SECTION I

GENERAL DESCRIPTION

1.1 EQUIPMENT DESCRIPTION

The REMEX RFD4000 and RFD4001 Diskette Drives are a small, portable, double-headed direct access storage devices which utilize a removable two-sided flexible diskette as the storage medium. See Figure 1-1. The mechanism consists of a belt driven spindle, spindle motor, two read/write heads and a split band stepping motor drive system for positioning the heads. The drive also uses a light emitting diode and phototransistor for index sensing, and a printed circuit board to provide all required internal electronic functions. The RFD4000 and RFD4001 are identical except the RFD4001 provides for data and clock separation from the data stream. The RFD2000 is identical to the RFD4000 except data is recorded only on one side; similarly the RFD2001 is identical to the RFD4001 for the same reason. All information given in this manual is identical to all four drives unless specifically noted.

Magnetic data is written on or read from the 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 belt driven at 360 RPM by a drive motor.

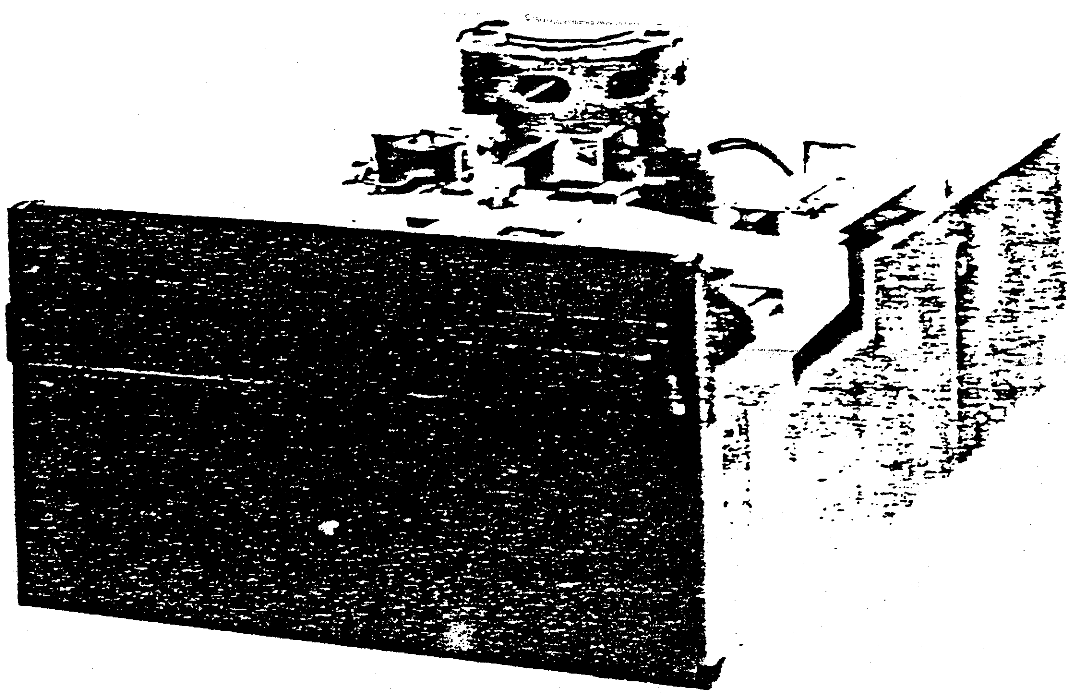


Figure 1-1. RFD4000 Diskette Drive. The RFD4001, RFD2000 and RFD2001 are Identical in Outward Appearance.

1.1.1 RFD4000 AND RFD2000 FEATURES

All units provide physical and electrical interface compatibility with the Shugart SA 850R/851R with the exception of the LOW CURRENT input which is used on the REMEX drives. The use of the LOW CURRENT input provides improved data integrity compared to similar models by other manufacturers. The RFD4000 and RFD4001 are media compatible with the single-sided IBM 33FD drives and two-sided IBM 43FD drives. Read/Write/Erase head geometry is identical to that in IBM diskette drives and the mechanism for positioning the head meets the precise requirements of track location, thereby allowing complete diskette interchangeability. For applications where IBM format compatibility is not a requirement, storage capacity may be increased by the use of hard-sectored diskettes or double density encoding. The drive employs specially designed electronics which allows data capacity of twice that used in single density recording techniques.

Drive select code circuitry is provided which allows the address code of an individual drive to be selected by a jumper. Up to four drives may be connected in parallel. This feature eliminates the unit select decode circuitry from the host system and makes it possible for the user to change the drive address without physically removing the drives and interchanging them. Unit select line features allows bussing of up to four drives on a ribbon cable.

The heads are ceramic and are positioned on a lightweight head carriage. The bottom head is fixed while the top head is mounted on a movable head load arm which provides less wear and higher overall reliability. Other features include automatic erase control which eliminates the need for erase gate electronics in the host system and a head load indicator, installed on the front panel, which is lit when the head is loaded.

1.1.2 RFD4001 AND RFD2001 FEATURES

The RFD4001 and RFD2001 contain the same features as described in Section 1.1.1 for the RFD4000 and RFD2000 except for a built in data and sector separator that provides separate output lines for sector signals when a 33 hole media is used and provides separate output lines for Data and Clock signals. In the RFD4000 and RFD2000 data and clock signals are contained in the Read Data output stream.

1.1.3 OPTIONS, FACTORY INSTALLED

The following options are available on all four model drives. A more complete description of each option is included in Section 3.5. In addition certain modifications are available for optional voltages and drive motors. See Section 1.8 and Table 1-2 which describes how these options are incorporated into the model number.

a. Modification for 100/115/230 VAC, operation of a synchronous motor.

1.1.4 OPTIONS, CUSTOMER INSTALLED

Several options can be implemented by the customer so that the diskette drives function differently than that described for the standard unit. Certain traces are added or subtracted and alternate I/O pins are used to implement these modifications. A shorting plug (AMP P/N 530153-2) is used in some cases as the connection. A 16-pin programmable shunt is provided for the eight most commonly used cut trace options. Section 3.6 describes in detail the various options available, as well as their installation. Table 3-2 lists the various options, their trace locations and how the circuit board is factory wired. It should be noted in those options that use the same traces and/or alternate I/O pins, only one option can be installed.

1.2 MAINTENANCE EQUIPMENT REQUIRED BUT NOT SUPPLIED

The maintenance procedures in Section 5 require equipment that is not supplied. This equipment is listed in Table 5-1.

1.3 EQUIPMENT WARRANTY

A statement covering the warranty of this equipment is given on page iii (second page in book). It should be read and understood. All preventive maintenance procedures must be performed as outlined in Section 5.2 during the warranty period in order that the warranty remain in effect. Any question arising concerning the warranty should be directed to the REMEX Service Department.

1.4 SPECIFICATIONS

The specifications for the four diskette drives are listed in Table 1-1.

Table 1-1. Specifications for the RFD4000, RFD4001, RFD2000 and RFD2001.

Characteristic	Specification
Capacity/Side	400K Bytes, single density, unformatted 800K Bytes, double density, unformatted 250K Bytes, IBM Format (26 sectors), single density 500K Bytes, IBM Format (26 sectors), double density
Recording Density	RFD400X: 3408 BPI, single density; 6816 BPI, double density. RFD200X: 3268 BPI, single density; 6536 BPI, double density.
Track Density	48 TPI
Number of Tracks	154 (77 each side)
Heads	2 (RFD4000, RFD4001); 1 (RFD2000, RFD2001).
Recording Method	FM, single density; MFM or M^2FM, double density
Rotational Speed	360 RPM
Transfer Rate	250K Bits/Sec, single density; 500K Bits/Sec, double density
Latency	83 ms, average
Access Time	3 ms, track to track; 15 ms, settle; 91 ms average (including settling).
Head Load Time	35 ms
Motor Start Time	2 sec
Media	REMEX recommended media only.
Error Rate	Read Error Rate (Recoverable): Less than 1 in 10^9 bits read. Read Error Rate (Non-Recoverable): Less than 1 in 10^{12} bits read. Seek Error Rate: Less than 1 in 10^6 seek operations.
MTBF	6000 power on hours
MTTR	30 minutes
Design Life	15,000 power on hours or 5 years
Media Life	3.5×10^6 passes/track
A.C. Power	95-127 VAC, 50/60Hz ± 0.5Hz at 0.4 Amps synchronous motor or 0.8 Amps shaded pole motor. 170-253 VAC, 50/60Hz ± 0.5Hz at 0.2 Amps. See Table 1-2 for voltage and frequency of a particular model.
D.C. Power	+24 Vdc ± 10% @ 0.6A, typical +5 Vdc ± 5% @ 1.0A, typical -7 to -16 Vdc @ 0.1A typical Optional -5 Vdc ±5% @ 0.05A typical
Temperature	$40^{\circ}F$ to $115^{\circ}F$, Operating $-30^{\circ}F$ to $150^{\circ}F$, Storage (without media)
Relative Humidity	20 to 80% Operating, without Condensation 5 to 95% Storage, without Condensation
Weight	13 lbs.
Outline Dimensions	See Figure 1-2.

1.5 DISKETTE

The storage element used is a two-sided ferromagnetic coated flexible disk enclosed within a protective plastic jacket. See Figure 1-3 for two sided diskette and Figure 1-8 for one sided diskette. The interior of the jacket is lined with a wiping material to clean the disk of contamination. The diskette is always kept in a storage and traveling envolope to further protect the recording surface. Characteristics of the storage element are as follows:

Track Width:	0.014 inch
Track Spacing:	0.02083 inch (48 tracks/inch)
Disk Diameter:	7.875 inches
Envelope Size:	8 x 8 inches

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 best take advantage of the total available bit capacity of any one track or diskette.

The following are four examples of data formatting:

Figure 1-4 shows the IBM track format.
Figure 1-5 shows a recording format using index recording.
Figure 1-6 shows a sample format used with MFM encoding. A discussion of MFM encoding is contained in Section 2.5.2.
Figure 1-7 shows a recording format used with a 32 sectored diskette.

1.7 MAINTENANCE AND RELIABILITY

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

1.7.1 DESIGN LIFE

The drive is designed and constructed, to provide a useful life of 15,000 power on hours or 5 years. During the useful life repair or replacement of parts is permitted. The read head is designed for a minimum of 30,000 hours operation.

1.7.2 RECOVERABLE READ ERROR

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

1.7.3 NON-RECOVERABLE READ ERROR RATE

The non-recoverable read error rate is less than one error in 10^{12} bits read. A read error is defined in Section 3.3.8.2. Errors attributed to the diskette are not included in determining the non-recoverable read error rate.

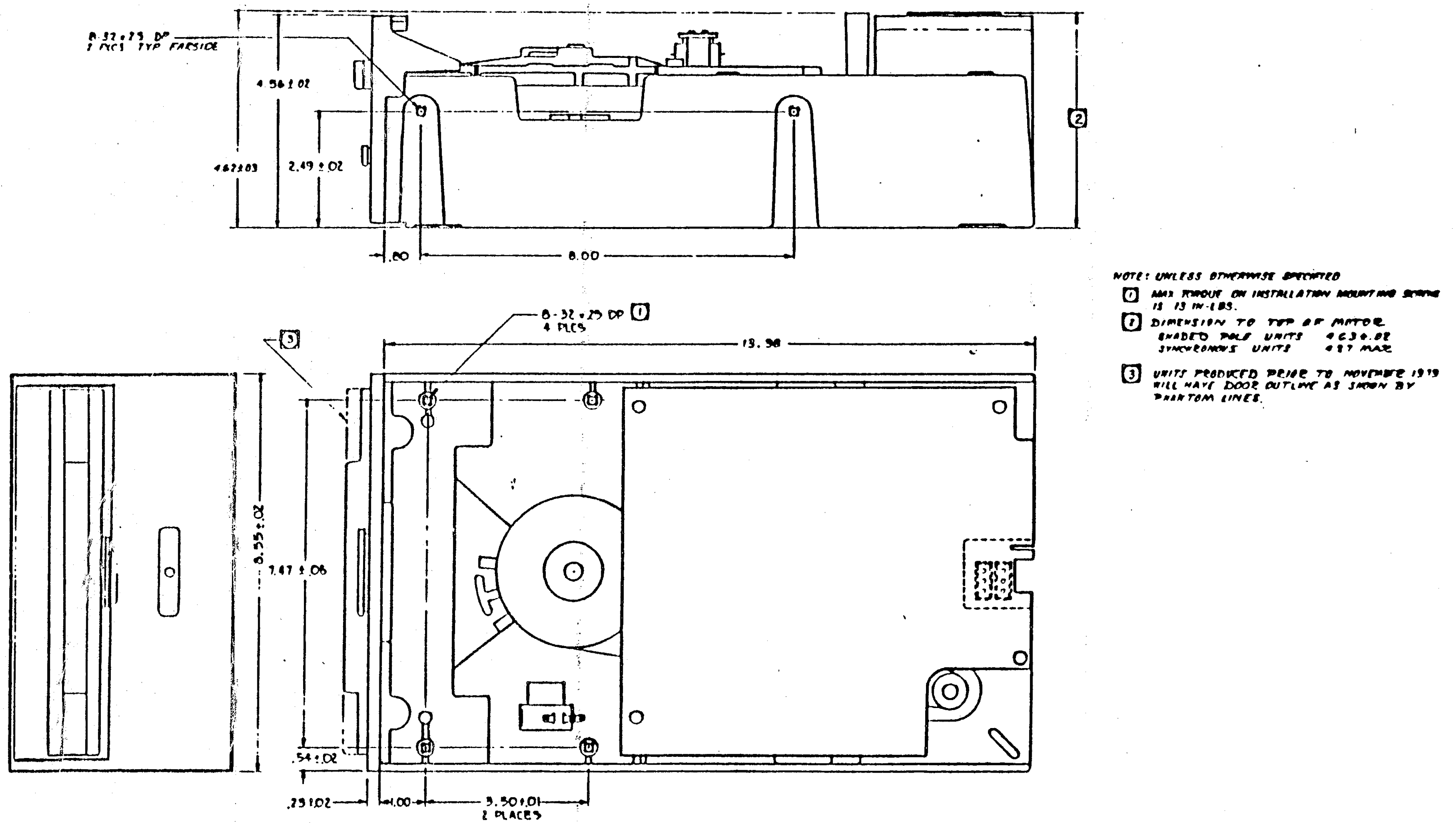
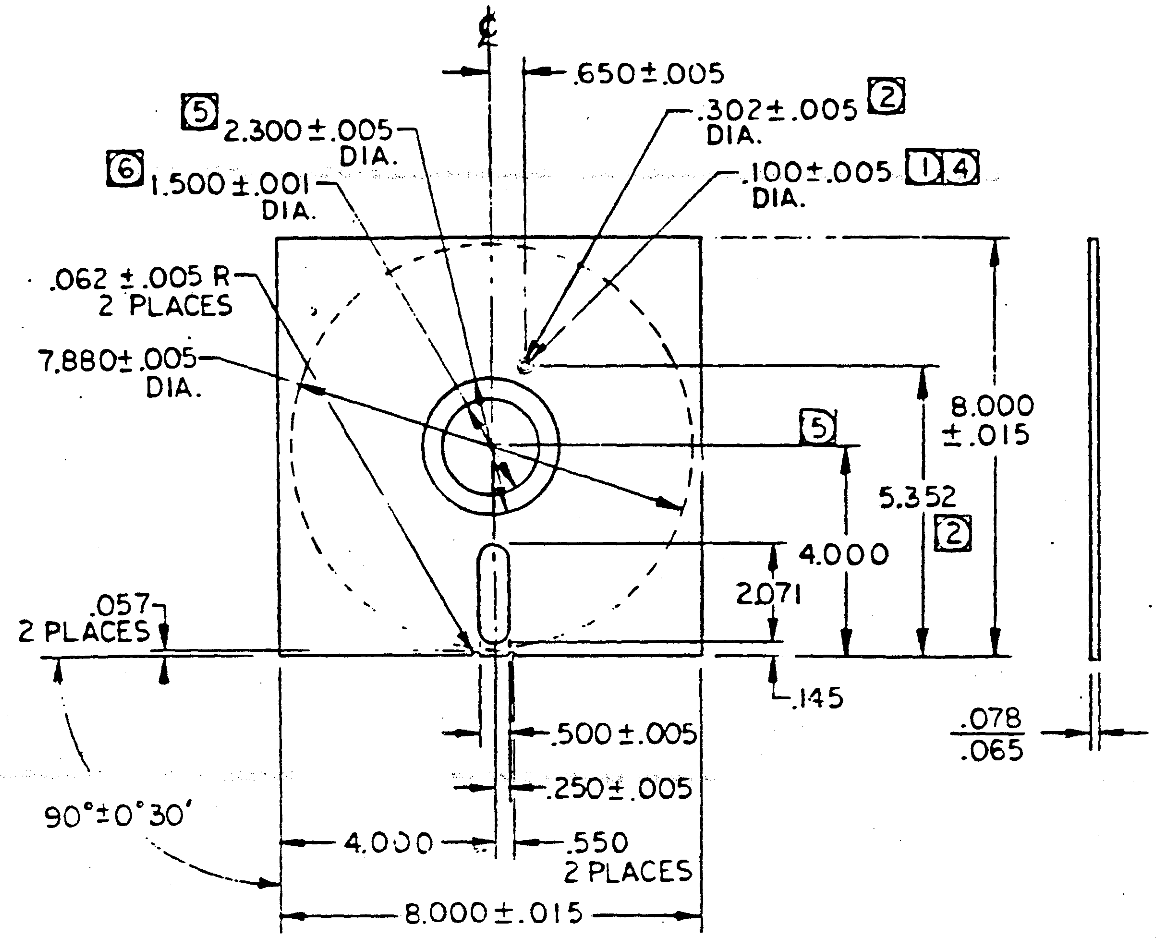


Figure 1-2. Installation Drawing, Models RFD4000, RFD4001, RFD2000 and RFD2001.



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1 INDEX HOLE IN DISK.

2 INDEX HOLE IN JACKET — BOTH SIDES.

3. ALL DIMENSIONS ARE ±.010 INCH UNLESS OTHERWISE INDICATED.

4 CENTER OF MOUNTING HOLE TO CENTER OF INDEX HOLE IS 1.500±.002 INCH.

5 MOUNTING HOLE IN JACKET — BOTH SIDES.

6 MOUNTING HOLE IN DISK.

Figure 1-3. Two Sided Storage Element Physical Dimensions.

		SINGLE DENSITY 26 SECTORS		SINGLE DENSITY 15 SECTORS		SINGLE DENSITY 8 SECTORS		DOUBLE DENSITY 26 SECTORS		DOUBLE DENSITY 15 SECTORS		DOUBLE DENSITY 8 SECTORS	
		#BYTES	HEX	#BYTES	HEX	#BYTES	HEX	#BYTES	HEX	#BYTES	HEX	#BYTES	HEX
TRACK INDEX FIELD	PREAMBLE	40 6	FF 00	40 6	FF 00	40 6	FF 00	80 12	4E 00	80 12	4E 00	80 12	4E 00
TRACK INDEX FIELD	TRACK MARK	1	FC CLOCK = D7	1	FC CLOCK = D7	1	FC CLOCK = D7	3 1	C2 (1) FC	3 1	C2 (1) FC	3 1	C2 (1) FC
TRACK INDEX FIELD	GAP 1	26	FF	26	FF	26	FF	50	4E	50	4E	50	4E
SECTOR FIELD	GAP 2	6	00	6	00	6	00	12	00	12	00	12	00
SECTOR FIELD	ADDRESS MARK	1	FE CLOCK = C7	1	FE CLOCK = C7	1	FE CLOCK = C7	3 1	A1 (2) FE	3 1	A1 (2) FE	3 1	A1 (2) FE
SECTOR FIELD	TRACK #	1	01-4C	1	01-4C	1	01-4C	1	01-4C	1	01-4C	1	01-4C
SECTOR FIELD	SIDE #	1	00-01	1	00-01	1	00-01	1	00-01	1	00-01	1	00-01
SECTOR FIELD	SECTOR #	1	01-1A	1	01-0F	1	01-08	1	01-1A	1	01-1A	1	01-08
SECTOR FIELD	SECTOR SIZE = 128 x 2^N	1	N = 00	1	N = 01	1	N = 02	1	N = 01	1	N = 02	1	N = 01
SECTOR FIELD	CRC-PREVIOUS 'Y' BYTES	2 Y = 5	XX	2 Y = 5	XX	2 Y = 5	XX	2 Y = 8	XX	2 Y = 8	XX	2 Y = 8	XX
SECTOR FIELD	GAP 3	11 6	FF 00	11 6	FF 00	11 6	FF 00	22 12	4E 00	22 12	4E 00	22 12	4E 00
SECTOR FIELD	DATA MARK	1	FB(3) CLOCK = C7	1	FB(3) CLOCK = C7	1	FB(3)	3 1	A1(2) FB(3)	3 1	A1(2) FB(3)	3 1	A1(2) FB(3)
SECTOR FIELD	DATA	128	E5	1 259	C4 5E	1 511	C4 5E	256	40	512	40	1024	40
SECTOR FIELD	CRC PREVIOUS 'Z' BYTES	2 Z = 129	XX	2 Z = 257	XX	2 Z = 513	XX	2 Z = 260	XX	2 Z = 516	XX	2 Z=1028	XX
SECTOR FIELD	GAP 4	27	FF	42	FF	58	FF	54	4E	84	4E	116	4E
	REPEAT SECTOR 'M' TIMES	M = 26		M = 15		M = 8		M = 26		M = 15		M = 8	
	TRAILING GAP 5	247	FF	170	FF	311	FF	598	4E	600	4E	654	4E

(1) Missing clock between bits 3 and 4.

(2) Missing clock between bits 4 and 5.

(3) This is F8 for deleted data or IBM calls it "control data" when used on T00 Side 0 Sector 8-26 and T00 Side 1 all Sectors. This is not applicable to the Data Warehouse.

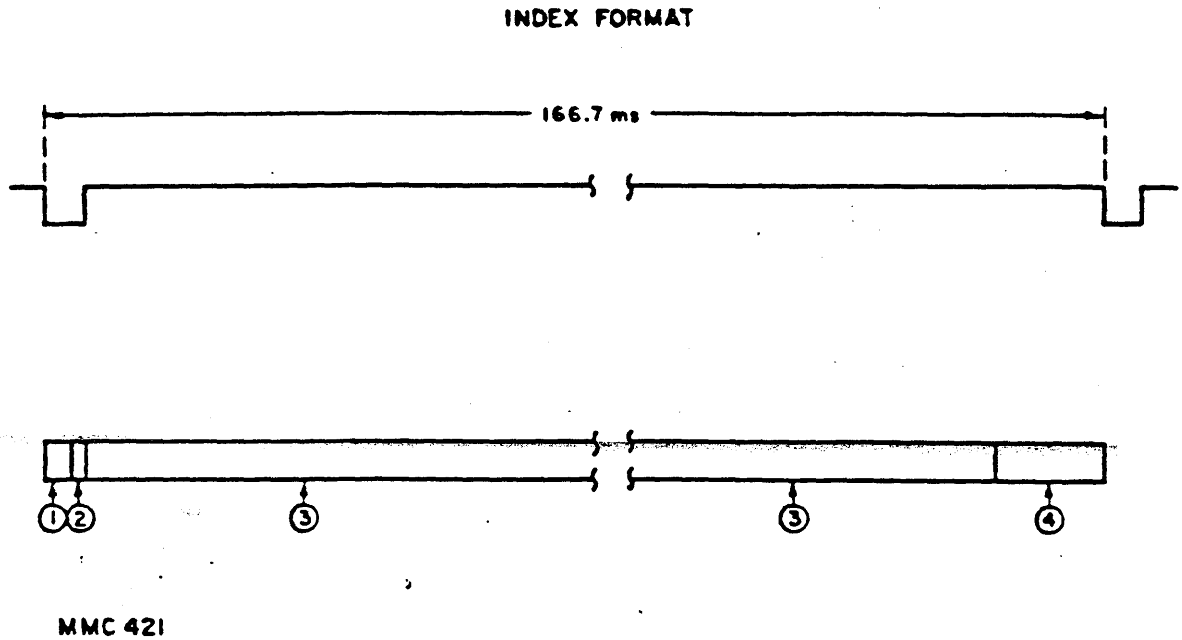
(4) Initialize parameters are estimated from other formats for which we have IBM Specs.

