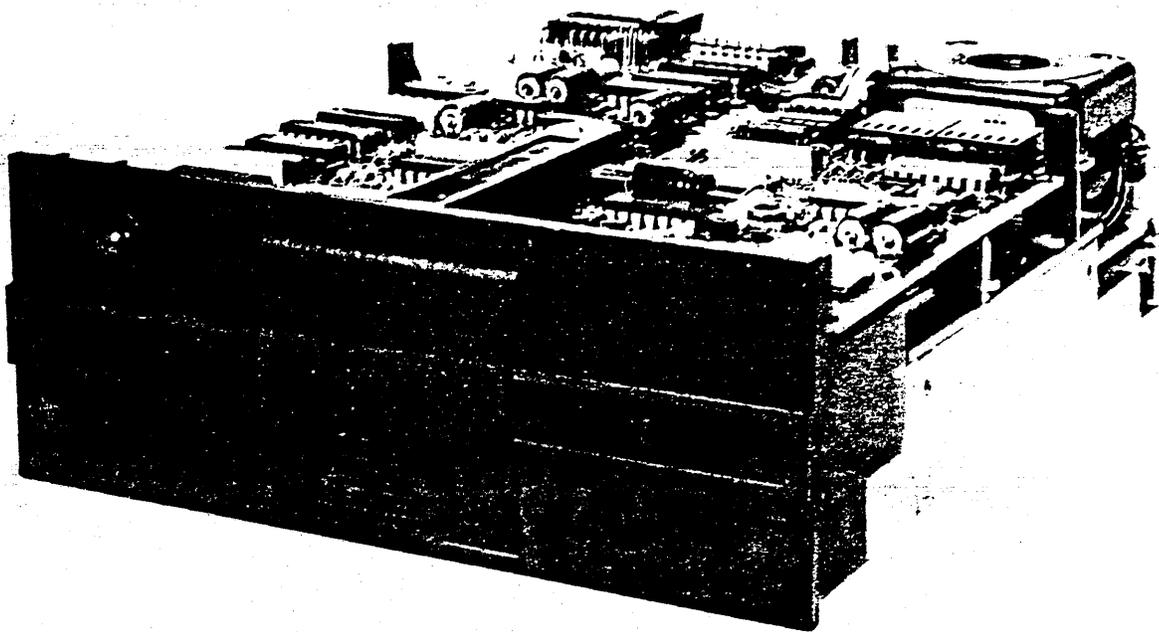


Remex

Product Reference Manual
and Performance Specifications



RFD480 Dual-Headed Flexible 5/4 Inch Diskette Drive, 48 TPI
RFD960 Dual-Headed Flexible 5/4 Inch Diskette Drive, 96 TPI



PRODUCT REFERENCE MANUAL

5-1/4 INCH FLEXIBLE DISK DRIVE

MODELS: RFD 480 and RFD 960

Ex-Cell-O Corporation

REMEX Division

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SECTION I

GENERAL DESCRIPTION

1.1 EQUIPMENT DESCRIPTION

The REMEX RFD480 and RFD960 diskette drives are small, direct access storage devices which utilize a removable flexible diskette as the storage medium. The standard slimline drive measures only 2.10 inches high by 5.75 inches wide thereby providing true slimline packaging. An optional bezel is available which measures 3.40 inches high. The drive consists of a spindle motor, two read/write heads and a split band stepping motor drive system for positioning the heads. The drive also uses light emitting diodes and phototransistors for index sensing, write control sensing and Track 00 detection, and two printed circuit boards to provide all required internal electronic functions. The RFD480 and RFD960 are similar units except for the density and capacity of each drive. The RFD480 has a recording density of 48 tracks per inch which provides up to 500 kbytes of unformatted data per diskette while the RFD960 has a recording density of 96 tracks per inch, thereby providing up to 1.0 Mbytes of unformatted data per diskette.

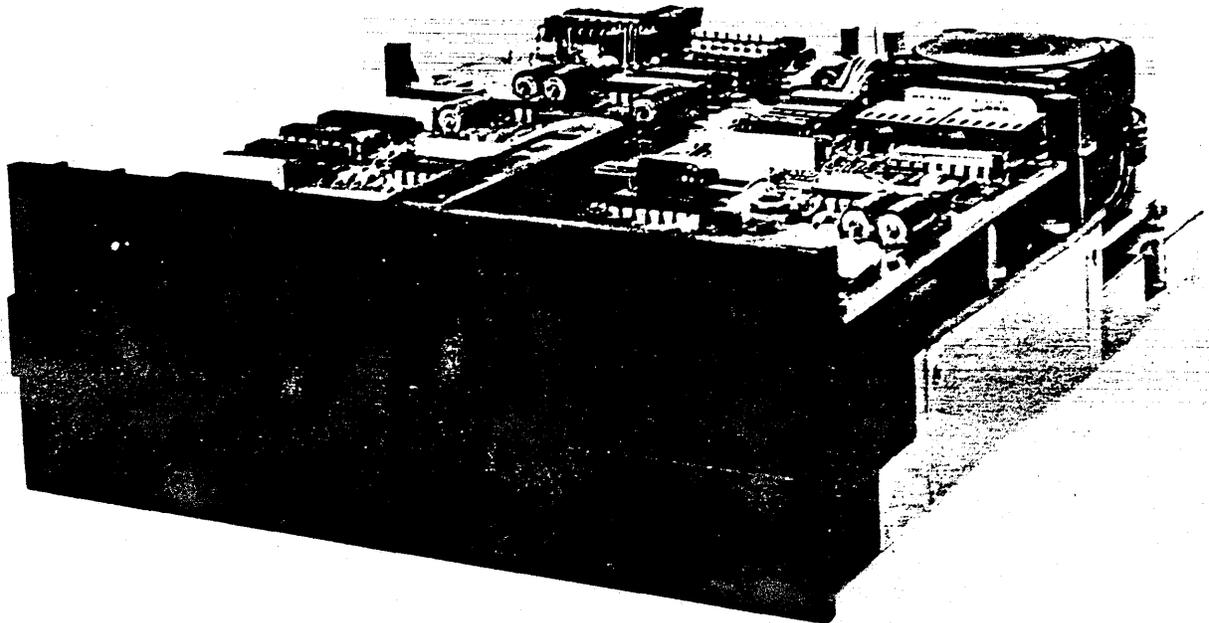


Figure 1-1. REMEX RFD960 Flexible Disk Drive.

Data is written on or read from the magnetic diskette surface by one of two read/write heads which are positioned to concentric tracks on the diskette surface by means of the stepper motor. The diskette spindle is driven at 300 RPM by a long life, direct drive, brushless DC motor.

The RFD480 and RFD960 are ANSI interface compatible as well as being compatible with many non - ANSI drives thru jumper options.

1.2 FEATURES

The following is a short summary of the features of the RFD480 and RFD960:

- a. Storage capacity of up to four times that of single sided, single density flexible 5-1/4 inch drives.
- b. Direct drive, brushless DC motor for longer life.
- c. Closed loop, speed control servo gives motor speed regulation of 1%. Improved speed control stabilizes the data stream and reduces jitter.
- d. Up to four drives may be daisy chained.
- e. Single or double density capability.
- f. 5 ms track - to - track access time.
- g. Customer selectable jumper options for drive select.
- h. An ANSI and industry compatible 5-1/4 inch drive.
- i. No head load solenoid is used which reduces media wear and damage from "tap,tap" loading in conjunction with a fast start/stop spindle motor.
- j. Improved clutch and spindle design ensures accurate media - to - spindle registration.
- k. Optical write control for reliable data security.
- l. Band drive positioning for fast and reliable data access.
- m. Electronic stepper motor damping shortens carriage settling time compared to mechanical damping techniques.
- n. Overall height of 2.10 inches for true slimline and low profile packaging.
- o. Low power consumption of 16.9 watts, maximum.
- p. Light weight of 3.0 lbs.

