FD 200 SERIES
FIXED DISK DRIVE

PRODUCT SPECIFICATION
1882 5307
REVISION A

BURROUGHS
OEM CORPORATION
DETROIT, MICHIGAN 48232

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FD 200 SERIES FIXED DISK DRIVE PRODUCT SPECIFICATION

1.0 SCOPE

This document describes the physical and functional characteristics and the specification of the Burroughs FD 200 Series Fixed Disk Drives, namely the FD 211 (1 Disk) and the FD 214 (4 Disks).

2.0 RELATED DOCUMENTS

The following documents are related to this specification. In the event of a conflict between this specification and the related documents, this specification shall have precedence.

Related Documents	Specification Number
Logic and Semantic Interface Specification	1883-7773
Implementation Interface Specification	1883-8722

3.0 PRODUCT DESCRIPTION

3.1 General

The FD 200 Series of Fixed Disk Drives is comprised of random access storage devices containing either one (FD 211) or four (FD 214) fixed 14-inch rigid disk(s) which provide(s) between 20 and 80 million bytes of formatted on-line data.

The drive contains an Advanced Microprocessor Controller (AMC) which performs many of the functions traditionally required of a host system controller. The AMC accepts host controller commands and translates them into basic control signals for the drive to execute. The presence of the AMC allows the host system to address data by logical sector rather than head, track and physical sector. Some of the functions performed by the AMC are:

- Logical to physical address translation.
- File Search using host supplied parameters.
- Sector relocation.
- Error detection, retry and correction.
- Error logging and analysis.
- Confidence/diagnostic tests.

The drive is intended for use as a data storage device for data processing, word processing, or data entry/collection systems.

3.2 Functional Components

The FD 200 Series Fixed Disk Drive consists of two basic functional parts, the storage module and the electronics cage. The storage module is a sealed unit containing the disk(s), the rotary actuator with read/write heads and a recirculation filter.

The disk(s) is/are mounted on a spindle which is belt driven from an A.C. motor. The electronics cage contains all the electronic assemblies with the exception of the preamplifier board.

3.2.1 Mechanical Assemblies

3.2.1.1 Module Structure

The base consists of a strengthened aluminum casting with mounting areas for location of the precision spindle and actuator subassembly. The design of the module is aimed at maintaining a high degree of air cleanliness in view of the low-flying head height. The spindle is sealed with a labyrinth type seal. Disk motion causes a macroscopic air flow which is channelled and recirculated through an absolute filter. The base is treated to prevent shedding of particles. The plastic cover provides a complete seal of the base.

Provision is made on the base structure for three mounting points. These are used to connect the module to a main frame by means of antivibration mounts.

3.2.1.2 Motor Drive

The spindle is rotated at 3000 rpm by an A.C. induction motor. The motor has a starter winding, controlled by a thermal relay, to increase start-up torque. An electromagnetic failsafe brake, energized from a bridge rectifier connected directly to the A.C. power, is attached to the motor shaft. By these means, the disks are brought up to speed and back to rest in a minimum time, typically ten seconds, thus reducing head/disk wear.

Belt tension is kept constant by use of a tensioner acting between motor and baseplate.

3.2.1.3 Positioner (Actuator)

The rotary actuator acts like a linear motor and is pivoted on preloaded angular contact bearings at its center of balance. Motion is provided by a voice coil which acts in the field of a permanent (ceramic) magnet assembly. At the end of the actuator are mounted the head assemblies, arranged to provide two heads per surface. The FD 211 has four heads and the FD 214 has sixteen. The actuator is accurately controlled at each of its 338 cylinder positions by means of a closed loop servo system based on signals produced from an optical encoder. Current to the heads, encoder and coil is routed on a flexible circuit designed for maximum strain relief and brought through a sealed aperture in the base. The optical transducer operates via a light guide system whose source is a lamp external to the sealed unit.

3.2.1.4 Heads

The FD 200 Series uses lightly loaded single-gap heads (two per surface) which start and stop in contact with the disks. The heads are parked on designated landing areas on the disks. In operation, the heads fly at heights 20 and 26 microinches, depending on radius.

3.2.1.5 Disks

The recording media are 14-inch diameter, oriented-oxide disks suitably lubricated to minimize head/disk wear. Disk pitch in the FD 214 is accurately established by the use of precision spacers.

3.2.2 Electronic Assemblies

The electronic circuitry is subdivided into three major groups:

a. Data channel electronics

b. Positioner electronics

c. Device controller

Groups a and b are primarily analog circuitry and group c is digital. Apart from the preamplifier board located in the sealed module, the electronics reside on eight printed circuit boards mounted in the card cage (see Figure 1). These boards are designated Data Channel, Servo, Interface 1, Interface 2, Advanced Microprocessor Controller, Data Channel Controller, Direct Memory Access, and Search.

3.2.2.1 Data Channel Electronics

The data channel electronics consist of circuits to provide head selection, MFM encode/decode, read/write, data separation, and clocking. In addition, a circuit is present to read the servo tri-bits to provide positioner calibration information to the device controller.

3.2.2.2 Positioner Electronics

The positioner electronics consist primarily of a closed-loop servo system operating in both velocity and position modes under the supervision of the Advanced Microprocessor Controller.

3.2.2.3 Device Controller

The device controller accepts and executes commands from the host system and provides data and status to the host system. The device controller consists of three functional blocks:

a. Advanced Microprocessor Controller (AMC)

b. Host interface circuitry

c. Data channel control and buffers.

The device controller is capable of executing the full set of functions (commands and status reports) described in paragraph 8.2 "Logic and Semantic Interface."

Overall control of the drive is via the Advanced Microprocessor Controller with its associated program store, scratchpad memory, and input/output latches. The AMC contains routines to control the basic functions of the positioner and the data channel and to execute the retry procedure, the relocation of faulty sectors, the correction of data errors using the error syndrome, and the maintenance test routines.

The host interface circuitry contains line drivers and receivers as well as the parity generation and check circuits.

