

SPECIFICATION FOR MODEL 5022 DISCFILE STORAGE SYSTEM

NO. 102253

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1.0 GENERAL

This document is the technical specification for a Mass Random Access DISCfILE Memory System. The DISCfILE System comprises two types of components referred to as the Disc Unit and the Logic Unit. The system is composed of one Logic Unit and from one to four Disc Units. Data is stored in the Disc Unit and the Logic Unit controls the flow of data between the Disc Unit and a system controller which interfaces and is part of a computer.

The Disc Unit contains 18 magnetically-coated discs which rotate on a common shaft. Sixteen discs are used to store data while the other two discs located at the top and bottom of the stack are used as baffle discs. The top baffle disc is also used to store timing information. The file contains the read/write heads, positioners to locate the read/write heads, selection matrices, positioner power controls, and the necessary d-c power supplies.

Air pressure is used to maintain the heads a specified distance from the rotating disc surface. An entrance for externally supplied compressed air, and a compressor with all required filtration is included. Either air supply may be used. All power sequencing circuitry necessary to automatically place the file in an operable condition or shut it down is contained in the cabinet. Sequencing may be initiated locally at the Disc Unit or Logic Unit in test mode or remotely from the Controller.

Within the file there is a key-locked box containing 16 switches, one for each of the data discs. When any one or more of the switches are activated, data on the corresponding discs cannot be altered or erased.

The Logic Unit is designed to execute the commands generated by the Controller. The Logic Unit uses the commands to locate a record in a DISCfILE and transfer data between the addressed record and the Controller. The Logic Unit uses an address from the Controller to select a DISCfILE and instruct the file to move a positioner to the desired position and select a read/write head. The Logic Unit then reads headers (a header is an address prerecorded before each record) from the DISCfILE to determine if the head has settled over the desired track. This process is called track confirmation. Then the Logic Unit controls the transfer of data between the Controller and the record or records in the desired track.

Before data can be transferred between the Controller and the selected DISCFILE, the Controller must receive a signal from the Logic Unit indicating that it is ready to transfer data (at this time the Logic Unit issues the Ready signal). The Controller then responds with signals indicating whether the record is to be read or written (this is done by the Controller issuing the Alert signal followed by Read or Write). After these signals are received the record is read or written. A specific time period is provided following the record during which the Controller must either terminate communication (by issuing the End signal) or request that the next record be read or written. The Controller may terminate communication any time after data transfer has begun (if this is done before the end of a record when data is being written, the Logic Unit will record data ZERO's in the remainder of the record).

The Logic Unit will also write headers either on command from the Controller or by internal programming on the maintenance panel (the circuit modules necessary to perform this function are not included in the Logic Unit).

2.0 PHYSICAL DESCRIPTION

2.1 General

The Logic Unit is hinged to the Disc Unit. Both units are totally enclosed with a minimum of trim; access is gained through simple sheet metal doors. Cable entry is through the base of the units. All exterior metal surfaces are coated either with zinc chromate primer or paint specified by Data Products. The structural frames of both units are anodized aluminum.

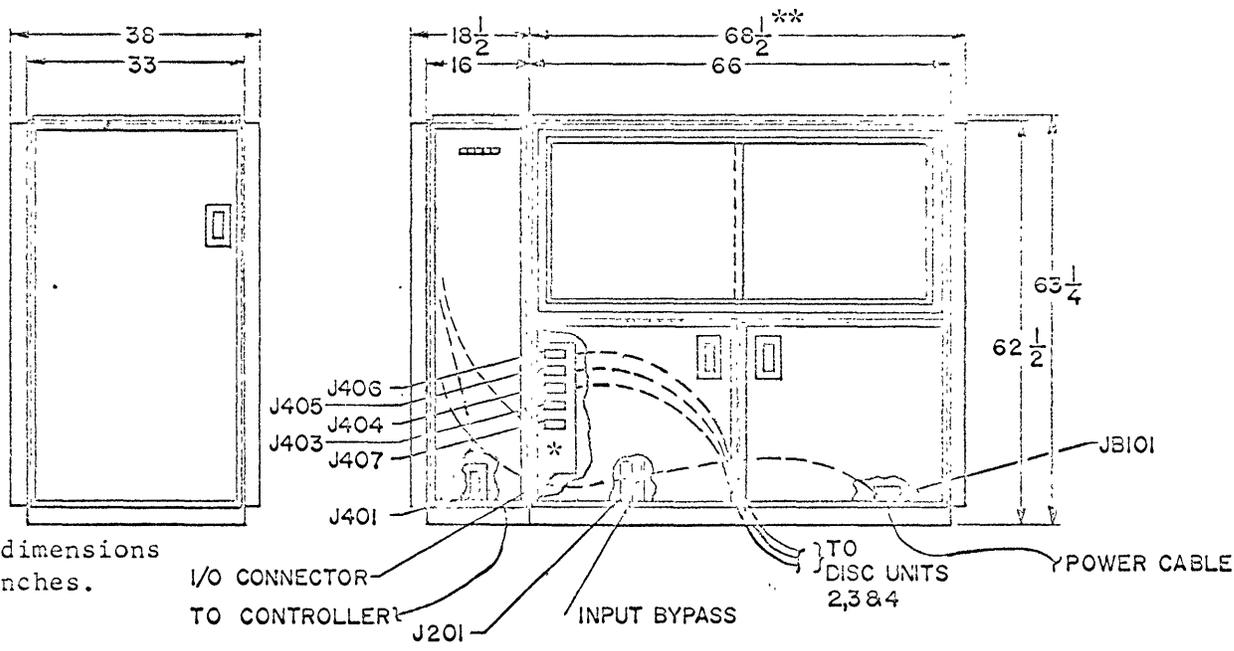
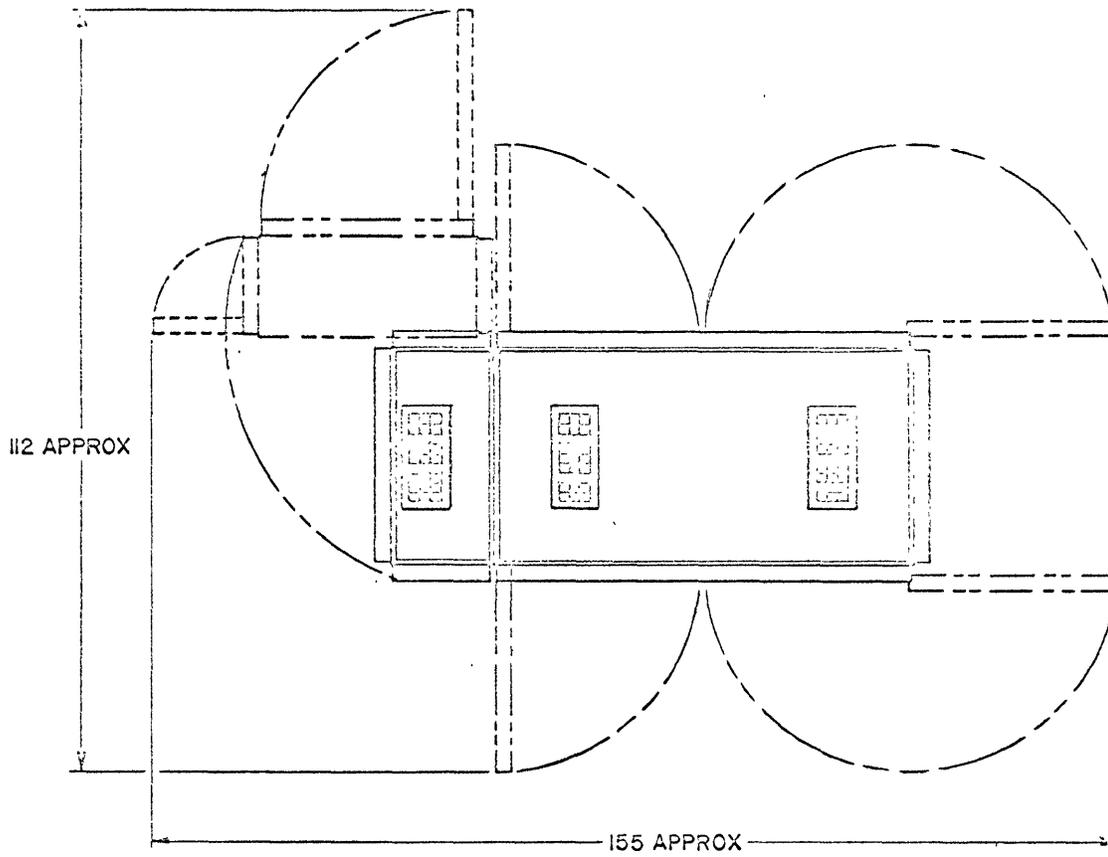
2.2 Physical Characteristics

