FD-11S

FLEXIBLE DISK SYSTEM

MAINTENANCE MANUAL

Serial # 325

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CRDS

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The following terms used in this manual are trademarks or designations of Digital Equipment Corporation:

Unibus

RX-11

PDP-11

RT-11

LSI-11

INTRODUCTION

This manual contains all the information necessary to install, operate and maintain the FD-11 Flexible Disk System. Section 2 contains information on unpacking, installation and diskette care. It should be read carefully before any use of the unit is attempted.

1.1 SYSTEM CONFIGURATION

All FD-11 systems are shipped with the following parts:

1	FD11-100	Controller and formatter card for PDP-11
1	FD11-300	Dual drive chassis
1	FD11-401	50 connector ribbon cable
1	FD11-402	6 connector power cable
1	FD11-501	Chassis slides and mounting hardware
1	FD11 Manual	

In addition the following options are available:

1	FD11-301	Dual drive with self-contained 5 Volt power supply
1	FD11-502	4 rubber feet for table mounting

All electronics except the read/write electronics located in each drive are found on the FD11-100, a quad-height card.

The controller is connected to the drive chassis as shown below:

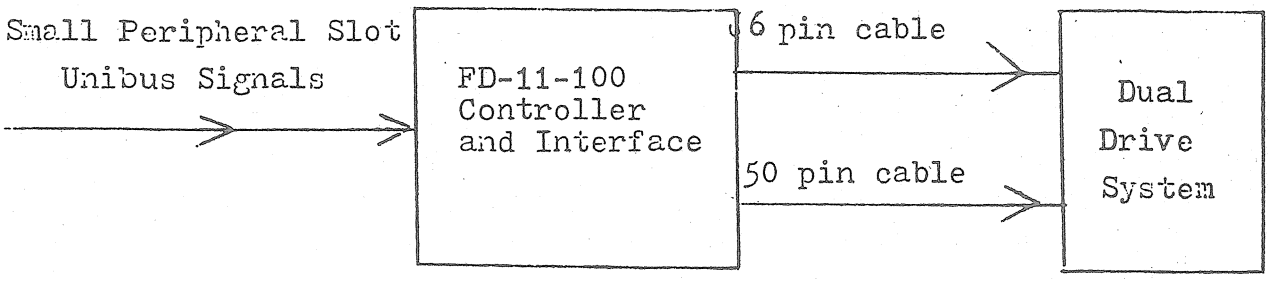


FIGURE 1-1 FD-11 System Configuration

1.2 FD11-100 CONTROLLER CARD

The controller card is based around an 8080 microprocessor which controls all reading and writing to the disk drives, follows the IBM 3740 format in disk operations, and emulates DEC's RX-11 instruction set. In addition it has the capability of formatting diskettes, bootstrapping the system, and executing an internal diagnostic routine.

This card plugs into an SPC (small peripheral controller) slot with any PDP-11 processor (LSI-11 processors require a different card). A 50 conductor ribbon cable connects this card directly to each of 2 disk drives that are daisy-chained. For processors with good 5 volt capability, a cable of twisted pair 18 guage wire connects the 5 volt supply of the processor to the disk drives.

1.3 FD11-300 DUAL DRIVE CHASSIS

This chassis holds two drives, above and below each other, as well as write-protect switches, unit select switches, a power switch, and 1 or 2 power supplies.

1.3.1 ELECTRO-MECHANICAL

Each drive may be removed individually on a set of small slides inside the chassis.

Each drive has an activity LED mounted on its bezel indicating the recording head is loaded and an I/O operation is taking place.

1.3.2 POWER SUPPLIES

All systems have a power supply that generates +24 volts at 2.0 amps and -5 Volts at 200 milliamps. If the processor is not capable of supplying the necessary 4.2 amps required to power both the controller card and 2 drives, a 5 volt power supply is needed in the chassis. This can be used to power both the drive electronics and the controller card.