(5) Track 00 Side 0 is written similar to single density 26 sectors for all formats except data fields are different.

(6) Track 00 Side 1 is written in 26 sector pattern either single or double density to match rest of diskette.

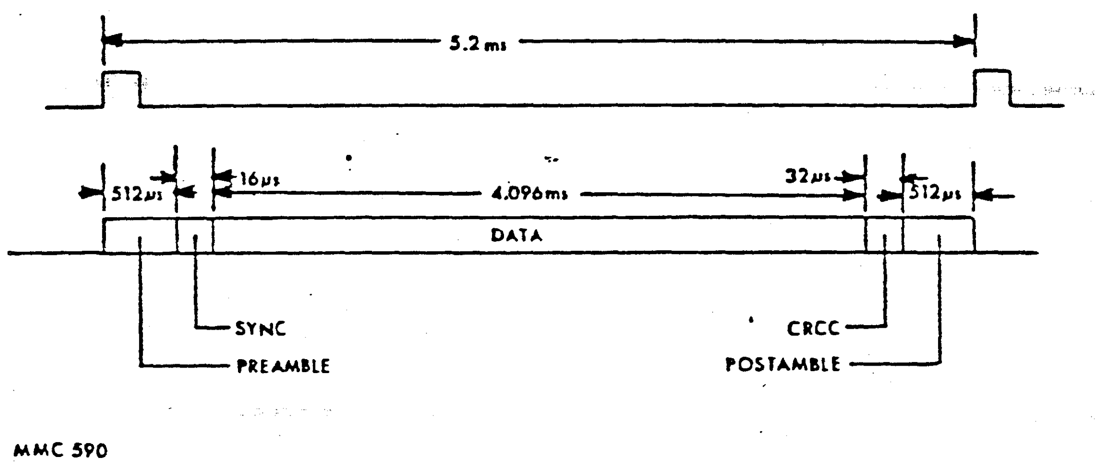
XX = CRC calculated by $1 + x^5 + x^{12} + x^{16}$

Figure 1-4. IBM Track Format. Hexidecimal Notation Used (X'00') In This Illustration.



1 Preamble = 175 Bits
2 Data Mark = 1 Byte
3 Data = 40,441 Bits
4 Postamble = 331 Bits

Figure 1-5. Recording Format Using Index Recording.



Preamble -7 words = 00_{16}
8th word = AA_{16}, AA_{16}
7.5 words = 00_{16}

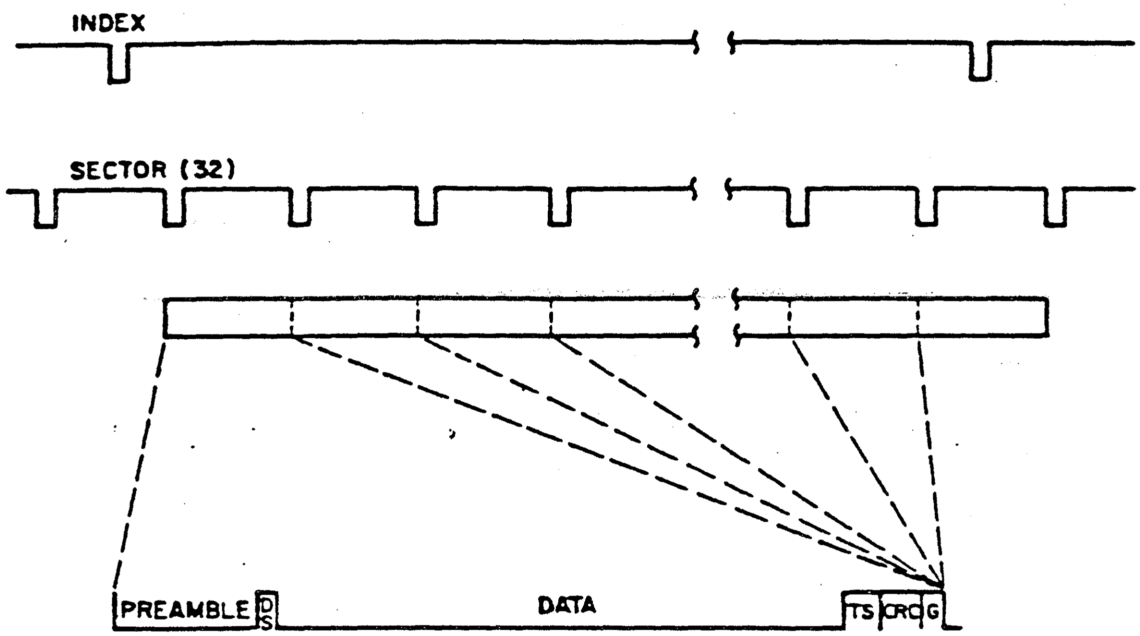
Sync - 1 Byte = FF_{16}

Data - 128 words

CRCC - 1 word

Postamble - 16 words = 00_{16}

Figure 1-6. A Recording Format for MFM Encoding.



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Preamble	= 22 Bytes '00'	32 Sector Data N	= 119 Bytes
Data Sync	= 1 Byte	16 Sector Data N	= 277 Bytes
Data	= N Bytes	8 Sector Data N	= 593 Bytes
Track and Sector	= 2 Bytes	4 Sector Data N	= 1237 Bytes
CRC	= 2 Bytes	2 Sector Data N	= 2488 Bytes
Guard	= 1 Byte		

Records/Track	Bits/Record	Bits/Track	Bits/Disk (77)
32	952	30,464	2,345,728
16	2,216	35,456	2,730,112
8	4,744	37,952	2,922,304
4	9,799	39,196	3,018,092
2	19,909	39,818	3,065,986

Figure 1-7. 32-Sector Format.

1.7.4 ACCESS POSITIONING ERROR RATE

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

1.7.5 INTERCHANGEABILITY

The RFD4000 and RFD4001 diskette drives are designed to be media interchangeable with all other RFD4000 and RFD4001 drives with the two side IBM 43FD drives and Shugart SA850R/851R drives and with single side drives including REMEX RFS12X0 and RFS1100 subsystems and REMEX 1111A, 1112A, 120X, RFS7400 and RFS7500 systems and the RFD1000 and RFD7401 drives. Similarly, the media for the RFD2000 and RFD2001 are interchangeable with the single sided IBM 33FD drives and Shugart SA 800R/801R drives and the aforementioned single sided REMEX drives and systems.

1.8 MODEL NUMBER DESIGNATION AND OPTIONS

The model number system is used for product identification. It includes a basic model series number which is followed by a virgule (/) and then a six digit number and finally a three digit dash number. The model number is used to code and identify a particular combination of options used in a given product line. This number is printed on the Identification Decal and is located on one of the rear surfaces. Those digits to the left of the virgule are the basic model series of the product line (RFD4000). The six digits to the right and the three dash numbers give the top assembly number of the product. The three digit dash number is unique for any particular combination of options and configurations used in the basic assembly. Table 1-2 lists the various assemblies possible and a description of option combinations used for each dash number. An X in a model number (as used in many parts of the manual, especially the parts list) denotes any of the letters or digits used in that space is applicable in the situation cited.

Table 1-2. Model Number Configurations

MODEL NUMBER	DESCRIPTION
(1) RFD4000/814080-001	Basic Drive, 115VAC, 60Hz (SP)
(1) RFD4001/814080-003	Basic Drive with Data Separator, 115VAC, 60Hz (SP)
(1) RFD4000/814090-001	Basic Drive, 100/115VAC, 50Hz (SY)
(1) RFD4000/814090-002	Basic Drive, 115VAC, 60Hz (SY)
(1) RFD4000/814090-003	Basic Drive, 220VAC, 50Hz (SY)
(1) RFD4001/814090-004	Basic Drive with Data Separator, 100/115VAC, 50Hz(SY)
(1) RFD4001/814090-005	Basic Drive with Data Separator, 115VAC, 60Hz(SY)
(1) RFD4001/814090-006	Basic Drive with Data Separator, 220VAC, 50Hz(SY)
(1) RFD4000/814090-007	Basic Drive, 115VAC, 60Hz, no P.C. Card.(SY)
(1) RFD4000/814090-008	Basic Drive, 220VAC, 50Hz, no P.C. Card.(SY)
RFD4000/814255-001	Basic Drive, 115VAC, 60Hz (SP)
RFD4001/814255-003	Basic Drive with Data Separator, 115VAC, 60Hz(SP)
RFD4000/814256-001	Basic Drive, 100/115VAC, 50Hz (SY)
RFD4000/814256-002	Basic Drive, 115VAC, 60Hz (SY)
RFD4000/814256-003	Basic Drive, 220VAC, 50Hz (SY)
RFD4001/814256-004	Basic Drive with Data Separator, 100/115VAC, 50Hz(SY)
RFD4001/814256-005	Basic Drive with Data Separator, 115VAC, 60Hz(SY)
RFD4001/814256-006	Basic Drive with Data Separator, 220VAC, 50Hz(SY)
RFD4000/814256-007	Basic Drive, 115VAC, 60Hz, no P.C. Card.(SY)
RFD4000/814256-008	Basic Drive, 220VAC, 50Hz, no P.C. Card.(SY)
RFD4000/814256-009	Basic Drive, 115VAC, 50Hz, no P.C. Card.(SY)
RFD4000/814256-010	Same as RFD4000/814256-001 except uses 114522-001 Door Latch Plate.
RFD4000/814256-011	Same as RFD4000/814256-002 except uses 114522-001 Door Latch Plate.
RFD4000/814256-012	Same as RFD4000/814256-003 except uses 114522-001 Door Latch Plate.
RFD4000/814256-013	Basic Drive 220V, 60Hz, Synchronous AC Motor.
RFD4001/814256-014	Basic Drive with Data Separator, 220VAC, 60Hz, Synchronous AC Motor.
RFD4000/814256-015	Same as RFD4000/814256-003 except uses 114810-001 Drive Motor Assembly.
RFD4001/814256-016	Same as RFD4001/814256-004 except uses 114810-001 Drive Motor Assembly.

(1) These are older units with aluminum casting and are not now available but listed for reference only.

SP = Shaded Pole AC Motor

SY = Synchronous AC Motor

Table 1-2. Model Number Configurations (Continued).

	MODEL NUMBER	DESCRIPTION
1	RFD2000/814225-001	Basic Drive, 115VAC, 60Hz(SP)
1	RFD2001/814225-003	Basic Drive with Data Separator, 115VAC, 60Hz(SP)
1	RFD2000/814226-001	Basic Drive, 100/115VAC, 50Hz (SY)
1	RFD2000/814226-002	Basic Drive, 115VAC, 60Hz(SY)
1	RFD2000/814226-003	Basic Drive, 220VAC, 50Hz(SY)
1	RFD2001/814226-004	Basic Drive with Data Separator, 100/115VAC, 50Hz(SY)
1	RFD2001/814226-005	Basic Drive with Data Separator, 115VAC, 60Hz(SY)
1	RFD2001/814226-006	Basic Drive with Data Separator, 220VAC, 50Hz(SY)
	RFD2000/814257-001	Basic Drive, 115VAC, 60Hz (SP)
	RFD2001/814257-003	Basic Drive with DAta Separator, 115VAC, 60Hz(SP)
	RFD2000/814258-001	Basic Drive 100/115VAC,50Hz (SY)
	RFD2000/814258-002	Basic Drive, 115VAC, 60Hz (SY)
	RFD2000/814258-003	BAsic Drive, 220VAC, 50Hz (SY)
	RFD2001/814258-004	Basic Drive with Data Separator, 100/115VAC, 50Hz(SY)
	RFD2001/814258-005	Basic Drive with Data Separator, 115VAC, 60Hz(SY)
	RFD2001/814258-006	Basic Drive with Data Separator, 220VAC, 50Hz(SY)
	RFD2000/814258-007	Basic Drive, 115VAC, 60Hz, no P.C. Card.(SY)
	RFD2000/814258-008	Basic Drive, 220VAC, 50Hz, no P.C. Card.(SY)
	RFD2000/814258-009	BAsic Drive, 115VAC, 50Hz, no P.C. Card.(SY)
	RFD2000/814258-010	Same as RFD2000/814258-001 except uses 114522-001 Door Latch Plate.
	RFD2000/814258-011	Same as RFD2000/814258-002 except uses 114522-001 Door Latch Plate.
	RFD2000/814258-012	Same as RFD2000/814258-003 except uses 114522-001 Door Latch Plate.
	RFD2000/814258-015	Same as RFD2000/814258-003 except uses 114810-001 Drive Motor Assembly.
	RFD2001/814258-016	Same as RFD2001/814258-004 except uses 114810-001 Drive Motor Assembly.

1 These are older units with aluminum casting and are not now available but listed for reference only.

SP = Shaded Pole AC Motor

SY = Synchronous AC Motor

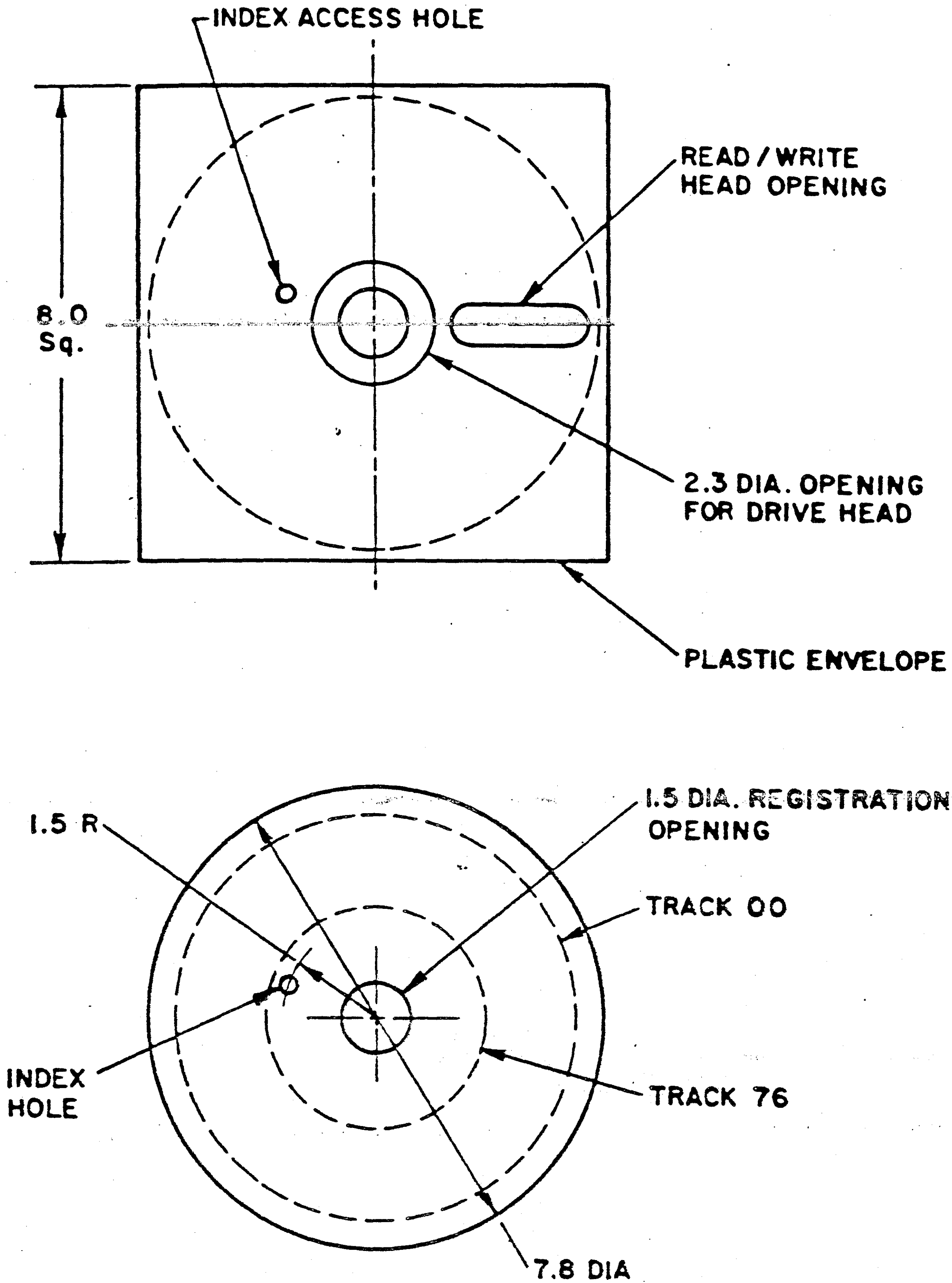

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Figure 1-8. Single Sided Storage Element Physical Dimensions.

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 Diskette Drive from the carton, lift the unit with both hands under it. Never lift or attempt to carry the unit by any of the covers, drive door or other delicate parts. Carefully inspect the unit for any apparent damage as soon as it is removed from the carton. In the event the equipment has been damaged as a result of shipping, the carrier and REMEX must be notified as soon as possible. Figure 2-0 (3 sheets; pages 2-2A, 2-2B and 2-2 C/D) provide instructions for packing and unpacking a REMEX drive.

CAUTION

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

2.2 MOUNTING

The drive is designed to operate in three planes: horizontal front load, vertical front load and vertical top load. Threaded holes in the main frame sides and on the bottom are provided for either slide or fixed mounting. See Figure 1-2. It should be placed in an environment so that the unit does not exceed the ambient temperature specification listed in Table 1-1.

2.3 INITIAL ADJUSTMENTS

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. Two procedures, however, must be completed by the customer as described below. Section 3.6 lists additional customer options which can be made.

2.3.1 LINE TERMINATOR

At location 7A on each drive, there is a removable resistor pack (220Ω/330Ω) installed as shipped from the factory. This resistor pack is for input line terminations. 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 interface line.

2.3.2 DRIVE SELECT JUMPERS

Traces DS1, DS2, DS3 and DS4 have been provided to select which Drive Select line will activate the interface signal for a unique drive. Each drive is shipped with the shorting plug installed at DS1 for selecting drive number 1. To change to another drive select number, remove the shorting plug and re-install it on the DS number desired.

2.4 POWER AND SYSTEM CONNECTIONS

Figure 2-1 shows the connections between the diskette drives and the host system via connectors P1/J1, P8/J8, and P5/J5. Data, control and status signals are routed through J1 and DC power is routed through J5. I/O cables must not exceed 10 feet in length. AC power is connected to a three contact jack (J8) illustrated in Figure 2-2. Table 2-1 gives the recommended mating connectors for J1, J8 and J5. Table 3-1 describes the interface signals. Figure 2-3 gives recommended interface circuits. The mating connectors are available in the form of a kit of parts. Order RMF0020 for connectors and manual or RMF0021 for connectors without manual. See Table 7-7.

CAUTION

> Always consult the serial number tag and TB1 wiring (if applicable) for the proper voltage and frequency to be used as coded in the model number. See Section 1.8 and Table 1-2. Failure to do so could result in damage to the unit. If another A.C. voltage or frequency is required, conversion kits are available as described in Section 2.4.1.

Table 2-1. Recommended Connectors P1, P8 and P5

Connector	Cable Type	Manufacturer	Connector P/N	Contact P/N
P1	Twisted Pair #26	Amp	1-583717-1	583616-5 (Crimp) 583854-3 (Solder)
	Twisted Pair #26	Viking	3VH25/1JN-5	NA
	Flat Cable	Amp	88077-1	Polarizing Key 88113-1
P8	NA	Amp	1-480700-0	350550-1
P5	NA	Amp	1-480270-0	60619-1

2.4.1 OPTION VOLTAGE AND FREQUENCIES

Table 7-7 lists various conversion kits which are available in the event a particular drive requires a different voltage and/or frequency. Each conversion kit contains an instruction drawing which describes the changes.

UNPACKING INSTRUCTIONS

1. SET CARTON ON A FLAT SURFACE.

2. REMOVE STAPLES (Figure 1).

3. SLIDE OUT INNER BOX (Figure 2).

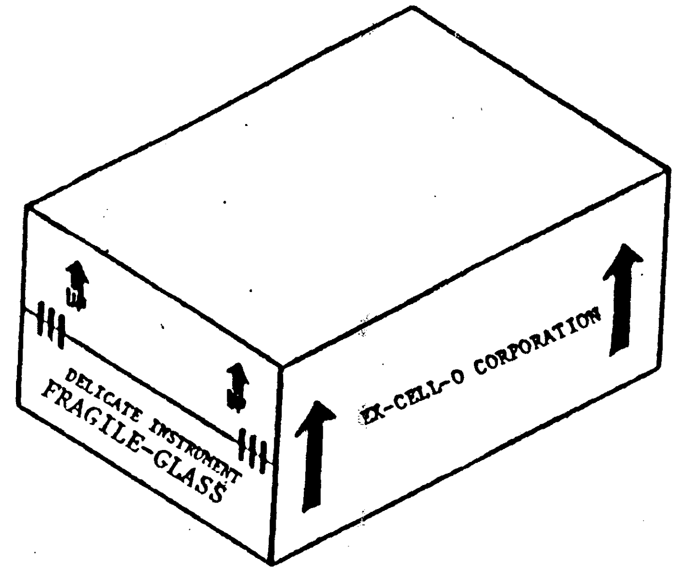


FIGURE 1

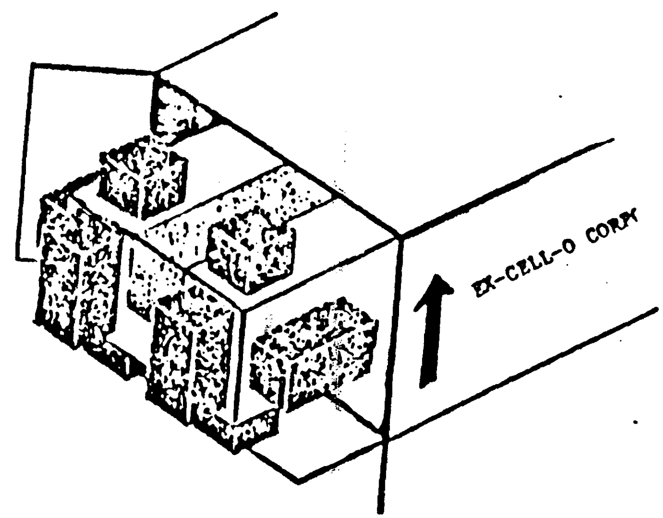


FIGURE 2

Figure 2-0, sheet 1. Unpacking/Repacking Instructions.

4. REMOVE TAPE FROM INNER BOX AND SPREAD OUT BOX (Figure 3).

5. REMOVE PLASTIC BAG COVERING DISK DRIVE (Figure 4).

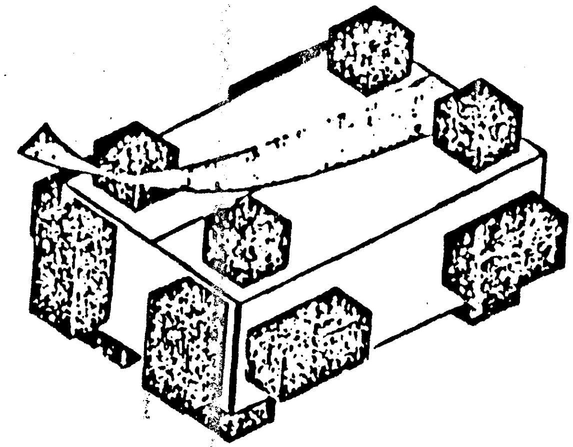


FIGURE 3

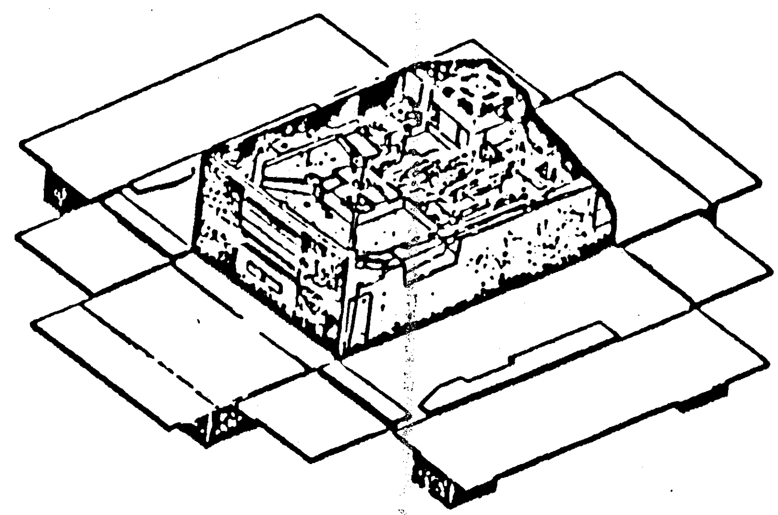


FIGURE 4

Figure 2-0, sheet 2. Unpacking/Repacking Instructions.

