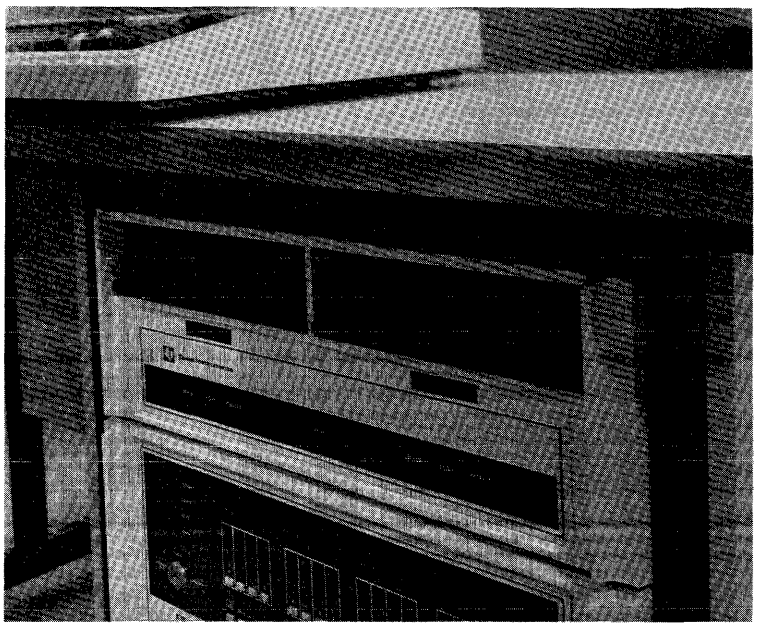
Model FD800
Floppy-Disk System



TEXAS INSTRUMENTS.

Model FD800 Floppy-Disk System

The Texas Instruments Model FD800 Floppy-Disk System provides the TI 990 computer user with an economical, random-access, mass-storage peripheral with exceptional utility and reliability. The FD800 uses a standard format, 2-megabit, single-sided diskette with a burst transfer rate of 250 kilobits per second, adjacent track step time of 8 milliseconds, head settling time of 8 milliseconds, and head load time of 35 milliseconds. In most applications, the transfer rate will average 25 kilobits per second.

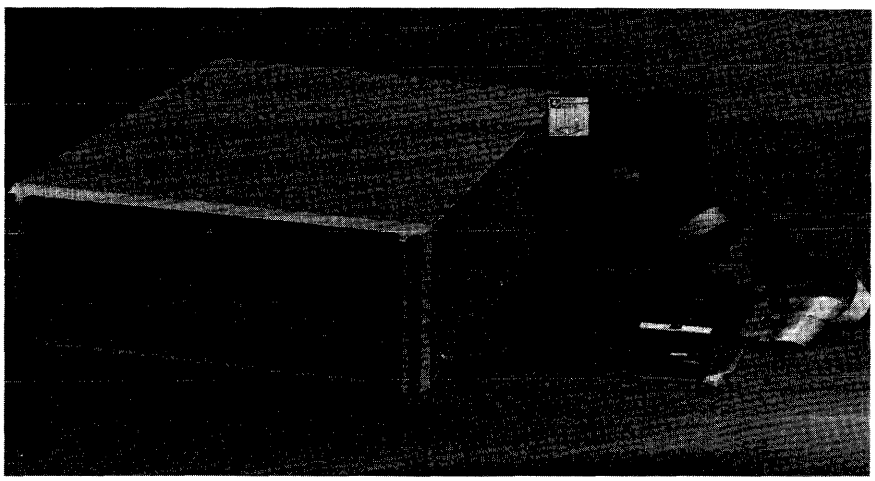


Figure 1. Dual Floppy-Disk System

The FD800 floppy disk is available in a single or dual configuration that mounts in a 177.8-mm (7-inch panel), EIA standard 482.6-mm (19-inch) rack. The floppy disk interfaces with the 990 computer by means of a communications register unit (CRU) base controller that mounts into the computer chassis and can handle up to four disk-drive units (two 177.8-mm panels). A dual floppy-disk system with controller and cabling is shown in figure 1.

SYSTEM CONFIGURATION

The FD800 system configuration with the 990 computer is shown in figure 2. The 990 computer provides a serial data interface to the floppy disk by means of a floppy-disk controller through the CRU. Two cables are provided for control/data and status functions to the floppy-disk drive units. Disk drives are installed in a rack-mountable chassis that contains the power supply and status panels for one or two floppy drive units. A single disk drive can be installed in the master chassis with removable blank panel for adding a second disk drive. An expansion chassis may be added to increase the capacity to four disk drive units.

SYSTEM FEATURES

Features of the FD800 include:

- Operating capability for up to four disk drives
- Internal on-board disgnostics with other programmed maintenance aids
- Positive write protect (ANSI standard)
- Power-failure detection to prevent data alteration
- Cyclic redundancy error checking of sectors
- Firmware-programmed retries for automatic error recovery
- Automatic head unloading when not accessed to minimize wear
- IBM-compatible formatting
- Mechanical door interlock that insures diskette registration
- Long-life ceramic read/write heads
- Simple diskette loading with spindle power on
- Convenient flat file storage.