1.3 SPECIFICATIONS

Table 1-1 lists the specifications for the RFD960 and RFD480.

1.4 DISKETTE

The storage element used is a two - sided, removable, ferromagnetic coated flexible disk enclosed within a protective plastic jacket. See Figure 1-3 for an outline drawing of the diskette. The interior of the jacket is lined with a wiping material to clean the diskette of contamination. The diskette is always kept in a storage and traveling envelope to further protect the recording surface. Characteristics of the storage element are as follows:

Envelope Size:	5.25 x 5.25 ± 0.015 inch
Disk Diameter:	5.125 ± 0.003 inch
Track Width 96 TPI:	.00625 inches
Track Width 48 TPI:	.01300 inches
Track Spacing 96 TPI:	.01042 inches
Track Spacing 48 TPI:	.02083 inches

1.5 RELIABILITY

This section defines the long term unit reliability and data integrity of the diskette drive.

1.5.1 DESIGN LIFE

The drive is designed and constructed to provide a MTBF of 10,000 power on hours and a design life of 5 years. During the design life, repair or replacement of parts is permitted by the factory. The read head is designed for a minimum of 30,000 hours operation.

1.5.2 RECOVERABLE READ ERROR

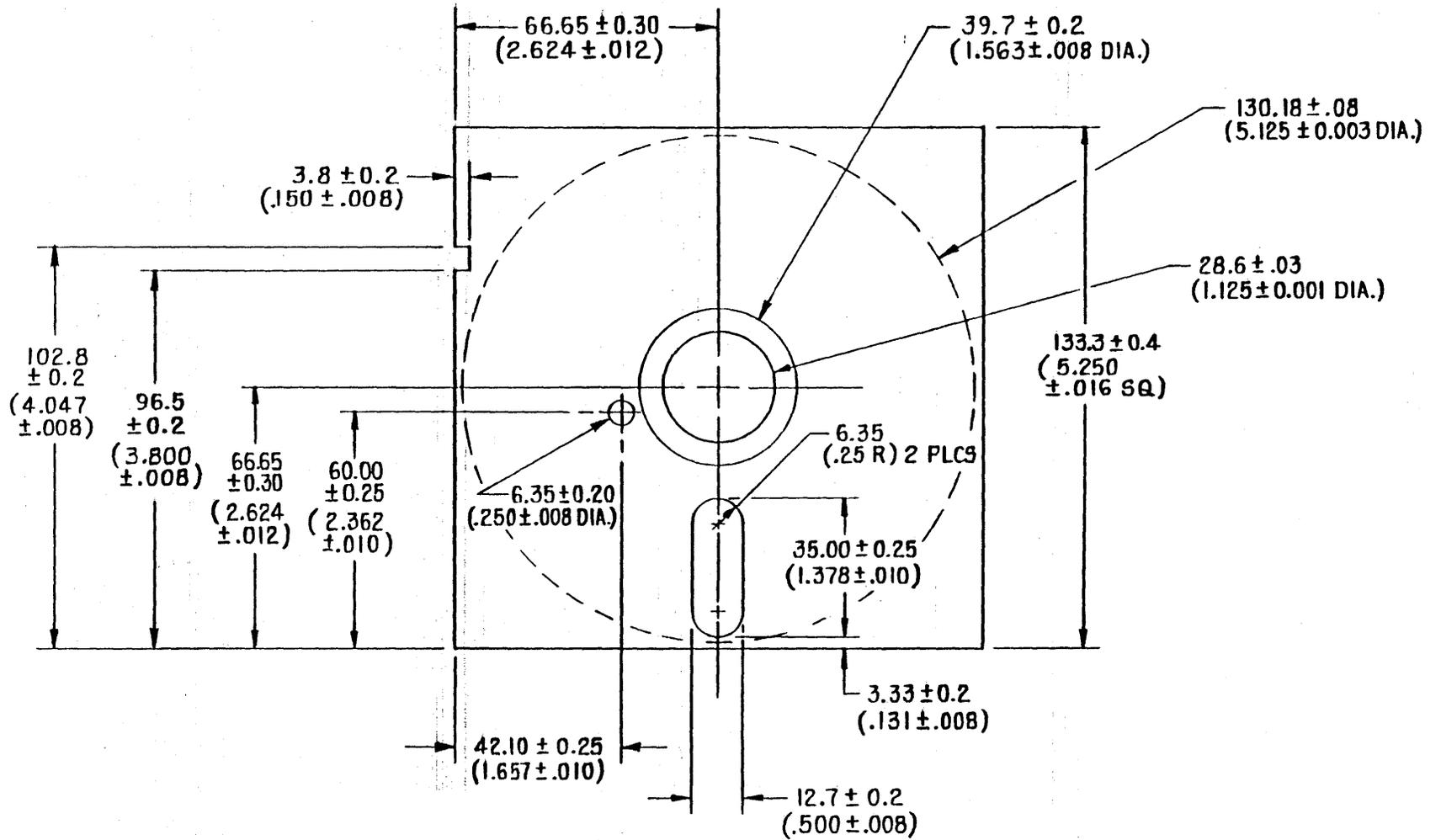
The recoverable read error rate is less than one error in 10^9 bits.

1.5.3 NONRECOVERABLE READ ERROR RATE

The nonrecoverable read error rate is less than one error in 10^{12} bits read. A read error is defined in Section 3. Errors attributed to the diskette are not included in determining the nonrecoverable read error rate.

Table 1-1. Specifications, RFD960 and RFD480.

Specification, Units - Dual Head SD = Single Density DD = Double Density	RFD480		RFD960	
	SD	DD	SD	DD
Unformatted Bytes Per Disk	250K	500K	500K	1.0M
IBM Format (16 Sectors/Track), Bytes Per Disk	163,840	327,680	327,680	655,360
Recording Density, BPI	2938	5876	2961	5922
Track Density, TPI	48	48	96	96
Number of Tracks Per Diskette	80	80	160	160
Transfer Rate, Bits/Sec.	125K	250K	125K	250K
Recording Method	FM	MF ² M ² FM	FM	MF ² M ² FM
Temperature:	Operating:	10°C to 50°C (40°F to 122°F)		
	Storage:	-34°C to 65°C (-30°F to 149°F)		
	Max. Wet Bulb:	29°C (85°F)		
Humidity:	Operating:	20% to 80%		
	Storage:	5% to 98% (No Condensation)		
Rotational Speed	300 rpm ± 1%			
Latency (average)	100 ms			
Track to Track:	5 ms max.			
Access Time (average including settling)	RFD480: 80 ms		RFD960: 147 ms	
Settling	15 ms max.			
Motor Start Time	200 ms max.			
Weight	3.0 lbs (1.4 Kg)			
D.C. Power Requirements	Average Operating: + 12 VDC ± 5%, 1.25 A, max. + 5 VDC ± 5%, 0.41 A, max. Current Surge: + 12 VDC, 1.65 A, max. + 5 VDC, 0.57 A, max.			
Power Dissipation	16.9 Watts (57.7 BTU/Hr) max.			
Dimensions See Installation Drawing, Figure 1-2	Height: 53.5 mm (2.11 in) Width: 146 mm (5.75 in) Depth: 203 mm (8.00 in)			



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Figure 1-3. Storage Element Physical Dimensions.