6. REMOVE FOAM PAD PROTECTING DISK HEAD AND THE STOP HOLDING DOOR.
SLIDE OUT DUMMY DISK (Figure 5).

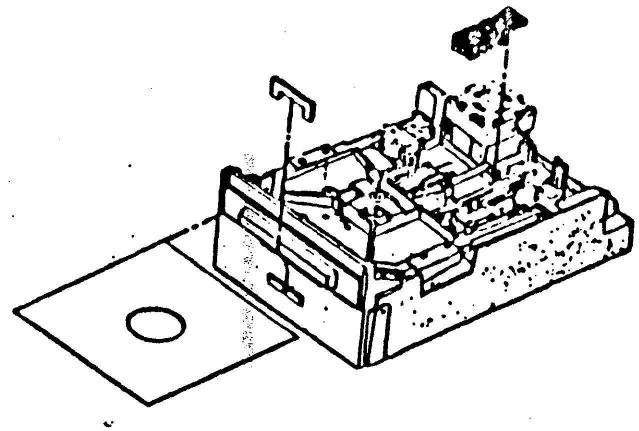


FIGURE 5

REPACKING INSTRUCTIONS

1. ADD FOAM PAD TO PROTECT DISK HEAD, SLIDE IN DUMMY DISK AND THE STOP HOLDING DOOR. INSERT INTO PLASTIC BAG.
2. PLACE UNIT IN INNER BOX. FOLD UP INNER BOX AND TAPE (Figure A).
3. SLIDE INNER BOX INTO SHIPPING CONTAINER (Figure B).
4. TAPE SHIPPING CONTAINER FOR RETURN TO REMEX (Figure C).

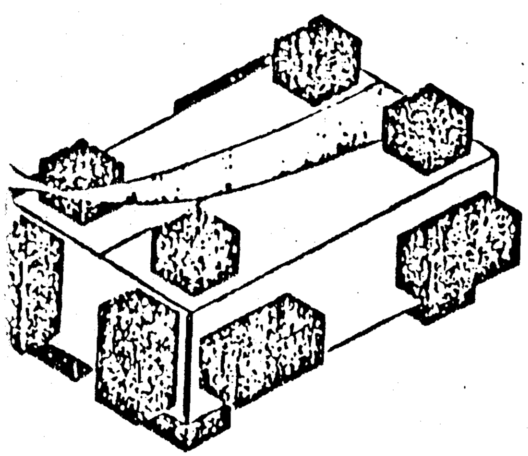


FIGURE A

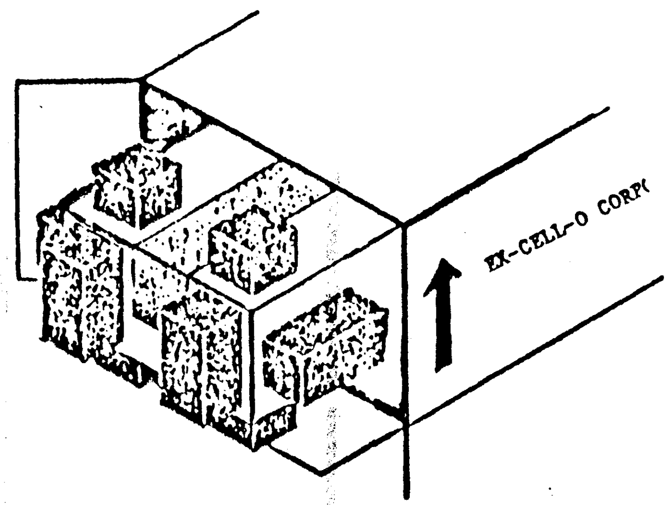


FIGURE B

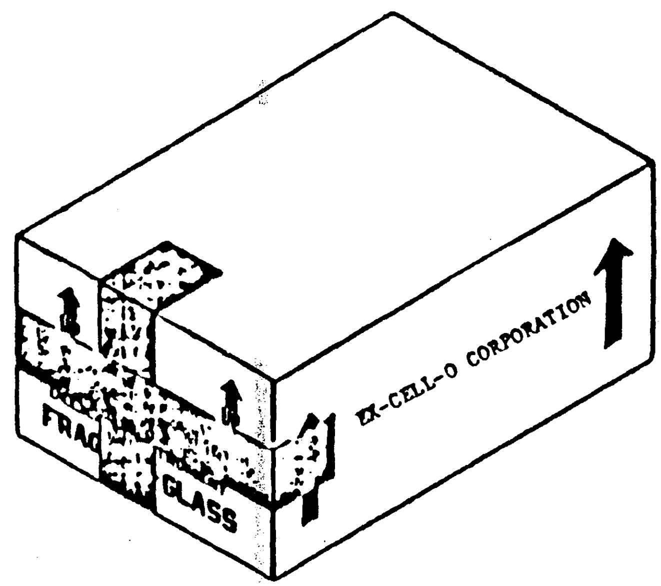


FIGURE C

Figure 2-0, sheet 3. Unpacking/Repacking Instructions.

J1	
(1) 1,2	Low Current
3,4,5,6,7,8	Alternate Pins for Customer Installed Options
9, 10	Two-Sided (RFD4000 and RFD4001 Only)
11,12	Disk Change
13,14	Side Select (RFD4000 and RFD4001 Only)
15,16	In Use
17,18	Head Load
19,20	Index
21,22	Ready
23,24	Sector (RFD4001 and RFD2001 Only)
25,26	Drive Select 1
27,28	Drive Select 2
29,30	Drive Select 3
31,32	Drive Select 4
33,34	Direction Select
35,36	Step
37,38	Write Data
39,40	Write Gate
41,42	Track 00
43,44	Write Protect
45,46	Read Data
47,48	Separate Data (RFD4001 and RFD2001 Only)
49,50	Separate Clock (RFD4001 and RFD2001 Only)

J5	
1	+24 Vdc
2	-24 Vdc Return
3	-5 Vdc Return
4	-7 to -16 Vdc (-5V Option)
5	+5 Vdc
6	+5 Vdc Return

J8	
1	AC Input
2	Frame Ground
3	AC Input

(1) All odd pins for J1 are used as return lines.

See Table 3-1 for description of all signals. See Section 3.6 for description of customer installed options.

Figure 2-1. Interface Signal Connections.

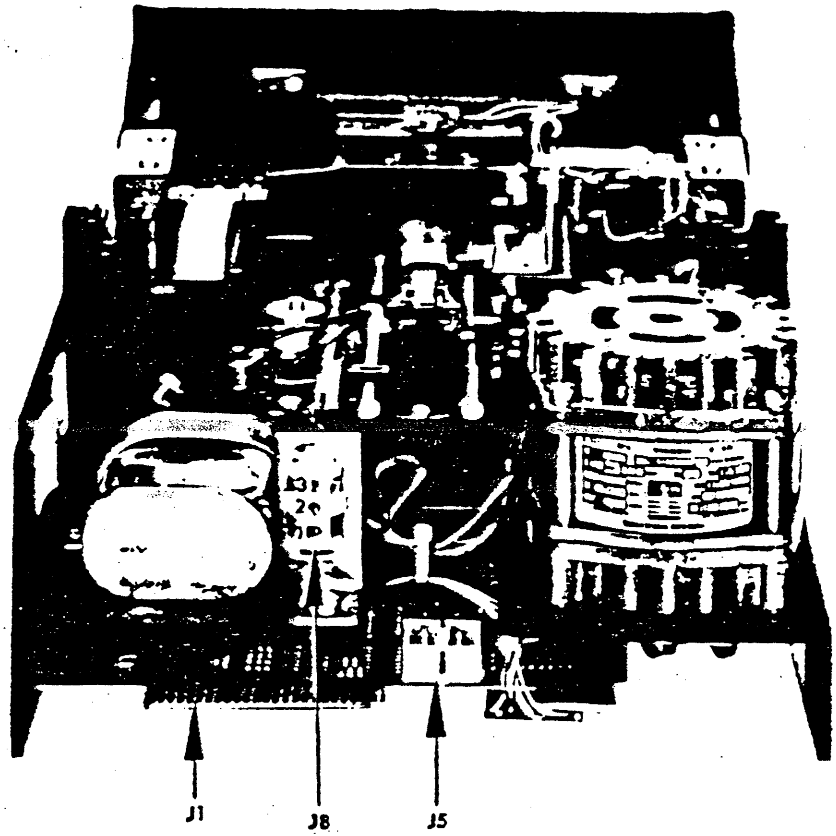


Figure 2-2. Interface Signal and Connector Locations. Pin numbers are shown for J8. Pin numbers for J1 and J5 can be read on the component side of the circuit card.

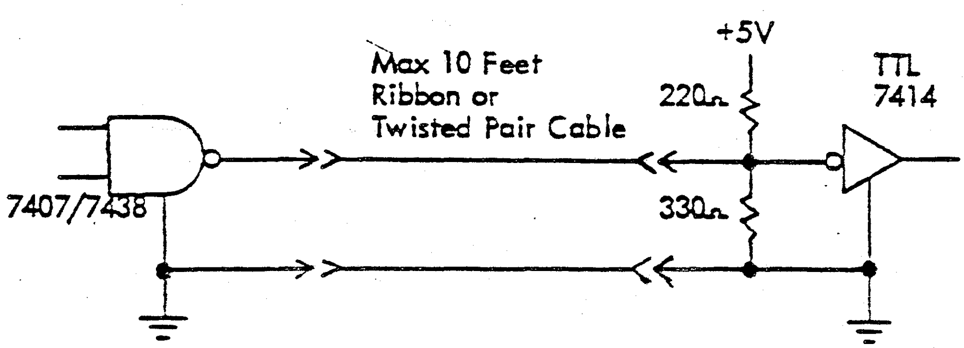


Figure 2-3. Recommended Interface Circuits.

2.5 DOUBLE DENSITY DESIGN CONSIDERATIONS

The REMEX Diskette Drives may be implemented in both single density and double density systems. By utilizing double density encoding schemes, the system designer is able to double the capacity of a standard IBM 3740 type flexible diskette. Standard diskettes, using double frequency recording, will store a maximum capacity of 6.4M bits on both sides. Double density encoding schemes will increase the maximm capacity of diskettes to 12.8M bits. This increase is achieved without increasing the number of flux reversals per inch on the diskette. The following discussion compares double frequency recoding with double density and describes the basic circuit components required for implementation.

More than one type of double density recording is available to the designer. But it is important to realize that any double density drive will be optimized for only one type of recording technique. REMEX recommends either the modified frequency modulation (MFM) or the modified, frequency modulation (M^2FM) be used with the diskette drives. Discussion in this section will be confined to techniques only.

2.5.1 DOUBLE FREQUENCY AND MFM ENCODING COMPARED

With either single density or double density schemes, the stream of data into or out of the drive is divided into bit cells. Each bit cell is encoded as either a "0" or a "1". The key to the various encoding schemes lies in the definition of the "0" or "1" within a bit cell.

Single density applications use a double frequency encoding scheme. Double frequency coded information incorporates a clock pulse at the beginning of each bit cell. See Figure 2-4. If a data pulse is present at the center of a bit cell, that cell representa a "1". If no data pulse is present between clock pulses, that bit cell represents a "0". The clock pulses are required to maintain synchronization in the event of a long stream of "0" bit cells. However, at least half of the diskette flux reversals are clock pulses, not useful data pulses.

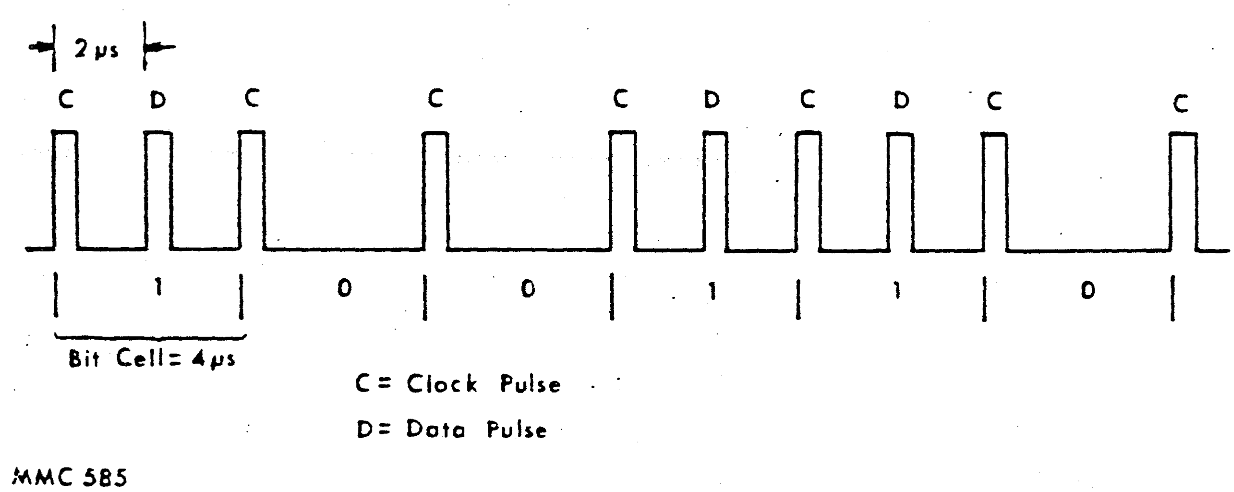


Figure 2-4. Double Frequency Encoding.

Modified frequency modulation (MFM) is a self-clocking encoding scheme. By using MFM it is possible to double the number of recorded data bits without increasing the flux changes per inch on the media. Basically the rules for MFM encoding are as follows:

a. A "1" is defined as a pulse occurring at the center of a bit cell.
b. A "0" is defined as a pulse occurring at the beginning of a bit cell, except when preceded by a "1". In that case, no pulse occurs during the bit cell for a "0".

An example of a stream of data pulses using MFM encoding is shown in Figure 2-5. Note that by comparing Figures 2-4 and 2-5, the minimum time between pulses is $2\mu s$ for both double frequency and MFM encoding. But the data transfer rate for MFM encoding is twice that for double frequency encloding, i.e., 250 kHz. MFM encoding is 100% efficient because of a 1 for 1 relationship between the flux changes per inch and the bits per inch recorded on the diskette. Double frequency encoding on the other hand is only 50% efficient.

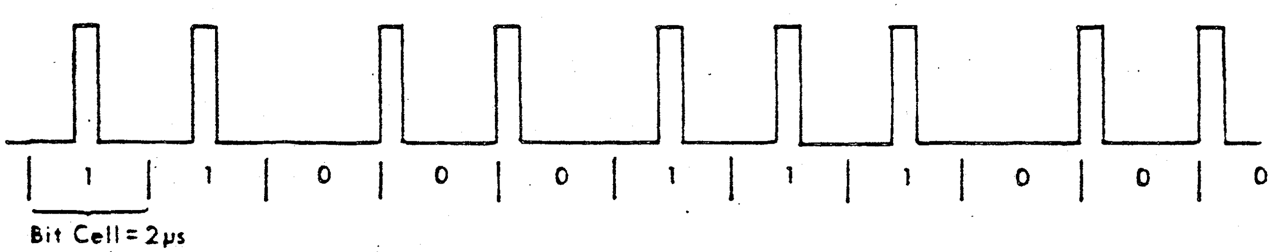
2.5.2 IMPLEMENTATION OF MFM

MFM encoding and decoding can be implemented with the RFD400X by the addition of the following components to a system:

a. Write encoding circuit with write precompensation.
b. Read decoding circuit with a phase locked oscillator.

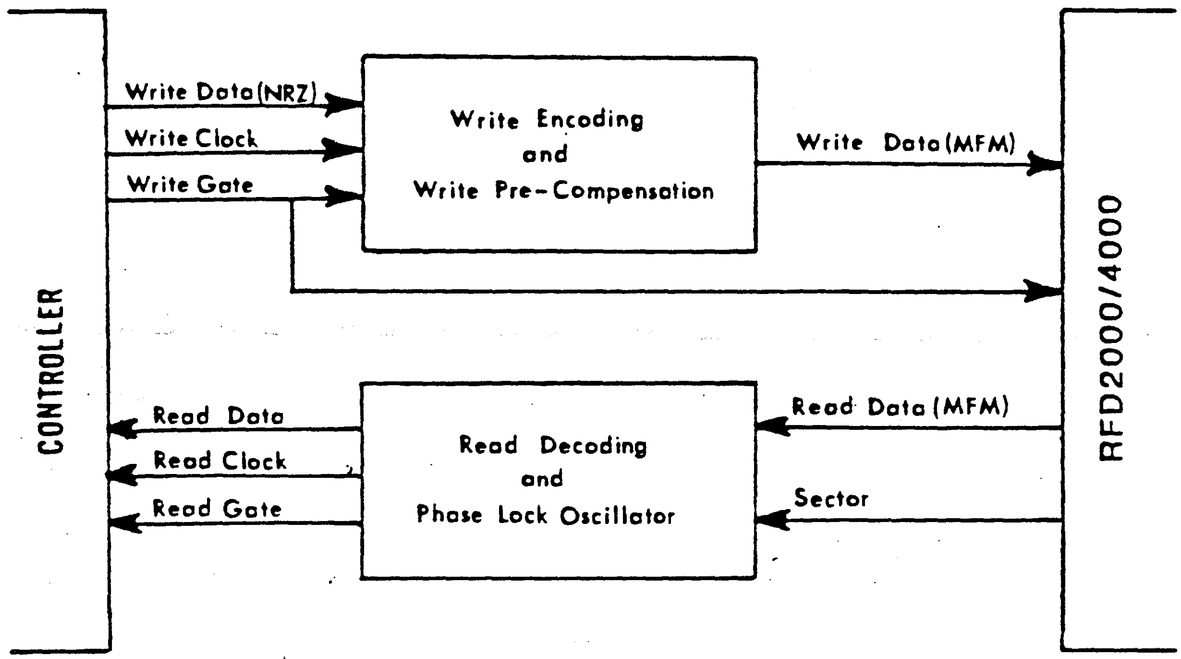
The block diagram for this implementation is shown in Figure 2-6.

Basically the write encoding circuit must receive serial write data from the controller and provide MFM encoded data. This circuit and the write precompensation circuit (described below) will usually be combined. The MFM encoded write data must consist of pulses 250 nanoseconds ± 20% in length and are true at the logic 1 level.



MMC 584

Figure 2-5. MFM Encoding.



MMC 586

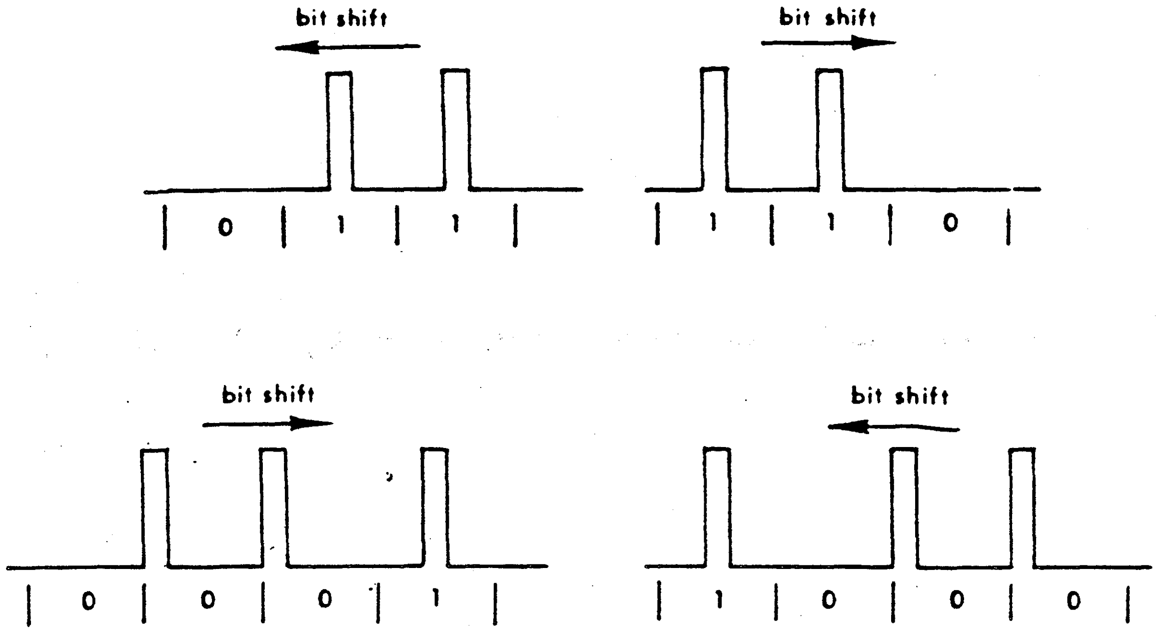
Figure 2-6. Basic Components of Double Density System.

Since the bit cell time for double density is 2μs versus 4μs for single density, bit shifting becomes much more critical with double density. The allowable window for detecting a data pulse is only half as long as for single density. The Diskette Drive is designed for minimum possible bit shifting, but write precompensation of the data stream will be required to further minimize large bit shifting for certain data patterns. The data patterns with large bit shift tendencies are:

X011X
X110X
X0001X
X1000X

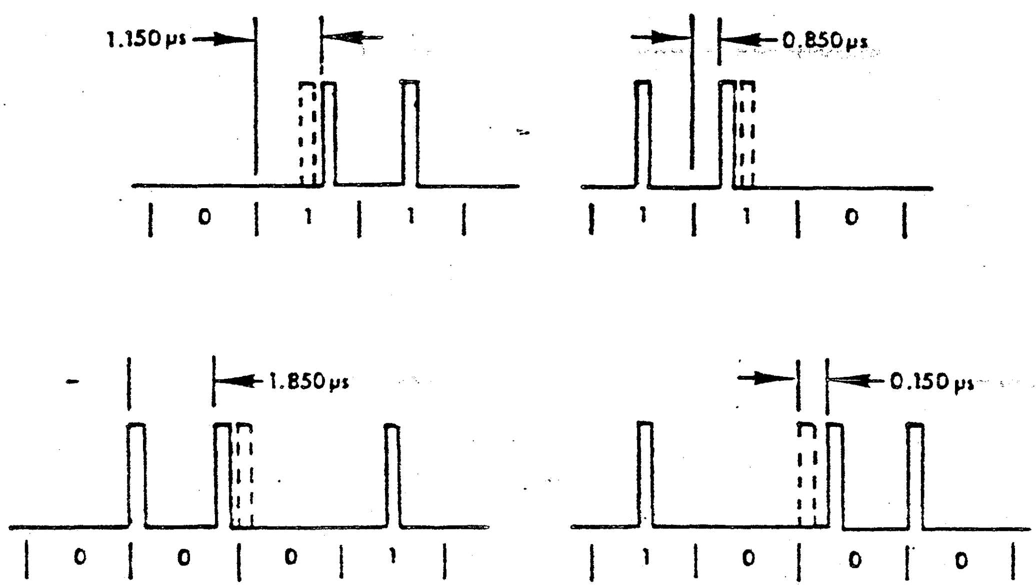
(an X denotes either a "0" or "1" can be in that digit)

These data patterns will have bit shift tendencies as shown in Figure 2-7 which indicates the bit shift tendency on read back data. Note that the bits will shift away from a nearby pulse and towards a space with no pulse. Additional information on bit shifting can be obtained from the REMEX Applications Group. A write precompensation circuit must compensate for this expected read data bit shift by providing an equivalent, but opposite bit shift on the write data stream. Optimum compensation for the drives is 150 ns. In order to implement this compensation, it is necessary to sample data blocks of at least four bits. The precompensated data would appear as shown in Figure 2-8.