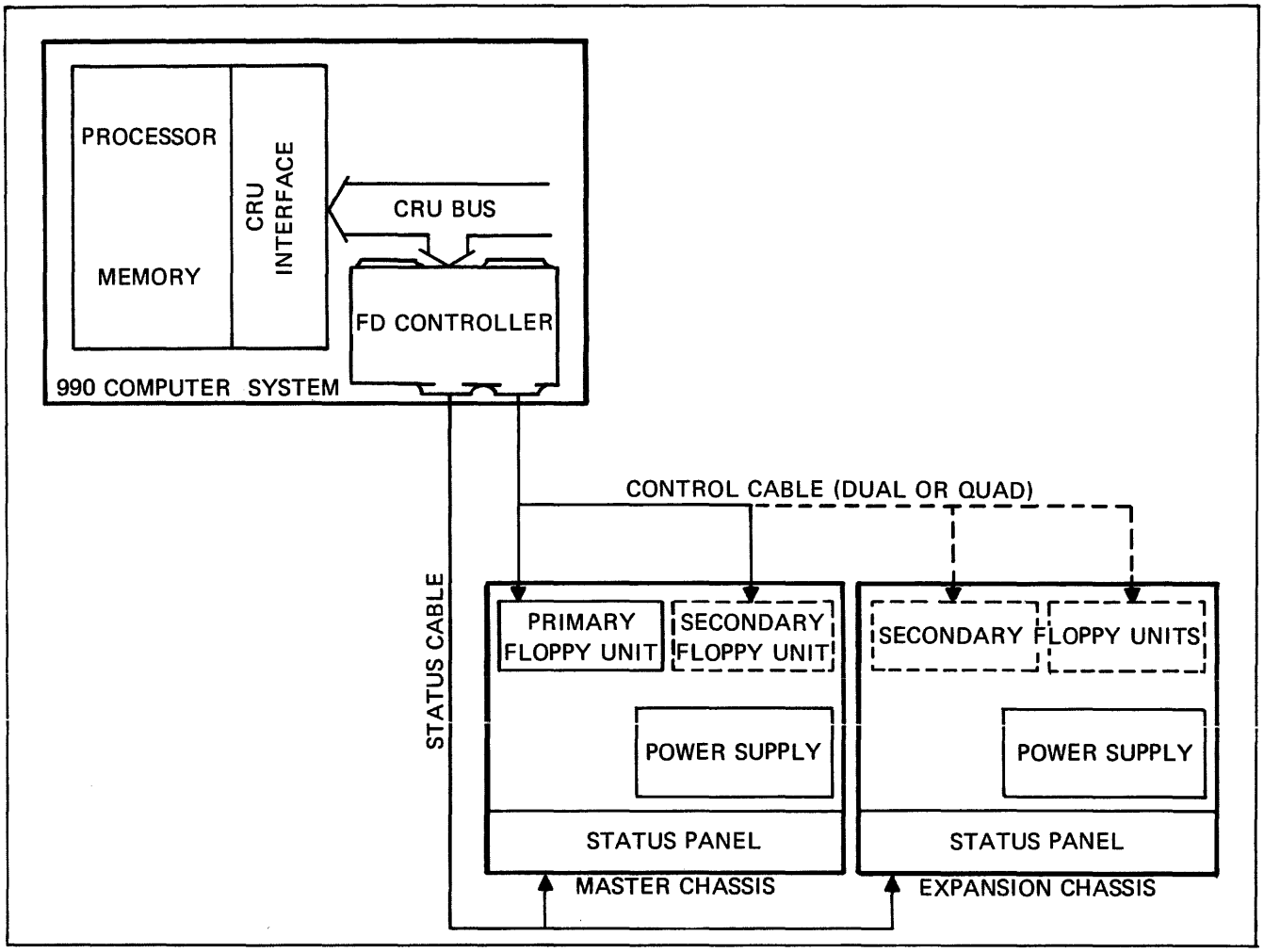


Figure 2. Floppy-Disk System Configuration

FLOPPY-DISK CONTROLLER

The floppy-disk controller handles all control, select and status communications, and data transmissions between the computer and the floppy drive units. The controller is a single, full-width printed circuit card that installs in a CRU chassis slot of the 990 computer. Data transfer to and from the disk is dual sector buffered (256 bytes) in the controller. A simplified block diagram of the controller is shown in figure 3.

CONTROLLER COMMAND AND STATUS WORDS. The floppy-disk controller responds to 23 commands from the computer and replies with one or more status bits, as defined in table 1. It interfaces with the computer software using a two-word format: a data word and a command or status word (as shown in figures 4 and 5).