The data channel control, in addition to its basic function, also contains two 256-byte buffers to accommodate asynchronous transfer of data to and from the host system.

4.0 OPERATIONAL FEATURES

4.1 Storage and Retrieval Features

The following features pertain to the basic storage and retrieval functions of the FD 200 Series Fixed Disk Drive. For a full description of the commands executable by the drive, refer to the Logic and Semantic Interface specification identified in paragraph 2.0.

4.1.1 Logical Addressing

The following definitions apply in the context of FD 200 Series addressing.

Sector - One of fifty-eight (58) physical subdivisions of a track capable of storing 256 bytes of data.

Block - One of 77,952 logical subdivisions of a FD 211 or one of 311,808 logical subdivisions of a FD 214, each capable of storing 256 bytes of data.

The host system, through the host controller, addresses data by block number. The AMC translates the block number to a surface, track and physical sector address. This translation takes into account any relocation of defective sectors.

4.1.2 Implicit Seek

The host system accesses the disk by issuing a READ or WRITE command to the AMC together with two parameters: block number and number of bytes to be transferred. After translating the block number to physical head, track and sector address and checking the sector relocation table (RAM) for possible relocation, the AMC positions the actuator over the selected track and begins reading sector addresses.

When the read/write head is eight sectors before the requested block, the drive informs the host controllers through the N-SECTORS-BEFORE-READ or N-SECTORS-BEFORE-WRITE status indication.

4.1.3 Search

The drive has the capability to search a file for data content that satisfies a condition relative to a tag argument. This capability is implemented via the SEARCH command (refer to paragraph 8.2).

In the SEARCH command, the host system supplies parameters defining the type and scope of the search and the tag argument to be used. Conditional tests available are:

- equal to
- not equal to
- less than
- less than or equal to
- greater than
- greater than or equal to

Upon acceptance of the SEARCH command, the drive will independently search the defined area of the disk for a tag that satisfies condition relative to the tag argument.

Upon completion of the search, the drive will communicate to the host, via the READ-SEARCH-RESULT command, the block number and offset within the block of the first tag that satisfied the condition, together with the contents of the block.

4.2 Data Integrity Features

The drive incorporates the following features to ensure the integrity of data transfers within the disk subsystem.

4.2.1 Interface Integrity

The operation of the interface between the host controller and the device controller consists of the transfer of sequences of codes from one controller to the other. The interface definition permits variable length sequence transfers in any of the four modes: COMMAND, STATUS, HOST-RECEIVE and HOST-SEND.

The integrity of the interface is monitored by two parity checks: longitudinal and vertical. The longitudinal parity check (LPC) is even and is applied to every sequence of codes transferred across the interface. The vertical parity is odd and is applied to each 9-bit code transferred on interface data buses. For a complete description of the interface protocol and error checking, refer to the Logic and Semantic Interface specification.

4.2.2 Disk Integrity

Error detection and correction in the FD 200 Series is an independent function of the device controller and is transparent to the host system except for a minor delay in transfer when correction is required.

Within each sector, error detection is treated separately for the address field and the data field. During the writing of the data field, Error Correction Code (ECC) is used by the device controller to compute a ECC and append it at the end of the field. When the sector is subsequently read, the device controller operates on the field and ECC to form a set of bits called a syndrome. An all zeros syndrome denotes an error-free read. Should the syndrome be nonzero, the retry procedure is started (refer to paragraph 4.3.2).

For errors in the data field, the retry procedure may invoke correction using the ECC.

The characteristics of the error correction algorithm are as follows:

Address Field Length:	4 bytes
Address ECC:	16 bits (Fire Code)
Data Field Length:	256 bytes
Data ECC:	32 bits (Fire Code)
*Detection:	Single error bursts of 32 bits or less
*Correction:	Single error bursts of 11 bits or less

* Applies to 32 bit ECC only.

4.3 System Integrity Features

In order to maximize the integrity of the system as a whole and to minimize the requirements placed on the host system, the following features are incorporated in the FD 200 Series Fixed Disk Drive.

4.3.1 Positioner Calibration

The accuracy of head positioning is affected by dimensional changes in the disk and drive due to temperature variations. To compensate for these changes, the FD 200 Series Fixed Disk Drive incorporates an automatic Postioner Calibration routine that uses servo tracks written on each disk.

During factory initialization, the servo tracks are written at the innermost and outermost track positions of each head on each surface.

4.3.1.1 Initial Calibration

When the drive is powered on, the AMC positions the head over each servo track in turn and measures the track offset from nominal. By interpolation from these offsets a correction is computed by the AMC for each track and used as a vernier position adjustment on subsequent data track seeks. An initial calibration takes less than two seconds.

4.3.1.2 Recalibration

After initial calibration the drive periodically recalibrates itself to match the thermal time constants. Recalibration frequency is initially once every 90 seconds, decreasing to once every 20 minutes after the first 20 minutes. Recalibration time is less than one second.

Recalibration is essentially transparent to the host system. It is manifested as a hesitation in the interface hand-shaking routine.

4.3.2 Retry on Read Error

Upon encountering a read error, the AMC initiates the following retry procedure:

3 Normal Retries
3 + Offset Retries
3 - Offset Retries
1 Recalibration
1 Normal Retry

A "normal retry" is a re-read of the sector in question without any positioner adjustment.

An "offset retry" is a re-read of the sector in question with a plus or minus vernier adjustment of the positioner.

If a successful read is achieved at any step, normal operation is resumed after noting the error for statistical purposes. Successful retries are transparent to the host system except for a delay in data transfer.

If the retry procedure is unsuccessful, the next step is dependent upon whether the error was in the data field or the address field.

4.3.2.1 Data Field Error

If the retry procedure is unsuccessful and the error is in the data field, the error correction algorithm is involved (refer to paragrah 4.2.2). The data is transferred to the host together with the status indication CORRECTED and the sector relocated with a corrected flag.