1.5.4 ACCESS POSITIONING ERROR RATE

The access mechanism positioning error rate is less than one error per 10^6 seek executions.

1.5.5 MEAN TIME TO REPAIR (MTTR)

The mean time to repair is 30 minutes when performed by a thoroughly trained technician.

1.6 RECORDING FORMAT

The format of the data recorded on the diskette is totally a function of the host system and can be designed to the user's application to take best advantage of the total available bit capacity of any one track or diskette. While many formats currently exist, the format described in Figure 1-4 was compiled from the ECMA standard TC19/80/7 as is presented as a representative sample.

DESCRIPTION	TRACK 00 SIDE 0 SINGLE DENSITY		ALL OTHER TRACKS MFM		
	BYTES	HEX	BYTES	HEX	
INDEX GAP	16	FF	32	4E	
E A C H S E C T O R • R E P E A T 15 T I M E S	SECTOR IDENTIFIER	6	00	12	00
	IDENTIFIER MARK	1	FE*	3	A1*
				1	FE
	CYLINDER ADDRESS	1	00	1	(1)
	SIDE NUMBER	1	00	1	00 or 01
SECTOR NUMBER	1	01-10	1	01-10	
4 th BYTE	1	00	1	01	
EDC	2	XX	2	XX	
IDENTIFIER GAP	11	FF	22	4E	
DATA BLOCK					
DATA MARK	6	00	12	00	
	1	FB*	3	A1*	
			1	FB*	
DATA FIELD	128	(1)	256	(1)	
EDC	2	XX	2	XX	
DATA BLOCK GAP	24	FF	48	4E	
TRACK GAP (AFTER 16 th SECTOR DATA BLOCK GAP ONLY)	(2)	FF	(2)	4E	

FE* = 11111110 with missing clock transitions of B₆, B₅ and B₄.

FB* = 11111011 with missing clock transitions of B₆, B₅, and B₄.

A1* = 10100001 with missing boundary transition between B₃ and B₄.

(1) = Required data or number.

XX = Error Detection Code (EDC) = $X^{16} + X^{12} + X^5 + 1$.

(2) = Writing of Track Gap takes place until Index Hole is detected.

Figure 1-4. ECMA Proposed Format For 5-1/4 inch Diskettes.

SECTION II

INSTALLATION AND INTERFACE

2.1 UNPACKING

To provide the most protection during transit, specially designed and reinforced packing cartons are used to ship the REMEX diskette drive. When removing the drive from the carton, lift the unit with both hands under it. Never lift or attempt to carry the drive by any of its components, drive door or other delicate parts. Carefully inspect the drive for any apparent damage as soon as it is removed from the carton. In the event the drive has been damaged as a result of shipping, the carrier and REMEX must be notified as soon as possible.

CAUTION

To prevent magnetization of the heads, it is important that during unpacking, installation and operation, that the read/write heads do not come in contact with stray magnetic fields.

Each drive is shipped with a dummy diskette inserted in the drive. This diskette should be removed after the drive is installed in the system.

2.2 MOUNTING

The unit may be installed and operated in either of two positions, i.e., horizontal front load or vertical front load. It should be placed in an environment so that the unit does not exceed the ambient temperature specifications listed in Table 1-1.

2.3 INITIAL ADJUSTMENTS AND OPTIONS

Each diskette drive has been accurately adjusted and aligned before leaving the factory. No adjustment or calibration should be required prior to installation or use. Five optional procedures (Sections 2.3.1 thru 2.3.5) are available to the customer as described below and must be performed as required before operating the drive.

2.3.1 LINE TERMINATOR

At location 12B on the Control Card, there is a removable resistor pack (220 Ω /330 Ω) installed as shipped from the factory. This resistor pack is for input line termination. If the drives are used in a daisy chain application, this resistor pack should be removed from all drives except the last drive on the daisy chain.

2.3.2 DRIVE SELECT JUMPERS

Four sets of pins (DS0-DS3) have been provided to select which Drive Select line will activate the interface signals for a unique drive. Each drive is shipped with a jumper installed at DS0 for selecting drive number 0. To change to another drive select number, remove the jumper and reinstall it as directed in Table 2-1.

Table 2-1. Drive Select Jumper Installations.

JUMPER	FUNCTION
DS0	Drive selected by Drive Select 0* input
DS1	Drive selected by Drive Select 1* input
DS2	Drive selected by Drive Select 2* input
DS3	Drive selected by Drive Select 3* input provided RDY is not jumpered (See Section 2.3.3).

2.3.3 READY SIGNAL OPTION

On drives using Drive Control Card 114761-001, a 0V static output can be provided on J1-6 as a Ready signal for those controllers that require this indication. This is accomplished by jumpering the RDY pins located below the DS0 - DS3 pins. When using this option, only three drives (DS0 - DS2) can be selected. On drives with the Drive Control Card 114861-001, a dynamic 'L' Ready signal is available at J1-34 and at J1-6 (provided RDY is jumpered as previously described for the static output). This signal indicates the drive is selected, DC power is applied and index pulse repetition rate is 200-300 ms (the spindle motor is rotating at 200-300 rpm or faster).

CAUTION

Either pin J1-6 or J1-34 should be used singularly as the Ready line. If J1-6 is used, J1-34 must not be terminated. If J1-34 is used, the RDY pins must not be jumpered.

2.3.4 MOTOR CONTROL OPTIONS

Jumpers A - D located on the Drive Control Card are used to operate the spindle and stepper motors as described in Table 2-2. Only one of the four combinations can be selected for any drive.

Table 2-2. Spindle and Stepper Motor Operation Options.

JUMPER	FUNCTION
A and D	Motor On* command turns on the spindle motor and any valid Drive Select energizes the stepper motor.
A and C	Motor On* command alone simultaneously turns on the spindle motor and energizes the stepper motor.
B and C	Any valid Drive Select* command alone simultaneously turns on the spindle motor and energizes the stepper motor.
A	Motor On* command only turns on the spindle motor. The stepper motor is always energized with the application of DC power to the drive.
B	Any valid Drive Select* Command alone simultaneously turns on the spindle motor. The stepper motor is always energized with the application of DC power to the drive.

2.3.5 WRITE PROTECT DEFEAT

In normal operation, write current through the R/W head is inhibited internally in the drive when a write protected diskette is installed. This can be defeated by cutting the trace coming from Z3C, pin 11 on the Drive Control Card.

2.4 SIGNAL CONVENTIONS

The following conventions are used throughout the manual to define the various signal mnemonics:

- a. 'H' represents a high voltage ($+ 2.5V \leq 'H' \leq + 5.25V$).
- b. 'L' represents a low voltage ($0V \leq 'L' \leq + 0.4V$).
- c. Rising edge represents a transition from 'L' to 'H'.
- d. Falling edge represents a transition from 'H' to 'L'.
- e. Mnemonic (signal name without asterisk) represents positive logic, i.e., 'H' is active and 'L' is inactive.
- f. Mnemonic* (signal name with asterisk) represents negative logic, i.e., 'H' is inactive and 'L' is active.
- g. Input line specifications are as follows:
 - 'L' = $0 \leq V \leq + 0.4$ @ 30 mA, max.
 - 'H' = $+ 2.5 \leq V \leq + 5.25$ @ 0 mA.
- h. Output lines are driven by open collector TTL gates with the following specifications:
 - 'L' = $0 \leq V \leq + 0.4$ @ 24 mA max.
 - 'H' = Open collector (250 μ A, max. @ 5.25 VDC).