The controller commands shown in table 1 are coded in the four-bit field. The commands are addressed to the selected floppy unit for the parameter identified by the 8-bit parameter field. A flag (bit 8) is used for special operations. Briefly, the command functions are described as follows:

- SELECT chooses the specified unit and replies with OP COMPLETE and interrupt. DRIVE NOT READY and/or WRITE PROTECT STATUS are returned if detected.
- SEEK positions the head to the specified logical track.
- RESTORE returns the head to physical track 00.
- SET SECTOR LENGTH specifies the number of data words transferred during read/write from each buffer.
- READ begins reading at the sector specified, buffers the data to the host, checks for errors and performs retries for detected errors. The data buffering can be simultaneous with the host data transfer. The N suppress sequential sector command may be used to stop the overlapped transfer that increases the host/controller transfer rate.
- READ ID gives the host access to the next ID under the specified head/drive unit.
- READ UNFORMATTED positions the head to the specified physical track and reads from the specified sector, ignoring all IDs, to recover data from tracks having ID or CRC errors.
- WRITE buffers data from the host, locates the specified sector, and writes the data on the disc, while accepting data for the next sector

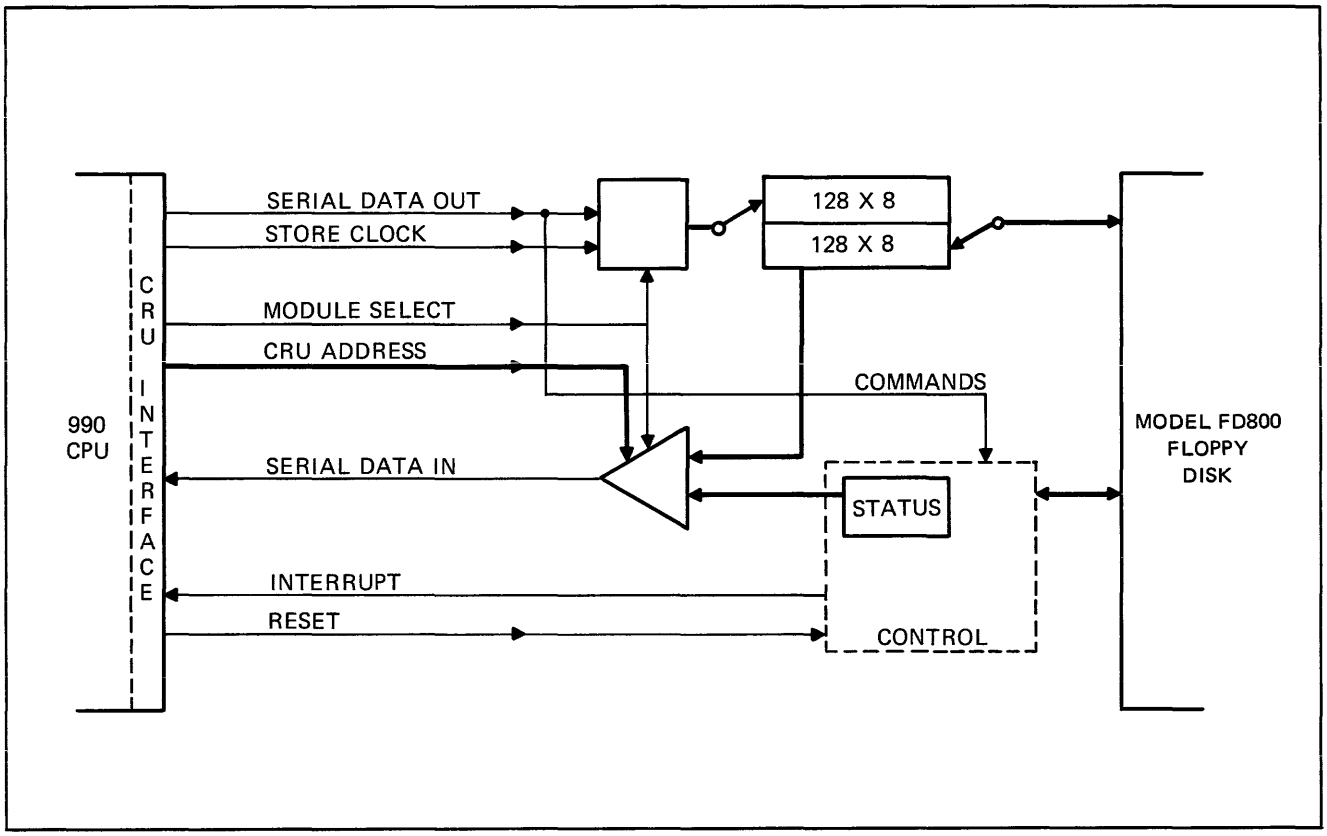


Figure 3. Floppy-Disk Controller, Simplified Diagram

Table 1. FD-800 Command Word Format

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

Command Table Key:

0	Logic zero
1	Logic one
U	Unit number (0-3)
H	Head number (1 = Upper)
T	Track number (00-4C)
L	Sector word count (00-40)
N	No sequential sectoring (1 = Active)
S	Sector number (01-1A)
V	Verify only (1-Verify, 0-Format, and Verify)
I	Track ID (Track #, FF-Bad track)
B	Bad mask for interrupt (0 = Unmask or enable interrupt)
E	Enable LEDS
W	LED #4 Enable
X	LED #3 Enable
Y	LED #2 Enable
M	Controller memory address left byte (MM00)
R	RAM Address of set (1800+RR)

from the host. When WRITE is terminated with a STOP or other command, the host completes the current host transfer, and the last buffer sector is written on the disk.