2.2.1 Environmental Specifications

<u>Operating</u>	<u>Shipping and Storage</u>
Temperature: 60°F min. to 85°F max.	Temperature: 20°F min. to 150°F max.
Relative Humidity: 20% min. to 80% max.	Relative Humidity: 98% max.

2.2.2. Dimensions

The dimensions for the basic system are shown in Figure I.



NOTE: All dimensions in inches.

Figure I. DIMENSIONS AND CABLING FOR THE BASIC 5022 SYSTEM.

* This switching module is only installed if more than one Disc Unit is used.

** This dimension is 71 inches for any Disc Units added to the system.

2.2.3 Weight

Disc Unit	Logic Unit
2575 Lbs.	490 Lbs.

2.2.3.1 Floor Loading

Disc Unit	Logic Unit
107 lbs/square foot	134 lbs/square foot
33 lbs/square foot pad loading	122 lbs/per caster

2.2.3.2 Shipping Weight

Add approximately 100 lbs. for the Logic Unit and 200 lbs. for each Disc Unit for necessary equipment and packaging.

2.2.4 Cooling

The top and bottom of the Disc Unit are cooled by separate air currents. The top compartment is cooled by air drawn in from the top of the unit and exhausted through both sides. The bottom compartment is cooled by air which is drawn in on one side of the unit and exhausted on the other. The air exhausted on the side facing the Logic Unit escapes through the top of the Logic Unit. The Logic Unit also has its own supply of air which is drawn in through the side and is exhausted through the top.

2.2.5 Power Requirements

The basic system utilizing one Disc Unit and one Logic Unit requires 4.5 KW, 3-Phase, wye connected AC power. Each additional Disc Unit requires 3.5 KW. The system operates from 208 volts, $\pm 10\%$ and from 60 cps ± 1 cps line frequency. At customer option*, the system can operate from 385 or 415 volts, $\pm 10\%$ source and a 50 cps ± 1 cps line frequency.

The frequency variations specified above may occur either transiently or steady state.

* All options specified in this document are available at a reasonable cost.

2.2.5.1 Start Current

The start current of the basic system shall not exceed 35 amps on any line of the 3-phase input and shall last for less than 30 seconds.

2.2.5.2 Run Current

The run current shall not exceed 15 amps on one line nor 10 amps on either of the other two lines.

2.2.5.3 System Power Control

The Logic Unit contains relay control circuitry to sequence the starting of the Disc Unit. It requires approximately six minutes for each Disc Unit to sequence up.

2.2.6 Disc Rotational Speed

The discs are driven at a rotational speed of 1200 RPM nominal. Induction slip may account for a rotational speed decrease of not more than 5% (60 RPM). (For 50 cps units* the rotational speed is 1000 RPM with a maximum decrease due to induction slip of 50 RPM).

2.2.7 Physical Mechanization

There are 18 discs in the disc rotation assembly; two of these are baffle discs. The top baffle contains pre-recorded timing information accessed by a fixed head assembly. The data tracks on the remaining 16 discs (256 concentric tracks per disc surface divided into two zones of 128 tracks each) are accessed by means of gas lubricated, slider bearing heads mounted in fixed positions on a moveable arm. The arm is part of a magnetically-actuated positioner which moves the arm to a selected position. The file can be supplied with less than 16 data discs,** the minimum complement of data discs is four.