1.4 SYSTEM COMPATIBILITY

The FD11 system is completely compatible with DEC's RX-11 instruction set and should run with any DEC supplied software or with any software designed to work with DEC's RX-11 system.

1.5 MEDIA COMPATIBILITY

The FD-11 is designed to be compatible with IBM's 3740 format just as DEC's RX-11 system. For this reason, diskettes written on an RX-11 can be read on an FD-11 and vice-versa. The IBM format is also used by many other manufacturers providing something of an industry-standard format.

1.5.1 DISKETTE

The flexible diskette consists of a flexible mylar disk coated with an oxide and encased in a plastic jacket. The jacket is lined with a fiber material that cleans the diskette as it is rotated.

Care should be used in handling these diskettes as described in Chapter 2.

1.5.2 IBM FORMAT

In the IBM 3740 Data Entry System, each disk contains one index track (address 00), 73 record tracks (addresses 01 through 73), two alternate tracks (addresses 74 and 75) and a spare (address 76). Each track is divided into 26 sectors containing from 1 to 128 characters. The organization of sectors on a track is determined logically (soft sectoring) rather than mechanically (hard sectoring). The principal characteristics of this format are shown below:

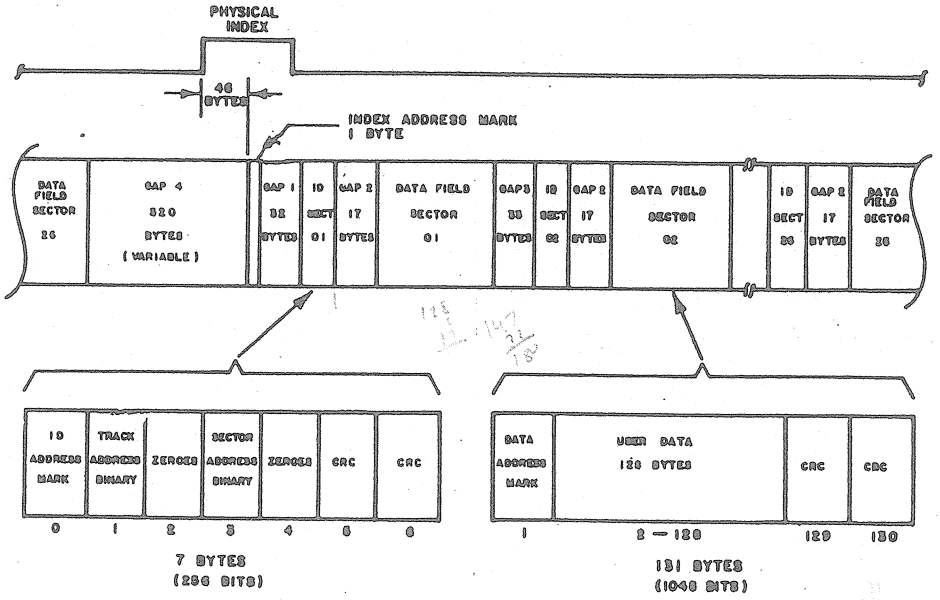


FIGURE 1-2

1.5.2.1 CYCLIC REDUNDANCY CHECK (CRC)

Every ID and data field on the track has a pair of CRC bytes appended to it. These bytes, which are generated as the field is written, represent a cyclic permutation of all the data bits in the field, from bit 0 of the address mark to bit 7 of the last byte in the field (excluding the CRC bytes).

The cyclic permutation is the remainder that results from dividing the data bits (represented as an algebraic polynomial) by a generator polynomial G (X). The polynomial used in the 3740 system is $G(X) = X^{16} + X^{12} + X^5 + 1$.