2.5

POWER AND SYSTEM CONNECTIONS

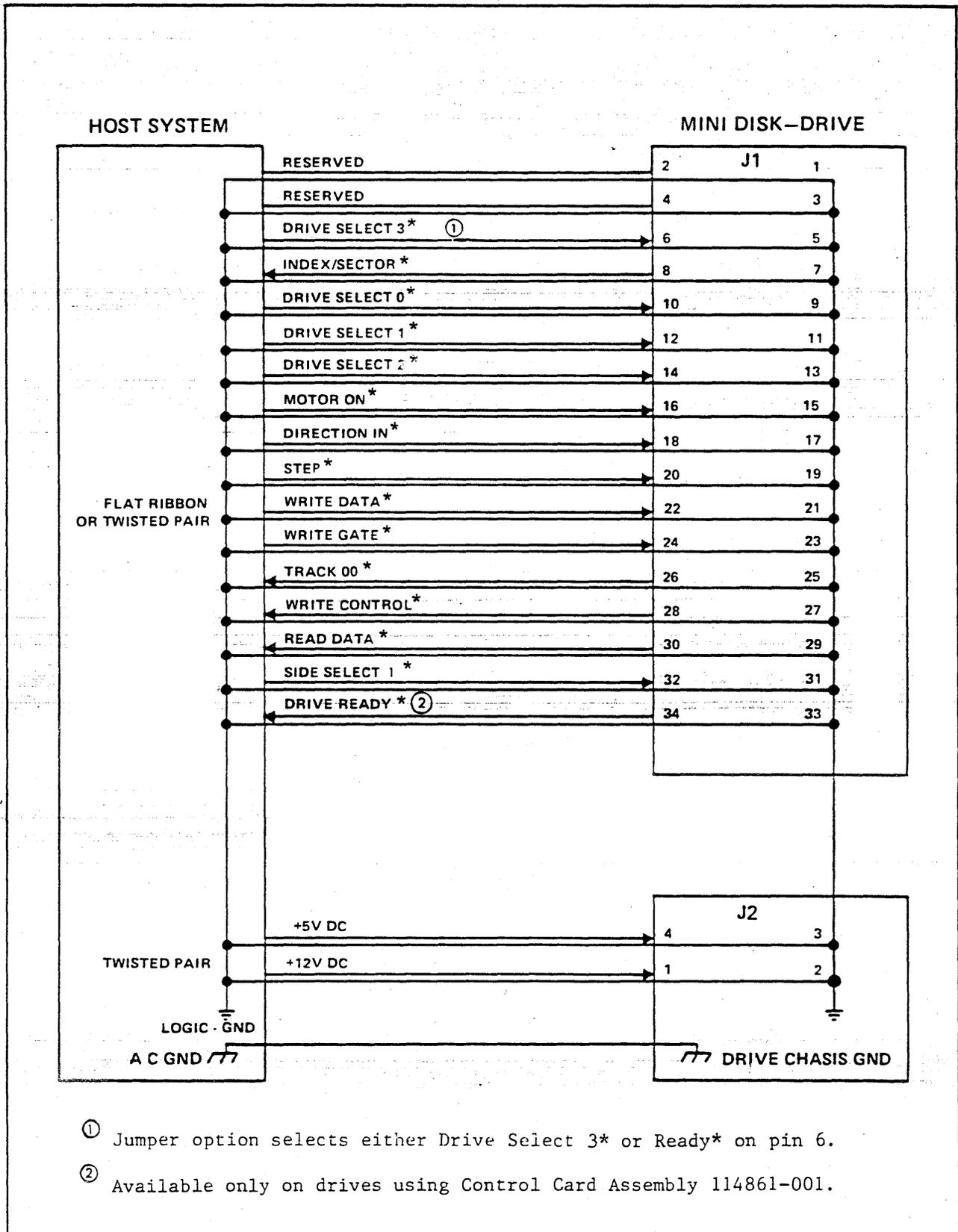
Figure 2-1 shows the pin assignments and the interface connections between diskette drive and the host system via connector J1 on the Drive Control P.C. Card. The figure also shows the pin assignments for the D C power at J2. No A.C. power is required. The physical locations of J1 and J2 are shown in Figure 2-2. The mating connector for J1 (not supplied) may be a Scotch - Flex Ribbon, 3M, P/N 3463-0001 (REMEX P/N 706510-347) or alternatively an AMP 583717-5 (REMEX P/N 706510-360) utilizing contact 1-583616-1 (REMEX P/N 706530-187) with twisted pair, No. 26 AWG wire. Figure 2-3 shows the recommended interface signal driver/receiver circuitry. The maximum recommended cable length between the host and drive is 10 feet.

D C power to the drive is via connector J2. Table 2-3 gives the D C power specifications. J2 is a four pin AMP connector 350211-1. The mating connector for J2 (not supplied) is an AMP 1-480424-0 (REMEX P/N 706510-348) utilizing AMP contacts 60619-1 (REMEX P/N 706530-114).

Table 2-3. D.C. Power Voltages

J2 PIN	DC VOLTAGE	MAXIMUM SPIKE MAXIMUM RIPPLE	MAXIMUM STEADY STATE CURRENT	MAXIMUM SURGE CURRENT
1	+ 12 VDC \pm 0.6 VDC	100 mv, pp	1.25 A	1.65 A
2	+ 12 VDC Return			
3	+ 5 VDC Return			
4	+ 5 VDC \pm 0.25 VDC	50 mv, pp	0.41 A	0.57 A

The drive and host system chassis may be connected to reduce noise pickup in the drive. An AMP Faston Connector, P/N 60972-1 using No. 18 AWG wire, minimum is recommended.



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Figure 2-1. Interface Signal Connections.