* At the customers option.

** At a decrease in price..

2.2.7.1 Positioners Per File

There are 16 positioners in the DISCFILE; each positioner accesses all 512 tracks on one disc.

2.2.7.2 Heads Per Positioner

There are 8 heads per positioner. Four heads are used for the upper surface and four for the lower surface. Two of the four heads on each surface access the tracks of the inner zone and the other two heads access the tracks in the outer zone.

2.2.7.3 Positions Per Positioner

There are 64 positions for each positioner.

2.2.7.4 Tracks Per Positioner

Eight tracks may be accessed per position, since each of the eight heads accesses its own track.

2.3 Single Access Channel

The basic system contains all circuitry required to transfer data to or from a particular record location. Only one read/write head on one positioner is enabled at any one time.

2.4 System Cabling and Connectors

Refer to Figure I. The system is supplied with all necessary cabling between the Logic Unit and the Disc Unit. The only connection between the Controller and the system is to the Logic Unit. The necessary cable for this connection is supplied by the customer. The Controller to Logic Unit input connector (supplied by Data Products Corporation) which mates with J401 in Figure I, is Elco part number 00-8017-100-000-012 keyed 1 to 1. Refer to paragraph 4.1.3 for interface connections.

2.5 Compressed Air Option

2.5.1 An external source of compressed air is required only when the compressor contained in the file is not used.

2.5.2 Air Pressure: 40 to 175 psi.

2.5.3 Volume: 4.5 cfm minimum.

2.5.4 Filtration: External water trap and 10 micron filter.

2.5.4.1 Recommended filtration media:

Filter F300-A with
Cartridge F-113A.

2.6 Color

All exterior sheet metal surfaces of the Logic Unit and Disc Unit will be supplied coated with either: zinc chromate primer, or paint specified by ~~Data~~ ^{and} DEC ~~Products.~~ ^{supplied}

3.0 FUNCTIONAL DESCRIPTION

3.1 Address Format

Records are identified and selected by means of a record identification address. This address consists of ~~21~~²⁰ bits separated into five fields. This complete address is stored in the Logic Unit and compared with the data read from headers. A header is a pre-recorded address stored with the record in each sector. Each record in the file is uniquely identified by one of these headers.

3.1.1 Disc Field

This field consists of six bits in the most significant address positions. The two most significant bits are used to select one of four sets of 16 positioners and thus, one of four Disc Units in a maximum system configuration. These two bits are not written as part of the header address. The four least significant bits are used to select one of the 16 positioners, and hence, one of the discs in the selected file for reading and writing.

3.1.2 Position Field

This field consists of six bits in the next most significant address positions. This field is used to select one of the 64 possible positions of the selected positioner. Each position has access to eight tracks.

3.1.3 Record Field

This field consists of seven bits in the next most significant address positions. This field is used to select one of the records associated with the selected position. The record is selected by selecting one of the eight heads and one of the sectors associated with that head. The head address tabulation for a track pair of 32 is shown in Table I.

3.1.4 Read Next Sector Field

This field consists of one bit in the second least significant address position. This field is used as a command to the file and is not written as part of the header address. The functions executed are as follows:

3.1.4.1 Read Next Sector Field ZERO

The complete address is used to select a record.

3.1.4.2 Read Next Sector Field ONE

A partial address is used to select the first available record from a selected track. The partial address consists of that portion of the address required to select a head and thus a given track.

3.1.5 Parity Field

The parity field consists of one bit in the least significant position. It is a bit which makes the address have an odd number of ONE's. It is not used as part of the header address.

Table I. Head Address Tabulation for Track Pair of 32.

Decimal Address	Record Field Binary Equivalent							Zone	Addressed Head
	64	32	16	8	4	2	1		
0 through 11	0	0	0	0	0	0	0	Inner	Head 0
	0	0	0	1	0	1	1		
12 through 23	0	0	0	1	1	0	0	Inner	Head 1
	0	0	1	0	1	1	1		
24 through 35	0	0	1	1	0	0	0	Inner	Head 2
	0	1	0	0	0	1	1		
36 through 47	0	1	0	0	1	0	0	Inner	Head 3
	0	1	0	1	1	1	1		
48 through 67	0	1	1	0	0	0	0	Outer	Head 4
	1	0	0	0	0	1	1		
68 through 87	1	0	0	0	1	0	0	Outer	Head 5
	1	0	1	0	1	1	1		
88 through 107	1	0	1	1	0	0	0	Outer	Head 6
	1	1	0	1	0	1	1		
108 through 127	1	1	0	1	1	0	0	Outer	Head 7
	1	1	1	1	1	1	1		

3.2 Sectors and Sector Organization

The Disc Unit is supplied with inner zone tracks of 12 equal sectors per track and outer zone tracks of 20 equal sectors per track, thus the standard system is a track pair of 32. At the customer's option, track pairs of 16 (6 and 10) or 8 (3 and 5) can be supplied.

3.2.1 Sector Organization

The sector format is determined by the number of coded sector characters recorded on a single sector control track. The total number of bits per sector is determined by the number of sectors per track and the number of clock bits for the zone which contains the sector. The total number of bits per sector, in either zone, is ~~1742 using a track pair of 32.~~ (For track pairs of 16 and 8, the total number of bits is ~~3484~~ and ~~6968~~ respectively.) Each sector consists of a header containing the record identification address followed by a record containing the stored data. Additional space before the header and between the header and the record is used to accommodate mechanical tolerances, including the erase-to-read/write gap. Both the header and the record are preceded by a sync bit (ONE) to identify the beginning of the data.

3.2.1.1 The Header

The header contains 19 bits. The read next sector and parity bits are not recorded in the header. In place of these bits, two ZERO bits are recorded (following the sync bit) so that the header has the same number of bits as the address (for comparison during track confirmation and record validation).

3.2.1.2 Record Length

For a track pair of 32, the record length is 1548 bits. (For track pairs of 16 or 8, the record lengths are 3290 and 6774 respectively.)