1.6 SYSTEM SPECIFICATIONS

Capacity

Bytes per sector:	128
Sectors per track:	26
Tracks per diskette:	77
Total byter per diskette:	256,256

Access time and rates

Diskette to controller buffer	32 usec/byte
Buffer to CPU	16 usec/byte
Track to track	6 msec
Head settle time	14 msec
Rotational speed	360 rpm ± 2.5%
Average Access (25 track seek and rotational latency)	320 ms

Recording Technique

Method:	Double frequency
Bit density:	3200 bpi
Track density:	48 tpi
Surfaces:	1

Reliability

Seek error rate:	1 in 10^6 seeks
Soft read error rate:	1 in 10^9 reads
Hard read error rate:	1 in 10^{12} reads

Environmental Restrictions:

FD-11 operating temperature 50 to 100 degrees F
FD-11 non-operating temperature 32 to 150 degrees F
Diskette non-operating temperature -30 to +125 degrees F

FD-11 Humidity 10 to 80 percent without condensation

Power requirements:

FD-11 AC power 120 VAC, 60 HZ ± at 2 amps
FD-11 DC power +5 VDC at 4.2 amps

NOTE: 220 VAC and 50 HZ power available at customer option.

Enclosure Dimensions: (per dual drive system)

19.0 in. (482.6 mm) wide
10.5 in. (266.7 mm) high
14.0 in. (355.6 mm) deep

INSTALLATION AND OPERATION

2.1 UNPACKING

The FD-11 is shipped with all items listed on page 1-1. The container must be opened from the top (printing on side of box reading correctly). Remove the slides, hardware, manual, controller card, and cables from the top green packing section. By then removing this top green container piece, access is gained to the drive chassis. This may be removed by dropping your hands down a cut-away section on each side of the chassis, and pulling the unit up.

2.2 RACK-MOUNTING THE FD-11

First, seperate each slide into 2 pieces by pulling them apart. It may be necessary to release the safety catch button inside the slide section depending upon which direction they are pulled apart.

The slide sections with right angle ears should now be mounted as shown in Fig. 2-1. In order to exactly fit the FD-11 into a $10\frac{1}{2}$ inch section, it is necessary to count off 4 holes above the section below. The slides are mounted by screwing two 10-32 machine screws into a tapped retainer plate clamping each slide section in front of the cabinet's mounting rail as shown in Fig. 2-2

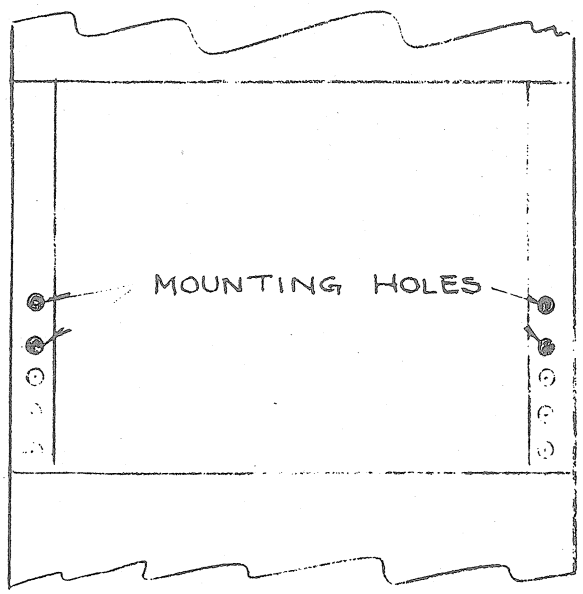


FIGURE 2-1

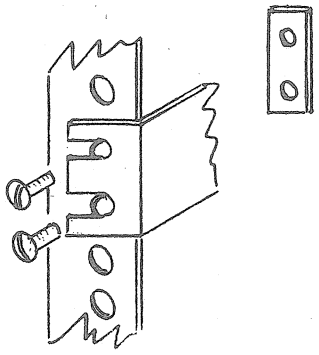


FIGURE 2-2

2.2 (continued)

Two right angle rear mounting brackets have been supplied for attaching the slides to the rear mounting rail of the cabinet. First mount the 2 brackets to the rear mounting rail in the same way that the front ears of the slides were mounted. Use two 10-32 machine screws and 1 tapped plate on each side.