MMC 587

Figure 2-7. Expected Bit Shift on Read Back Data.



MMC 588

Figure 2-8. Precompensated Write Data.

The read decoding circuit must provide the opposite function as the write decoding circuit. The data stream at the output of drive will consist of 200 ns pulses encoded in MFM. Good design practice will combine the Read Decoding circuit with a phase lock oscillator for data recovery. Data recovery should be accomplished with 1 μs windows centered on the expected bit location. See Figure 2-9. The read data is then transmitted to the controller.

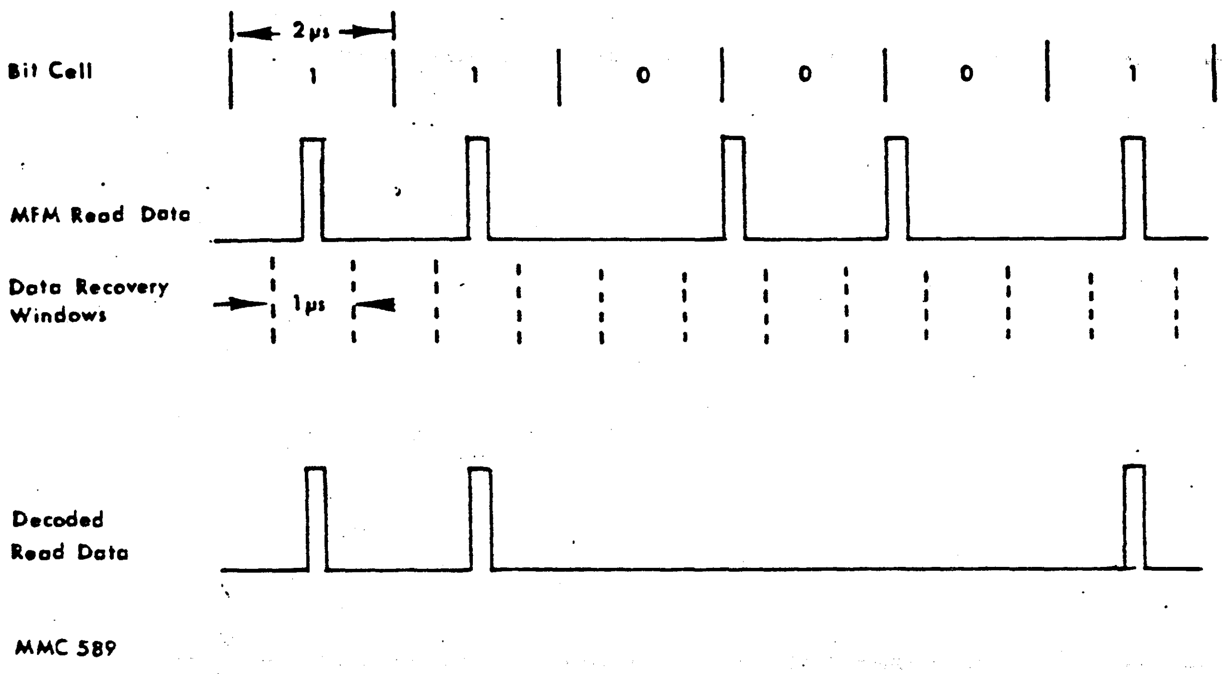


Figure 2-9. Data Recovery Timing.

2.5.3 M^2FM FORMAT DESCRIPTION

Modified, modified frequency modulation (M^2FM) also provides a 1 for 1 relationship between the flux changes per inch and the bits recorded per inch on the diskette. The encoding scheme for M^2FM is as follows.

a. A "1" is defined as a pulse occurring at the center of a bit cell.

b. A "0" is defined as a pulse occurring at the beginning of a bit cell, except when preceded by cell containing a pulse (0 or 1). In that case, no pulse occurs during the bit cell for 0.

Figure 2-10 gives the same example for M^2FM that is used in Figure 2-5 for MFM encoding.

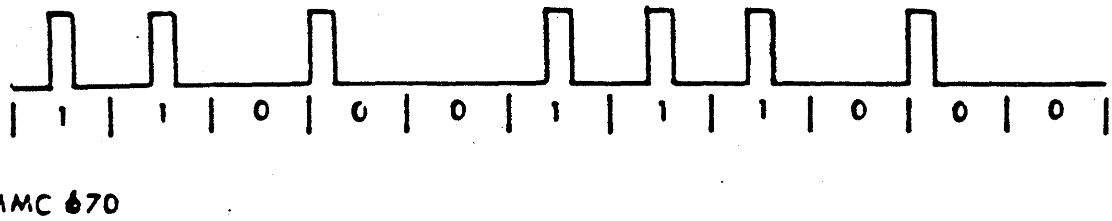


Figure 2-10. M^2FM Encoding.

SECTION III

OPERATION

3.1 INPUT-OUTPUT SIGNALS

Section 2.4 and Table 3-1 describe the input, output and power signals which are routed through I/O connectors. Section 3.3 describes the various operations and timing required when operating the diskette drive.

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 LED indicates that drive is busy. 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 and to facilitate a wide range of operator oriented applications. There are no complicated controls and indicators. The following section outlines 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 AC and DC power to the drive can be done in any sequence. However, once AC power has been applied, a 2-second delay must be completed before any Read or Write operation is attempted. This delay is for stabilization of the Diskette rotational speed. When DC power is applied, a 90 msec power on reset automatically resets the electronics and inhibits inadvertent writing or erasing on the Diskette. See Figure 3-1. Thus, the drive is ready for operation 2-seconds after application of AC power and 90 msec after application of DC power. Also, initial position of the R/W head with respect to data tracks is indeterminate immediately after application of DC power. In order to assure proper positioning of the R/W head prior to any read/write operation, a Step Out operation should be performed until the Track 00 indicator becomes active.

Table 3-1. Interface Signal Descriptions.

Connector Pin	Description
J1-1①, 2	Low Current* Input. A low active level on this line is required when writing on tracks 44 through 76. This input is used to lower the write current by 20%.
J1-3 thru J1-8	Not Used.
J1-9, 10	Two-Sided Output*(Customer Installed Option). A low active signal on this line indicates a two-sided diskette is rotating in the drive. An inactive signal indicates a single-sided diskette is installed. Used on RFD4000 and RFD4001 Only.
J1-11, 12	Disk Change Output*(Customer Installed Option). This line is low active when the drive is selected (Drive Select true) provided during the previous period when the drive was not selected, Ready was lost. When Drive Select next goes inactive, this line goes inactive provided the drive has gone Ready.
J1-13, 14	Side Select Input. A low signal selects side 1 surface for reading or writing and a high signal select side 0 surface. A 100 us delay is required when switching from one head to the other before any Read or Write operation can be initiated. Deactivation of the Drive Select and/or changing the Side Select must be delayed at least 600 usec following a Write operation to ensure that the track is fully tunnel erased. Used on RFD4000 and RFD4001 Only.
J1-15, 16	In Use Input (Customer Installed Option). A low active signal will lock the door and turn on the BUSY LED. To use this line, place jumper across pad D.
J1-17, 18	Head Load Input (Customer Installed Option). A low active signal will cause the Read/Write head to be loaded against the diskette provided Ready is active. A 35 ms delay is required after the low active signal before Read data is valid or before the Write Gate and Write Data signals can be applied. To use this line, place jumper across pad C.
J1-19, 20	Index Output* The leading edge of this low active signal indicates the beginning of the track. This signal is present once each revolution (every 166.67 ms) and remains active for 1.8 ± 0.6 msec (RFD4000), 0.4 ± 0.2 msec (RFD4001). In order to properly detect the Index at the Host system the transition from inactive to active should be recognized after the drive has been selected.
J1-21, 22	Ready Output* A low active signal indicates all of the following conditions have occurred: (1) a diskette has been properly inserted and is rotating, (2) two index holes have been recognized and (3) the appropriate drive select line is true. Ready is also active if after DC power is applied, two index holes have been recognized (AC power previously applied and diskette properly inserted). If a single-sided diskette is installed and Side 0 is selected, this signal will be active. If Side 1 of a single-sided diskette is selected, this signal will be inactive. When either side of a two-sided diskette is selected, this signal will be active.
J1-23, 24	Sector Output*(RFD4001 and RFD2001 Only). This signal is generated when a 33 hole diskette is inserted and is low active 32 times each revolution for a period of 0.4ms.
J1-25, 26 27, 28 29, 30 31, 32	Drive Select 1, 2, 3 and 4 Inputs. A low active signal is used to select one of four drives depending upon the line selected. The line selected must correspond to the Drive Select Jumper locations as described in Section 2.3.2. Under normal operation this Drive Select line will perform the following: (1) load the read/write heads, (2) apply power to stepper motor, (3) enable the input lines, (4) activate the output lines, (5) illuminate the BUSY LED and (6) lock the front door. Refer to Figure 3-1 for timing diagram.
J1-33, 34	Direction Select Input. A low signal will move the read/write head in toward the center of the diskette when the Step line is active. A high signal will move the read/write head out away from the center of the diskette when the step line is active. Refer to Figure 3-1 for timing diagram.
J1-35, 36	Step Input. This input is used in conjunction with the Direction Select Input and causes the read/write head to move in or out. When the trailing edge of this pulse goes from low to high the head is moved one track. The pulse width must be 1 us min. A 1 us delay must be made when any change in the Direction Select line is made before the trailing edge of the Step pulse. Refer to Figure 3-1 for timing diagram.
J1-37, 38	Write Data Input* Data to be written on the diskette is transferred on this line. An active Write Gate signal will enable this line. Current through the read/write head is reversed with each transition from a high level to a low level. The timing diagram is shown in Figure 3-4.
J1-39, 40	Write Gate Input* A low active signal enables Write Data to be written in the diskette. A high, inactive signal enables the read and stepper logic. The timing diagram is shown in Figure 3-4.
J1-41, 42	Track 00 Output* A low active signal indicates that the read/write head is located at track 00 and step motor phase 1 is energized. A high, inactive signal indicates that the read/write head is not located at track 00.
J1-43, 44	Write Protect Output* A low active signal indicates that a diskette with an uncovered ANSI Write protect notch is loaded, causing writing to be inhibited. A high level indicates that a diskette with a covered Write protect notch or a diskette with no notch has been inserted and writing may occur.

Table 3-1. Interface Signal Descriptions (Continued)

Connector Pin	Description
J1-45, 46	Read Data Output. This line provides the composite clock and data signals as read directly from the diskette. A low level indicates a data or clock bit is present and a high level indicates the absence of data. Each flux reversal causes a transition from the high inactive level to the low active level for a period of 200 ± 30 nanoseconds. Data output to the host is the same form as the write data received from the host.
J1-47, 48	Separate Data Output (RFD4001 and RFD2001 Only). This line provides the data signal which has been separated out of the composite read data (J1-46). This signal is low active for 200 ± 30 nanoseconds for each data bit.
J1-49, 50	Separate Clock Output (RFD4001 and RFD2001 Only). This line provides the clock signal which has been separated out of the composite data (J1-46). This signal is low active for 200 ± 20 nanoseconds for each clock pulse.
J6-1, 2, 3	A.C. Input. 100/115 VAC ± 10%, 50/60 Hz ± 0.5 Hz @ 0.8A or optional 200/230 VAC ± 10%, 50/60 Hz ± 0.5 Hz @ 0.4A. See Table 1-1 for complete AC specifications and Figure 1-8 for model description.
J5-1	+24 Vdc ± 10% @ 0.8A.
J5-2	+24V Return.
J5-3	-5V Return.
J5-4	-7 to -16 Vdc @ 0.1A max. If the customer installed -5V option is used, this voltage will be -5Vdc ± 0.25 Vdc @ 0.07A Max.
J5-5	+5 Vdc ± 0.25 Vdc @ 1.1A Max.
J5-6	+4V Return.

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

All signals on J1 are TTL logic. Refer to Figure 2-3 for recommended interface circuits.

Input Lines have the following characteristics: Active (True) = $0 < V < +0.4$ @ 40mA max.
Inactive (False) = $+2.5 < V < +5.25V$ @ 0 mA.

Output Lines are driven by TTL gate with open collector capable of sinking 40 mA @ $0 < V < +0.4$ in the active state. In the inactive state the collector current is 250 μA max. (drive off).

See Table 2-1 for Mating Connectors.

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 suface. Abrasions or foreign material from the hands may cause loss of stored data.

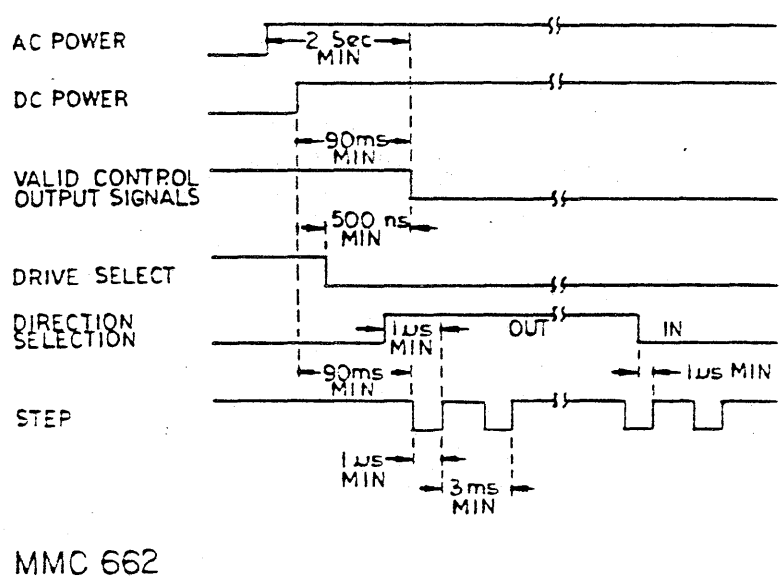


Figure 3-1. Power Up and Seek Sequence.

3.3.3 DISKETTE LOADING/UNLOADING

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

a. Apply AC/DC power to the unit.
b. Open the drive door by depressing the button assembly release (item 44, Figure 7-1).
c. Carefully remove the diskette from its storage envelope.

NOTE

On units containing the write protect option, if it is desired to protect the diskette data from inadvertent or accidental erasure and write-over, make sure the notch on the jacket is uncovered. An optional sensor senses the notch and if it is covered writing is allowed; if it is uncovered the write circuitry is disabled.

d. Insert the diskette into the drive. The diskette is inserted with the index hole nearest the operator and the diskette label on the same side as (facing) the door. See Figure 3-2. To load the drive, insert a diskette into the open mouth of the drive until ejection mechanism is engaged and the door will shut when closed. Close the door to the drive.

e. The drive may now be operated in any of the modes of operation described in Sections 3.3.4, 3.3.5, 3.3.6, 3.3.7, or 3.3.8.

f. To unload the diskette, open the door (when busy light is off), by depressing the latch, remove the diskette (returning it to its protective storage envelope) and close the door.

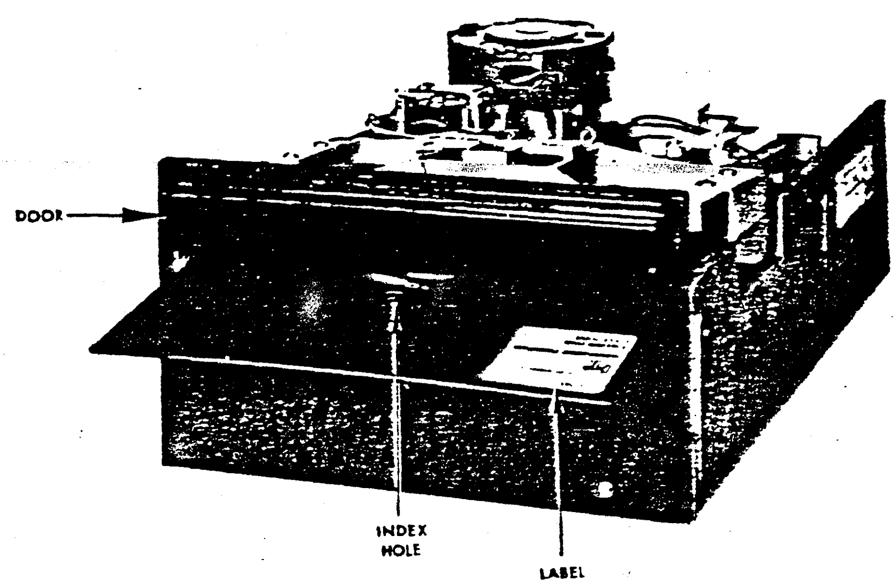


Figure 3-2. Diskette Insertion.

3.3.4 DRIVE SELECTION

Applying a 0V active signal to J1-26, J1-28, J1-30 or J1-32 for drive 1, 2, 3 or 4, respectively, will enable the selected drive only. The position of the drive select jumpers is used to select the number of the drive as described in Section 2.3.2. The functions of the drive select line are the following: (1) load the read/write heads, (2) apply power to the stepper motor, (3) enable the input lines, (4) activate the output lines, (5) illuminate the BUSY LED and (6) lock the front door. Drive select timing is shown in Figure 3-1.

3.3.5 TRACK POSITIONING

The following sequence should be used when stepping from one track to the other. Figure 3-1 show the track access timing.

a. Place the desired drive select line in the active state. See Section 3.3.4.
b. Place the Direction Select Input (J1-34) in the low (0V) state to move the head in toward the center of the diskette or in the high state to move the head out away from the center of the diskette.
c. Apply the negative going step pulse to J1-36 for each track to be stepped. It is important that the Direction Select line be in the desired state and be stable at least 1μs before the positive going (trailing) edge of the step pulse appears. The minimum width of the step signal is 1μsec.

3.3.6 SIDE SELECTION (RFD4000 AND RFD4001 ONLY)

Applying a low (0V) signal to J1-14 selects side 1 surface for reading or writing or applying a high (+5V) signal selects side 0. The side selection must be made 100μs min before a read or write operation can be performed or before data can be considered valid. See Figures 3-3 and 3-4.

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 line in the active state. See Section 3.3.4. After applying the drive select signal a 35 ms min. delay must be present to allow for head load settling time.
b. Make sure the Write Gate input J1-40 is high (false).
c. Step the head to the desired track. See Section 3.3.5. A 15 ms delay must be present if stepper power is applied independent of head load to allow for head step settling time.
d. Select the desired side by performing Section 3.3.6 (RFD4000 and RFD4001 Only).
e. Valid read data will appear after the minimum delays shown in Figure 3-3 have occurred. The composite stream of data appears at J1-46. On models RFD4001 and RFD2001 the composite clock and data are separated into data signal only at J1-48 and clock signals only at J1-50. The data and clock separator is designed to work with double frequency code only.

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 line in the active state. See Section 3.3.4. After applying the drive select signal, a 35 ms min. delay must be present to allow for head load settling time.

b. Step the head to the desired track. See Section 3.3.5. A 15 ms delay must be present if stepper power is applied independent of head load to allow for head step settling time.

c. Place the Write Gate input at J1-40 in the low (true) state.

d. Select the desired side by performing Section 3.3.6 (RFD4000 and RFD4001 Only).

e. Apply the data to be written on the Write Data input line at J1-38 after the minimum delays shown in Figure 3-4 have occurred. The coding scheme used for the data can be any of the methods described in Section 2.5.

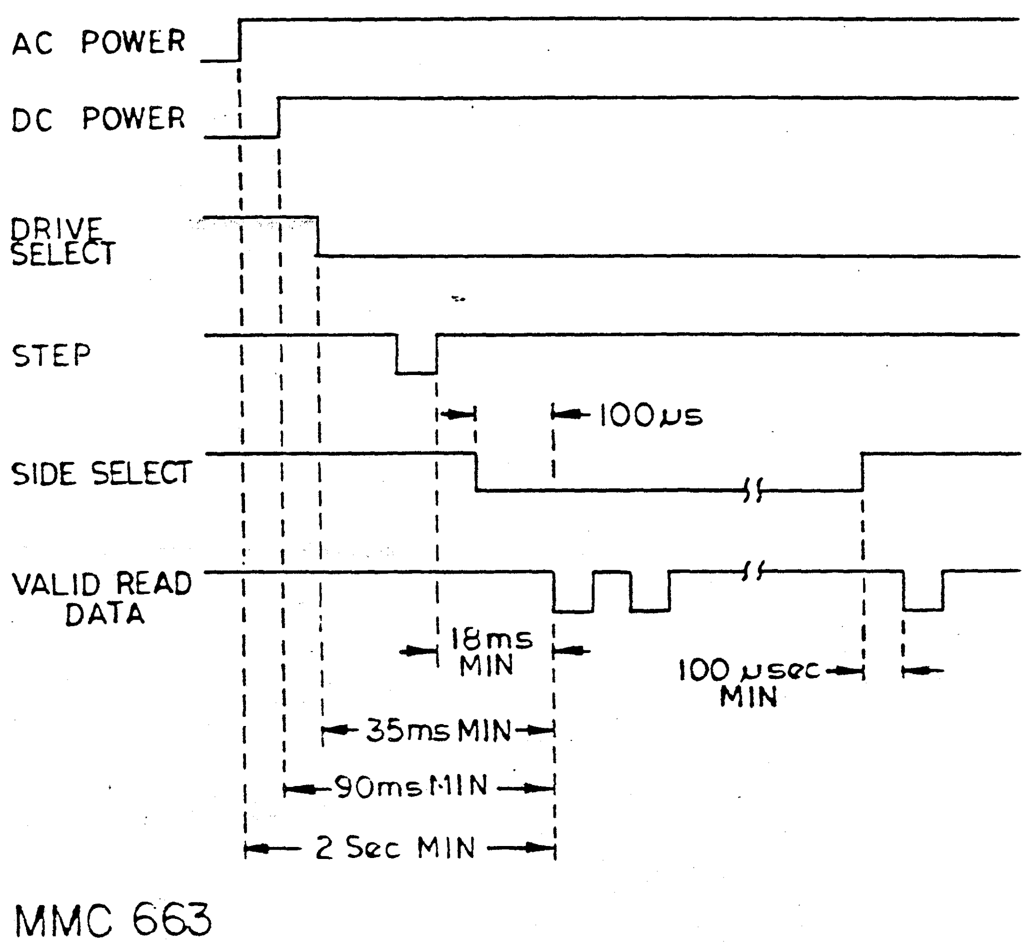


Figure 3-3. Read Sequence Operation.