3.3 Control Tracks

There are four independent sets of control tracks. Each set consists of four control tracks. These tracks are located on the top baffle disc and are pre-recorded by Data Products Corporation. Data Products Corporation retains records of customer control track requirements to enable recording of new control discs.

3.3.1 One control track contains clock information used to generate clock pulses for inner zone writing. This track contains 20,904 bits and is recorded with a one-bit maximum anomaly at the splice point.

3.3.2 The second control track contains clock information used to generate clock pulses for outer zone writing. This track contains 34,840 bits and is recorded with a one-bit maximum anomaly at the splice point.

3.3.3 The third control track contains characters used to define the beginning of each track and to locate each sector within the track. There shall be a minimum of four ZEROS between any two characters. Index, inner zone, and outer zone sector characters are pre-recorded on this track at a frequency of 500 KC and are identified by means of a 4-bit character code as follows:

Index Character	- 1111
Outer Zone Sector Character	- 1011
Inner Zone Sector Character	- 1101

3.3.4 The fourth control track contains a single revolution index character (four ONES in a track of ZEROS). This track is normally used as the index reference mark for maintenance purposes.

3.3.5 The other three independent sets of control tracks are provided as spares so that an alternate set may be used in case a selected set is inoperative.

Table III. Addressable Capacity

Bits Per	Sectors per Track Pair		
	8*	16*	32
Record	6,774	3,290	1,548
Track Pair	54,192	52,640	49,516
Position	216,768	210,560	198,264
Disc	13,873,152	13,475,840	12,688,896
Disc Unit	221,980,432	215,623,440	203,022,336

3.5 Transfer Rates and Timing

The transfer rates and timing are determined by the number of bits on the control disc clock tracks and the disc rotational speed. Clock and data information are each transferred between the Logic Unit and Controller over twisted pair lines. Data is transferred over two complementary channels (see paragraph 3.7.8). Each channel consists of two twisted pairs, one for the transmission of ONE's the other for ZERO's. The use of two complementary channels halves the data transmission frequency over each channel.

3.5.1 Disc Unit to Logic Unit

3.5.1.1 Outer zone -697 KC with a bit-to-bit timing of approximately 1.4 microseconds (for the 50 cps option: 580 KC and 1.7 microseconds). The bit-to-bit timing may vary as much as $\pm 30\%$ from the average of

$$\frac{1}{\text{Disc RPS} \times 34,840}$$

3.5.1.2 Inner zone -418 KC with a bit-to-bit timing of approximately 2.4 microseconds (for the 50 cps option: 380 KC and 2.9 microseconds). The bit-to-bit timing may vary as much as $\pm 30\%$ from the average of

$$\frac{1}{\text{Disc RPS} \times 20,904}$$

* At the customer's option.

3.5.2 Logic Unit to Controller

- 3.5.2.1 Outer zone-291 KC for each channel of the complementary pair with a bit-to-bit timing of approximately 2.8 microseconds (for the 50 cps option: 242 KC and 3.4 microseconds).
- 3.5.2.2 Inner zone-174 KC for each channel of the complementary pair with a bit-to-bit timing of approximately of 4.8 microseconds (for the 50 cps option: 145 KC and 5.8 microseconds).

3.6 Access Times

The time required to access data depends on the positioner power status of the file at the time the operation is requested and upon the length of the stroke required to reach the selected track. The following paragraphs define the various components of access time.

3.6.1 Disc Unit Switching Time

This is the time required (in a system using more than one Disc Unit) to switch from one Disc Unit to another. This time is 5 milliseconds minimum.

3.6.2 Power Switching Time

When the positioner is in the "power hold" status and a new disc and/or position is requested, power switching time is required. This is the time between a power off pulse for one positioner and the power on pulse for a new positioner. The time required is an average of 26 milliseconds but may vary from 20 to 30 milliseconds. When the file is in the power off status, the power switching time for a new address is seven milliseconds minimum.

3.6.3 Positioning Time

The positioning time is defined as the time from the power on pulse to the time when reading or writing of data can begin. This time has two components; motion time and confirmation time. During the latter period the final settling of the positioner takes place. Settling is normally assured by reading correctly 15 contiguous outer zone headers or 10 contiguous inner zone headers.

Confirmation is complete when this has been accomplished. A minimum of 39 milliseconds (for 50 cps, 47 milliseconds) must be allowed for confirmation. The motion time shall not exceed 225 milliseconds and shall be consistent with the values shown in Figure II.

3.6.4 Latency

Latency time will vary from a minimum of one sector time to a maximum of one disc revolution. Average latency is one-half a disc revolution. Minimum latency is always achieved in the read next sector mode.

Minimum Latency

Inner zone: 4.3 ms (50 cps: 5.3 ms)
Outer zone: 2.6 ms (50 cps: 3.2 ms)

Maximum Latency

52 ms (with slip) (50 cps: 63 ms)

Average Latency

26 ms (50 cps: 32 ms)