The brackets may now be attached to the slides by using one 10-32 machine screw and one 10-32 kep hex nut on each slide. The hex nut must be kept on the outside of the slide.

The remaining slide sections may now be mounted on the FD-11 chassis. Use six 10-32 machine screws, 3 on each side to attach the slide sections as shown in Figure 2-3.

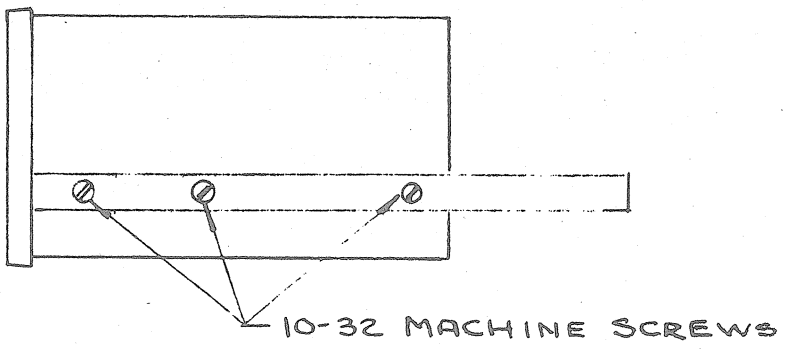


FIGURE 2-3

The FD-11 may now be installed by lining up the 2 slide sections and mating them. After pushing in a short distance, the safety catches must be pressed in allowing the FD-11 to be pushed all the way in.

2.3 ELECTRICAL INSTALLATION

The controller card should next be mounted in the unit. If a device address, interrupt vector address, or a priority level different from the standard DEC assignment is desired, jumper changes should now be made according to the instructions in Appendix A. Any change in these assignments necessitates a change in the system software. The DEC standard assignments are given below:

Device Address:	177170
Vector interrupt Address:	264
Priority level:	5

2.3.1 CONTROLLER CARD INSTALLATION

The controller card can function only in a small peripheral slot. Other types of memory and other backpanels cannot be used. The card should be mounted, as all other small peripheral controllers, in slots C,D, E and F of the panel.

2.3.1.1 5 VOLT POWER

Normally the power from the processor is used to power the controller card and drive electronics via a 6 conductor cable. If however the 5 volt power supply option is purchased, the drive electronics will not draw power from the processor.

2.3.1.1 5 VOLT POWER (continued)

The end of the power cable with 6 female pins slides over the 6 prong male connector on the edge of the controller card as shown in Fig 2-4. This 6 pin female housing must have the lip on one edge note with the locking piece on the board connector. Reversal can damage the power supplies.

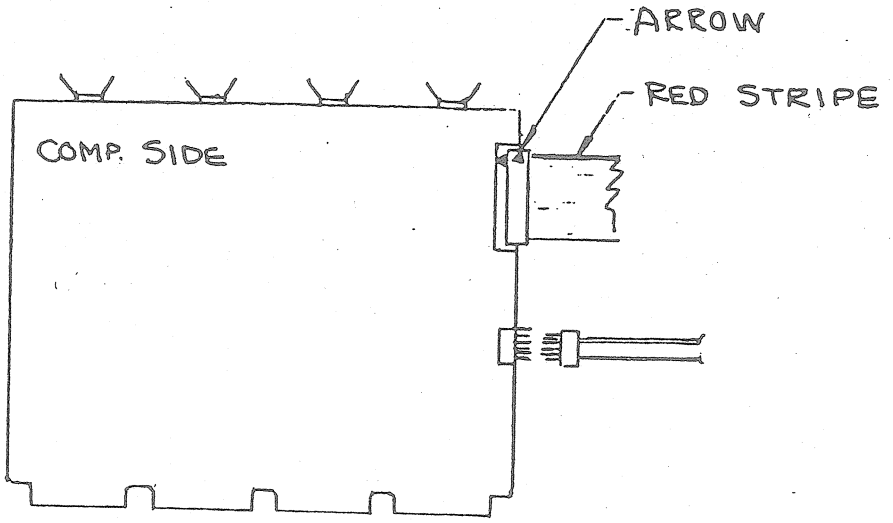


FIGURE 2-4

2.3.1.2 50 CONDUCTOR-RIBBON CABLE

The 50 conductor grey ribbon cable should now be installed. The mating connector and the header connector on the controller board both have 2 small arrows that should line up as shown in Figure 2-4.