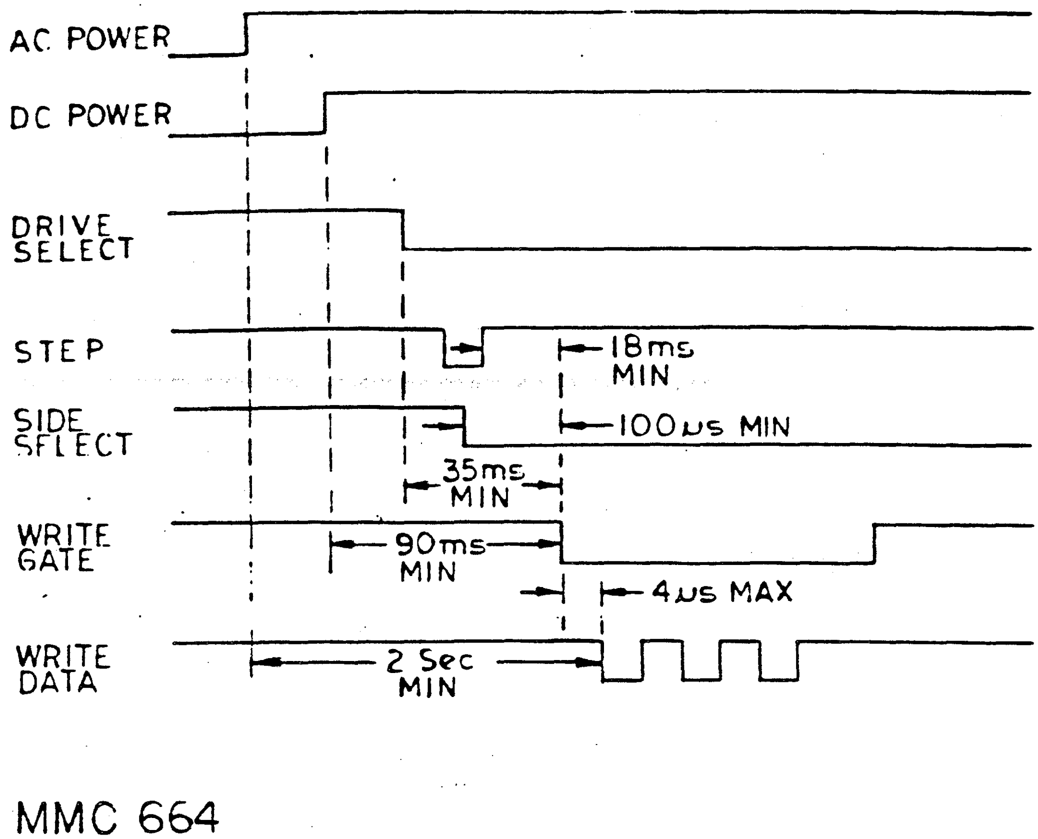


Figure 3-4. Write Sequence.

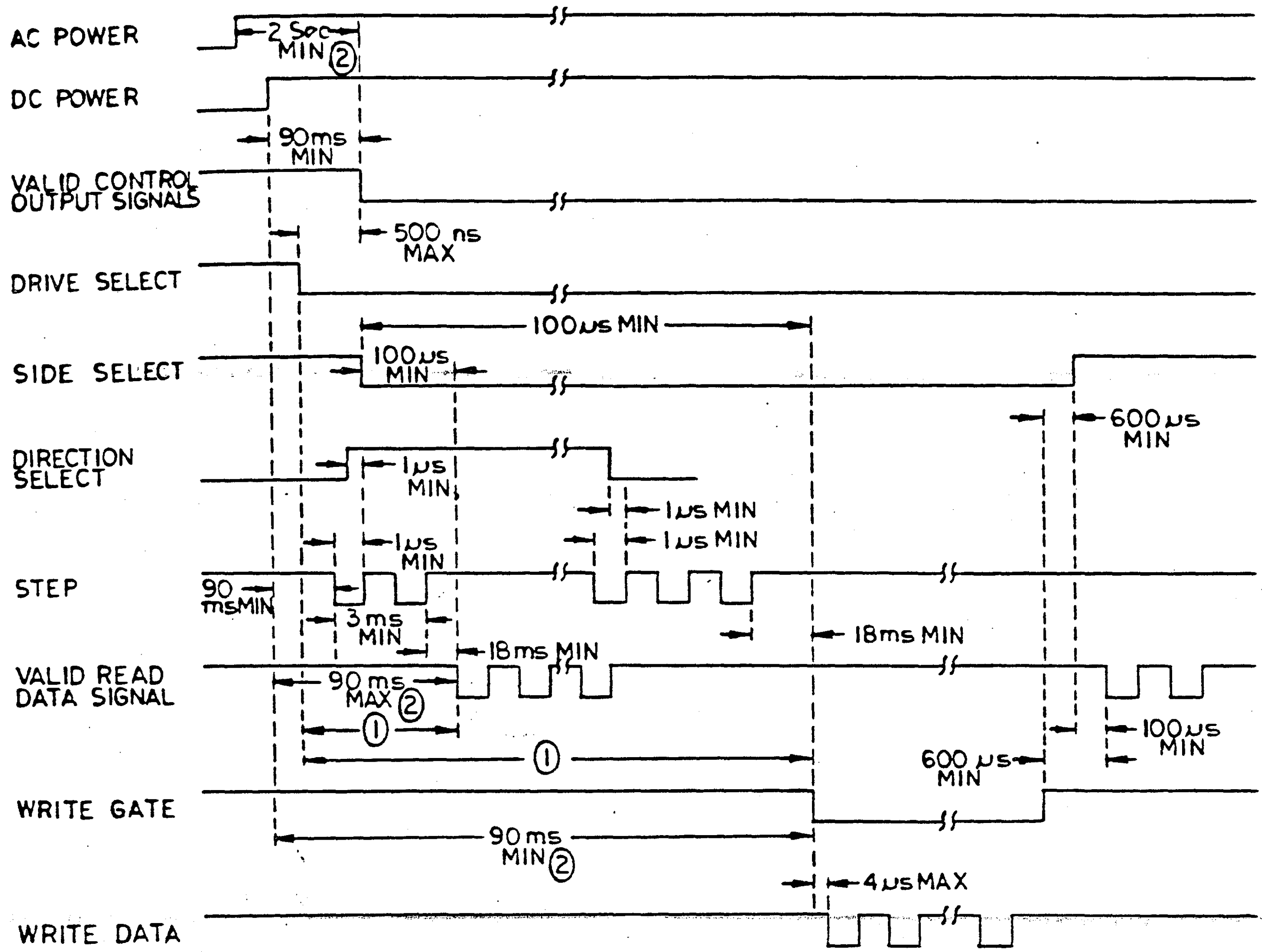
3.3.9 COMPOSITE SEQUENCE

Figure 3-5 illustrates the combining of both read and write operations in a typical sequence along with various timing restrictions, which are necessary for correct operation.

3.3.10 ERROR DETECTION AND CORRECTION

3.3.10.1 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", to correct the error, another write and write check operation must be done. 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.



① AFTER APPLYING DRIVE SELECT SIGNAL, A 35ms MIN. DELAY MUST BE PRESENT TO ALLOW FOR HEAD SETTING TIME. A 15ms DELAY MUST BE PRESENT IF STEPPER POWER IS APPLIED INDEPENDENT OF HEAD LOAD, AGAIN TO ALLOW FOR HEAD SETTLING TIME.

② IF DC AND AC POWER ARE APPLIED SIMULTANEOUSLY, THIS TIME BECOMES 2 SEC IN ALL CASES, A 2 SEC. DELAY IS REQUIRED BEFORE ANY SIGNAL IS VALID WHEN AC IS TURNED ON.

MMC 665

Figure 3-5. General Read and Write Sequences.

3.3.10.2 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 Non-Recoverable Read Error Rate.

NOTE

Unloading the head when not transferring data will increase the data reliability and extend the diskette life.

3.3.10.3 Seek Errors

Seek errors rarely occur unless the stepping rate of 3 msec is significantly exceeded. In the event of a seek error, recalibration of track location is achieved by repetitive Step and Out Direction commands until the Track 00 signal is received.

3.4 RFD4001 AND RFD2001 FEATURES

The following features are applicable to the RFD4001 and RFD2001 Only.

3.4.1 DATA SEPARATOR

The data separator included as a standard feature on the RFD4001 and RFD2001 separates the composite read data stream into a separate data output (J1-48) and a separate clock output (J1-50). The composite data signal at J1-46 is unaffected. This feature can be used only with single density recording. Figure 3-6 illustrates Data Separator Signals.

3.4.2 SECTOR OUTPUT

Models RFD4001 and RFD2001 provide a separate output for the sector signal on J1-28. This line becomes active 32 times per revolution when used with a 33-hole diskette. In addition, the index line at J1-20 becomes active once each revolution. The sector and index timing is given in Figure 3-7.

3.5 FACTORY INSTALLED OPTIONS

The following options are available on both the diskette drives. These options are coded as part of the model number as shown in Table 1-2. Units are available which are designed to operate on 100VAC, 50Hz; 115VAC, 60Hz; or 220VAC, 50Hz. The parts list describes the differences between these changes. It is not recommended that these changes be made in the field.

3.6 CUSTOMER INSTALLED OPTIONS

The diskette drives can be modified by the user to function differently than outlined in Sections 3.1 thru 3.4. This is accomplished by adding or deleting traces and/or using shorting plugs. Certain I/O pins have been reserved for this usage. When shorting plugs are used, the type of plug recommended is AMP 530153-2 or equivalent. The following sections describe the options and their installation. Table 3-2 contains a summary of the customer cut/add trace options as they are shipped from the factory. Figures 3-8 and 3-9 show the trace locations on the circuit card. Section 4.2.13 describes the differences in theory for each option.

NOTE

Since many of the options, utilize the same traces or interface pins only one option using a given trace or interface pin must be used.

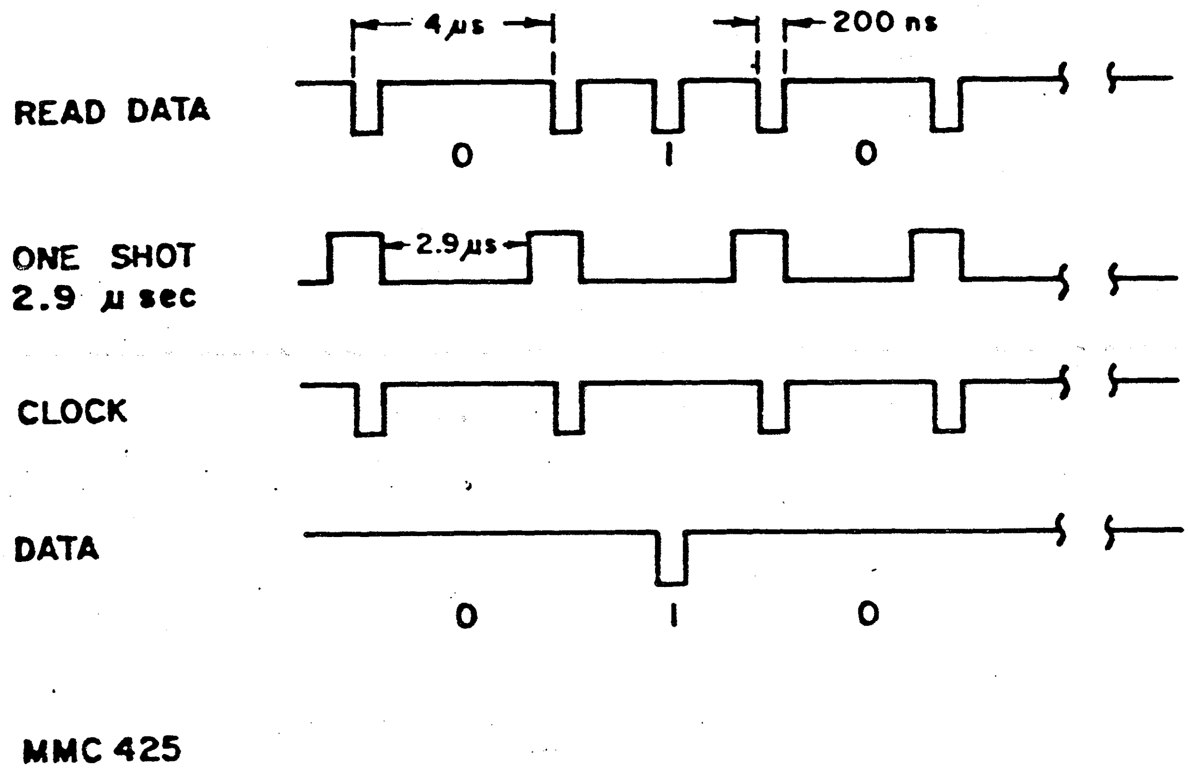


Figure 3-6. Data Separator Timing.

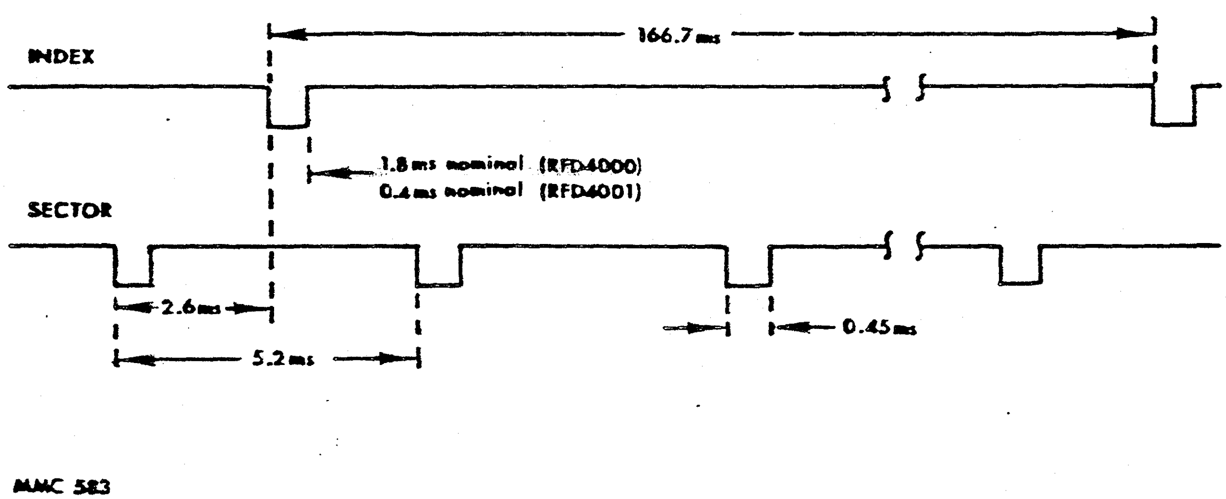


Figure 3-7. 32-Sector/Index Timing. The tolerance of the INDEX pulse is a function of the hole tolerance in the diskette.

3.6.1 SIDE SELECTION UTILIZING DRIVE SELECT LINES (RFD4000 AND RFD4001 ONLY)

With this option, the drive select lines can be used to select four read/write heads on two drives rather than select the four different drives. This can only be used in systems containing no more than two drives. It is implemented by moving jumper S2 to S3 (see Figure 3-9) and adding a jumper at DSn (see Figure 3-9) where n (n = 1, 2, 3 or 4) is the desired head select number for side 0. A jumper is also added at nB where n (n = 1, 2, 3, 4) is the desired head select number of side 1 of that drive. For example, to allow drive select lines 2 and 3 to select sides 0 and 1, respectively, change S2 to S3 and add jumpers at DS2 and 3B. It should be noted that 0V is required to select both sides. No drive select lines are to be duplicated.

3.6.2 RADIAL READY

The purpose of this option is to allow the user to monitor the Ready line of each drive (including drives not selected). The following steps are required for the installation of this option:

a. Cut trace R (see Figure 3-8).

b. Cut trace RR (see Figure 3-8).

c. Add a wire from pad R to one of the following: pin 4, 5 or 8. Do not use the same pins again on this drive or any other drive since all drives are daisy chained.

NOTE

If desired one of the drives can use pin 22 as its Ready output line thereby eliminating steps b and c. The remaining drives must incorporate all three steps and not use pin 22.

Later model cards (113971-001 or -002 B assembly or higher or card 114951-001 or -002) which contain the U (Unselect Ready) pin can select Radial Ready by adding a jumper from the U pin to one of the adjacent unused pins 4, 6 or 8. Thus the above procedure can be eliminated with B assembly or higher.

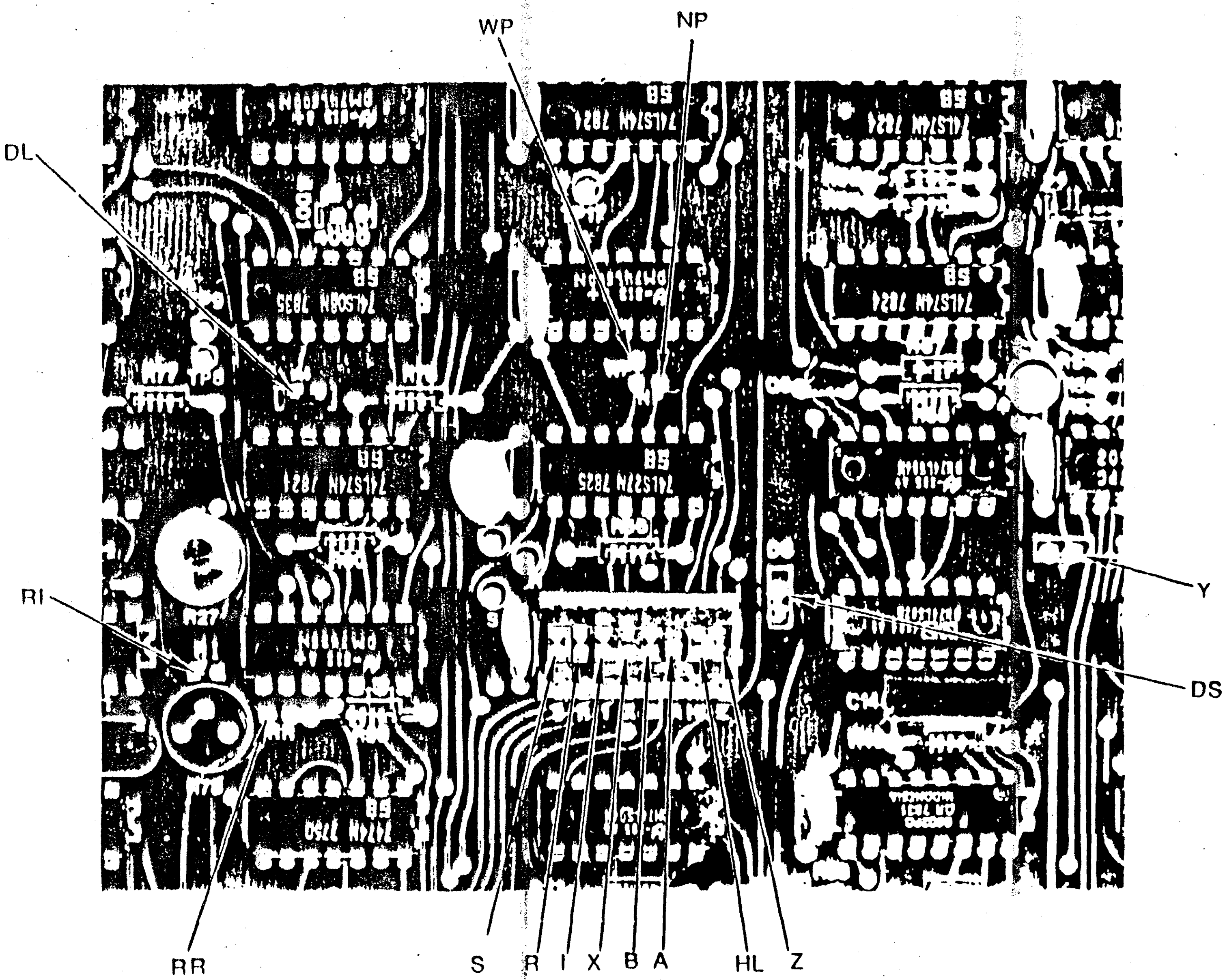


Figure 3-8. Trace and Jumper Locations for DL, WP, NP, RI, RR, S, A, I, X, B, A, HL, Z, DS, Y.

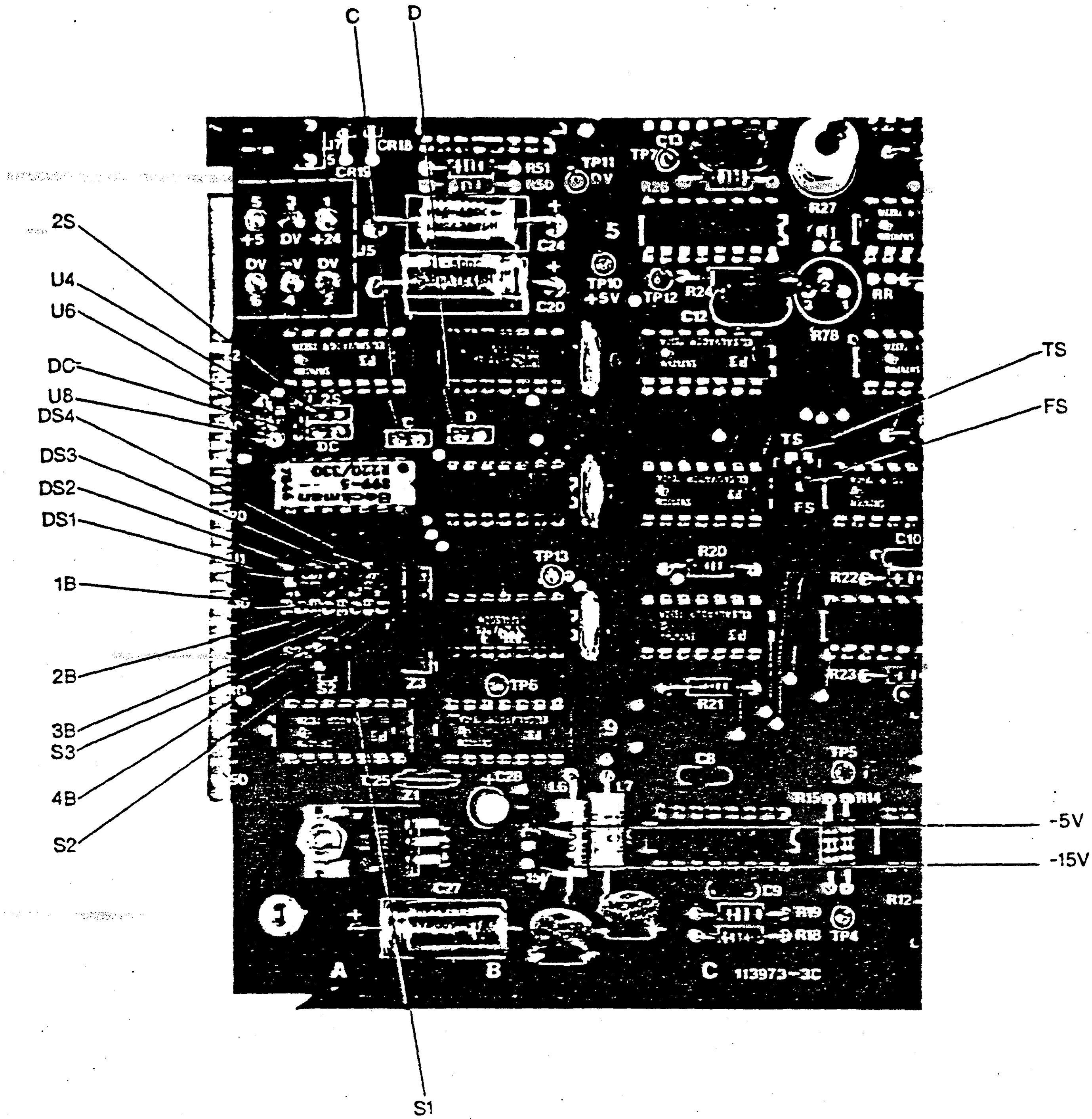


Figure 3-9. Trace and Jumper Locations for 2S, DC, C, D, TS,
FS, DS1-DS4, 1B-4B, S1-S3, U4, U6, U8.