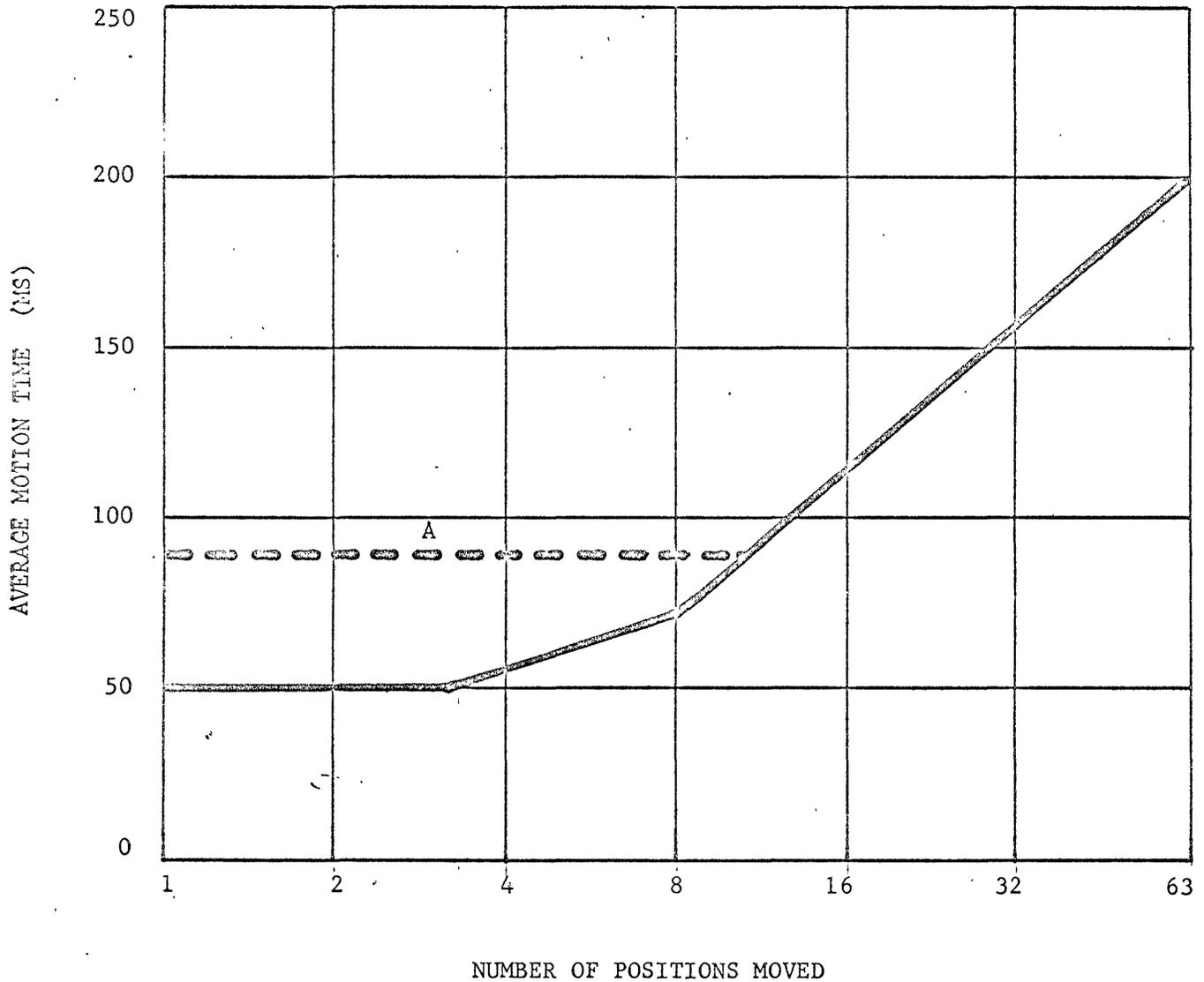
3.6.5 Head Switching Time

The total head switching time (including read amplifier recovery time) is a nominal 100 microseconds. This time does not affect access time since it is much shorter than the electro-mechanical times which occur.

3.7 Control Signals and Operation Sequence

3.7.1 Select (Controller to Logic Unit)

The Select pulse logically prepares the Logic Unit to receive and store an address and clears all data and sequence error conditions. The Select pulse must always be followed by an address; it is usually sent following the end of a completed read or write operation. However, it is permissible to send a Select pulse followed by a new address after Address Termination (paragraph 3.7.3) is received and before the Alert pulse (paragraph 3.7.5) is sent. A new



A = Allowance for short strokes to ends of positioner.
The probability is not more than 0.05 that the motion time for any stroke length will exceed the average time by more than 30 msec.

Figure II.

Select pulse sent after Address Termination but before Ready (paragraph 3.7.4) causes a seek interrupt which automatically interrupts the seek operation being executed. The Select pulse shall not be sent between the Alert pulse and the End pulse (paragraph 3.7.10).

The time required to execute a seek interrupt depends upon how far the interrupted seek operation has progressed. When the new Select arrives before the positioner is set in motion, the file immediately begins to operate on the new address. When the new Select is received after the positioner is set in motion, there is a delay before the new address is operated upon. This delay is dependent upon the time the file has spent operating upon the old address but shall not exceed a nominal 250 milliseconds. The delay is required to ensure that power is not removed from the positioner while it is in motion.

3.7.2 Address (Controller to Logic Unit)

The address of the record that the Controller is seeking is sent serially over the Even Data complementary channel. Address bits will be sent in the following order: address parity bit, read next sector bit, record field, position field, and disc field with the least significant bit of each field first.

Address transmission shall not begin sooner than 5 microseconds after the Select pulse has been sent. The rate of transmission is determined by the controller and is 750 KC maximum.

The complete address is stored in the Logic Unit. The address is checked for parity and correct length. After the transmission of the address information, an Address Termination pulse is sent which disconnects the file system from the Controller. The read next sector field is stored and interpreted by the Logic Unit to select the full address or the partial address for record selection.

The seek operation begins after the Address Termination pulse is received. The stored address is used to select a positioner, move that positioner to the selected position and select a head for reading headers (A header is a unique code stored in each sector to identify each record). A sufficient number of headers from the selected track are read to determine that the positioner is settled on the track. After the desired address is found, the file system is prepared to perform a read or write operation. The time to locate the address sought is conditioned by the read next sector bit, since a full address compare is performed only if it is a ZERO.

3.7.3 Address Termination (Controller to Logic Unit)

The Address Termination pulse is sent over the ONE twisted pair of the Odd Data complementary channel (see paragraph 3.7.8), 10 ± 9 microseconds after the last bit of the address is sent to the Logic Unit. This pulse logically disconnects the Logic Unit from the Controller and initiates the seek operation.

3.7.4 Ready (Logic Unit to Controller)

The seek operation terminates with the transmission of a single Ready pulse to the Controller over the twisted pair used to receive the Clear pulse. This pulse is generated after the positioner has settled, and the address stored in the Logic Unit agrees with the address read from a header. This pulse indicates that the read/write head is located in the sector immediately prior to that in which reading or writing may be performed.