- WRITE DELETED RECORD writes the delete code (F8) over the address mark (FB) for the indicated sector.
- FORMAT TRACK writes the ID specified in the parameter field to format the track where the head is positioned, and then verifies the ID. If the V bit is set, the command ignores the format write and simply verifies the track format.
- LOAD INTERRUPT MASK will load the interrupt mask FF with a specified value. A zero will enable the controller interrupt for subsequent status completions.
- STOP terminates all commands except FORMAT TRACK.
- STEP HEAD is primarily used during diskette initialization to position the specified drive/head to the specified physical track.
- RESET terminates all pending operations, reinitializes controller parameters, performs the diagnostic test, and replies with the test status code in a four-bit test parameter field.
- INITIAL PROGRAM LOAD is equivalent to a SEEK to the track specified and a READ FORMATTED at sector 1 of that track.
- CLEAR STATUS PORT clears interrupt and status of the last operation.

The following commands under code D are implemented primarily for diagnostic and maintenance software:

- RETRY INHIBIT causes the retry capabilities of the controller to be inhibited so that marginal data transfer operations can be detected. Retries are reenabled by the RESET command.
- LED TEST allows the CPU to selectively turn on the controller LED error indicators to test their operation. The status returned from this command includes the error code bits as selected by the command.
- INVALID COMMAND returns status indicating that a program error has occurred. No other controller action is involved.
- MEMORY READ allows the reading of the contents of the ROM and RAM on the controller's TMS 9900 memory bus. The starting address for the read is specified by the command parameter field, and the read function is done in the same manner as the READ operation.
- RAM LOAD transfers data from the CPU to the specified locations in the RAM via the TMS 9900 memory bus.
- RAM RUN causes the microprocessor to branch its program execution to the RAM at the location specified in the command.
- POWER-UP SIMULATION causes the controller to simulate the power-up sequence (including controller reset and diagnostic test).

The status word is shown in figure 4. One or more of the bits may be set as required by the status.

ERROR RECOVERY. The floppy-disk 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.

DISKETTE FORMAT. The FD800 disk system records data on the diskette in an IBM-compatible record format for 128-byte data sectors. Sectors of longer length (256 or 512 bytes) are not supported by the controller firmware. Track allocation and use is a function of the operating software. The TI-supplied software does not allocate tracks per the IBM convention, but does format the tracks per the IBM format. IBM format conversions are provided in special conversion utilities, which are part of the operating software system.

Track formatting of the diskette is illustrated in figure 6. 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 FD800 software.

As illustrated by the figure, sector 1 is preceded by preambles and track address mark synchronized from the light-detected mark through the index hole. Each sector contains 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.