Table 3-2. Customer Cut/Add Trace Options

Trace Designation	Description	Shipped From Factory	
		Open	Short
7A	Terminations for Multiplexed Inputs		Plugged
DS1	Drive Select 1 Input Pin		X
DS2,3,4	Drive Select 2,3,4 Input Pins	X	
1B,2B,3B,4B	Side Select Option Using Drive Select	X	
RR	Radial Ready		X
RI	Radial Index and Sector		X
R (Shunt 5E)*	Option Shunt for Ready Output		X
2S	Two-Sided Status Output	X	
4000/4001	Sector Option Enable	4000 2000	4001 2001
I (Shunt 5E)*	Index Output		X
S (Shunt 5E)*	Sector Output		X
DC	Disk Change Option	X	
HL (Shunt 5E)*	Stepper Power from Head Load		X
DS	Stepper Power from Drive Select	X	
WP	Inhibit Write When Write Protected		X
NP	Allow Write When Write Protected	X	
D	Alternate Input — In Use	X	
DL	Door Lock Latch Option		X
A,B,X (Shunt 5E)*	Radial Head Load		X
C	Alternate Input — Head Load	X	
Z (Shunt 5E)*	In Use from Drive Select		X
Y	In Use from Head Load	X	
S1	Side Select Option Using Direction Select	X	
S2	Standard Side Select Input		X
S3	Side Select Option Using Drive Select	X	
TS,FS	Data Separation Option Select TS - True Separation FS - False Separation (The Data Separation goes out of Phase in the IBM Address Mark Fields)	FS	TS
-5V, -15V	-5 Volt Supply Option		X
U4,U6,U8,U	Unselect Ready (See Section 3.6.2)	X	
AA,BB,CC	Disk Change Output (See Section 3.6.7)		BB to CC

*Part of 16-pin programmable shunt (at location 5E) these traces are usually

3.6.3 RADIAL INDEX AND SECTOR

This option permits constant monitoring of the Index and Sector lines. This results in reduced latency time since it permits the drive to be selected just prior to the sector that is to be processed. The following steps are required for the installation of this option:

a. Cut Trace RI (see Figure 3-8).

b. Cut Trace I (see Figure 3-8).

c. Cut Trace S (see Figure 3-8).

d. Add a wire from pad I (see Figure 3-8) to one of the following: pin 4, 6 or 8. Do not use the same pins again on this drive or any other drive since all drives are daisy chained.

e. Add a wire from pad S (see Figure 3-8) to one of the following: pin 4, 6, or 8. Do not use same pin as step d. Do not use the same pins again on this drive or any other drive since all drives are daisy chained.

NOTE

> If desired one of the drives can use pin 20 (Index)and pin 24 (Sector) as its Index and Sector output lines, thereby eliminating steps b, c, d and e. The remaining drives must incorporate all five steps and use pins other than 20 and 24.

3.6.4 TWO-SIDED STATUS OUTPUT (RFD4000 AND RFD4001 ONLY)

As indicated in Table 3-2, the two-sided option is shipped with the jumper removed. Installing the jumper at 2S provides the two-sided output interface signal described in Table 3-1 at J1-10. Refer to Figure 3-9 for jumper 2S location.

3.6.5 INDEX OUTPUT

As indicated in Table 3-2, the circuit card is shipped from the factory with a jumper installed at I. This provides the interface output signal at J1-20 as described in Table 3-1. Removing the jumper disconnects this interface signal. See Figure 3-8 for I location.

3.6.6 SECTOR OUTPUT

As indicated in Table 3-2, the circuit card is shipped from the factory with a jumper installed at S. This provides the interface output signal at J1-24 as described in Table 3-2. Removing the jumper disconnects this interface signal. Refer to Figure 3-8 for S location.

3.6.7 DISK CHANGE OPTION

As indicated in Table 3-2, the circuit card is shipped from the factory without a jumper installed at DC. If the customer selects this option and installs the jumper at DC, the interface signal at J1-12 will provide the Disk Change Output as described in Table 3-1. Refer to Figure 3-9 for DC location.

On Drive Card Assembly 113971-001, E revision or higher, pads AA, BB and CC have been installed (sheet 5 of Figure 8-2). Normally, BB and CC are jumpered to provide the Disk Change Output (if customer selected) as described in Table 3-1. The reset line for the Disk Change Latch is a combination of the Ready Signal and correct side selection signal. If AA is connected to BB, the Disk Change Latch is reset by the Ready signal only (side selection has no effect on the Disk Change Latch).

3.6.8 DRIVE SELECT WITHOUT LOADING HEADS OR ENABLING STEPPER MOTOR

Generally, the head is loaded and the step motor is enabled at the time a drive is selected. This option allows the head to remain unloaded until a Read, Write or Seek operation is required. When one of these operations is required, the controller would load the head via the Head Load Input at J1-20 which would also cause the step motor to be enabled. The benefit of this options is to minimize the length of time during which head is loaded, thereby extending the life of both the head and media. The following steps are required for the installation of this option:

a. Cut trace X (see Figure 3-8).

b. Install a jumper at trace C (see Figure 3-8).

A delay of 35 ms is required after the Head Load signal is applied and before Read data is valid or before the Write Gate and Write Data signals can be applied.

3.6.9 DRIVE SELECT AND STEP MOTOR ENABLE WITHOUT LOADING HEAD

This option allows the drive to perform a seek operation while the door is open and without loading the head. Normally the door must be closed and the head loaded for a seek operation to occur. This option may be useful during a power up sequence when it is necessary to position the head to track zero. In addition, this option also minimizes the length of time the head is loaded, thereby extending the life of both the head and media.

The following steps are required for the installation of this option:

a. Cut trace X (see Figure 3-8).

b. Jumper trace DS (see Figure 3-8).

c. Cut trace HL (see Figure 3-8).

d. Jumper trace C (see Figure 3-9).

3.6.10 HEAD LOAD WITHOUT SELECTING DRIVE OR ENABLING STEP MOTOR

The option makes use of head load input to allow the heads to be loaded on all drives at the same time. This eliminates the 35 ms head load time. This option also requires that the head be loaded before the drive can be selected.

The following steps are required for the installation of this option:

a. Cut trace A (see Figure 3-8).

b. Jumper trace DS (see Figure 3-8).

c. Cut trace HL (see Figure 3-8).

d. Jumper trace C (see Figure 3-9).

3.6.11 IN USE ALTERNATE INPUT

As indicated in Table 3-2, the circuit card is shipped from the factory without a jumper installed at trace D. See Figure 3-9. If the customer selects this option and installs the jumper at D, the interface signal at J1-16 will provide the In Use function, i.e., will turn on the BUSY LED and lock the door.

3.6.12 SIDE SELECTION USING DIRECTION SELECT

This option allows the Direction Select line (J1-34) to perform the normal function of Direction Select as described in Table 3-1, J1-34 and in addition, during read/write operations to perform the function of Side selection as described for J1-14. The following steps are required for installation of this option:

a. Remove the jumper at trace S2 (see Figure 3-9).

b. Install the jumper at trace S1 (see Figure 3-9).

3.6.13 DOOR LOCK LATCH

This option allows the door latch circuit to be activated by the Drive Select line without maintaining the In Use line. This permits the door to remain locked without activating the In Use line. The door is unlocked by again activating the Drive Select line when the In Use line is inactive. The option is installed by installing jumpers at D (see Figure 3-9) and DL (see Figure 3-8).

3.6.14 WRITE PROTECT OPTIONAL USE

In its standard configuration, the drive will inhibit writing when a write protected diskette is installed. This option allows writing on a Write Protected Diskette but the drive will still activate the Write Protect Output at J1-44. The following steps are required for the installation of this option:

a. Cut trace WP (see Figure 3-8).

b. Install jumper at NP (see Figure 3-8).

3.6.15 -5 VOLT OPTION

As shipped from the factory, the standard drive is set up to run with a -7V to -16 Vdc external power supply. This voltage is then applied to a -5Vdc regulator which generates the required -5 Vdc. To allow the drive to operate directly from a -5 Vdc external power supply, install jumper trace -5V (see Figure 3-9).

3.6.16 DATA SEPARATION OPTION SELECT (MODEL RFD4001 ONLY)

For FM applications using IBM soft sector (missing clocks) format with jumper at trace TS the data separator will provide a true data and clock separation during read. See Figure 3-9. With the jumper at TS removed and a jumper installed at FS (see Figure 3-9), the data separator may not decode the data and clock correctly in the missing clock field.

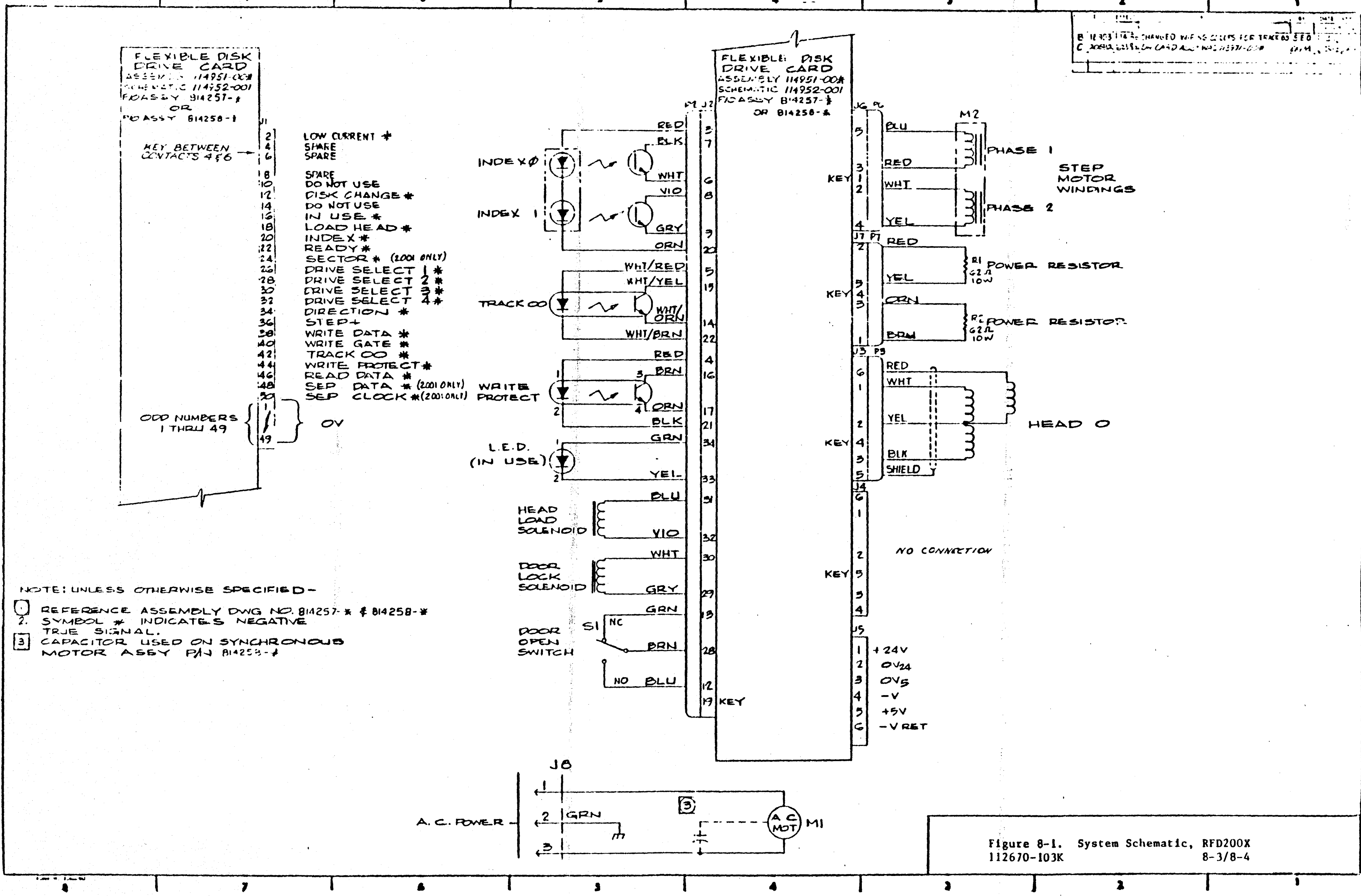


Figure 8-1. System Schematic, RFD200X

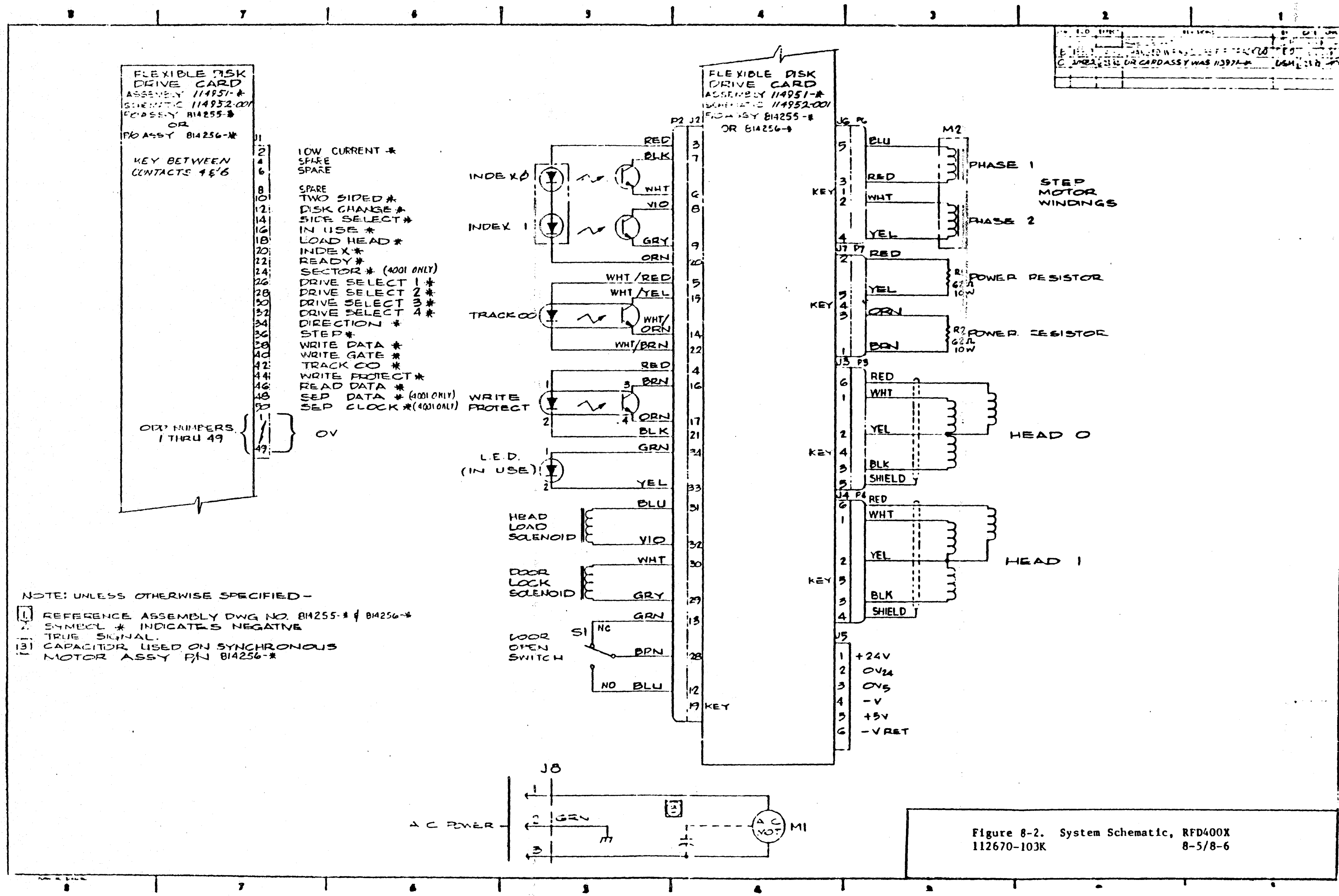


Figure 8-2. System Schematic, RFD400X

112670-103K 8-5/8-6

DESIGNATION	LAST USED
CAPACITOR	C34
DIODE	CR23
INTEGRATED CIRCUIT	Z9F
RESISTOR	R85
RESISTOR NET	Z3, 7A
TRANSISTOR	Q5
CHOKE	L7

STANDARD JUMPER TABLE

MODEL	JUMPERS
4000	DS1, DL, S2, 4000, -15V, UU
4001	DS1, DL, S2, 4001, -15V, TS, UU
2000	DS1, DL, S3, 4000, -15V, UU
2001	DS1, DL, S3, 4001, -15V, TS, UU

REVISION STATUS

FAB	SCHEM	ASSY
E	H	F_1
E	J	F_2
E	K	G
D	L	F_1
E	L	E_2
E	M	G_1
F	—	—
G	—	—
H	N	H
H	N'	H

REVISION STATUS

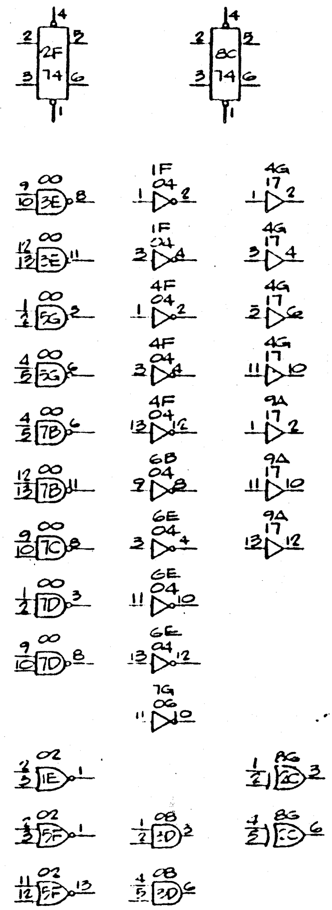
FAB	SCHEM	ASSY
A	—	—
B	A	A
B	B	A_1
C	C	B
C	D	C
D	E	D
D	F	E
D	G	E_1
E	G'	F

SYM	ECO	EFFECT	REVISIONS	BY	DATE	APPD
A	—	[illegible]	RELEASED	[illegible]	[illegible]	[illegible]
B	[illegible]		ADDED 5B1	[illegible]	[illegible]	[illegible]
C	[illegible]	[illegible]	ADDED [illegible]	[illegible]	[illegible]	[illegible]
D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
E	[illegible]	[illegible]	ADDED [illegible]	[illegible]	[illegible]	[illegible]
F	18111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
G	15212	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
G'	—	[illegible]	UPDATE STATUS BLOCK	[illegible]	[illegible]	[illegible]
H	[illegible]	[illegible]	SEE ECO (PROVIDES [illegible])	[illegible]	[illegible]	[illegible]
J	[illegible]	[illegible]	SEE ECO (RESTORES [illegible])	[illegible]	[illegible]	[illegible]
K	[illegible]	[illegible]	SEE ECO ([illegible])	[illegible]	[illegible]	[illegible]
L	19393	7.1.80	CHANGED TO FAB [illegible]	[illegible]	[illegible]	[illegible]
M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N	19506	3.18.81	[illegible] UPDATED REV. STATUS	[illegible]	3.18.81	[illegible]

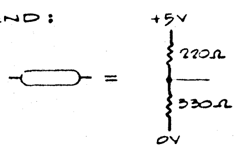
SIGNAL INDEX

SIGNAL	DEFINITION	SOURCE	LOCATION
CT0	CENTER TAP 0	6D4	2D8
CT1	CENTER TAP 1	6D4	2C8
DC INT	DISC CHANGE INTERRUPT	6A4	5D6
DIRECTION SELECT*	DIRECTION SELECT	4E7	6E7
DRSE	DRIVE SELECT ENABLE	6C4	3E7
DRV SEL INT	DRIVE SELECT INTERRUPT	6D4	4A4 5E4
DRV SEL INT*	DRIVE SELECT INTERRUPT	6C4	3D7 5D3
ERASE 0	ERASE 0	2D8	3B2
ERASE 1	ERASE 1	2D8	3A2
POWER UP RESET	POWER UP RESET	6B4	3A7 4D7
READ GATE*	READ GATE	3E3	2C4 4D7
READY	READY	5D4	6A2
READY 1	READY SIDE 1	5C4	2C3
READY 1 *	READY SIDE 1	5C4	3E7
SIDE 1 *	SIDE 1	6D4	3C7
STEP MOTOR ENABLE	STEP MOTOR ENABLE	6C4	4D4
TR 00	TRACK 00	5E7	4A4
U RDY*	UNSELECTED READY	3C2	2C2
W C +	WRITE CURRENT	2E8	3C3
W C −	WRITE CURRENT	2E8	3C3
WRITE PROT	WRITE PROTECT	5D4	3E7

SPARES:



LEGEND:



NOTE: UNLESS OTHERWISE SPECIFIED—

		+5V	0V
1.	REFERENCE DRAWINGS-ASSEMBLY 113971-*.		
2.	CAPACITORS ARE IN μF, 50V.		
3.	RESISTORS ARE IN OHMS, ±5%, 1/4W.		
4.	THE THREE CHARACTER ADDRESS IS: SHEET NUMBER: HORIZONTAL ZONE: VERTICAL ZONE		
5.	AN ASTERISK FOLLOWING SIGNAL NOMENCLATURE INDICATES THE NEGATIVE FUNCTION.		
6.	Z1 IS (MC7905) 704520-137		
7.	Z2 IS 701900-007	−	1
8.	Z3 IS 701900-022	6	1
9.	Z1D, 5C, 6F, 8D ARE (9602) 704610-127.	16	8
10.	Z1E, 5F, 8B ARE (74LS02) 704620-002.	14	7
11.	Z1F 4F 6B 6E ARE (74LS04) 704620-004.	14	7
12.	Z1G 8G ARE (75462) 704600-160.	8	4
13.	Z2C IS (74LS86) 704620-086.	14	7
14.	Z2D 3E 5G 7B ARE (74LS00) 704620-000.	14	7
15.	Z2G, 3G ARE (NE556) 704520-134.	14	7
16.	Z3B IS (UHP407) 704900-110.	14	7
17.	Z3F IS (74LS08) 704620-008.	14	7
18.	Z4B IS (ULN 2074B) 704900-111.		
19.	Z4E IS (74LS27) 704620-027.	14	7
20.	Z4G, 9A ARE (7417) 704600-141.	14	7
21.	Z5D, 6A ARE (7438) 704600-149.	14	7
22.	Z6C, 6D, 6G, 8C ARE (7474) 704610-110.	14	7
23.	Z7A IS 701900-011.	14	7
24.	Z7C 7D 9B ARE (7400) 704600-101.	14	7
25.	Z7F IS (QCT2905) 704202-113.		
26.	Z7G IS (7406) 704600-111.	14	7
27.	Z9C IS (8T20) 704610-172.	16	8
28.	Z9D, 9F ARE (NE592) 704520-145.		
29.	Z2E 2F 3C 3F 4D ARE (74LS74) 704620-074.	14	7
30.	CR1-8, 10, 12-17 ARE (FDH6666) 704000-110.		
31.	CR9 IS (1N747A) 704010-126.		
32.	CR11 IS (1N751A) 704010-116.		
33.	CR18-23 ARE (1N4003) 704005-137.		
34.	Q1-5 ARE (2N4401) 704203-114.		

USED ON | NEXT ASSY.

Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 1 of 6 8-7/8-8

113972-001 N

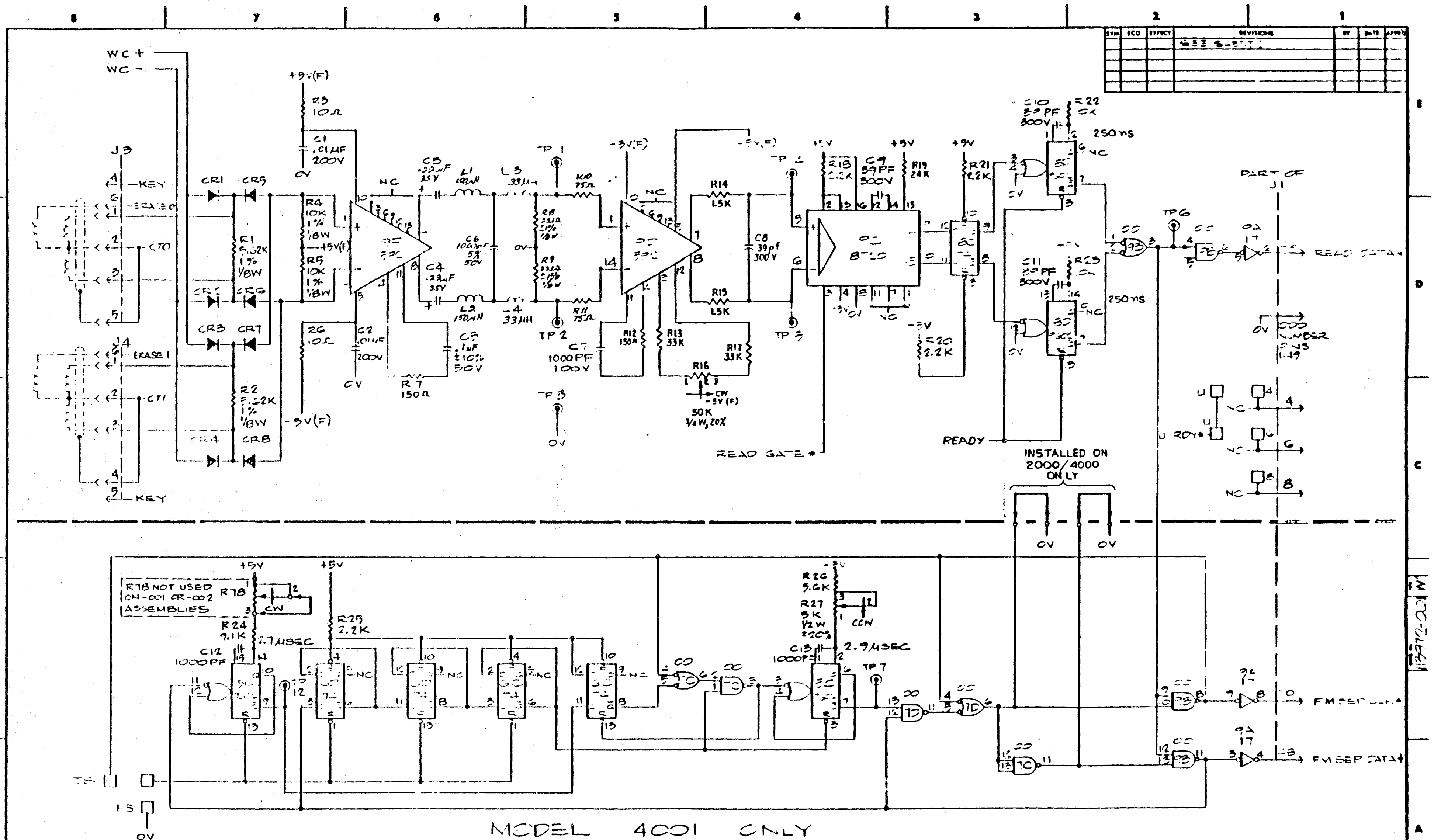


Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 2 of 6 8-9/8-10

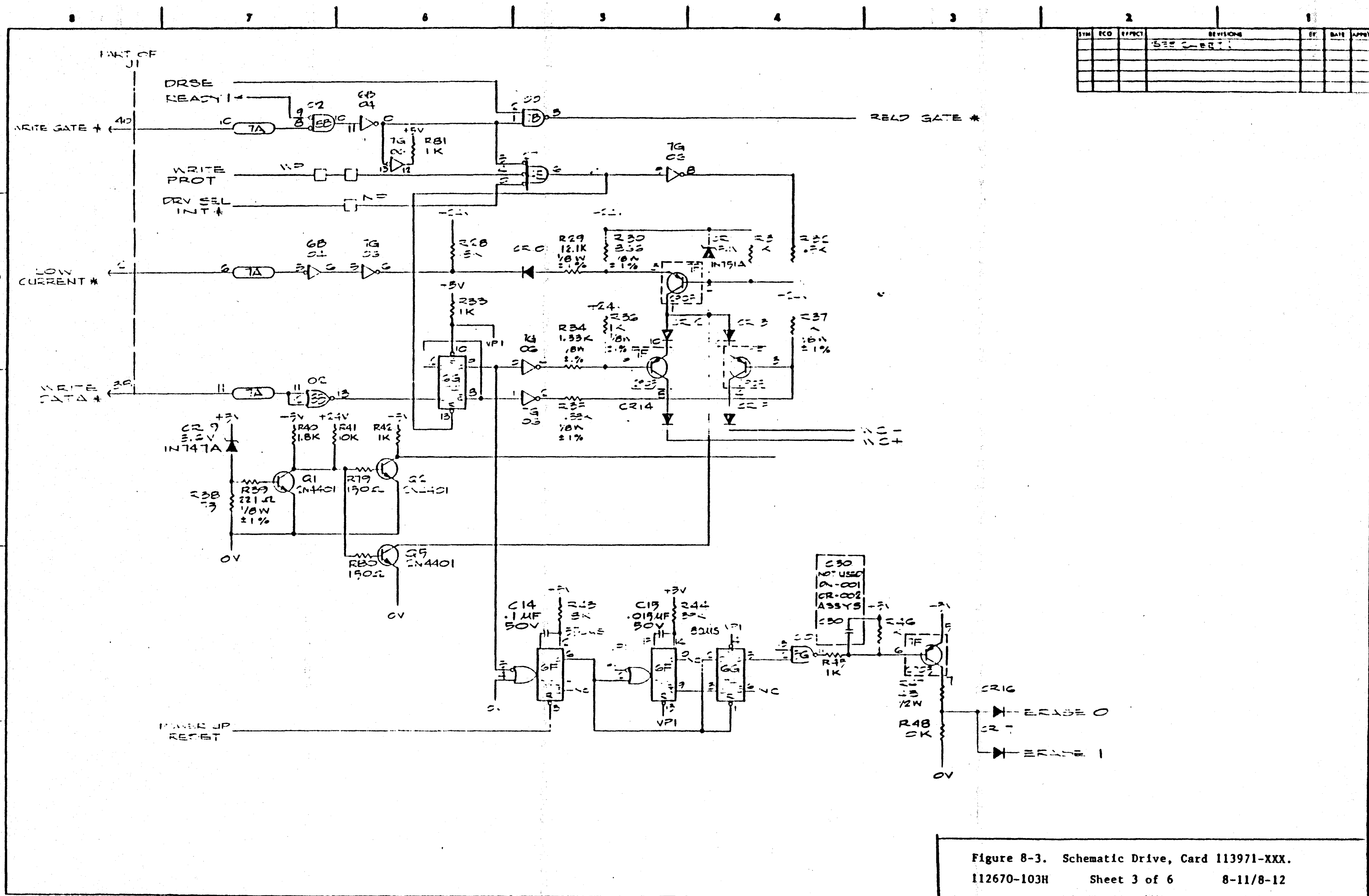


Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 3 of 6 8-11/8-12

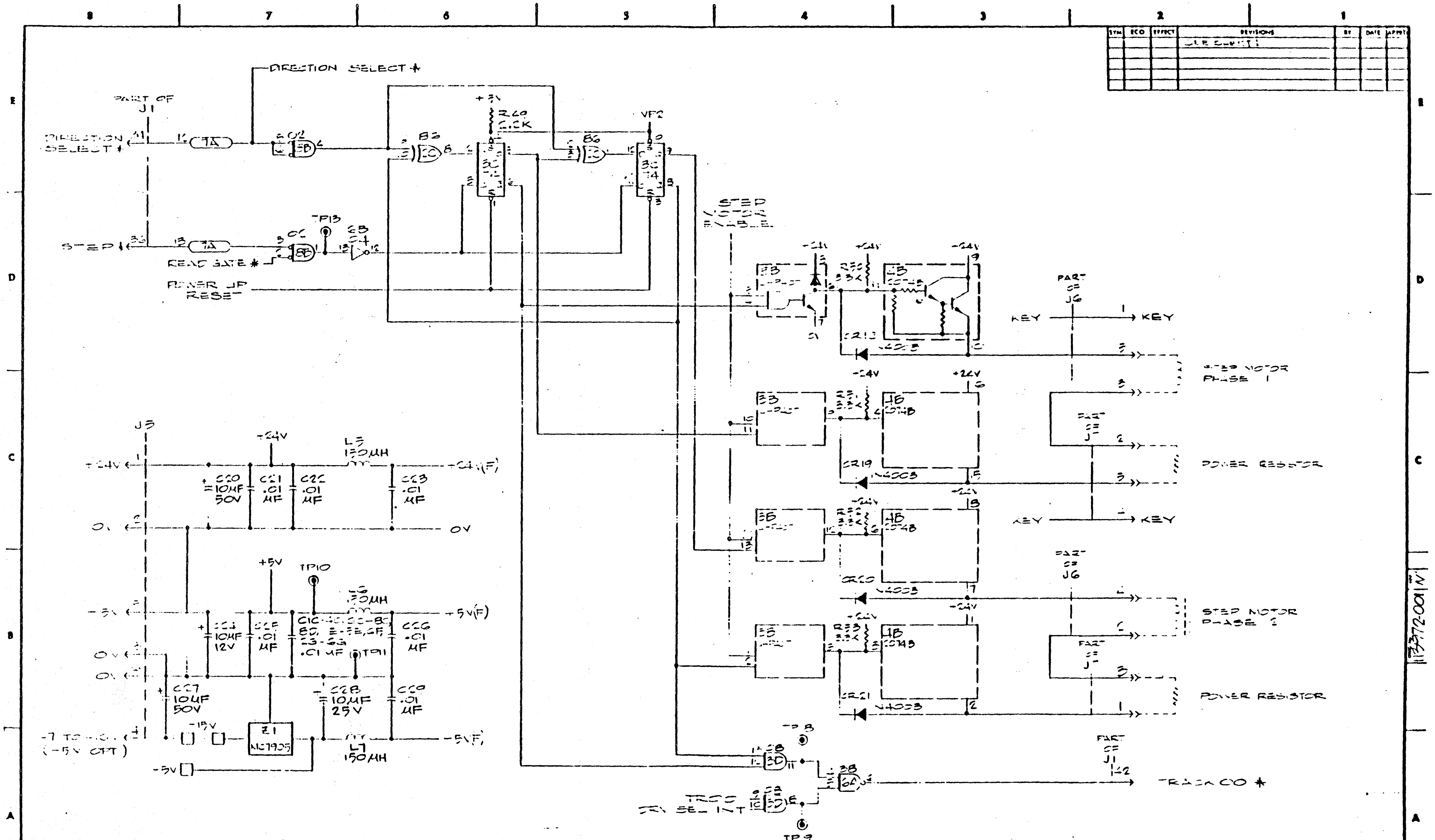


Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 4 of 6 8-13/8-14

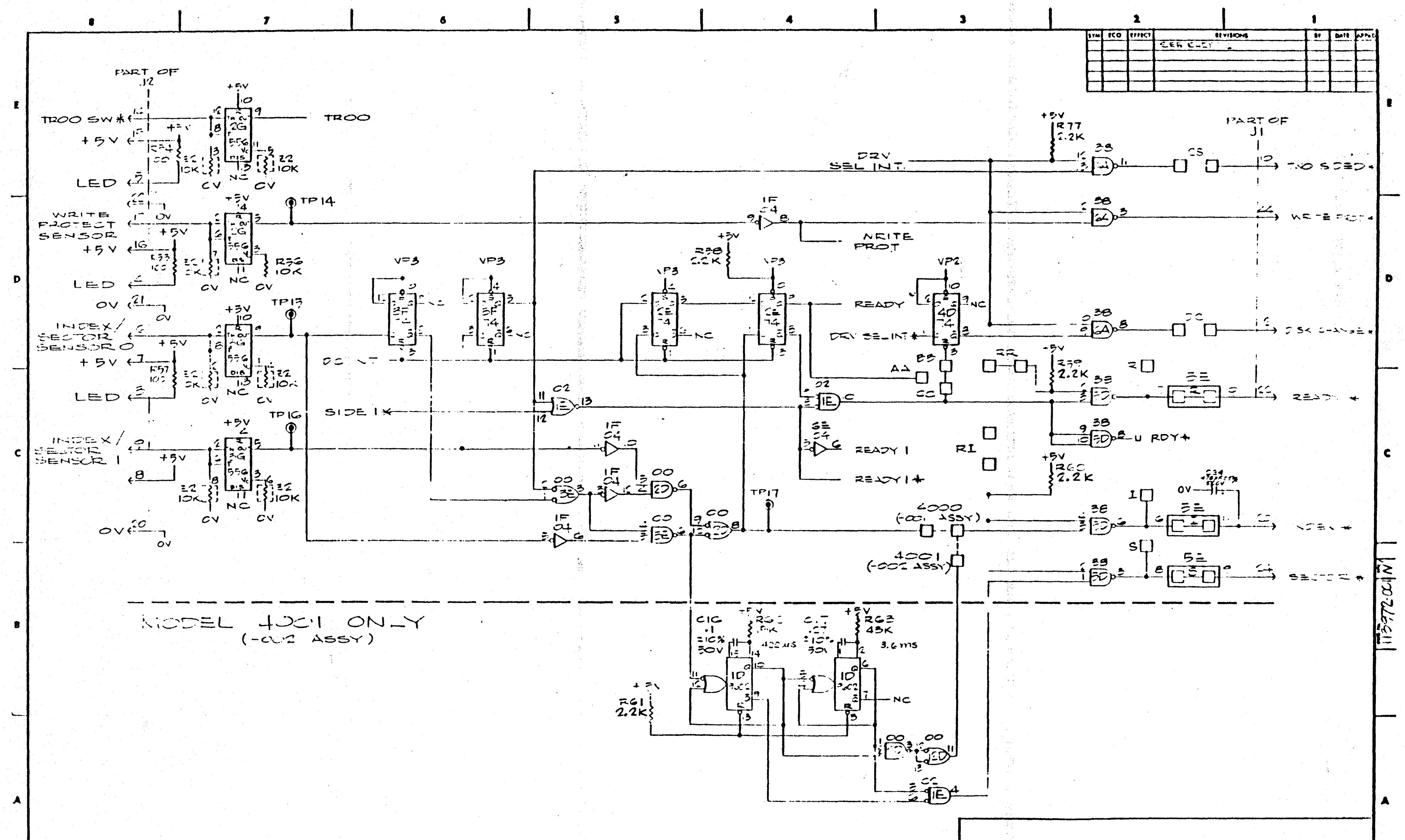


Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 5 of 6 8-15/8-16

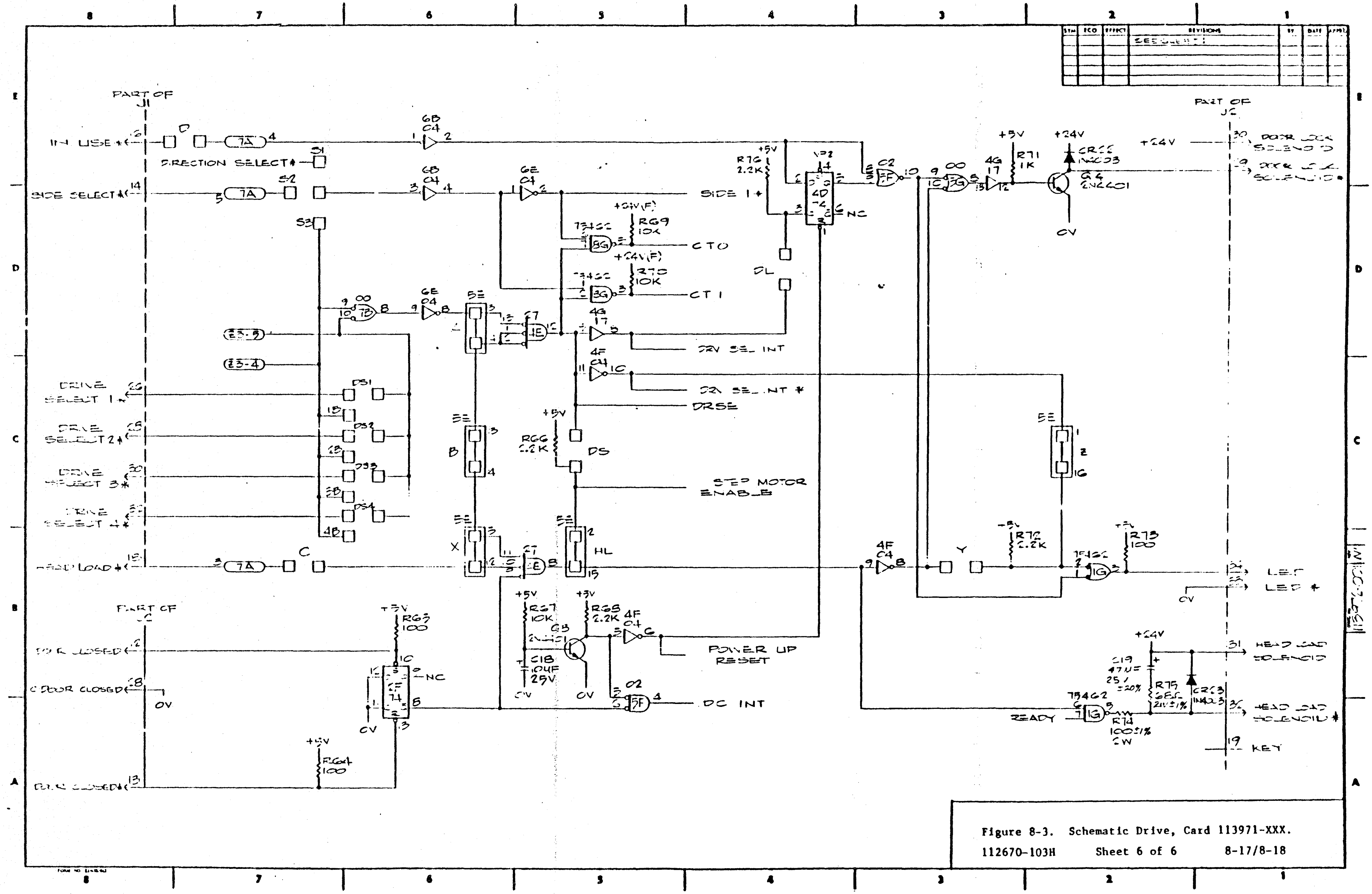


Figure 8-3. Schematic Drive, Card 113971-XXX.

112670-103H Sheet 6 of 6 8-17/8-18

SYM	ECO	EFFECT	REVISIONS	BY	DATE	APPR'D
X1			PROTOTYPE RELEASE	J.K.		
A	19121	[illegible]	PRODUCTION RELEASE	GSM	[illegible]	[illegible]
B	20020	[illegible]	UPDATE C REVISION STATUS	[illegible]	[illegible]	[illegible]

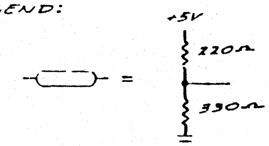
DESIGNATION	LAST USED
CAPACITOR	C25
DIODE	CR29
INTEGRATED CKT.	Z9F
RESISTOR	R97
RESISTOR NET	Z3, 7A
TRANSISTOR	Q7
CHOKE	L7

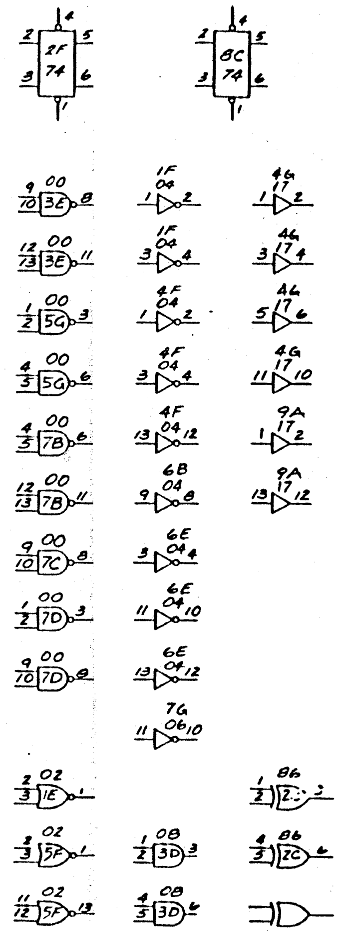
STANDARD JUMPER TABLE	
MODEL	JUMPERS
4000	DS1, DL, S2, 4000, -15V, UU
4001	DS1, DL, S2, 4001, -15V, TS, UU
2000	DS1, DL, S3, 4000, -15V, UU
2001	DS1, DL, S3, 4001, -15V, TS, UU

REVISION STATUS		
FAB	SCHEM	ASSY
X1	X1	X1
A	A	A
A	B	B

SIGNAL INDEX			
SIGNAL	DEFINITION	SOURCE	LOCATION
CTO	CENTER TAP 0	7D4	2D8
CT1	CENTER TAP 1	7D4	2C8
DC INT	DISC CHANGE INTERRUPT	7A4	5D6
DIRECTION SELECT *	DIRECTION SELECT	4E6	6E7
DRSE	DRIVE SELECT ENABLE	7C4	3E7
DRV SEL INT	DRIVE SELECT INTERRUPT	7D4	4A4, 5E4
DRV SEL INT *	DRIVE SELECT INTERRUPT	7C4	3D7, 5D3
ERASE 0	ERASE 0	2D8	3B2
ERASE 1	ERASE 1	2D8	3A2
POWER UP RESET	POWER UP RESET	7B4	3A7 4D7
F PULSE		4C1	5E1
READ GATE *	READ GATE	3E3	2C4, 4D7
READY	READY	6D4	6A2
READY 1	READY SIDE 1	6C4	2C3
READY 1 *	READY SIDE 1	6C4	3E7
SIDE 1 *	SIDE 1	7D4	5C7
STEP MOTOR ENABLE	STEP MOTOR ENABLE	7C4	4B5
TR00	TRACK 00	6E7	4A4
U RDY *	UNSLECTED READY	6C2	2C2
WC +	WRITE CURRENT	2E8	3C3
WC −	WRITE CURRENT	2E8	3C3
WRITE PROT	WRITE PROTECT	6D4	3E7
PHASE 1+ *		4D3	5A8, 5E8
PHASE 1− *		4D3	5D8
PHASE 2+ *		4E3	5C8
PHASE 2− *		4E3	5B8

LEGEND:





NOTE: UNLESS OTHERWISE SPECIFIED —

1. REFERENCE DRAWINGS - ASSEMBLY 114951-*
2. ALL CAPACITOR VALUES ARE IN MICROFARADS, 50V.
3. ALL RESISTOR VALUES ARE IN OHMS, ±5%, 1/4 W.
4. THE THREE CHARACTER ADDRESS IS: SHEET NUMBER - HORIZONTAL ZONE - VERTICAL ZONE.
5. AN ASTERISK FOLLOWING SIGNAL NOMENCLATURE INDICATES THE NEGATIVE FUNCTION.

		+5V	0V
6.	Z1 IS (MC7905) 704520-137		
7.	Z2 IS 701900-007	−	1
8.	Z3 IS 701900-022	6	1
9.	Z1C IS (LM339) 704520-156		
10.	Z1D, 5C, 6F, 8D ARE (9602) 704610-127	16	8
11.	Z1E, 5F, 8B ARE (74LS02) 704620-002	14	7
12.	Z1F, 4F, 6B, 6E ARE (74LS04) 704620-004	14	7
13.	Z1G, 8G ARE (75462) 704600-160	8	4
14.	Z2C IS (74LS86) 704620-086	14	7
15.	Z2D, 3E, 5G, 7B ARE (74LS00) 704620-000	14	7
16.	Z2G, 3G ARE (NE556) 704520-134	14	7
17.	Z3B IS (ULN2813A) 704212-112	14	7
18.	Z3D, 4C ARE (74LS08) 704620-008	14	7
19.	Z4B IS (ULN2074B) 704900-111		
20.	Z4E IS (74LS27) 704620-027	14	7
21.	Z4G, 9A ARE (7417) 704600-141	14	7
22.	Z5D, 6A ARE (7438) 704600-149	14	7
23.	Z7A IS 701900-011	14	7
24.	Z7C, 7D, 9B ARE (7400) 704600-101	14	7
25.	Z7F IS (Q2T2905) 704202-113		
26.	Z7G IS (7406) 704600-111	14	7
27.	Z6C, 6D, 6G, 8C ARE (7474) 704610-110	14	7
28.	Z9C IS (8T20) 704610-172	16	8
29.	Z9D, 9F ARE (NE592) 704520-145		
30.	Z2E, 2F, 3C, 3F, 4D ARE (74LS74) 704620-074	14	7
31.	CR1-8, 10, 12-21, 24-29 ARE (FDH6666) 704000-110		
32.	CR9 IS (1N747A) 704010-126		
33.	CR11 IS (1N751A) 704010-116		
34.	CR22, 23 ARE (1N4003) 704005-137		
35.	Q1-5 ARE (2N4001) 704203-114		
36.	Q6 IS (2N6726) 704212-115		
37.	Q7 IS (2N4403) 704202-108		

114952-001

Figure 8-4. Schematic Drive Card, 114951-XXX.