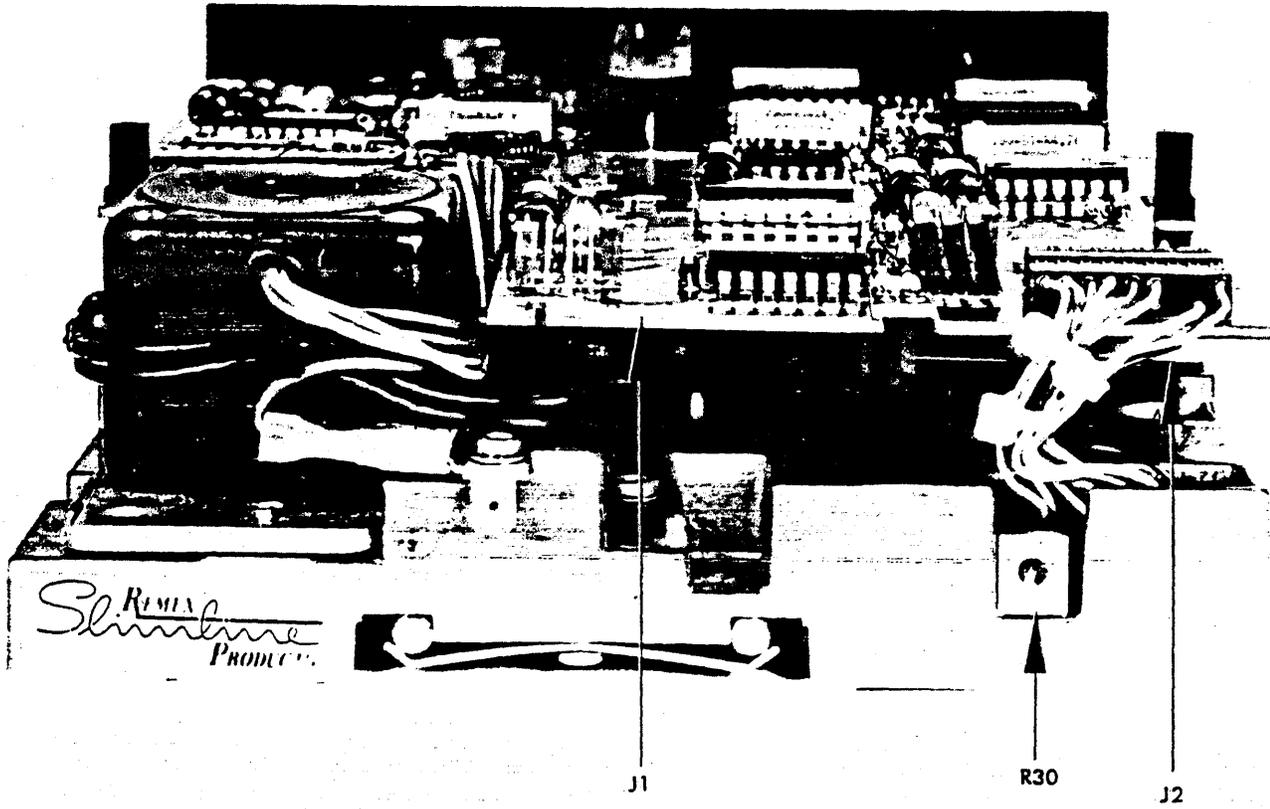


Figure 2-2. Interface Connector Locations

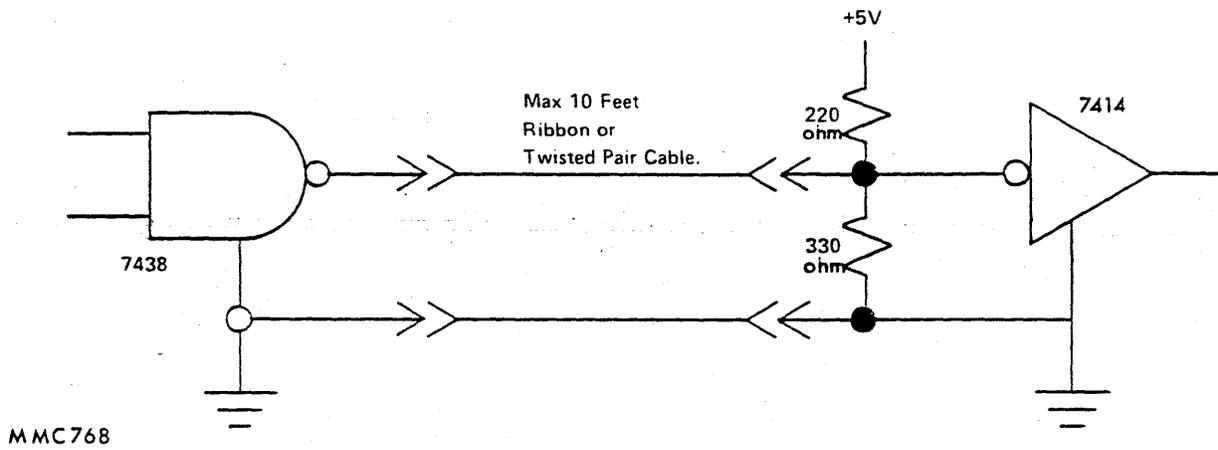


Figure 2-3. Recommended Interface Circuits.

SECTION III

OPERATION

3.1 I/O INPUT - OUTPUT SIGNALS

Section 2.5 and Table 3-1 describe the input/output signals routed through J1. Section 3.3 describes the various operations and timing required when operating the diskette drive. DC power is described in Section 2.5. No AC input is required. Signal level definitions are given in Section 2.4.

3.2 OPERATOR CONTROLS

The diskette drive is under full, automatic direction of a computer controller except for loading and unloading the diskette. A front panel indicator light indicates that the drive is selected. The only operator control is the front door mechanism which provides access to insert and remove diskettes. Section 3.3.3 describes the loading and unloading of a diskette.

3.3 LOADING AND OPERATING INSTRUCTIONS

The REMEX diskette drives are designed for ease of operator use. There are no complicated controls and indicators. The following sections outline the procedures for loading and operating the drive. Also included are some suggested software procedures for handling error conditions which might occur during writing or reading operations.

3.3.1 POWER UP MODE

Applying DC power and a Motor On* Command to the RFD960 and RFD480 requires that a 200 ms delay be introduced before any Read or Write operation is attempted. This delay is for stabilization of the diskette rotational speed. After powering on, the initial position of the R/W heads with respect to the data tracks is indeterminable when using an unformatted diskette. In order to assure proper positioning of the R/W heads prior to any read/write operation after powering on, a series of step out operations should be performed until the Track 00* signal is active. If the diskette is formatted, a read operation will identify the track position of the heads.

3.3.2 DISKETTE HANDLING

The diskette consists of the flexible disk encased in a plastic jacket. When not in use the diskette is always stored in a protective envelope.

An analogy of this protective storage envelope would be the same as the envelope used to store phonograph records used in your home. The storage envelope affords the same protection from dust and contaminants.

To protect the diskette, the same care and handling procedures specified for computer magnetic tape apply. These precautionary procedures are as follows:

- a. Return the diskette to its storage envelope whenever it is removed from file.
- b. Store diskettes vertically.
- c. Keep diskettes away from magnetic fields and from ferromagnetic materials which might cause magnetization. Strong magnetic fields can destroy recorded data on the disk.
- d. Replace storage envelopes when they become worn, cracked or distorted. Envelopes are designed to protect the diskette.
- e. Do not write on the diskette with a lead pencil or ball-point pen. Use a felt tip pen.
- f. Do not smoke while handling the diskette. Heat and contamination from a carelessly dropped ash can damage the disk.
- g. Do not expose diskettes to heat or sunlight. The read/write head cannot properly track a warped disk.
- h. Do not touch or attempt to clean the disk surface. Abrasions or foreign material from the hands may cause loss of stored data.

Table 3-1. Interface Connection Descriptions for J1.

