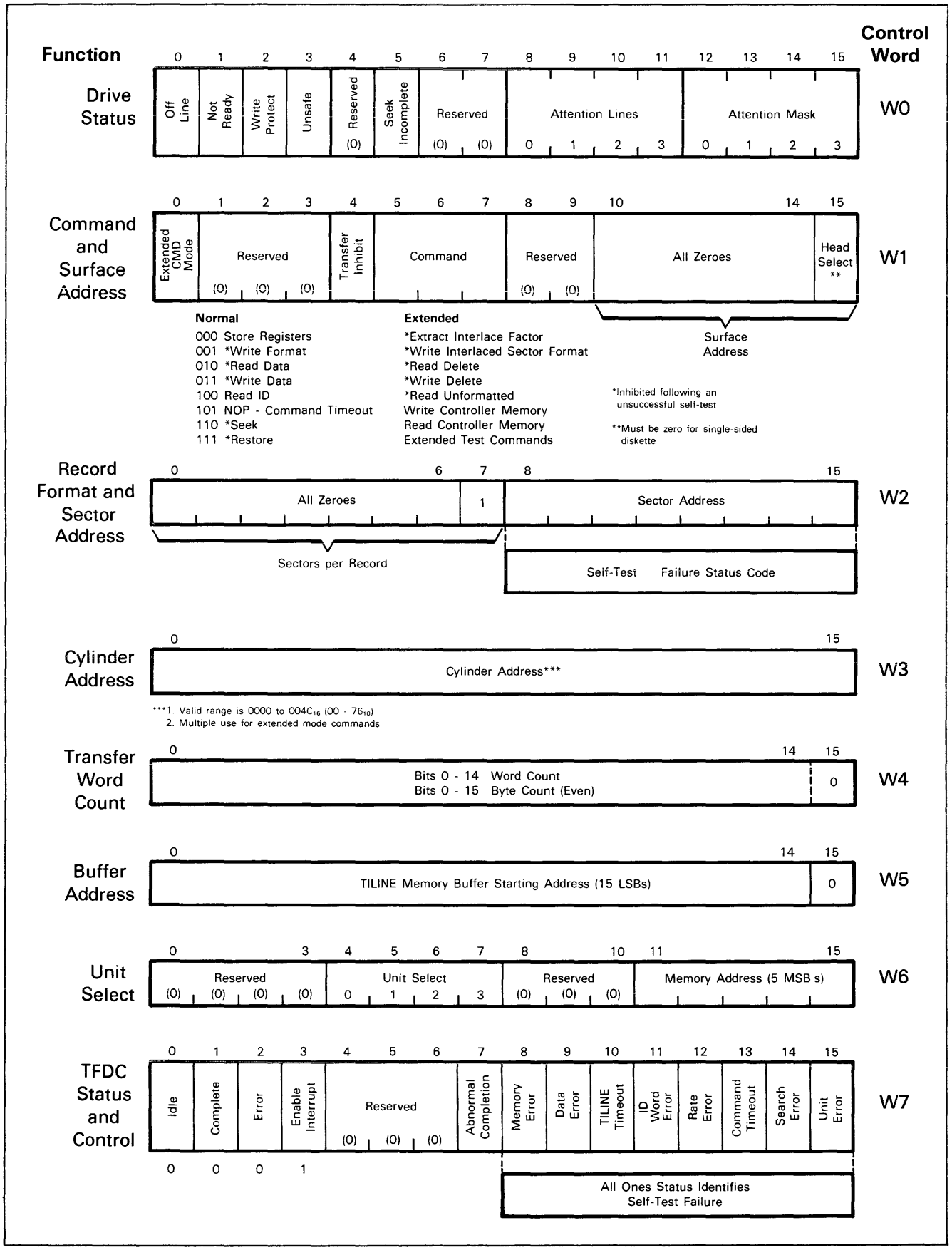


Figure 2. TFDC Control and Status Words

- EXTRACT INTERLACE FACTOR is an extended mode command which reads back the interlace factor from the specified track (see WRITE INTERLACED SECTOR FORMAT).
- READ DELETE is an extended mode command which provides compatibility with the IBM scheme which assigns a special address mark to certain sectors. These "deleted" sectors cannot be read by an ordinary read command, but the READ DELETE command can read such sectors. READ DELETE applies to single-density diskettes only.
- WRITE DELETE is an extended mode command which provides compatibility with the IBM "deleted sector" concept. It is like an ordinary write command except that the special address mark renders the recorded data unreadable except by a Read Delete command. It applies to single-density diskettes only.
- READ UNFORMATTED allows the controller to start from a specified sector and read back everything recorded in that track without regard to standard format convention or error checking. This command is useful for diagnostic purposes only.
- MAINTENANCE and EXTENDED TEST commands are included, but are not exercised in normal operation.