2.3.2 DRIVE CABLING INSTALLATION

The 50 conductor ribbon cable should now be attached to the drive unit as shown in Figure 2-5. The cable must be connected to both drives and come from below the unit. The remaining end of the 5 volt connector can now be pushed onto the small white connector also shown in Figure 2-5. The AC line card should preferrably be plugged into AC power switched by the processor.

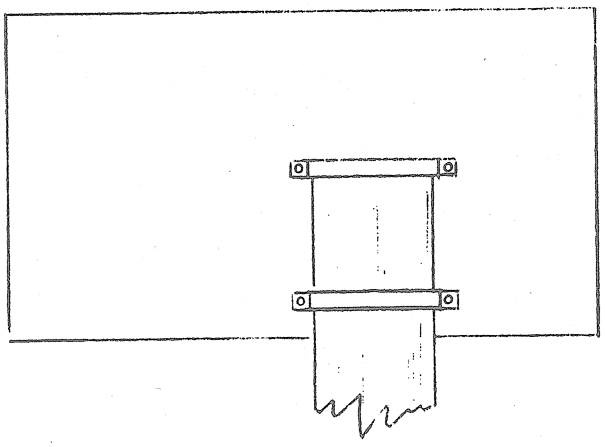


FIGURE 2-5

2.4 DISKETTES

Diskettes must be treated with good care to prolong diskette life and prevent damaging the sensitive recording surface. In addition we have found that not all of the media available is of good quality. We have found the three media manufacturers listed below to have a reputation for good quality control on production of their media.

IBM
ITC
Dysan

Read errors on diskettes are often the result of bad media and we therefore cannot be responsible for the performance of the FD-11 with other media.

2.4.1 DISKETTE CARE

The following rules should be observed in diskette handling:

(1) Always return a diskette to its envelope after use.

(2) Do not place any object on top of diskettes stored horizontally.

(3) Observe the storage temperature and humidity specifications of the diskettes and preferrably store them at operating conditions.

(4) Do not write on labels on the jacket above diskette surface.

(5) Do not touch the diskette through the oval read/write aperature.

(6) Do not store diskettes in dusty areas.

(7) Never clean the diskette.

(8) Never expose to prolonged heat or sunlight.

2.4.2 DISKETTE INSERTION AND EXTRACTION

Diskettes should be inserted into the FD-11 drives with the small white label up. The diskette should be inserted fully into the drive until it is stopped and a click is heard. The long white handle may now be pressed down locking the diskette in place. If the diskette was not fully inserted into the drive, the door handle is prevented from closing.

The diskette is extracted by simply pressing the black button located on the handle. The door will pop up and the diskette will pop out. It may now be removed from the drive.

Diskettes may be inserted or extracted with either the power on or off. They should not be removed while in use or any time the red activity LED is on.

2.5 INITIAL OPERATION AND CHECK-OUT

The following procedure should be used after installation is completed in order to check that the system is functioning properly:

(1) Press the top edge of the red power switch which turns the FD-11 system on.

(2) Turn on the processor's power switch. The red power switch on the FD-11 should now light up if its power cord is plugged into AC power switched by the processor.

(3) Set one of the unit select switches to 0 and the other to 1.

(4) Place a scratch diskette in each drive.

(5) Press the reset switch on the PDP-11 (called INIT on some PDP-11's, on others press HALT and START).