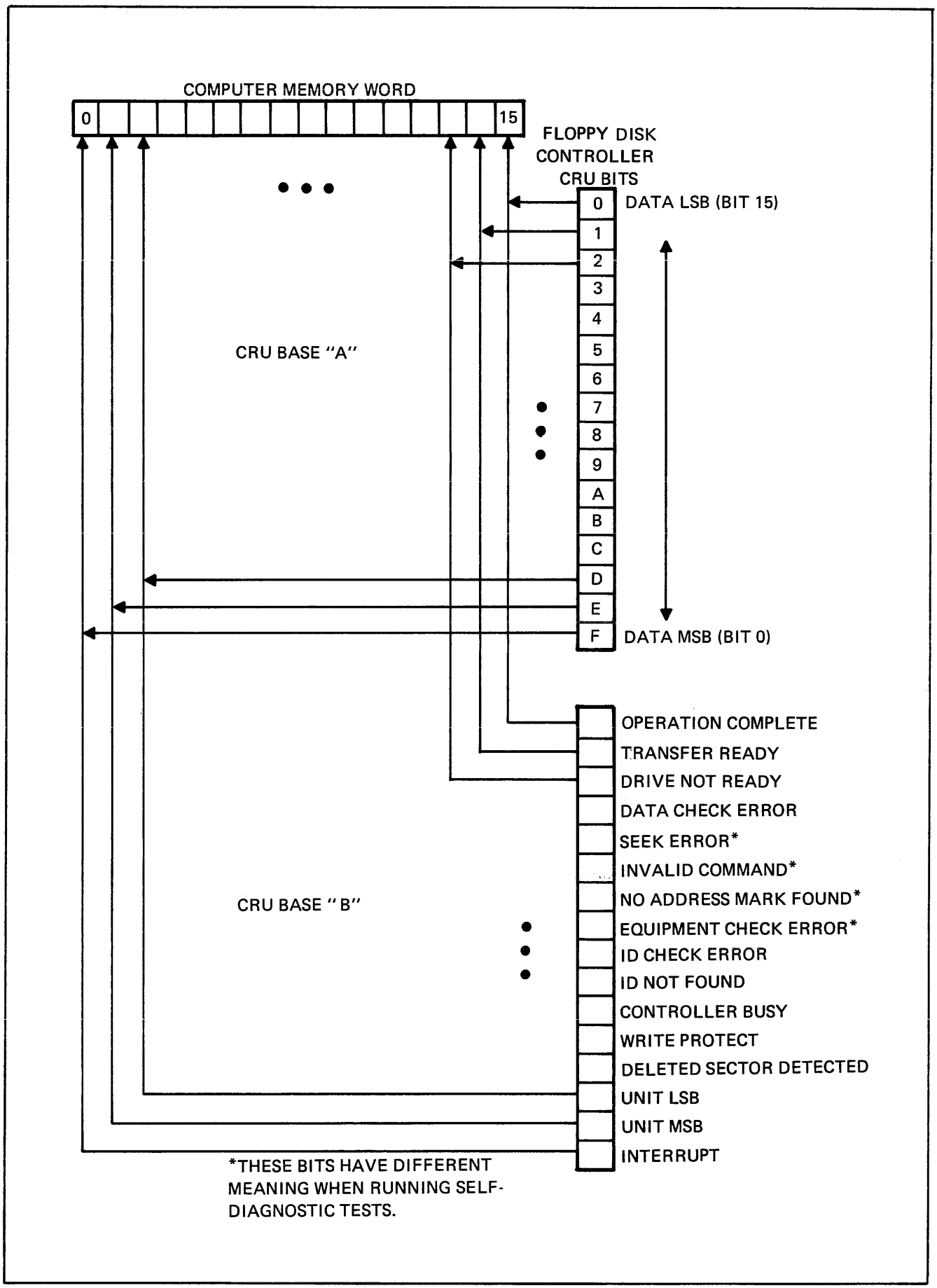


Figure 4. CRU Input Format (Controller to Computer)