When the read next sector bit is a ZERO, the Ready pulse is sent to the Controller at the end of the header which completely agrees with the disc, position and record fields of the address stored in the Logic Unit. If the Controller does not respond to a Ready with an Alert within the specified time, the Ready pulse is sent on the next revolution of the disc. The Logic Unit, however, logically disconnects from the Controller at the end of the sector in which Ready was sent and does not accept an Alert until after the next Ready is sent.

If the read next sector bit is a ONE, then the Ready pulse is sent as soon as the positioner is settled on the track. The Ready pulse is then sent after each header is read until an Alert pulse is received. When headers are written from the Controller, the Ready pulse indicates that the positioner has settled at the selected position.

3.7.5 Alert (Controller to Logic Unit)

The Alert pulse logically prepares a Logic Unit to receive a Read or Write pulse.

The Alert pulse shall follow the Ready pulse by 2 microseconds minimum, 2 milliseconds maximum. The Alert pulse causes the Logic Unit to increment the stored record address by one. Then, the header associated with the record to be operated on is compared with the incremented address, the extent of the compare depending on the read next sector bit. Hence, the address of the record in which the read or write operation will be performed is the address originally received from the Controller augmented by one.

3.7.6 Read (Controller to Logic Unit)

The Read pulse shall follow the Alert pulse by 10 ± 9 microseconds and prepares the file for a read operation.

The Logic Unit commences to transmit the data read from the addressed record. When the Controller has received sufficient data, it may disregard further read signals, however, it cannot properly terminate the flow of data unless it sends an End, Read or Write pulse. A Read or Write pulse given before the end of the record will terminate data transfer and the read or write operation will be performed in next sector; an End will terminate communication.

After the selected record is read, a time slot (8 microseconds) is available to tell the file whether the operation is to terminate or continue. If a Read pulse is sent during this time slot, the record address stored in the file is incremented by one and the record following the one

just read will then be read. This operation of reading the following record may be repeated so that all records which correspond to a given position are read sequentially. The file system can execute this mode of operation indefinitely. If a Write pulse is sent during this time slot, the record address will be incremented and a write operation will be performed in the next sector.

3.7.7 Write (Controller to Logic Unit)

The Write pulse shall follow the Alert pulse by 10 ± 9 microseconds. The Controller then responds to the Logic Unit Write Clock pulses with write data pulses.

After the selected record is written, a time slot (8 microseconds) is available to tell the file whether the operation is to terminate or continue. An End pulse terminates the write operation. If a Write pulse is sent during this time slot, the address stored in the file is incremented by one and the next record following the one just written is written after a favorable compare. This operation of writing the following record may be repeated so that all records which correspond to a given position may be written sequentially. The same method of sequential accessing is used for write as is used for read. It is important that the Controller keep count of the number of records sequentially written at one position to avoid destroying data not yet read.

A Write Check mode is also available in the Logic Unit. This mode is enabled by issuing a Read pulse during the record or in the time slot following the record just written. The Read pulse does not increment the address. This mode thereby constitutes a write-check continue, since the Logic Unit increments the stored record address by one if given another Write pulse, the operation may be continued through all the continuously addressable records at one position.

A Read, Write or End pulse sent during a write operation terminates the Write Clock pulses; however, the file commences to pad the remainder of the record with ZERO's and then terminates or continues as commanded.

3.7.8 Complementary Data Channels (Controller to Logic Unit and Logic Unit to Controller)

There are two complementary data channels; one is the Odd Data Channel and the other is the Even Data Channel. Each channel contains two twisted pairs; one for transmission of ONE's and one for transmission of ZERO's. On each transmission of a bit, one, and only one twisted pair shall be pulsed. Furthermore, data transmission alternates between complementary channels and there must not be concurrent transmission on both channels. The direction of transmission on these channels depends upon whether the file system is reading or writing.

When reading, the Logic Unit transmits the information read over these channels. Each channel is pulsed alternately with the first bit of each record being transmitted over the Odd Data complementary channel.

During the write operation, the Controller transmits pulses over these channels in response to Clock pulses sent by the Logic Unit. The Clock pulses are gated back on the Odd or Even complementary data channel as ONE's or ZERO's over the appropriate twisted pair, in 0.4 to 1.0 microsecond. The delay time is determined by the propagation time of the line and the Controller delay and is measured at the file interface.

The time between two consecutive data pulses when reading may vary by $\pm 30\%$ from the average data rate, as defined in paragraph 3.5.1.

3.7.9 Write Clock (Logic Unit to Controller)

The Write Clock pulses are sent to the Controller on two twisted pairs (odd and even). The first clock pulse is transmitted on the odd twisted pair. The Write Clock pulses start when the head reaches the portion of the track to be written. The pulses terminate with the receipt of an End, Write, or Read pulse. If an End pulse is received, no more data is to be written. If a Write pulse is received, the file will start sending the clock pulses again after reaching the next record to be written. If the

End, Read, or Write pulse is received before the record is completely written, ZERO bits are automatically written in the remainder of the record.

The clock pulses are generated from information read from the control disc clock tracks.

3.7.10 End (Controller to Logic Unit)

The End pulse is sent by the Controller to discontinue communication. The End pulse also disconnects the Logic Unit from the Controller and the file is then ready to receive a new Select command. Upon receipt of the End pulse, the Logic Unit transmits no more than one clock pulse or data bit. The End pulse may be given at any time during the record. If communication is to be terminated after a record, the End pulse must be sent during the 8 microsecond guard slot.

3.7.11 Clear (Controller to Logic Unit)

The Clear pulse is sent on the same twisted pair used for Ready. This pulse is used if it is desired to interrupt the "power hold" state of the file system. The positioner circuits of the file system are designed so that the heads remain on the tracks at the position selected until a Clear pulse or master clear level is received or a new disc and/or position is selected.

The End pulse is also used to gate the Clear pulse into the system. The Clear pulse shall be transmitted to the Logic Unit no sooner than the End pulse, and no later than 2 microseconds after the End pulse.