If the data is uncorrectable by the ECC, an irrecoverable error exists. In this case, ERROR status is reported to the host and the sector is relocated with an error flag.

4.3.2.2 Address Field Error

If the retry procedure is unsuccessful and the error is in the address field, AMC will attempt to salvage the data field by searching for the data identifier (DID) (refer to paragraph 8.4.2).

If this salvage operation is successful the data is transferred to the host and the sector is relocated.

If the salvage operation is unsuccessful, an irrecoverable error exists. In this case ERROR status is reported to the host and the sector is relocated with an error flag.

4.3.3 Sector Relocation

In addition to the 336 data cylinders there is a cylinder reserved for sector relocation. Two (2) tracks are used on the bottom disk. One contains both the table of relocated addresses and the relocated sectors. The other contains a copy of the table.

After power on, the relocation table is loaded into random access memory (RAM). During a READ or WRITE operation, the AMC checks the RAM to determine if the sector has been relocated before initiating the seek. The table is updated upon every relocation. Each entry in the table contains the address of the original sector, the address of its relocation and a status flag. The latter indicates whether the sector was relocated with (a) a data error, (b) data corrected, or (c) no error or correction.

The relocation table is available to the host system through the READ RELOCATION-MAP command.

The drive is capable of handling up to 50 relocated sectors. In the unlikely event of the relocation table being filled completely, the drive reports DISK-EXPIRING status to the host. After 58 relocations drive reports DANGER and NOT READY.

4.4 Head and Disk Protection

A number of features are incorporated in the drive to prevent spurious overwriting of data and to maintain a high degree of head and disk integrity.

4.4.1 Parking Zone

On power off, the actuator moves the read/write heads to a parking zone where the heads land. This zone has no data recorded on it.

4.4.2 Servo Protect

The servo tracks are written during factory initialization. During normal operation writing is inhibited when the heads are positioned in the servo track zone, a five track band straddling each servo track by means of a status signal derived from the optical transducer.

4.4.3 Power On/Off Write Protect

The write driver is protected by a circuit which prevents noise spikes at power-on from causing spurious write transitions. Similarly, at power-off, or when the D.C. voltage drops by more than 10 percent from nominal, the write driver is disenabled.

4.5 Maintenance Features

The following features have been incorporated in the FD 200 Series Fixed Disk Drive to aid in maintenance of the drive.

4.5.1 On-Board Confidence Test

A confidence test routine is stored in read-only memory (ROM) in the device controller. At power-on time, the AMC executes the confidence test which checks ROMs, RAMs and the AMC. Utilizing the maintenance track, the test checks each head on READ and one head on WRITE to verify the write driver.

Upon completion of the confidence test, the drive indicates results to the host system via the DEVICE-ATTRIBUTE-RECORD.

4.5.2 Interface Wraparound Test

The drive incorporates an interface wraparound feature which, when combined with suitable host system software, allows a field engineer to quickly isolate a fault to either the host/interface or the FD 200 Series Drive.

If the wraparound test fails, the fault is on the interface or in the host system.

If the test succeeds, the fault is in the FD 200 Series Drive.

4.5.3 Stand-Alone Diagnostic Tests

The drive has the capability to execute stand-alone diagnostic tests called Maintenance and Test Routines (MTR). These MTRs are capable of isolating a fault to a single printed circuit board in 95 percent of the faults.

5.0 FUNCTIONAL CHARACTERISTICS

5.1 Recording Characteristics

Data is recorded on both sides of the disks. The disks are soft sectored and pre-initialized to the format described in paragraph 8.4.

Bit Density:	5500 bits per inch
Track Density:	300 tracks per inch
Areal Density:	1.65×10^6 bits per inch^2
Recording Mode:	Modified Frequency Modulation (MFM)

5.2 Storage Capacity

The following data excludes two (2) cylinders. One is used for sector relocation (see paragraph 4.3.3) and the other for maintenance and statistics logging. These two cylinders are not available for data.

	FD 211	FD 214
Data Bytes per Sector:	256	256
Sectors per Track:	58	58
Data Bytes per Track:	14,848	14,848
Disks per Drive:	1	1
Tracks per Cylinder:	4	16
Data Bytes per Cylinder:	59,392	237,568
Cylinders per Drive:	336	336
Data Bytes per Drive:	19,955,712	79,822,848

5.3 Performance Characteristics

5.3.1 Positioner Performance

All times given include settling time.

	Seek Time
Track-to-Track:	8 ms
Full Data Track Seek:	65 ms
Average:	35 ms

5.3.2 Rotational Characteristics

Latency times, disk rotational rate, and data transfer rate are as follows:

Average Latency:	10 msec
Maximum Latency:	20 msec
Disk Rotational Rate:	3000 RPM
Data Transfer Rate: (to/from disk)	7.1 M bits per sec.

5.3.3 Time to Access a Data Sector

The total nominal time required to randomly access a data sector is as follows:

a. Minimum time:	0 msec
b. Average time:	45 msec
c. Maximum time:	85 msec
Maximum time when full retry/ correction routine is followed (paragraph 4.3.2) i.e., worst case access:	1.25 sec

6.0 PHYSICAL CHARACTERISTICS

Figure 1 shows outline details and overall dimensions of the FD 200 Series Fixed Disk Drive. The electronics cage may be positioned in front or behind the module.

The cage containing the AMC must receive a continuous air flow of 70 C.F.M. minimum with an air inlet temperature of 40° C maximum.

The following table lists dimensions of the storage module and card cage separately.

Module	Dimensions
Length	26.2 inches max (665.5 mm)
Height	10.00 inches max (254.0 mm)
Width	16.60 inches max (421.6 mm)
Weight	80 pounds (36 kg)
Cage	
Length	12.4 inches (315.0 mm)
Height	7.5 inches (190.5 mm)
Width	6.5 inches (165.1 mm)

7.0 MAINTENANCE SWITCHES AND INDICATORS

Maintenance aids are provided by a bank of eight switches enabling various drive and test conditions and eight light emitting diodes which display drive status, procedural guidance, and test results. The bank is located on the AMC board.