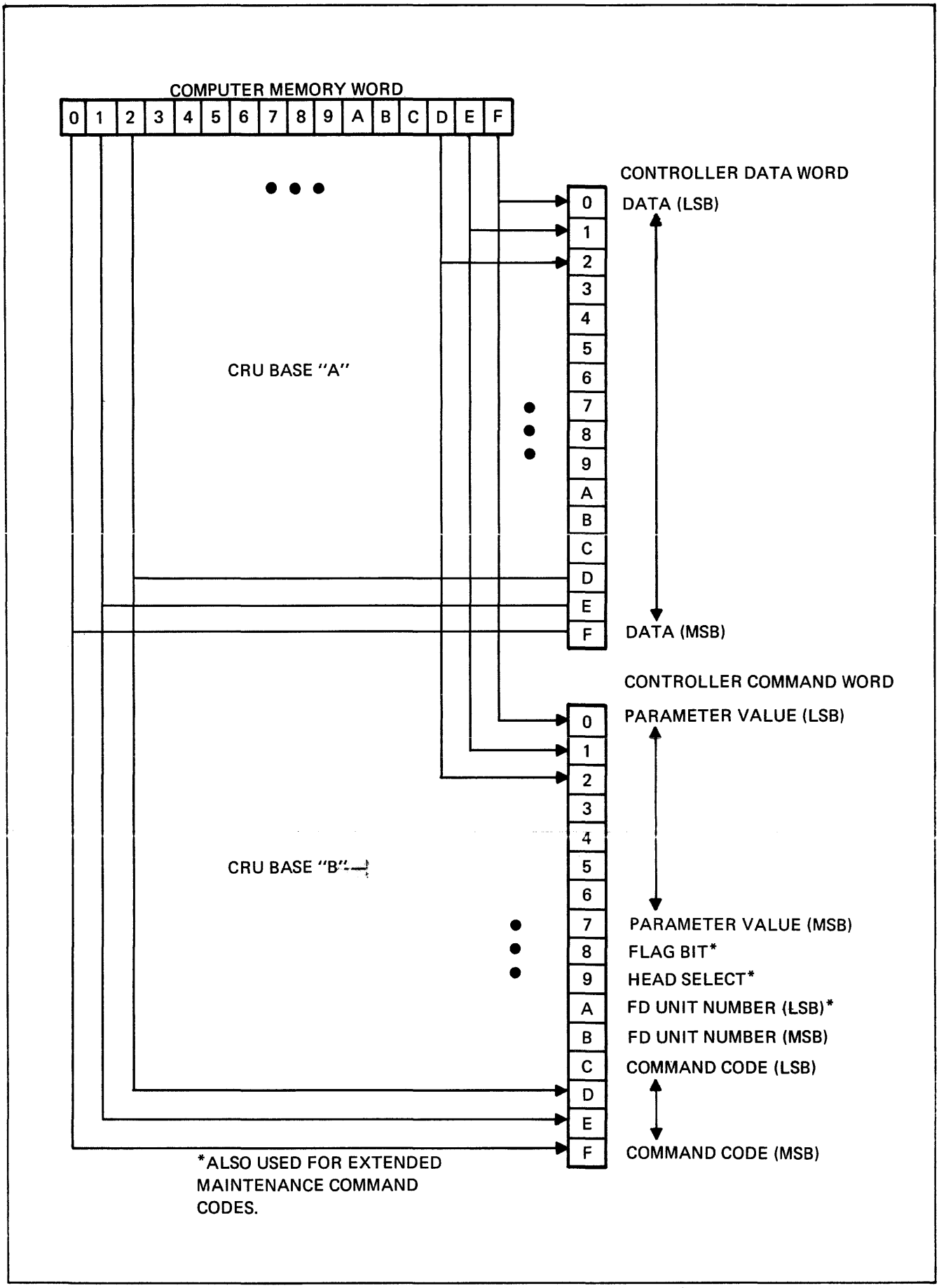
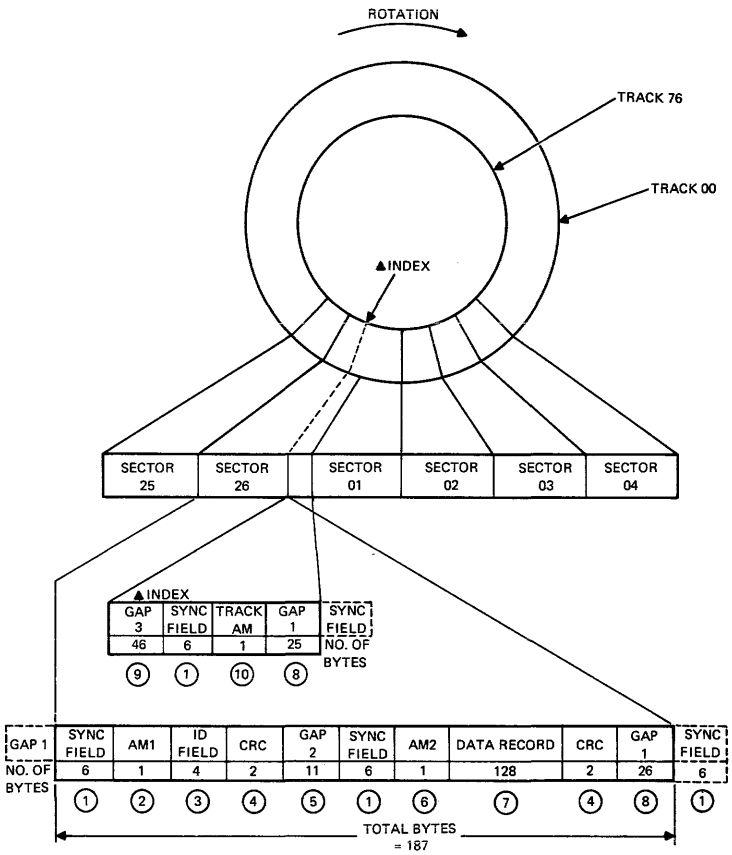


Figure 5. CRU Output Format (Computer to Controller)



1 SYNC FIELD - Each sync field contains six bytes of 0s. This field synchronizes the controller read circuitry to the information being read from the diskette.

2 AM1 (ADDRESS MARKER 1) - AM1 is always X'FE' (see note) and identifies the information that follows as the ID field.

3 ID FIELD - The ID field consists of four bytes of information identifying the address and size of the sector.

First Byte. Track Number
X'00' through X'4C' (00 through 76)

Second Byte. Head Number
Always X'00'

Third Byte. Record Number
128 byte per sector format.
X'01' through X'1A' (1 through 26)

Fourth Byte. Physical Record Length
X'00' = 128 bytes

4 CRC (CYCLIC REDUNDANCY CHECK) - The two CRC bytes associated with the ID field are generated during initialization. The two CRC bytes following the data record are generated during a write operation. The contents of the two bytes depends on the contents of the field following each sync field. Check bytes are constructed from the same fields during a read operation. The check bytes are compared with the CRC bytes; when equal, the record was read correctly.

5 GAP 2 - Gap 2 consists of 2 bytes of binary 0s and 9 bytes of binary 1s.

6 AM2 (ADDRESS MARKER 2) - AM2 is either X'FB' or X'F8'. X'FB' identifies the field that follows as a data record. X'F8' identifies the field that follows as a control record (FD800 recognizes 'F8' as a deleted sector mark).

7 DATA RECORD OR CONTROL RECORD - A data record contains 128 bytes available for data.

8 GAP 1 - Gap 1 consists of a variable number of binary 1s depending on the diskette speed and record length.

9 GAP 3 - Gap 3 is the index gap which consists of a variable number of binary 0s. Nominal 46 bytes. The index typically is followed by 36 bytes of FF's.