Error Recovery

The FD1000 controller is firmware programmed for automatic retry to recover soft errors, which are determined during the verification of ID and data integrity on SEEK, READ ID, READ data, and WRITE data operations.

Single-Density Diskette Format

The FD1000 disk system records data on the single-density, single-sided diskette in an IBM-3740 track format with 128-byte data sectors. Sectors of longer length (256 or 512 bytes) are not supported by the controller firmware. Track allocation and use is a function of the operating software. The TI-supplied software does not allocate tracks per the IBM convention, but does format the tracks per the IBM 3740 format. IBM 3740 format conversions are provided in special conversion utilities, which are part of the TI operating system software.

Track formatting of the diskette is illustrated in figure 3. The diskette is initialized with 77 tracks (00 to 76), each segmented into 26 sectors (1 to 26) of 128 bytes of data. Basic IBM data exchange normally uses tracks 1 through 73, providing 1898 sectors of 242,944 bytes. Track 00 is the index track, track 74 is not normally used, and tracks 75 and 76 are reserved for alternate track assignment to cover possible faulty tracks in the data field. Track 00 (the index track) contains the diskette contents descriptors, such as file nomenclature, owner, data, error, or security fields. This index track is organized by the operating system software.

As illustrated by figure 3, sector 1 is preceded by preambles and track address mark synchronized from the light-detected mark through the index hole. Each sector contains an identification (AM1) mark, track/sector ID, ID checksum, data mark (AM2), data field, data field checksum, and gaps that total a 187-byte composite. Sector 26 is followed by a nominal 241-byte postamble.

Double-Sided, Double-Density Diskette Format

The FD1000 flexible disk system records data on double-sided, double-density diskettes in a TI format of 288-byte sectors (figure 3). Track allocation and use is a function of the operating system software.

The diskette is initialized with 26 (soft) sectors, numbered 0-25. The diskette is organized into 77 "cylinders" where a cylinder consists of a track on the upper surface and a track on the lower surface, with head carriage position held constant. Track assignments are determined by operating system software. The index track (track 00) contains a catalog (maintained by the operating system) of the diskette contents.

Each sector contains an ID synchronization field, ID address mark, and three ID words identifying the cylinder, surface, sector address, number of sectors per track, and bytes per record. An additional error code word verifies the integrity of the ID field. All of this information is recorded as part of the Write Format operation.

After a gap, a data synchronization field, data address mark, and 288 bytes of data (followed by another error code word) are recorded. The gaps are used to absorb the tolerances due to the formatting and data recording (or rerecording) are performed at different times and possibly on different disk drives. A single index pulse per disk revolution is generated as a hole in the diskette passes a hole in the jacket. An additional gap (just prior to sector 0) accompanies the index mark.

Software Support

FD1000 system hardware operates with the DX10 and TX5 operating systems. With a double-sided diskette installed, the FD1000 diskette system participates fully in the dynamic file and overlay structure of the DX10 and TX5 operating systems. Only the unique disk parameters of the diskette and its performance distinguish the FD1000 from the larger hard disks such as the DS10, DS25, DS50, and DS200.

Although a single-sided, single-density diskette may not be used as a system disk because of different sector formatting, TX5 and DX10 operating systems provide utility support for reading and writing to single-density diskettes which can be treated as other input or output devices. Utility support for IBM 3740-compatible formatting is also provided.

Ordering Information

2261685-0001
FD1000 Single Drive Master Kit includes an FD1000 controller, one FD1000 drive mounted in a dual-drive chassis, double-sided, double-density diskette, interconnecting cable, and an installation and operation manual.

2261685-0003
FD1000 Dual Drive Master Kit includes all the items in the single drive master kit plus a second drive mounted in the chassis and a second diskette.