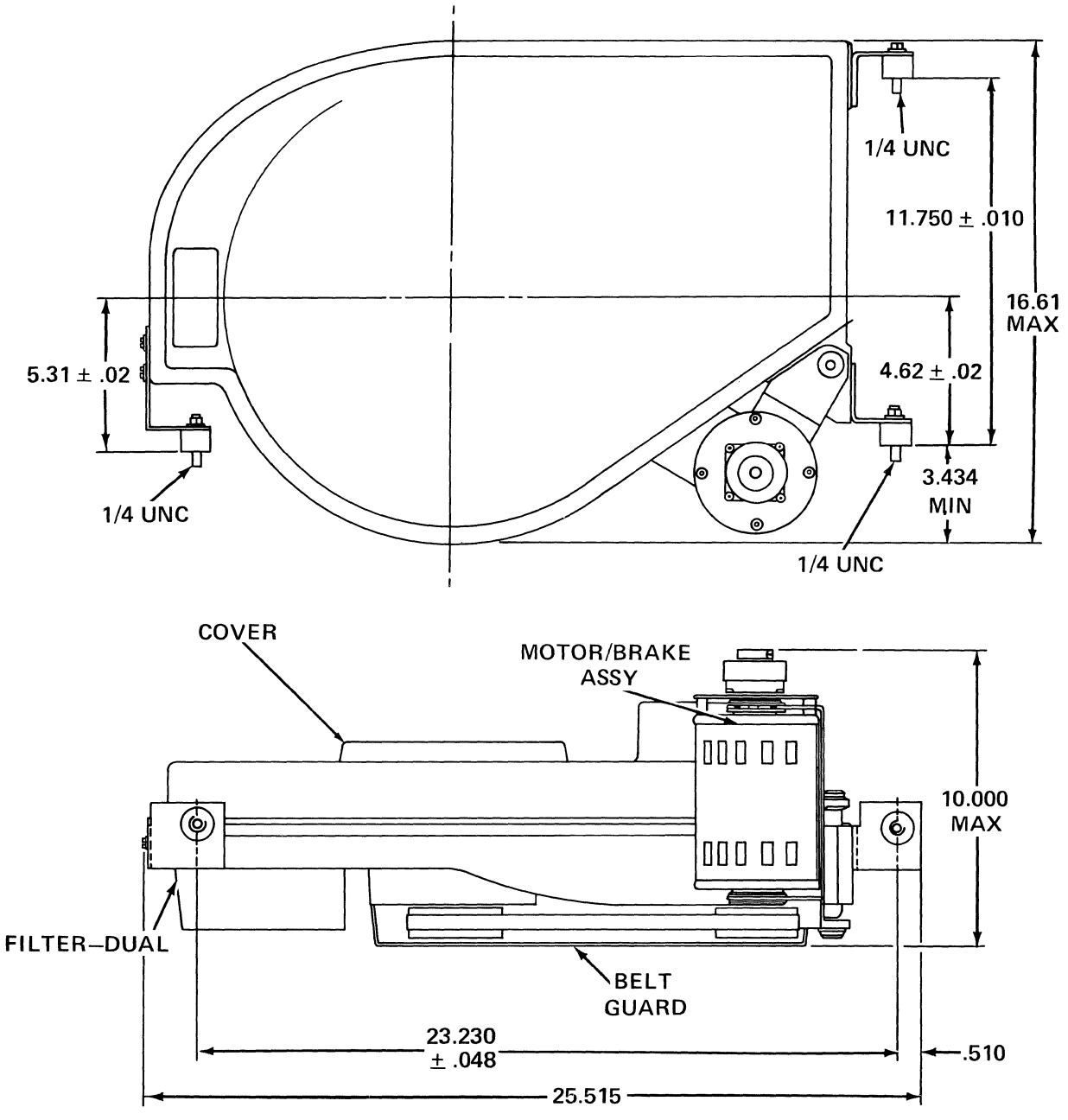


Figure 1. Fixed Disk Drive Inbuilt Layout and Dimensions

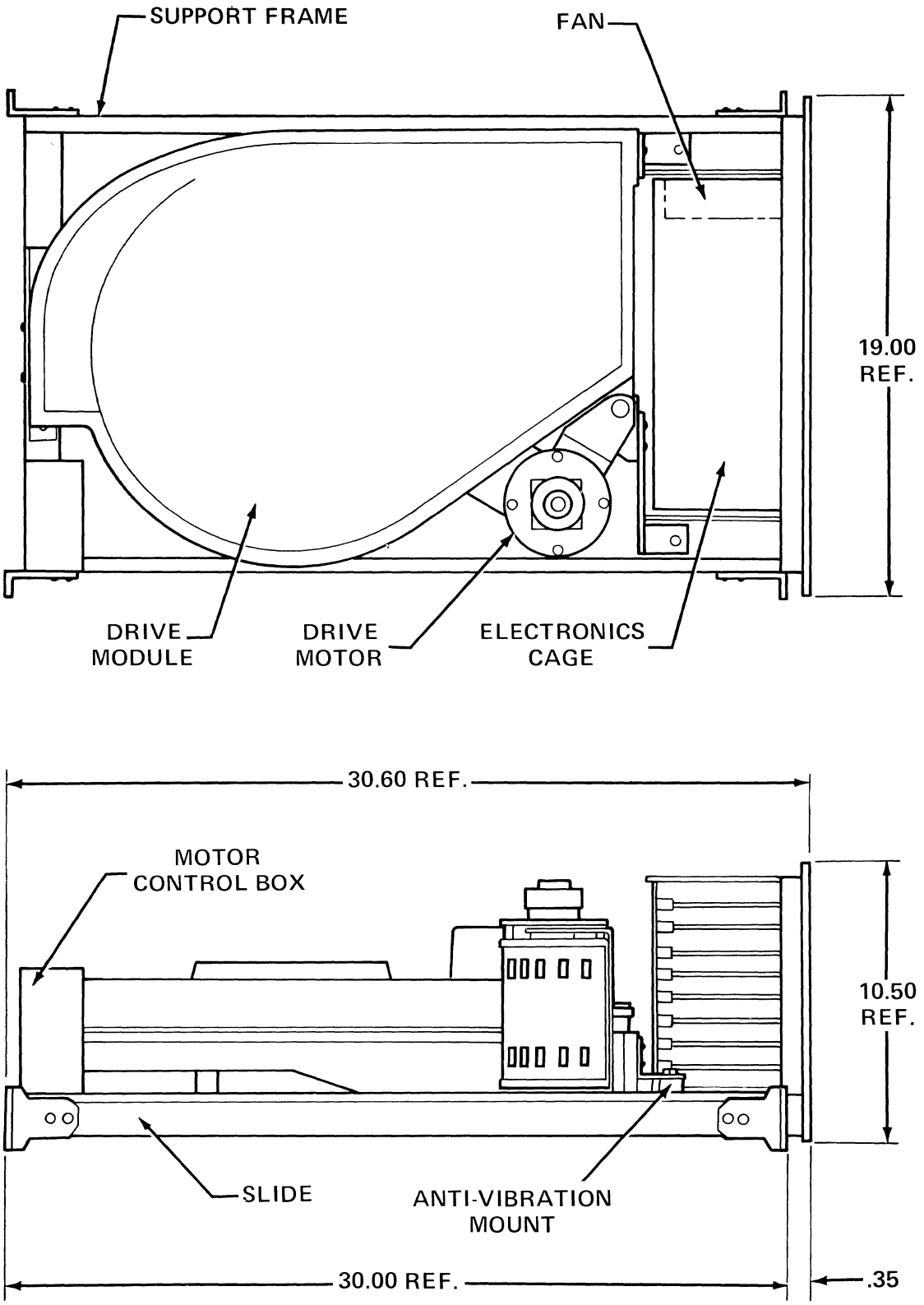


Figure 2. Fixed Disk Drive Rack Mount Option - FD 210-2

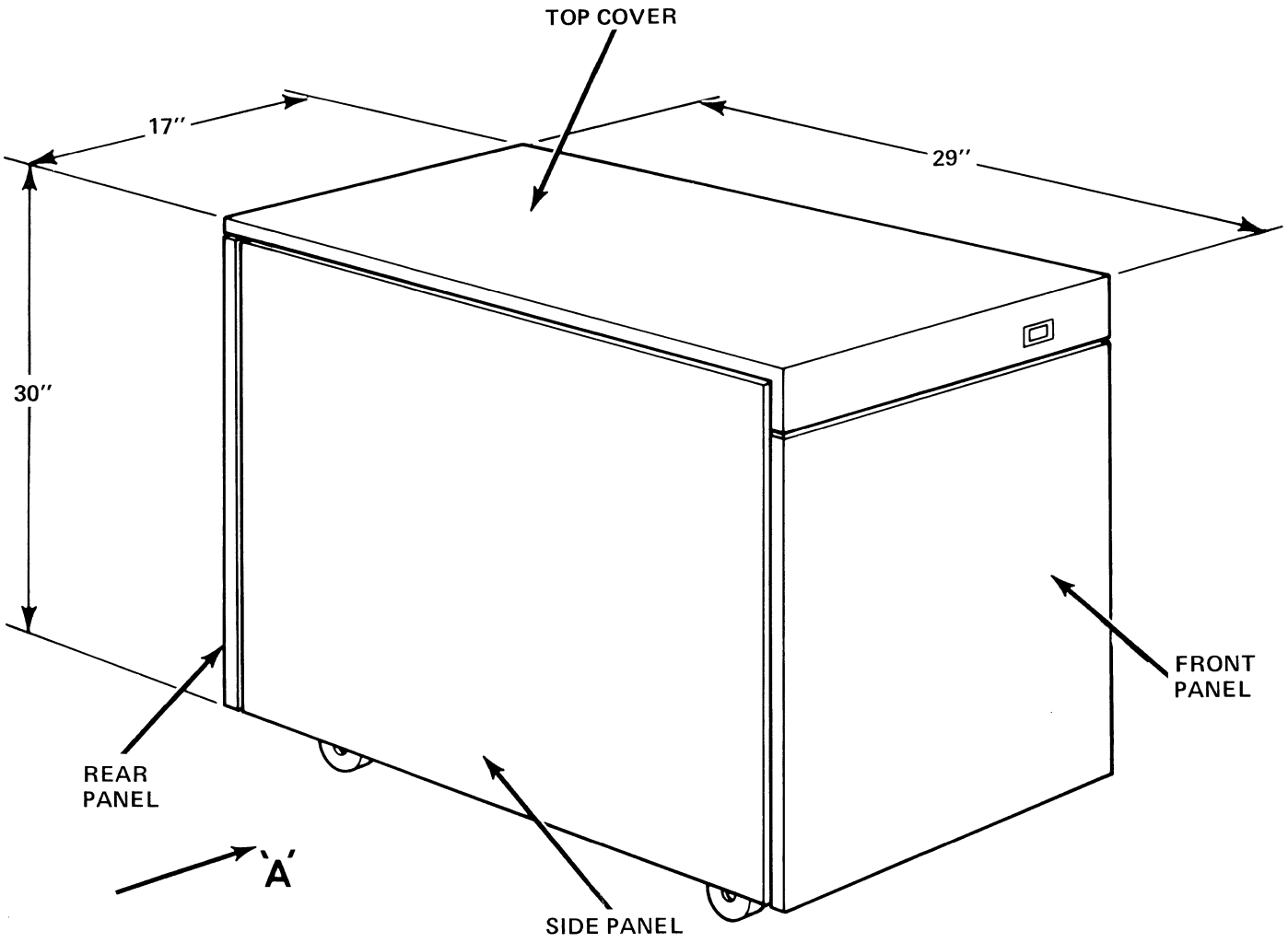
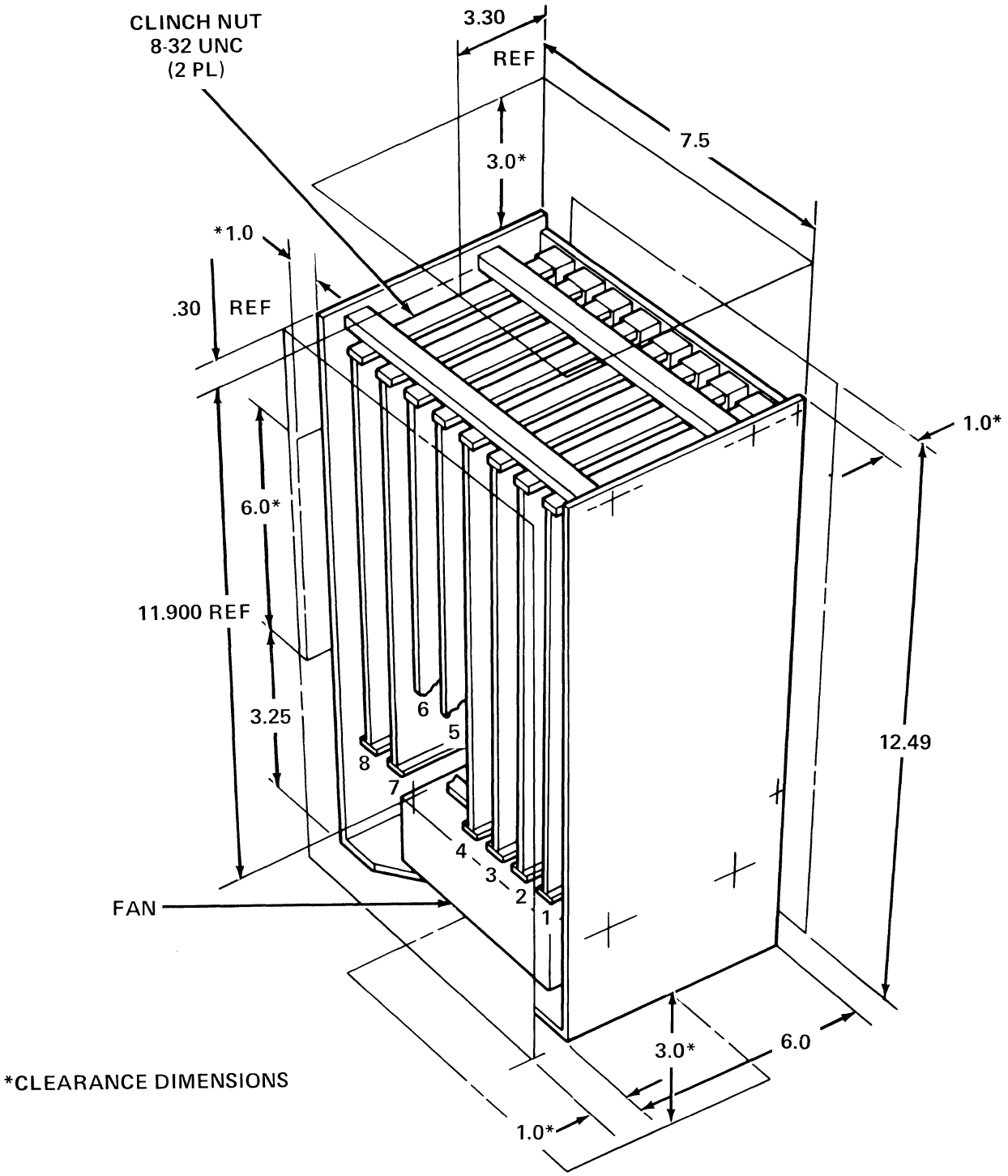


Figure 3. Fixed Disk Drive Stand Alone with Cabinet - FD 220



BOARD	DESCRIPTION
1	SERVO
2	DATA CHANNEL
3	DATA CHANNEL CONTROLLER
4	DMA
5	SEARCH
6	MICROCONTROLLER
7	I/O 2
8	I/O 1

Figure 4. Card Cage and P.C. Boards

8.0 INTERFACE

8.1 General

The FD 200 Series Fixed Disk Drive is compatible with the Burroughs OEM Products Standard Disk Interface as defined below.

8.2 Logic and Semantic Interface

8.2.1 Logic Interface

The logic interface is defined in the Logic and Semantic Interface Specification (refer to paragraph 2.0).

8.2.2 Semantic Interface

The semantic interface is a full implementation of command, status and system integrity functions listed below. For a complete description of these functions, refer to the Logic and Semantic Interface Specification (see paragraph 2.0).

8.2.2.1 Commands

The commands listed in Table 1 are fully implemented in the FD 200 Series Fixed Disk Drive.

8.2.2.2 Status Functions

Status information is reported by the drive controller to the host controller as required by the Logic and Semantic Interface Specification. The status functions implemented are shown in Table 2.

8.2.2.3 System Integrity Function

The following system integrity functions are implemented in the FD 200 Series Fixed Disk Drive.

a. Retry on read error.

b. Correction of read error.

c. Relocation of defective sectors.

d. Detection of disk end of life.

8.3 Electrical and Mechanical Interface

The electrical and mechanical interface is defined in the Implementation Interface Specification (refer to paragraph 2.0).