3.7.12 Lockout Warning (Logic Unit to Controller)

Data written onto the disc may be preserved for reading only. Switches are provided in the Disc Unit to manually prevent writing or erasing on any selected disc or combination of discs. A read or write operation addressed to a locked-out disc results in a pulse on the write lockout warning line. This pulse is generated either concurrent with or prior to the Ready pulse.

If the Controller attempts to write data, data writing or erasure is inhibited and a Data Check error (paragraph 3.8.12) is generated.

3.7.13 Master Clear (Controller to Logic Unit)

This signal removes power from the positioner currently accessed and then clears all internal logic. The signal is supplied over a twisted pair which is normally an open circuit. Contact closure from the Controller initiates the master clear function.

3.7.14 Operable (Logic Unit to Controller)

This signal is sent over a twisted pair which is a closed circuit when the storage system is operable. Power is first applied to the Logic Unit and the Disc Unit (or units) by depressing the Power On pushbutton on the Logic Unit. When the Logic Unit (and its associated Disc Units) is operable and available to receive commands from the Controller, a relay contact closure indicates Operable. The Operable signal is terminated: by depressing the Power On pushbutton on the Logic Unit; placing the Logic Unit or Disc Unit in test mode; when the positioner power supply output in the Disc Unit falls below normal; or when an over temperature condition is detected.

3.7.15 Alarm (Logic Unit to Controller)

This signal is sent over a twisted pair which is open-circuited if operation is normal. The Alarm signal is indicated by the closing of a relay contact if the ambient temperature in the storage system, (Logic Unit or Disc Unit) reaches the alarm level, or when any of the test mode switches is in a test position during the normal operate mode or when a malfunction in the flying head air supply is indicated. The signal is also active when the positioner power supply fails or when an over temperature condition is detected; these conditions are also indicated by loss of the Operable signal.

3.8 Error Signals

An error pulse is transmitted to the Controller in response to any of the error conditions to be discussed. The Logic Unit contains a FAULT indicator on its external control panel which lights when a sector or positioning error occurs. Each of the error conditions are indicated by separate lamps on the internal maintenance panel. A new Select pulse clears all data and sequence error conditions. Electro-mechanical malfunctions, as indicated by the Alarm signal, cannot be reset electronically but require manual interruption.

3.8.1 Address Parity Error

This error condition exists if the address parity bit as received by the file does not give odd parity to the address transmitted. Address parity is checked when the Address Termination pulse is received. If an address parity error exists, an Error pulse is transmitted to the Controller, and the PE (parity even) error indicator is lit.

3.8.2 Address Termination Error

If the Address Termination pulse is not received at the time specified in 3.7.3, an Address Termination error exists. An Error pulse is sent to the Controller approximately 30 microseconds after the last bit of the address is transmitted, and the AT (address termination) indicator is lit.

3.8.3 Incomplete Address Error

If the Address Termination pulse is received before the complete address has been transmitted; an Incomplete Address Error exists. An Error pulse is sent to the Controller and the IA (incomplete address) indicator is lit.

3.8.4 Address Transfer Error

The address information received from the Controller is shifted bit by bit into a shift register. After the Address Termination pulse is received, the portion of the shift register containing the disc field, position field, and the record field and the read next sector field

are transferred in parallel to a storage register. The contents of the storage register and the portion of the shift register which was transferred are then compared with the exception of read next sector field. If they do not agree, an Address Transfer Error exists. An Error pulse is transmitted to the Controller and the T (transfer) indicator is lit.

3.8.5 End Error

If, after reading or writing a record no End, Read, or Write pulse is received during the provided guard slot, an End error exists. An Error pulse is transmitted to the Controller and the END indicator is lit.

3.8.6 Write Clock Error

During a Write operation, pulses from the clock track used for generating Write Clock pulses are checked to see that no pulses are missing. If a pulse is missed, a Write Clock Error exists. An Error pulse is sent to the Controller and the WC (write clock) indicator is lit.

3.8.7 Positioning Error

When a seek operation is initiated, and is not terminated approximately 600 milliseconds later by the positioner settling down, a Positioning Error exists. An Error pulse is transmitted to the Controller and the DP (disc position) and the FAULT indicators are lit.

3.8.8 Sector Error

The Sector Error condition exists if, approximately 120 milliseconds after the positioner is settled, the desired record cannot be found. This condition would prevent a Ready pulse from being transmitted. Also, if, after the file has been alerted and conditioned to read or write the file is unable to match the header address with the stored address, then this error will also exist. Under either of these conditions, an Error pulse is transmitted to the Controller and S (sector) and FAULT indicators are lit.

3.8.9 Data-In Error

This error exists, while writing in the file, if any two successive data pulses received are separated in time by more than 150% of the normal time separation. Both complementary data channels are examined for this condition. The error condition sends an Error pulse to the Controller and lights the DI (data in) indicator.

3.8.10 Data-Out Error

This error exists, while reading from the file, if any two successive data pulses sent are separated in time by more than 150% of the normal time separation. Both complementary data channels are examined for this condition. The error condition sends an Error pulse to the Controller and lights the DO (data-out) indicator.

3.8.11 Clock Check Error

A clock check error is generated when, during a write operation, an odd or even clock pulse is dropped, an outer zone even clock is generated during an inner zone operation, or a write amplifier malfunction is detected. Any of these conditions results in an error pulse to the Controller and lights the CC (clock check) indicator.

3.8.12 Data Check Error

During a write operation, a bit-by-bit comparison is continually made between the data transmitted by the Logic Unit and the data content of the write current. Bad comparison results in an error pulse to the Controller and lights the DC (data check) error. This error will also occur if an attempt is made to write on a locked-out disc.

3.9 Equipment Life

The file shall have a design life of at least three (3) years before major overhaul is required, assuming that proper scheduled maintenance is performed.

3.10 Errors Warranty

There shall be no errors due to failure of the magnetic recording medium (bad spots) for the warrantable life of the equipment assuming that recommended maintenance procedures are followed. In addition, the equipment shall not exhibit any magnetic degradation with time of pre-written data sufficient to cause errors while reading.