10 TRACK AM - Track AM is always X'FC', always follows the index mark, and identifies the start of a track.

NOTE: X denotes hexadecimal

Figure 6. Track Format

SOFTWARE SUPPORT

The floppy-disk system hardware operates under the TX990 Operating System which executes in either a 990/4 or 990/10 computer. TX990 is a modular-constructed executive program that controls loading of tasks in a real-time environment and performs such functions as • program loading • task scheduling • interrupt handling • I/O processing.

TX990 also provides a number of utility programs for utilizing diskettes and diskette files. The TX990 uses logical unit numbers (LUNOs) to represent physical I/O devices. This feature permits the user to code an I/O device file operation independent of a specific hardware configuration.

LOGICAL RECORD FILES. TX990 supports two types of logical record files – sequential record files and relative record files. Manipulation of these files is controlled by either file management supervisor calls or by device file operations available under the file management supervisor. The logical records in a sequential file are accessed in a sequential manner. That is, record 1 must be processed before record 2, etc. When a sequential file (or sequential file-oriented device) is closed following an access, TX990 saves the position of the last access to the file or device. When the file or device is opened again, the next I/O call accesses the next logical record in the file. Relative record files (diskettes only) may be accessed in random sequence. Each logical record is identified by a logical record number. Space is automatically allocated for a relative record file in contiguous blocks when possible. There is no maximum number of logical records that can be placed in a file, but the maximum number of noncontiguous blocks of logical records is 20 and all blocks must be on the same diskette.

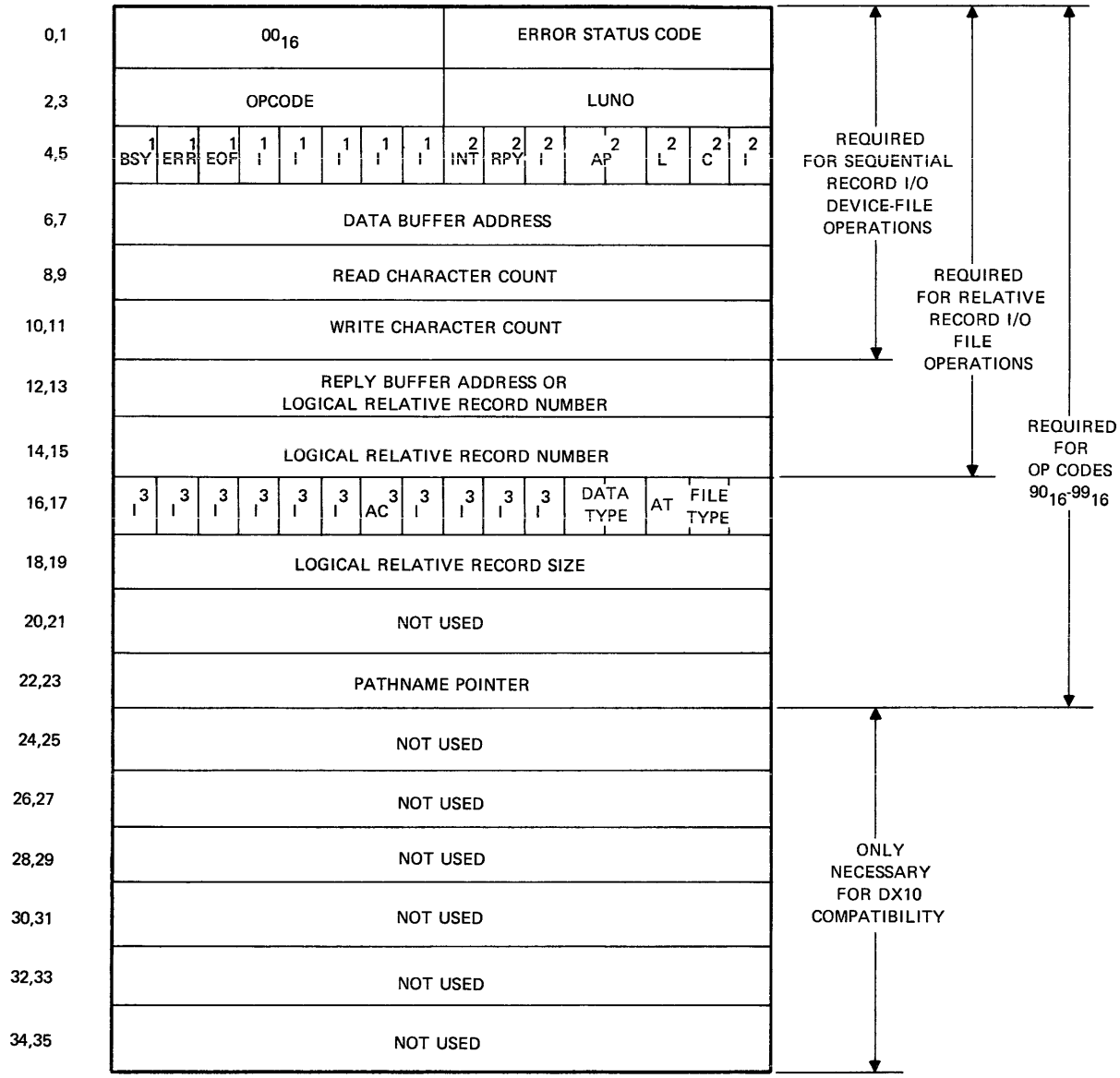
FILE MANAGEMENT SUPERVISOR CALL. The file management supervisor call supports 26 I/O device file operations including: open, close, close with EOF, open rewind, close unload, read device status, forward space, backward space, read ASCII, read direct, write ASCII, write direct, write EOF, rewind, unload, create file, assign LUNO to pathname, delete file, release LUNO assignment, compress file, assign new file name, unprotect file, write protect file, delete protect file, verify pathname, unlock.