Table 1 - Command Summary

	Commands	Requires Seek	Requires Data Transfer
GROUP 1	Read	x	x
	Read Statistic	x	x
	Read Location Map	x	x
	Write	x	x
GROUP 2	Search	x	x
	Read Search Result		x
	Read Device Attribute Record		x
	Read Status		x
	Host Receive MTR		x
	Host Send MTR		x
GROUP 3	Abort Device Controller		
	Abort Drive		
	Reset		
	Set Write Protect		
	Reset Write Protect		
	Interlace		

Table 2 - Status Summary

	BYTE 1	BYTE 2	BYTE 3
BIT 0	Drive Address Bit 0, Least Significant	Error	Not Ready
BIT 1	Drive Address Bit 1	Search Unsuccessful	Disk Expiring
BIT 2	Drive Address Bit 2, Most Significant	Corrected	Write Protected
BIT 3	Transfer Delay	Command Not Accepted	New Disk
BIT 4	N Sectors Before Read	Command Error	Danger
BIT 5	N Sectors Before Write	Address Error/ End of Drive	Confidence Test Completed
BIT 6	Operation Complete	Mandatory Interrupt to Host	Temporarily Not Available
BIT 7	Interrupt	Address Not Found	Unassigned

8.4 Data Format

A data track is made up of 58 sectors, each of which is divided into a sector header and a data block.

8.4.1 Sector Header

The sector header defines the soft sectoring of the disk and consists of a synchronization (sync) byte, address field, ECC and several zero bytes of preamble and postamble. This format is as follows:

Function:	Preamble	Sync (SID)	Address	Address ECC	Postamble
Bytes:	6	1	4	2	1

8.4.1.1 Address Field

The address field defines the physical location of the sector on the disk. The format is as follows:

	Byte 1	Byte 2	Byte 3	Byte 4
FD 211	XXXXXTTT	TTTTTTHH	XXSSSSSS	XXXXXXXX
FD 214	XXXTTTTT	TTTTHHHH	XXSSSSSS	XXXXXXXX

T.. T is track address

H.. H is head address

S.. S is sector address

X.. X is 'don't care'

8.4.1.2 Sync Byte (SID)

The sync byte in the sector header is called the Sector Identifier (SID) and is a unique combination of flux reversals apart from the three (3) least significant bits which are encoded 011.

8.4.2 Data Block

The data block is defined as follows:

Function:	Preamble	Sync (SID)	Data	ECC	Postamble
Bytes:	6	1	256	4	1

8.4.2.1 Sync Byte (DID)

The sync byte in the data block is called the Data Identifier (DID) and is a unique combination of flex reversals apart from the three (3) least significant bits which are encoded 00.

9.0 RELIABILITY AND SERVICE GOALS

9.1 Reliability

9.1.1 Mean Time Between Failure (MTBF)

The drive will be capable of 12,000 start/stop operations during service life.

The MTBF of the module (sealed unit) is dependent on the number of start/stops per unit time and is estimated by the following formula. Let N be the average number of start/stops per day.

	FD 211	FD 214
Module MTBF (Thousand hours AOT)	$\frac{75}{N+3}$	$\frac{45}{N+3}$

For example, 2 start/stops per day gives a module MTBF for the FD 211 of 15,000 hours.

The MTBF of all other components is 4,300 hours, AOT.

9.1.2 Error Rate

The maximum irrecoverable rate is 1 error in 10^{12} bits transferred.

Recoverable errors and seek errors are handled completely within the drive by the AMC and are noticeable to the host system only as a minimal decrease in throughput.

9.2 Service Goals

9.2.1 Preventive Maintenance

No preventive maintenance is required.

9.2.2 Mean Time to Repair (MTTR)

The MTTR is a function of maintenance philosophy. With a P.C. board replacement strategy, the MTTR should be less than 0.75 hour. With a component replacement strategy the MTTR should be less than 1.5 hours.

9.2.3 Service Life

Service life for the unit before factory rework of replacement is required is 7 years or 35,000 hours of actual operation time, whichever occurs first.

10.0 INSTALLATION

10.1 Power Requirements

10.1.1 A.C. Power

Line voltage:	115V, +6%, -13%, single phase
Line frequency:	50 or 60 Hz, +1%, -2%; selection determined by one changeable pulley
Max. permissible frequency change rate:	1.5 Hz per second
Max. permissible total harmonic distortion:	10%

Power consumption:	Starting	Running
FD 211	1100W	295W
FD 214	1100W	310W

10.1.2 D.C. Power

Supply Voltage	Max. Load	Max. Permissible Ripple
+5V ± 5%	9 A	50 mV RMS
+12V ± 10%	4.5 A	50 mV RMS
-12V ± 10%	4.5 A	50 mv RMS

D.C. voltages must be retained for 10 sec after A.C. removed to permit the heads to be retracted to their parking zones before landing.

Max. permissible noise spike: 0.25V for 5V supply
1.2V for 12V supplies.

NOTE: The drive will RESET if the 5V supply exceeds the tolerance limits shown.

10.2 Grounding Requirements

Threaded insert provided on card cage.

10.3 Environmental Requirements

The environmental limits specified for the drive are classified as operating conditions and non-operating conditions.

10.3.1 Operating Conditions

Relevant environmental operating conditions include: temperature and humidity, shock and vibration, radio frequency radiation, atmospheric pollutants, and altitude and barometric pressure.

10.3.1.1 Temperature and Humidity

The drive will operate reliably in an atmosphere ranging from 13° C to 40° C to 85 percent relative humidity. Condensation on or in the drive is not permitted. The maximum allowable rate of temperature change is 1° C per 5 minutes.

10.3.1.2 Shock and Vibration

The drive will withstand 0.1 g's peak acceleration in three mutually perpendicular axes over the frequency range of 5 to 1 kHz.

10.3.1.3 Radio Frequency Radiation

The drive will operate reliably in an electric field not exceeding 10 volts/meter rms in the range of 1.5 Hz to 10GHz. If the host system environment exceeds this limit, it must provided appropriate shielding and filtering.

10.3.1.4 Atmospheric Pollutants

The drive will operate reliably in an atmosphere containing not more than 60 milligrams of dust in 1000 cubic feet of air by weight of particles ($\geq$ 5 micron diameter).

10.3.1.5 Altitude and Barometric Pressure

The drive will operate reliably at altitudes ranging from sea level to 3 km (10,000 feet) and at barometric pressure ranging from 20 to 32 inches of mercury.