2261685-0004
FD1000 Single Drive Secondary Kit includes the required daisy-chain cable plus one FD1000 drive mounted in a dual-drive chassis, a double-sided, double-density diskette, and an installation and operation manual.

2261685-0005
FD1000 Dual Drive Secondary Kit includes all the items in the single drive secondary kit plus a second drive mounted in the chassis and a second blank diskette.

Note: All FD1000 kits include slide kits required for rackmounting of chassis.

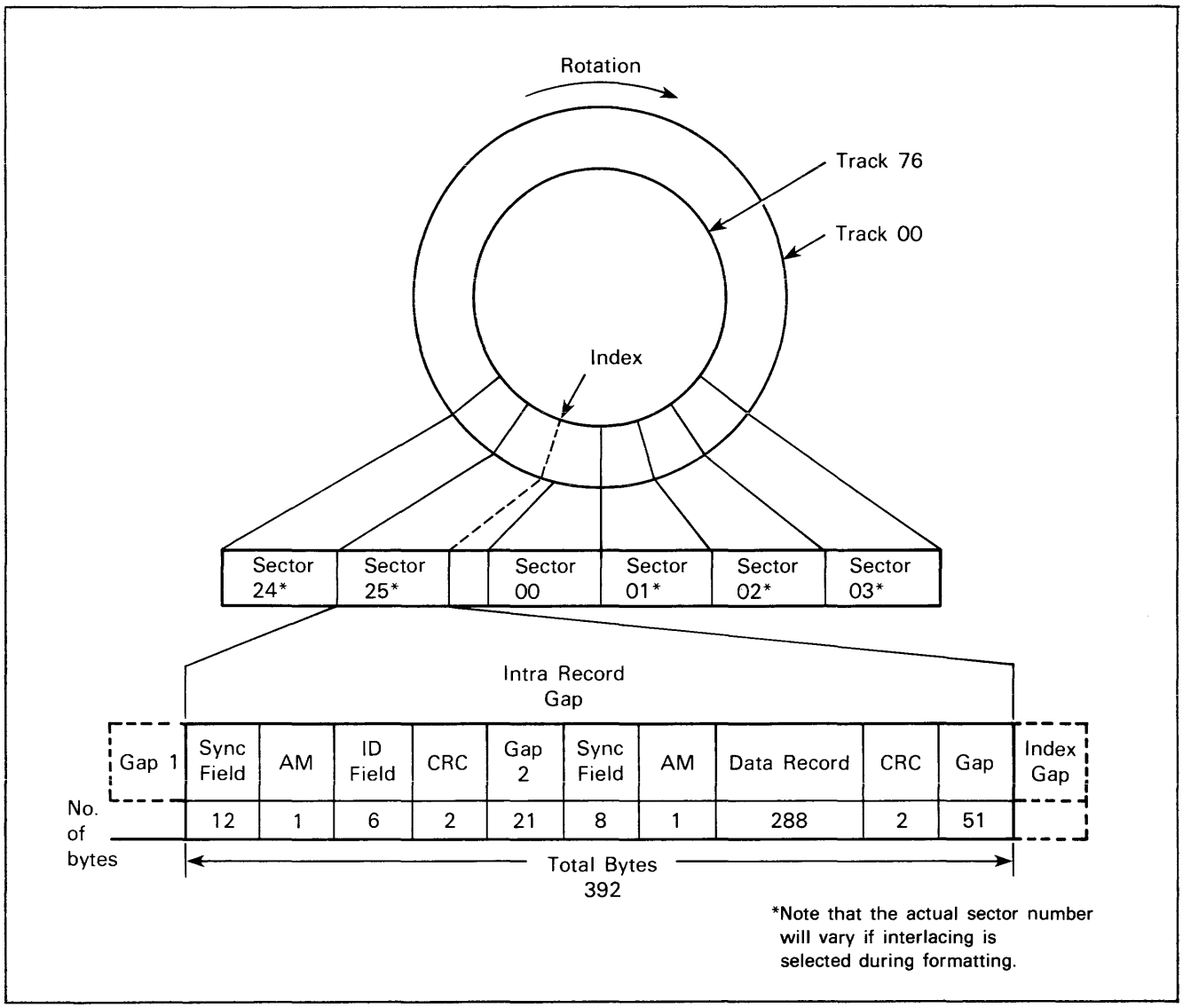


Figure 3. Track Format For Double-Sided, Double-Density Diskette

Flexible Disk Specifications

Performance Specifications

Capacity	Single-Sided Single-Density	Double-Sided Double-Density
Unformatted		
Per Diskette	3.2 megabits = 400,000 bytes	12.8 megabits/8 = 1,600,000 bytes
Per Track	41.7 kilobits = 5,212.5 bytes	83.3 kilobits = 10,412.5 bytes
IBM Format		
Per Diskette	256,256 bytes	n/a
Per Track	3328 bytes	n/a
TI Format		
Per Diskette	n/a	1,153,152 bytes
Per Track	n/a	7,488 bytes
Transfer Rate	250 kilobits/sec	500 kilobits/s
Rotational Latency (average)	83 ms	83 ms
Seek Time		
Track to Track	3 ms	3 ms
Average	91 ms	91 ms
Settling Time	15 ms	15 ms
Head Load Time	35 ms	35 ms

Functional Specifications

Capacity	Single-Sided Single-Density	Double-Sided Double-Density
Rotational Speed	360 rpm	360 rpm
Recording Density (inside track)	3408 bpi	6816 bpi
Flux Density	6816 fci	6816 fci
Track Density	48 tpi	48 tpi
Tracks	77	77
Sectors per Track (soft)	26	26
Index	1	1
Encoding Method	FM	MFM

Electrical and Physical Specifications

Chassis AC Power Requirements

50/60 Hz ± 0.5 Hz	
100/115 Vac Installations	= 90 to 110 V @ 1.2 A typical 104 to 127 V @ 1.2 A typical
220/240 Vac Installations	= 207 to 253 V @ .6 A typical

Electrical and Physical Specifications (Continued)

Environmental Specifications

Temperature

Operating:	5° to 46.1°C (41° to 115°F) with a maximum gradient of 11°C (19.8°F) per hour
Storage:	-34° to 65°C (-93° to 149°F)

Humidity

Operating:	20% to 80% relative humidity with a wet bulb temperature limit of 25.6°C (78°F), noncondensing.