Sheet 1-7

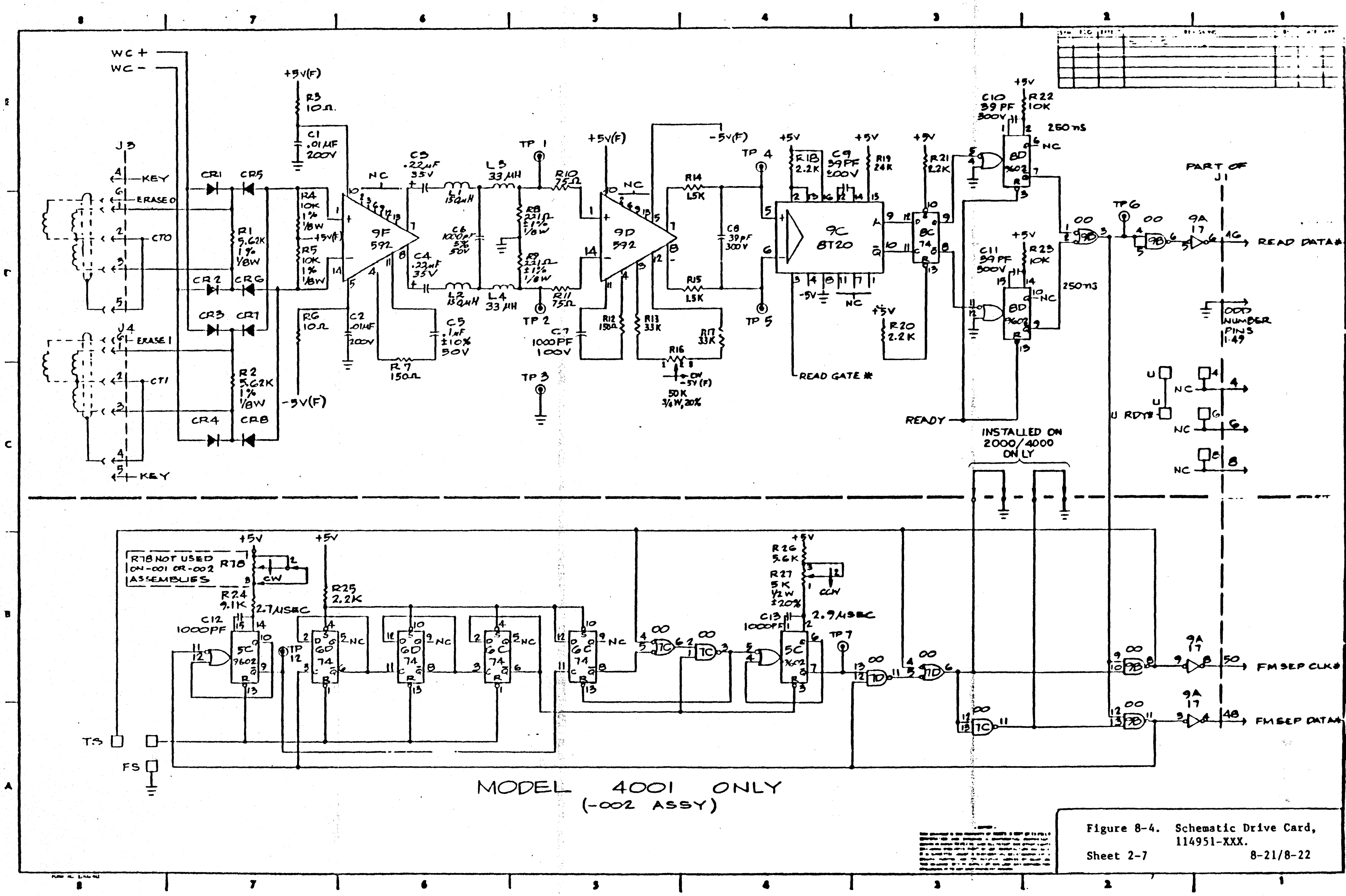


Figure 8-4. Schematic Drive Card, 114951-XXX.

Sheet 2-7

8-21/8-22

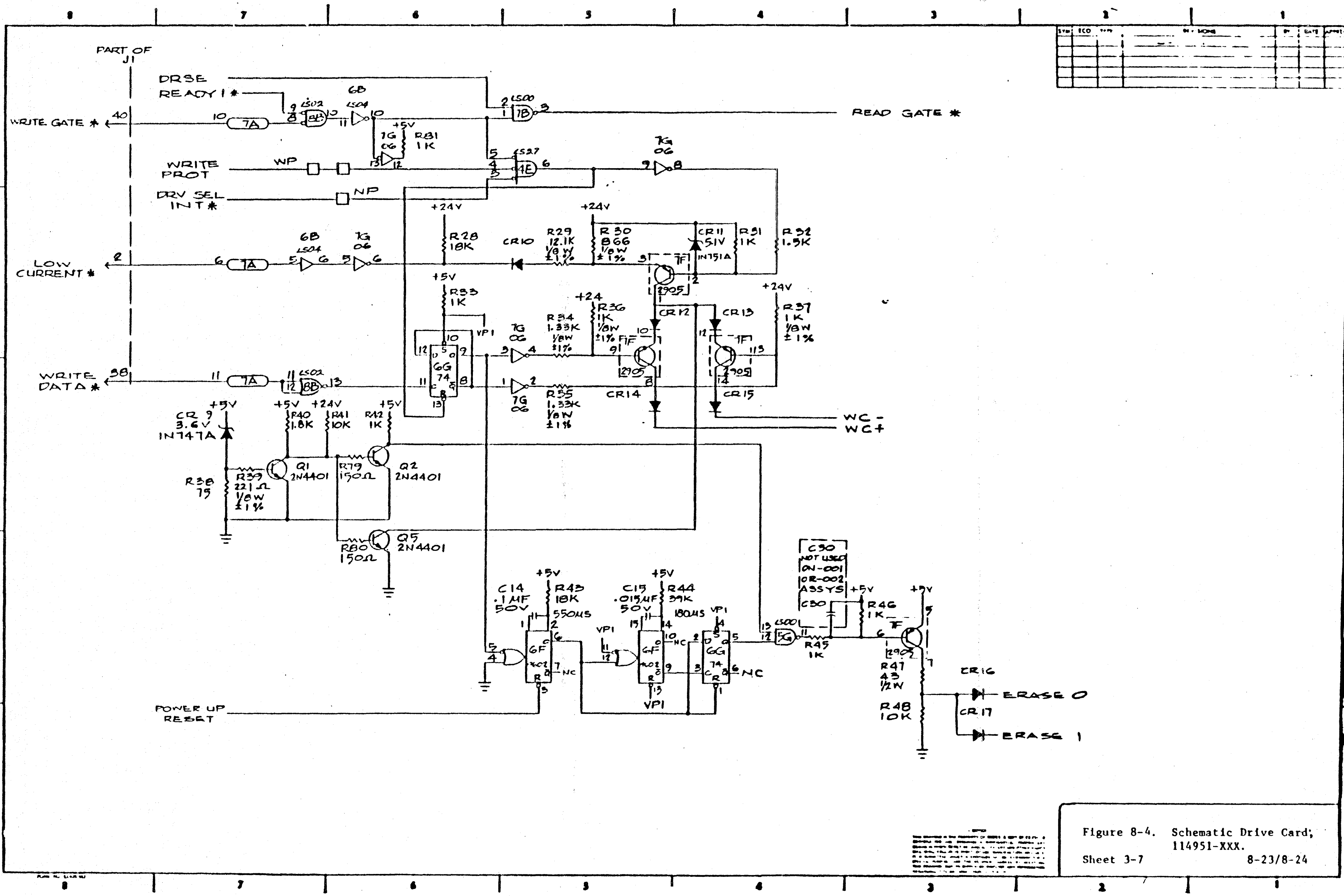


Figure 8-4. Schematic Drive Card; 114951-XXX.

Sheet 3-7 8-23/8-24

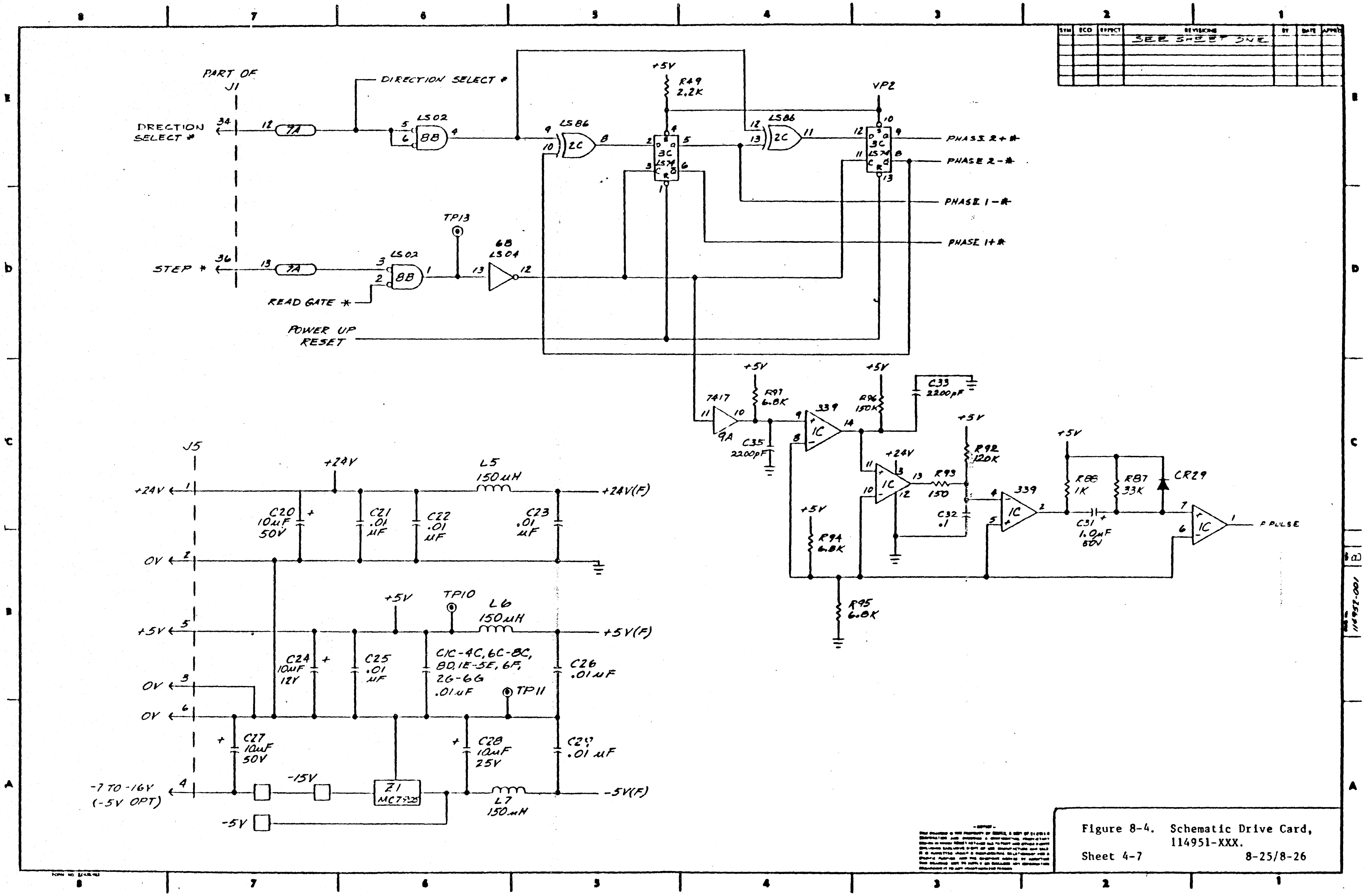


Figure 8-4. Schematic Drive Card, 114951-XXX.

Sheet 4-7 8-25/8-26

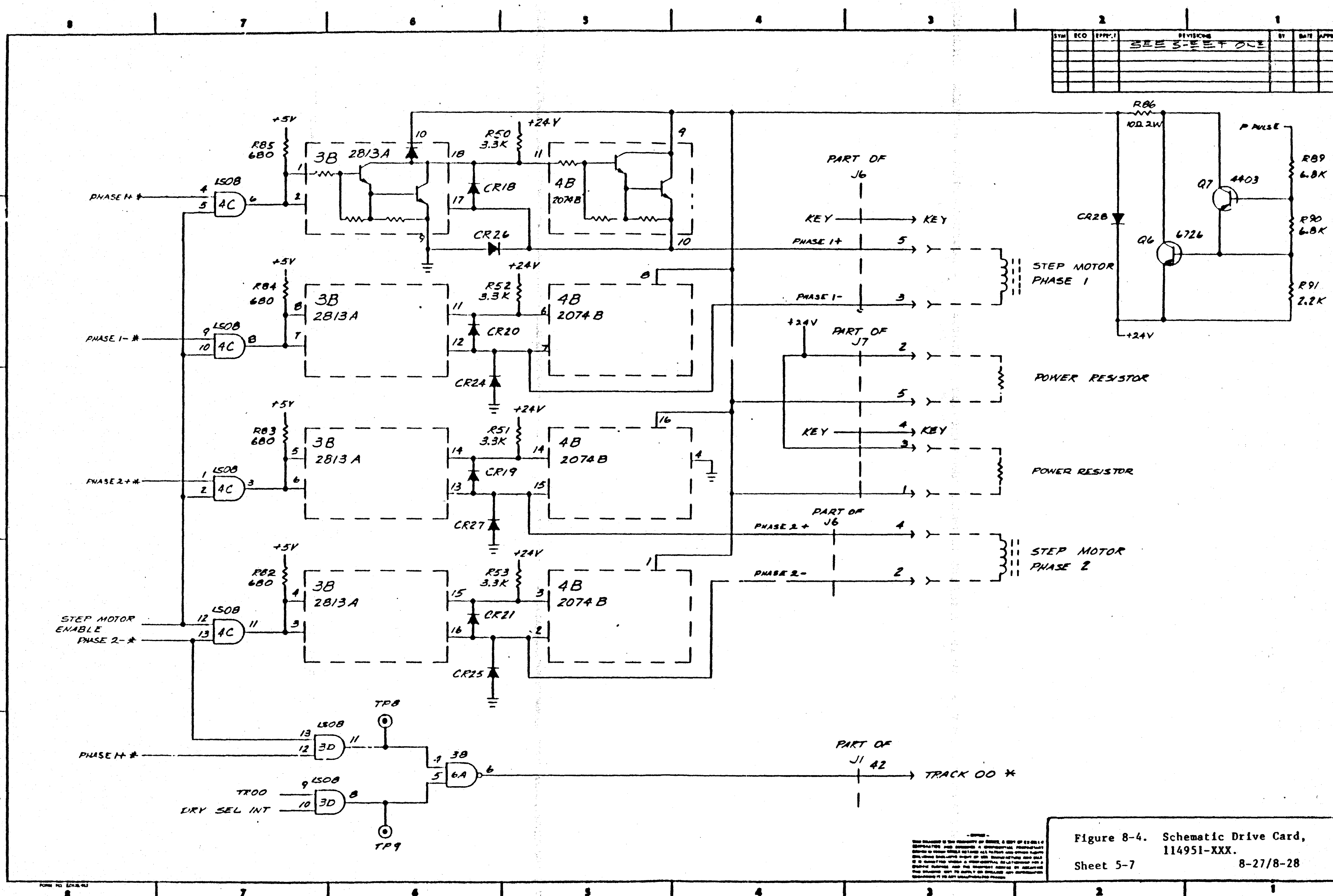


Figure 8-4. Schematic Drive Card, 114951-XXX.

Sheet 5-7

8-27/8-28

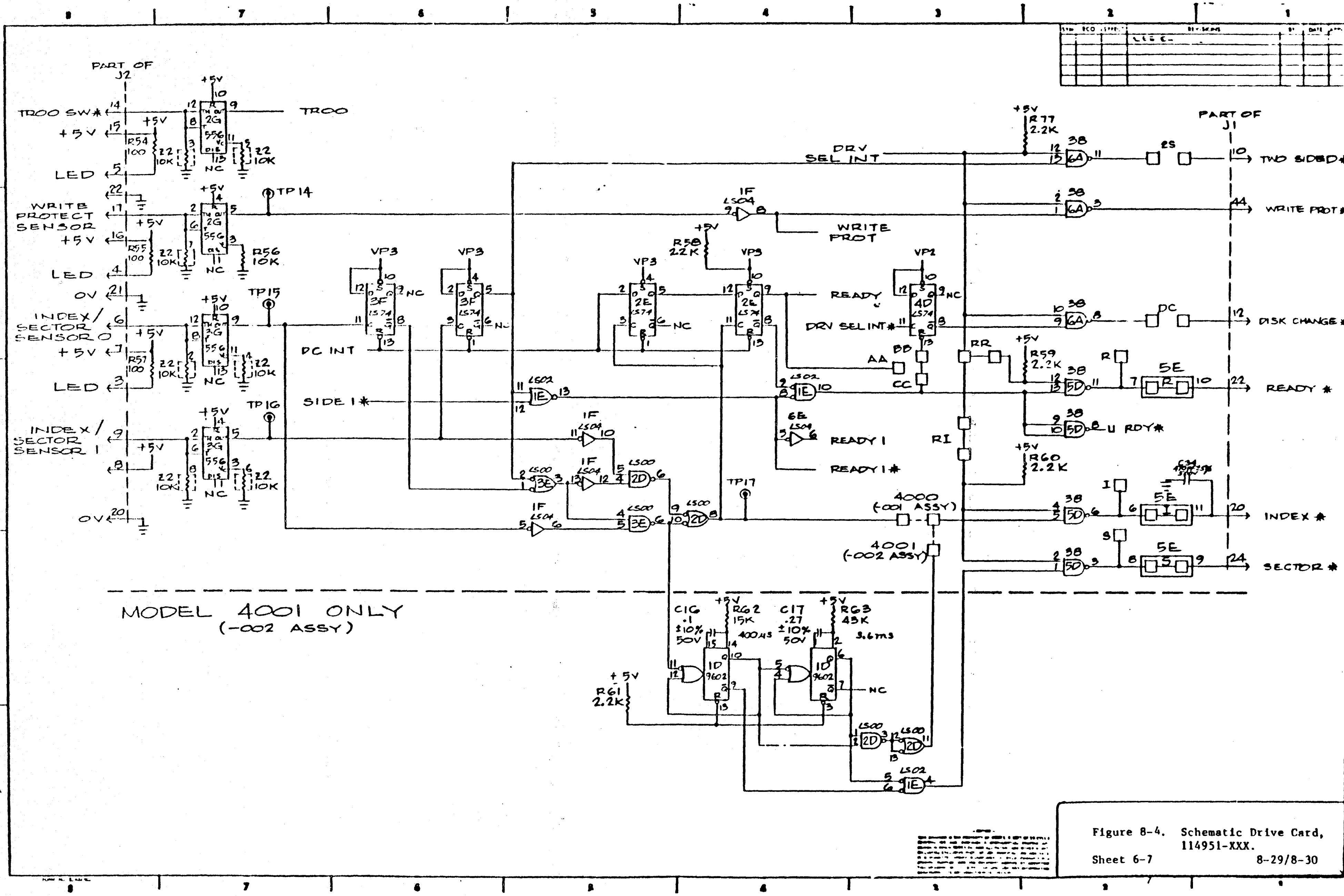


Figure 8-4. Schematic Drive Card, 114951-XXX.

Sheet 6-7

8-29/8-30

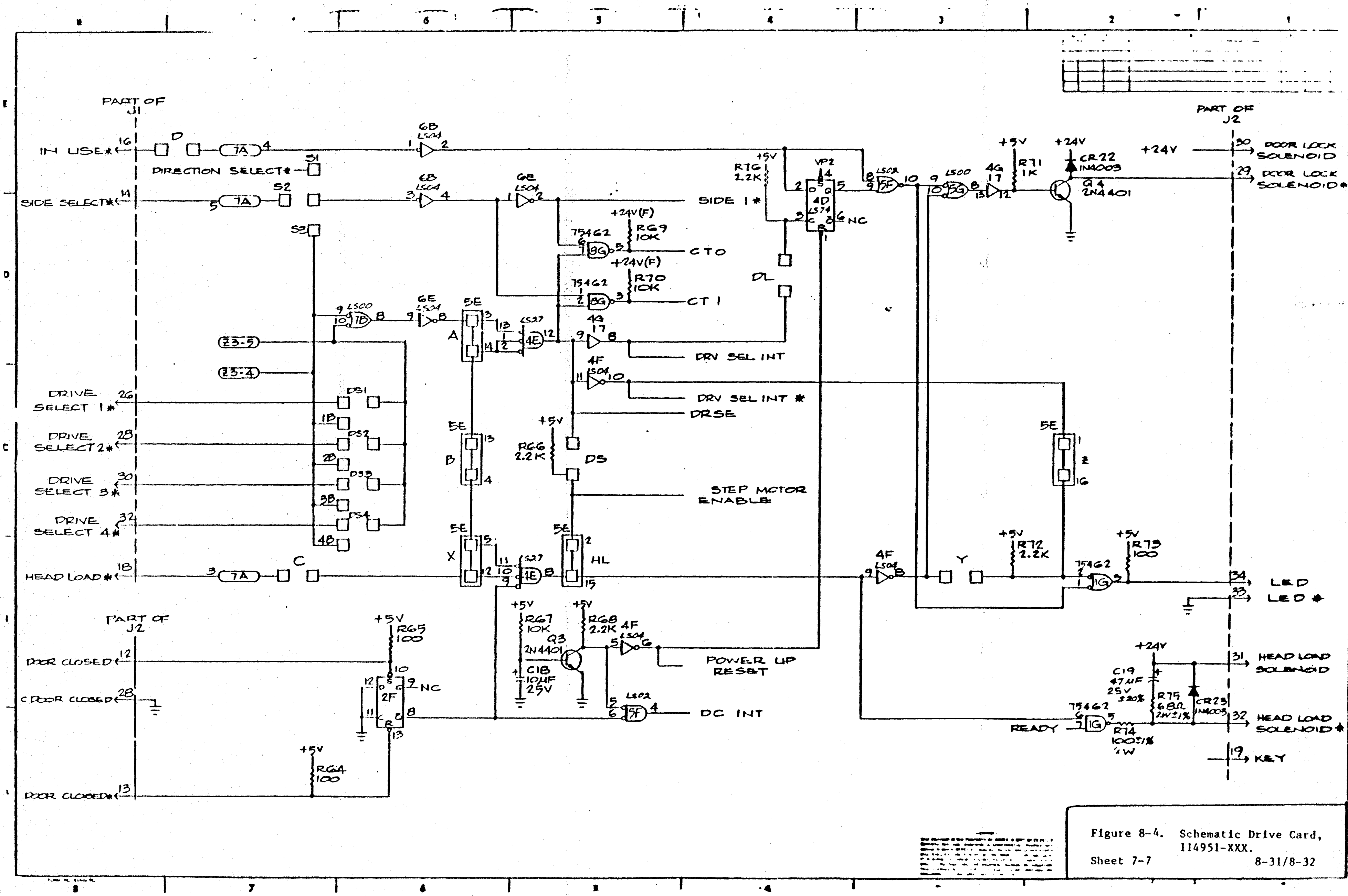


Figure 8-4. Schematic Drive Card, 114951-XXX.
Sheet 7-7