10.3.1.6 Stray Magnetic Field

There shall be no source of constant magnetic field which yields more than 0.0001 Tesla measured in the location occupied by the magnetic heads when the drive is installed.

10.3.2 Non-Operating Conditions

Relevant environmental non-operating conditions include: long term temperature and humidity, and shock and vibration.

10.3.2.1 Long-Term Temperature and Humidity

The unit will show no deterioration when stored in an area with temperatures ranging between -40° C and +50° C and with a non-condensing relative humidity ranging between 5 and 90 percent.

10.3.2.2 Shock and Vibration

When the unit with the actuator and spindle secured is packed in the approved container, it may be subject to the following shock and vibration conditions, on each of 3 orthogonal axes, without receiving damage that will prevent installation or hinder operation.

a. Shock levels of 5 g's impulse for 5 to 50 milliseconds, of 1/2 sine wave shape.

b. Vibration of 1.5 g's acceleration in a frequency range from 5 Hz to 500 Hz.

10.4 Drive Mounting

The FD 200 Series Fixed Disk Drive may be supplied either as an individual module and card cage, or, optionally, 19-inch rack mountable with slides. In either case, the host system must supply both A.C. and D.C. power and in addition must provide such switches and interlocks as may be required for safety or servicing. An optional D.C. power supply is available. When the individual module is supplied, the host system must ensure that adequate mounting points are provided for the antivibration mounts and for the electronics cage. Furthermore, it must ensure an airflow for the electronics cage as defined in paragraph 6.0

10.5 Connector

Connection to the host system input-output subsystem is made via a 60-way stripline connector (part number AMP 1-87733-7 Housing or Equiv. and AMP 87666-4 Contact).

D.C. power from the host system is connected to the unit via a power connector (part number AMP 530521-3 Housing, AMP 530518-1 Contacts, AMP 530533-1 Key, or equivalent).

11.0 SAFETY STANDARDS

The FD 200 Series Fixed Disk Drive complies with relevant product safety standards as issued by Underwriters Laboratories, Incorporated; Canadian Standards Association; and other national safety standards, as required.

12.0 GLOSSARY OF TERMS

Actual Operation Time (AOT) - The time power is connected to the drive.

Address - A number that defines the location of the smallest addressable unit of data in a track (sector) on the disk. The address contains track, surface, and sector location information. (Refer to paragraph 8.4.2.1).

Areal Density - A measure of recording density in units of bits per square inch defined to be track density (TPI) times bit density (BPI).

Average Access Time - The time taken for the positioner to complete all possible seeks (including settling at each location) divided by the number of possible seeks.

Bits per Inch (BPI) - The number of bits (unformatted) recorded per linear inch on the innermost data track.

Byte - Eight bits of data.

Data - The information transferred to and from the host system and read back from or recorded on the disk.

Error Correction Code (ECC) - A coding system that permits the detection and correction of errors in the data. (Refer to paragraph 4.2.2).

Failure - Any unplanned occurrence within the drive that prevents operation according to the specification.

Format - The arrangement by which data is written on the disk with certain code words, address words, etc. structured in a specific way. (Refer to paragraph 8.4).

Head - The magnetic element used to write and read data to or from the disk. The same head is also used to read the servo information.

Header - A set of data that is prerecorded and serves as the sector mark for the soft sectoring. The header contains the preamble, address mark, address, error correction code, status, closing statement, and gap. (Refer to paragraph 8.4.1).

Idle State - The normal state of the drive when waiting for a new instruction.

Interface - The definition of the means by which the host controls the drive. This consists of the electrical signal levels and their sequence and the interpretation of those signals.

Latency - The time interval needed to arrive at any sector on a given track assuming no positioner movement.

Maintenance and Test Routines (MTR) - The formal list of tests that can be supplied to the drive or subassemblies of the drive to establish which parts of the drive are nonfunctional and to confirm that their replacement or repair has eliminated the fault. They are prepared on the assumption that the drive was working prior to the fault and that only one fault exists.

Maintenance Tracks - Special tracks not normally available to the host system. They reside on a unique cylinder of the drive and contain maintenance aids, user log, etc.

Mean Time to Repair (MTTR) - The average number of hours required to repair a failure, including time for diagnosing, repairing and testing the drive. The MTTR figure assumes that repairs are performed by trained personnel with the proper tools, documentation, and repair parts and does not include the time to determine that the fault lies in the drive.

Noise Spike - Any transient disturbance on the D.C. power lines.

Preventive Maintenance (PM) - The maintenance scheduled to be performed on the drive to increase the probability that no parts will fail during the actual operation time.

Relocation - The reestablishment of a sector to a spare location when the sector is found to contain an irrecoverable error. This reestablishment is accomplished within the drive and is normally transparent to the host system. (Refer to paragraph 4.3.3).

Sector - The smallest addressable unit of data on a track, 256 bytes.

Seek - The act of moving the positioner to a new track location.

Seek Error - When the positioner goes to the wrong track location during a seek operation, or when the positioner exceeds its positional tolerance after the settling timeout.

Servo Track - A reserved track carrying a prerecorded signal that enables special circuits to use the head in the read mode as a position transducer.

Settling Time - The time needed in a seek for the head to come to a stable position on a track within the permitted position error.

Soft Sectoring - A method of detecting sectors on a track by means of headers prerecorded on the disk.

Syndrome - A set of words produced by the error correction code circuits at the end of the sector when a sector of data was read and the read data was checked by these circuits. The words are nonzero if an error is detected; they are used in the error correction process. (Refer to paragraph 4.2.2).

Tag Argument - A set of words held in a data buffer and compared with data in a sector. The tag argument is a host-supplied parameter of the SEARCH command.

Track - One "circle" of data accessed by a head at any one of the positioner discrete positions.

Tracks per Inch (TPI) - The average radial density of the data tracks, being the total number of tracks divided by the radial distance over which they are located.