Connector Pin ^①	Description ^②
J1-1, 2; 3, 4	Reserved
J1-5, 6; 9, 10; 11, 12; 13, 14	<p>Drive Select 3*, 0*, 1*, and 2* inputs, respectively. An 'L' signal is used to select one of four drives depending upon the line activated. To properly select a drive, the jumper for that drive must be installed as described in Section 2.3.2. Under normal operation, the Drive Select line will:</p> <p>(1) apply power to the stepper motor, (3) activate the output lines and (2) enable the input lines, (4) light the Activity LED.</p> <p>Power to the stepper motor can be optionally controlled as described in Section 2.3.4. Deactivation of the Drive Select* input must be delayed 935 us, min., following a Write operation to ensure that the track is fully tunnel erased. J1-6 can also be used as a static ground RDY output or a dynamic RDY output as described in Section 2.3.3.</p>
J1-7, 8	<p>Index/Sector* output. This 'L' signal is provided by the drive once each revolution of the diskette. The falling edge of the 'L' signal indicates the beginning of the track. To correctly detect Index* at the Host System, the Index* line is in the 'H' state until activated by the Drive Select*. The first falling edge, thereafter, indicates the first detection of Index*. When writing, the host should wait for the falling edge of the second Index* pulse.</p>
J1-15, 16	<p>Motor On* input. An 'L' signal activates the spindle motor. The 'H' signal prevents the spindle motor from running even when D.C. power is applied. Enabling the spindle motor can be can be optionally controlled as described in Section 2.3.4.</p>
J1-17, 18	<p>Direction In* input. This line defines the direction the read/write heads will move when the step line is pulsed. An 'L' signal will move the read/write heads in toward the center of the diskette on the rising edge of the Step* signal. An 'H' signal will move the read/write heads out away from the center of the diskette on the rising edge of the step signal.</p>
J1-19, 20	<p>Step* input. This line causes the read/write heads to move in the direction selected by J1-18, Direction In* line. The movement is initiated on the rising edge of the pulse. Any change in the Direction In* line must be made at least 1 us before the rising edge of the Step* pulse. If the movement is in the same direction, the minimum time between Step* pulses is 5 ms. If the Direction In* line is changed between Step* pulses, a 20 ms, min. delay is required between the rising edge of the Step* pulses. The minimum width of this pulse is 1 us.</p>
J1-21, 22	<p>Write Data* input. Data to be written on the diskette is transferred on this line. An 'L' level Write Gate* input at J1-23 will enable this line. Each transition from an 'H' level to 'L' level on this line will cause the current through the selected read/write head to be reversed.</p>
J1-23, 24	<p>Write Gate* input. An 'L' signal enables the Write Data* input line, allowing data to be written. An 'H' signal enables the read logic.</p>
J1-25, 26	<p>Track 00* output. An 'L' signal indicates that the read/write heads are located at track 00 and the stepper motor phases A and B are on. An 'H' signal indicates that the read/write head is not located at track 00.</p>
J1-27, 28	<p>Write Control* output. An 'L' signal indicates that the loaded diskette contains a covered ANSI Write protect notch, indicating that the diskette is write protected. An 'H' signal indicates that a diskette with an uncovered write protect notch has been inserted and writing may occur. This signal inhibits writing in the drive logic when the 'L' signal is present. The Write Protect feature can be defeated as described in Section 2.3.5.</p>
J1-29, 30	<p>Read Data* output. This line provides the composite clock and data signals as read directly from the diskette. An 'L' signal indicates a data or clock bit is present and an 'H' signal indicates the absence of data. The falling edge of the signal should be used for decoding the data stream.</p>
J1-31, 32	<p>Side Select 1* input. This line defines which side of the two sided diskette is to be used for reading or writing. An 'H' signal selects the read/write head on side 0. An 'L' signal selects side 1. When switching from one head to the other, a 4 us delay is required before any read or write operation commences. Changing the Side Select 1* input must be delayed at least 935 us following a write operation to ensure that the track is fully tunnel erased.</p>
J1-33, 34	<p>Ready* output. This output is available only on drives using Drive Control Card assembly 114861-001. An 'L' signal indicates that the drive is selected, D.C. power is applied and the index pulse repetition rate is 200 - 300 ms.</p>

① All odd pins on J1 are used as return lines.

② All signals on J1 are defined for negative TTL logic as described in Section 2.4. The mating connector for J1 is described in Section 2.5.

3.3.3 DISKETTE LOADING/UNLOADING

The following procedure should be followed when loading or unloading a diskette:

- a. Open the drive door by depressing the latch.
- b. Apply DC power to the drive.
- c. Select the drive to be used by using the appropriate Drive Select* signal. See Table 3-1.
- d. Activate the appropriate command to energize the drive motor. Refer to the jumper option description, Section 2.3.4 and Table 2-2.
- e. Carefully remove the diskette to be inserted from its storage envelope.

NOTE

When using a diskette containing the write protect notch, make sure the notch is covered if it is desired to protect the diskette data from accidental erasure and write-over. This will activate the Write Control output signal at J1-28. The host software should then process this signal and inhibit writing. However, the drive will inhibit write and erase current internally unless defeated by the trace cut described in Section 2.3.5. If writing is desired the notch must be uncovered.

- f. Insert the diskette into the drive with the label to the outside and facing up. See Figure 3-1. Exert inward pressure on the diskette until it stops. Close the door by pressing the latch shut.
- g. The drive may now be operated in any of the modes of operation described in Sections 3.3.4 thru 3.3.8.
- h. To unload the diskette, depress the door latch momentarily. The door will open and the diskette will eject approximately one inch for easy removal. Remove the diskette and return it to its protective envelope. Close the drive door.

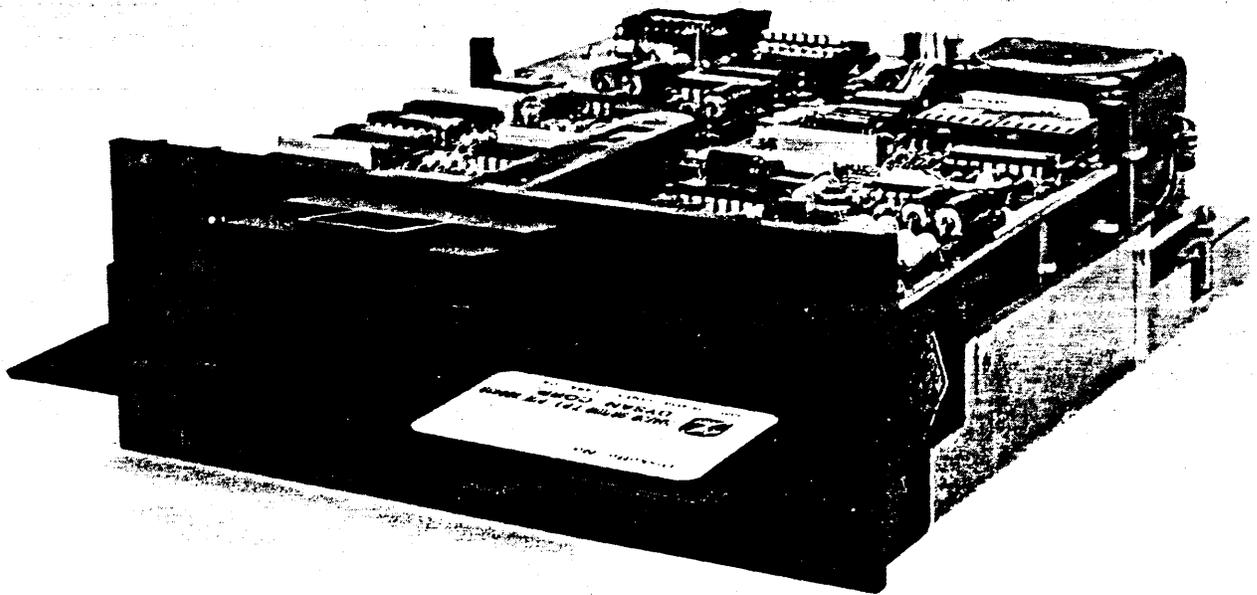


Figure 3-1. Diskette Insertion.