3.11 Design Objectives and ^{Performance} Acceptance Error Rates

The following paragraphs define the design objectives and acceptance error rates of the DISCFILE system. The system shall be accepted by the customer on the basis of criteria defined in Data Products Corporation acceptance test specification Number 102254.

3.11.1 Malfunction Definitions

3.11.1.1 Reading Error

A data error is detected and three repeated reading operations initiated either automatically or under program control, are error-free.

3.11.1.2 Writing Error

A data error is detected as the result of a write check* and three repeated writing operations, followed by write checks initiated either automatically or under program control are error-free.

3.11.1.3 Incomplete Operation Error

A malfunction of the equipment occurs during which there is no data error. Either automatically or under program control, the operation is repeated and is completed successfully.

3.11.1.4 Failure

A condition which causes errors or other malfunctions which can only be corrected by unscheduled maintenance.

* The first operation of reading and checking data written on a previous revolution of the disc.

- 3.11.2 The design objectives of the system for field operation are listed below.

NOTE

The following failure and error rates are design objectives for the equipment while operated in a typical commercial computer environment.

- 3.11.2.1 Incomplete Operation Error Rate

Not more than 1 in 10^5 operations.

- 3.11.2.2 Reading Error Rate

Not more than 1 in 10^{10} data bits transferred.

- 3.11.2.3 Writing Error Rate

Not more than 1 in 5×10^{10} data bits transferred.

- 3.11.2.4 Failure Rate

Not more than 1 failure for 250 hours of cumulative file operation.

- 3.11.3 ^{Performance} ~~Acceptance~~ Test Error Rates

Following are the ^{performance and pre-delivery} acceptance test criteria for the ~~final predelivery~~ acceptance test performed at Data Products Corporation.

- 3.11.3.1 Incomplete Operation Error Rate

Not more than 1 in 2×10^4 operations.

- 3.11.3.2 Read Error Rate

Not more than 1 in 2×10^9 data bits transferred.

- 3.11.3.3 Write Error Rate

Not more than 1 in 10^{10} data bits transferred.

3.11.3.4 Failure Rate

Four. maximum

4.0 INTERFACE CHARACTERISTICS

4.1 Controller to Logic Unit Interface

4.1.1 Electrical Characteristics

All communication between Logic Unit and controller shall be by 0.5-microsecond pulses over twisted-pair transmission lines with a characteristic impedance of approximately 100 ohms, each twisted pair constituting one channel. The 0.5-microsecond pulse, $\pm 20\%$ at the 50% crossover point, shall have a rise time of 0.1 microsecond maximum and a fall time of 0.1 microsecond maximum.

The pulse amplitude shall be 5.5 ± 1.3 volts at the receiving end, and the noise shall have a rise time of less than 2 volts per microsecond. The aforementioned signal characteristics shall be over a maximum cable length of 100 feet between the Controller and the Logic Unit (interface). Data Products Corporation shall supply a termination plug with each Logic Unit.

4.1.2 Interface Pulse Signal Summary

4.1.2.1 The following 14 signal twisted pairs constitute the pulse interface. Each has the characteristics defined in paragraph 4.1.1.

Select
 Even Data ONE's (Address)
 Even Data ZERO's
 Odd Data ONE's (Address Termination)
 Odd Data ZERO's
 Ready (Clear)
 Alert
 Read
 Write
 Write Clock Odd
 Write Clock Even
 End
 Error
 Lockout Warning

4.1.2.2 Three additional signals are provided by relay closures:

Operable
Alarm
Master Clear

4.1.3 Interface Wiring (Controller to Logic Unit)

The cable between the Controller and the Logic Unit (supplied by the customer) shall be constructed in the following manner:

4.1.3.1 Signals shall be transmitted over pairs of twisted conductors.

4.1.3.2 Each Conductor shall be #18 AWG stranded wire covered with 600-volt insulation.

4.1.3.3 Each pair shall be twisted a minimum of 12 turns per foot of cable length.

4.1.3.4 Each twisted pair shall be terminated in the Controller by approximately 100 ohms.

The twisted pairs are grouped below together with the pin numbers on the connector in the Logic Unit (Connector J401 in Figure I).

B4	Alert	+	E1	Data '1' Odd/Address Termination	+
B2	Alert	-	D2	Data '1' Odd/Address Termination	-
C1	Select	+	E11	Data '1' Even (Adress)	+
C3	Select	-	D12	Data '1' Even (Address)	-
C5	Write Clock Odd	+	F2	Read	+
C7	Write Clock Odd	-	F4	Read	-
C9	Write Clock Even	+	F6	Write	+
C11	Write Clock Even	-	F8	Write	-
D4	Data '0' Odd	+	F10	End	+
E5	Data '0' Odd	-	F12	End	-
D14	Data '0' Even (Address)	+	H2	Ready/Clear	+
E15	Data '0' Even (Address)	-	H4	Ready/Clear	-

L1	Alarm	+	M2	Error	+
L3	Alarm	-	M4	Error	-
L5	Master Clear	+	S6	Operable	+
L7	Master Clear	-	S1	Operable	-
	U9	Write Lockout Warning			+
	U11	Write Lockout Warning			-

5.0 MAINTENANCE

5.1 Scheduled Maintenance

Routine scheduled preventive maintenance procedures will normally require about 8 man-hours per month. This maintenance should be performed by suitable trained and competent customer personnel. The schedule for routine preventive maintenance shall be in accordance with the preventive maintenance procedures recommended by Data Products in the instruction manual and Customer Information Bulletins.

5.2 Unscheduled Maintenance

The unscheduled maintenance will not normally exceed an average repair time of one hour per month per 5022 DISCFIL, if parts and maintenance personnel are available, *provided in any event, unscheduled maintenance is not to exceed two hours per month.*

5.3 Spare Parts

Spare parts will be functionally interchangeable with like assemblies, sub-assemblies, and replaceable parts as found within the system. They must also be physically interchangeable, one with another. A list of spare parts will be supplied to the customer.

One month is defined as four weeks of sixteen hours per day running time consisting of five days per week.