The diskette files are capable of responding to all 26 operations. An operation is programmed by coding the appropriate blocks in File Management Supervisor Call Block as shown in figure 7.

RELATED PUBLICATIONS

The following publications contain additional information related to the FD800 floppy-disk system:

- *Model 990 TMS 9900 Microprocessor Assembly Language Programmers Guide*, 943441-9701
- *Model 990 Computer TX990 Operating System Programmer's Guide (Release 2)*, 946259-9701
- *Model 990 Computer Model FD800 Floppy Disk Controller Depot Manual*, 945418-9701
- *Model 990 Computer Model FD800 Floppy Disc System Installation and Operation*, 945253-9701
- *990 Computer Family Systems Handbook*, 945250-9701
- *Model 990/4 Computer System Hardware Reference Manual*, 945251-9701
- *Model 990/10 Computer System Hardware Reference Manual*, 945417-9701
- *Shugart Associates SA800/801 Diskette Storage Drive Maintenance Manual*, 945960-9701 through 945960-9704



NOTE 1: SYSTEM FLAGS
BSY = BUSY FLAG
ERR = ERROR FLAG
EOF = END-OF-FILE FLAG
I = IGNORED

NOTE 3: UTILITY FLAGS
AC = AUTO-CREATE FLAG
I = IGNORED
AT = ALLOCATION TYPE (CONTIGUOUS/ NONCONTIGUOUS)

NOTE 2: USER FLAGS
INT = INTIATE FLAG
RPY = REPLY FLAG
AP = ACCESS PRIVILEGE FLAG
L = LOCK AND UNLOCK FLAG
C = COMMUNICATION TIME-OUT FLAG
I = IGNORED

Figure 7. File Management Supervisor Call Block for File Management Supervisor Call 00_{16}

SPECIFICATIONS

MODEL FD800 DISK DRIVE CONTROLLER

Functional

Control Capability—Up to 4 disk drive units
Instruction Initiation—Via CRU instructions
Interface to CPU—32 bits (16 data bits, 16 command/status bits)

Environmental

Operating Temperature—0° to 52.2°C
Storage Temperature—minus 40° to 100°C
Operating Humidity—5% to 85% noncondensing
Storage Humidity—5% to 95% noncondensing
Maximum Altitude—2400 m (8000 ft.)

Power

Current (supplied by computer)—5.0 ±0.1 Vdc, 2.3A; 12.0 ±0.1 Vdc, 0.3 A; -12.0 ±0.1 Vdc, 0.01A

MODEL FD800 DISK DRIVE

Functional

Capacity—401,016 bytes unformatted; 256,256 bytes formatted
Transfer Rate—250K bits/sec.
Access Time-8 ms track to track; 8 ms head stabilization; 35 ms head load; 167 ms maximum rotational latency
Rotational Speed-360 rpm
Densities—48 tracks/in. (48 tracks/25.4 mm); 3200 bpi (3200 bits/25.4 mm) inside track; 5208 bits/track, 3328 formatted
Diskette—Flexible, IBM compatible; 1 recording surface; 77 tracks; 1 index mark; 128 bytes/sector; 26 sectors/track

Configuration

Dimensions—178-mm (7-in.) panel height; 483-mm (19-in.) width; 635-mm (25-in.) depth behind panel
Weight—20.4 kg (45 lbs.) dual configuration; 8.6 kg (19 lbs.) chassis w/power supply; 5.9 kg (13 lbs.) floppy-disk unit
Mounting—EIA standard 483-mm (19 in.) rack

Environmental

Temperature—10° to 37.8° C
Humidity—20% to 80%; 25.6°C maximum wet bulb
Altitude— 1800 m (6000 ft.)
Heat Dissipation—340 Btu/hr (100 W) per drive, including dc power provisions

Power

50/60 Hz ±0.5 Hz; 90 to 100 Vac, 1.2 A; 108 to 127 Vac, 1.2 A; 208 to 253 Vac, 0.6 A

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DIGITAL SYSTEMS DIVISION
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