Storage:	5% to 80% relative humidity, noncondensing.

Heat Dissipation of Drive Unit

195 BTU/hr typical (5% watts)

Error Rates:*

Soft Read Errors:	1 per 10^9 bits read
Hard Read Errors:	1 per 10^{12} bits read
Seek Errors:	1 per 10^6 seeks

*NOTE: Read error rates are based on "local" daisy chain diskette configurations in a computer center environment. System margin, and hence, read-error rates may be degraded by environmental factors which introduce more "noise" into the hardware (e.g., where remote cables are exposed to detrimental environmental conditions, etc.).

Medial Life:

Passes per Track	3.5×10^6
Insertions:	30,000+

Power Requirements

Controller Power

The FD1000 controller requires:

5.0 ± 0.1 Vdc @ 4.4 A

12.0 ± 0.1 Vdc @ .1 A

-5.0 ± 0.05 Vdc @ 0.01 A

Power Sequencing

During power up or down sequencing of the controller's power, the drive's power, or both, data previously recorded on the diskette will not be destroyed. Any operation in progress during a power sequence will not be completed.

Electrical and Physical Specifications (Continued)

Environmental

Controller Temperature

Operating: 0° to 50°C (32° to 122°F) @ sea level (excluding diskette drive)
Storage: -40° to +100°C (-40° to 212°F)

Controller Humidity

Operating: 5% to 85% relative humidity without condensation
Storage: 5% to 95% without condensation

Physical Characteristics

Controller Board Size: 364 mm W × 267 mm H (14.25 in. × 10.5 in.)
Component Height: 13 mm (1/2 in.) above board
Cable Length: 3 m (10 ft.) max.
Chassis Panel: 178 mm H × 483 mm W × 635 mm D (7 in. × 19 in. × 25 in.)
Weight
- Dual Drive Configuration: 20.4 kg (45 lbs.)
- Chassis Without Drives: 8.6 kg (19 lbs.)
- Disk Drive: 59 kg (13 lbs.)

Related Publications

The following publications contain additional information related to the FD1000 flexible disk system:

- *Model 990 TMS 9900 Microprocessor Assembly Language Programmer's Guide,* 943441-9701
- *Model 990/10 Computer System Hardware Reference Manual,* 945417-9701

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DIGITAL SYSTEMS DIVISION
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