3.3.4 DRIVE SELECTION

Applying an 'L' signal to one of the four Drive Select* lines will enable the selected drive only. The position of the Drive Select jumper is used to select the number of the drive as described in Section 2.3.2. Only one line can be active at a time. The functions of the Drive Select line are the following:

- (1) enable the input lines,
- (2) activate the output lines and
- (3) illuminate the activity LED.

The stepper motor can be powered on using the jumpering option described in Section 2.3.4 item (2). Drive select timing is shown in Figure 3-2. Generally the Motor On* line is also activated before or when the drive is selected (depending on the option selected) so that a diskette can be inserted.

3.3.5 TRACK POSITIONING

The following sequence should be used when stepping from one track to another. Figure 3-2 shows the track access timing. If power has just been applied, the position of the read/write heads may not be known. If this is the case, the head should be stepped out until the Track 00* signal is in the 'L' state.

- a. Select the drive and apply power to the drive motor. See Sections 3.3.4 and 2.3.4.
- b. Place the Direction In* input in the 'L' state to move the head towards the center of the diskette or in the 'H' state to move the head out away from the center of the diskette.
- c. Apply a Step* pulse to the Step* line for each track to be stepped. It is important that the Direction In* line be in the desired state and be stable at least 1 μ s before the rising edge of the Step* pulse appears. If the Direction In* line is changed between Step* pulses, a 20 ms min. delay is required between the rising edge of the Step* pulses. The minimum width of the step signal is 1 μ s. See Figure 3-2. When going from a write to a step operation, a delay of 935 μ s, min. is required from the change in the Write Gate* line to the rising edge of the Step* pulse.

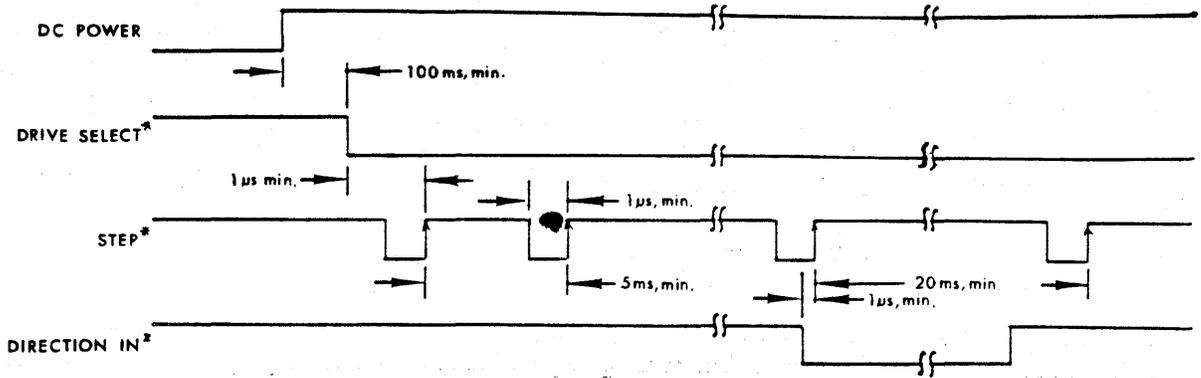
3.3.6 SIDE SELECTION

Applying an 'L' signal to the Side Select 1* line (J1-32) selects side 1 surface for reading or writing and applying an 'H' signal selects side 0. The side selection must be made 4 μ s minimum before the read or write operation in a read-to-read or a read-to-write mode. An additional delay of 935 μ s, minimum, is required when going from a write to a read or write operation to ensure that the written track is fully tunnel erased.

3.3.7 READ OPERATION

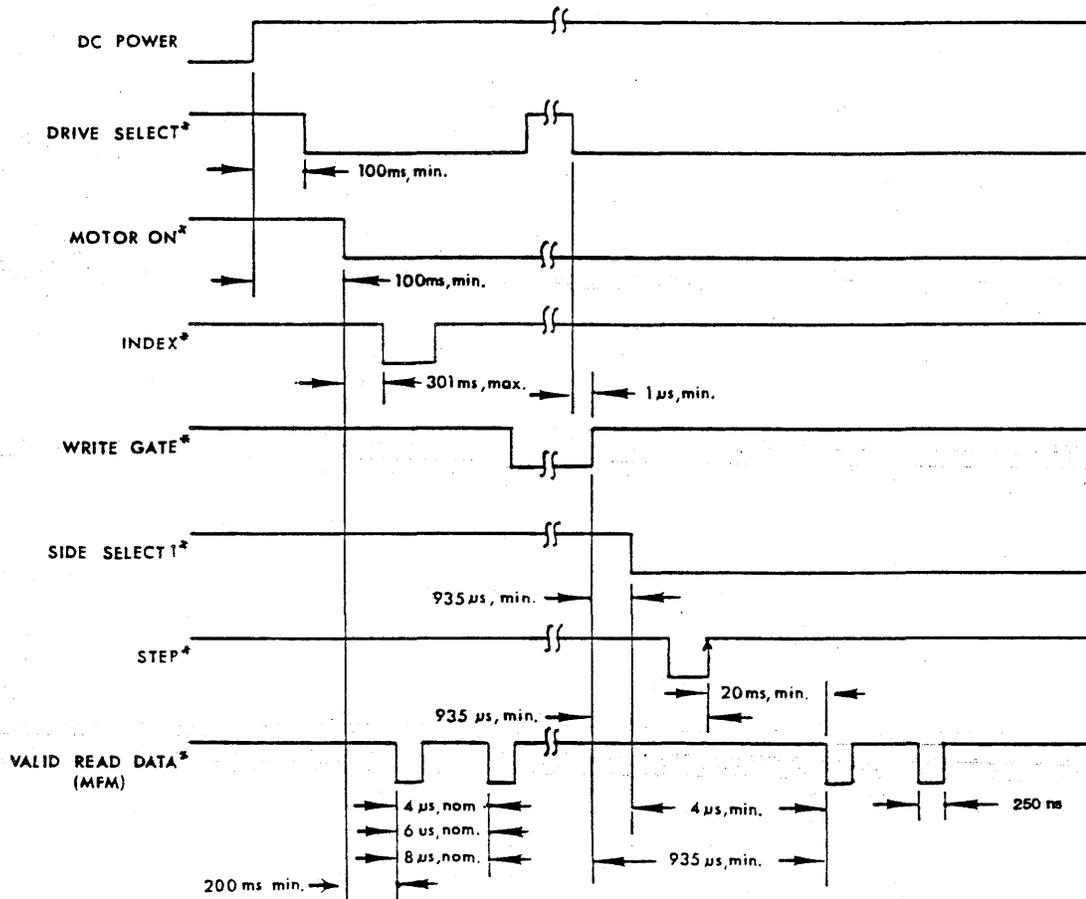
Figure 3-3 illustrates the read timing sequence. The following sequence should be followed:

- a. Place the desired Drive Select* and Motor On* lines in the active state. See Section 3.3.4.
- b. Make sure the Write Gate* input is in the 'H' state.
- c. Step the head to the desired track. See Section 3.3.5.
- d. Select the desired side. See Section 3.3.6.
- e. Valid read data will appear 200 ms after the Motor On* signal shown in Figure 3-3. When going from a write to a read operation, a delay of 935 μ s, min., is required from the change in the Write Gate* line to the first valid Read Data*. The read data is composite, i.e., composed of clock and data bits. For the MFM and M²FM codes, a phase lock oscillator (PLO) circuit is required to replace missing clock bits to the decoder.



MMC766

Figure 3-2. Track Access Timing.



MMC 764

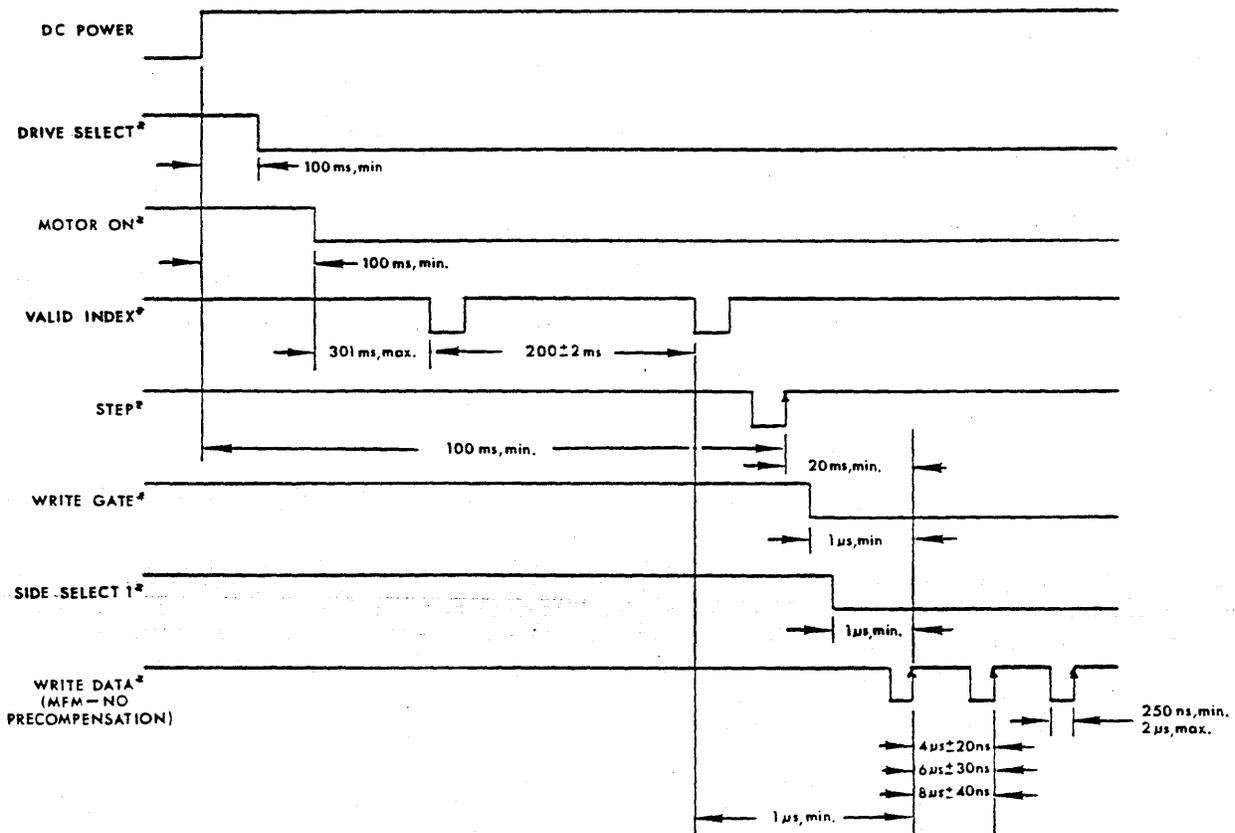
Figure 3-3. Read Initiate Timing (MFM Encoding).

3.3.8 WRITE OPERATION

Figure 3-4 illustrates the Write timing sequence. The following sequence should be followed:

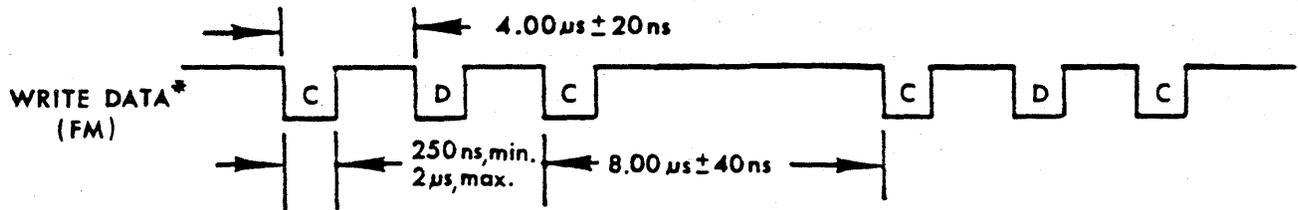
- a. Place the desired Drive Select* and Motor On* lines in the active state. See Section 3.3.4.
- b. Step the head to the desired track. See Section 3.3.5.
- c. Select the desired side. See Section 3.3.6.
- d. Place the Write Gate in the 'L' state. A 1 μ s min. delay is required after the desired side is selected before data can be written. See Figure 3-4.
- e. Apply the data to be written on the Write Data Input line after the required delays shown in Figure 3-4 have occurred. See Figure 3-5 for Write Data Timing using FM encoding.

Write data encoding can be FM, MFM or M²FM. If MFM or M²FM is used, the write data can be pricompenated to minimize the effects of bit shift. The amount and direction of compensation required for any given bit in the data stream depends on the pattern it forms with neaby bits. Recommended pre-compensation is 150ns or less.



MMC 763

Figure 3-4. Write Sequence Timing.



MMC 765

Figure 3-5. Write Data Timing (FM Encoding).

3.3.9 ERROR DETECTION AND CORRECTION

3.3.9.1 Write Error

If an error occurs during a write operation and is detected on the next revolution by doing a read operation, commonly called a "write check", the error can be corrected by doing another write and write check operation. If the write operation is not successful after 4 attempts have been made, that sector or track should be labeled defective and error correction should be attempted on another track. If the error still persists, the diskette should be considered defective and discarded.

3.3.9.2 Read Error

Most errors that occur will be "soft" errors, that is, by performing an error recovery procedure the data will be recovered.

Soft errors are usually caused by:

- a. Airborne contaminants that pass between the read/write head and the disk. These contaminants will generally be removed by the cartridge self - cleaning wiper.
- b. Random electrical noise which usually lasts for a few microseconds.
- c. Small defects in the written data and/or track not detected during the write operation which may cause a soft error during a read.

The following procedures are recommended to recover from the above mentioned soft errors.

1. Reread the track 10 times or until such time as the data is recovered.
2. If data is not recovered after using step 1, access the head To the adjacent track in the same direction previously moved, Then return to the desired track.
3. Repeat step 1.
4. If data is not recovered, the error is not recoverable.

Errors attributed to the diskette will not be included in determining the unrecoverable read error rate.

3.3.9.3 Seek Errors

Seek errors rarely occur unless the stepping rate of 5 msec is significantly exceeded. In the event of a seek error, recalibration of track location is achieved by positioning the read/write heads to Track 00 as described in Section 3.3.5.