(6) Both drives should now calibrate themselves. First unit 1 steps out 10 tracks and then steps in track by track until a microswitch in the drive indicates track 0 has been reached. This procedure is then repeated on unit 0.

    At the completion of this procedure, the head on drive 0 is loaded and sector 1 of track 1 on unit 0 is read into the internal buffer on the controller card. The head load is indicated by the red activity LED on the bezel of drive 0 and will remain on for 1 second after the read is completed.

2.5 INITIAL OPERATION AND CHECK-OUT (continued)

If after pressing INIT on the processor, the red LED on unit 0 does not come on for a second or two, there is a problem. The cabling should be checked as well as the 2 LED's close together in one corner of the controller card. If these are out, there is a power supply problem.

(7) Read the contents of the FD-11 command and status buffer, location 177170 (if standard assignment is used). This can be accomplished on some PDP-11's be entering 177170 in the switches and pressing LOAD ADR followed by EXAMINE. (On PDP-11/04's the ODT monitor allows examination of memory.) The contents of this location should be 40 (octal). Examining the next location, 177172, should yield the number 204. An explanation of what these bits mean can be found in Chapter 3.

(8) In order to check that unit 1 is also capable of reading, the unit select switch settings should now be reversed. The procedure followed in steps 5, 6, and 7 should now be repeated.

(9) If the above procedures work without any problem the system should be ready for use. Diagnostics may be run, either DEC diagnostics, or the internal diagnostics outlined in section 4-2. If it is desired to bootstrap an operating system, refer to section 4-1 .

2.6 FRONT PANEL CONTROLS

The front panel contains 3 types of controls: unit select switches, write-protect switches, and the power switch. Use of these controls is described below.

2.6.1 POWER SWITCH

This switch controls the AC power to the 2 drive motors and the +24 volts and -5 volt power supply. In the standard configuration, +5 volts may still be on inside the FD-11 even though this switch is off. The 5 volt twisted pair cable may still be supplying power if the processor is on.

2.6.1 POWER SWITCH (continued)

The bulb mounted inside this switch is connected directly across the +24 volt supply. It acts as a DC power good indicator for this voltage.

2.6.2 UNIT SELECT SWITCHES

These switches select which unit the top or bottom drive will be selected as. If the top switch is set to 0,for example, under RT11 the top drive will respond to DX0. These 2 switches may not be set to the same number. Normally, one should be set to 0 and the other to 1.

It is convenient to be able to switch a drive to be unit 0 if the other is defective. The bootstrap function can only run off unit 0, for example. It is important, however, not to switch units without reinitializing the system. In that event, the controller's record of which drive is on what track is thrown off and a header verification error will result. The operation is usually retried and will then execute successfully.

If the Unit select switch is set to 5, the unit becomes continually selected. This is used mostly for maintenance purposes. In this mode the other unit select switch is set to a non-existant unit number such as 2, 3, 4, 6, 7, 8, or 9. The system will run in this mode however accesses to more than one unit in this mode will cause track verification errors.

2.6.3 WRITE-PROTECT SWITCHES

These write protect switches are 2-position push-button switches that light up when the drive is being protected. These switches send a signal to the drive disabling the write function as well as to the controller which aborts a write operation before it is attempted and returns a status bit to the processor. These switches are very useful in protecting data from accidental destruction.

There are no special provisions in the DEC software to handle a write-protect violation condition. The error condition will cause the software to retry the operation several times. If the write operation is really desired there is sometimes enough time to unprotect the disk before the retry counter runs out. This usually works but could intefere with the write operation if the switch exhibits too much contact bounce.

2.6.3 WRITE-PROTECT SWITCHES (continued)

It should be noted that on the systems disk, unexpected write operations often occur. For example, under RT11, a control C out of PIP writes a scratch file on disk. Also, running EDIT immediately opens a scratch file. The write-protect feature must be used with care.

STANDARD INSTRUCTION SET

3.1 GENERAL

Program control of the FD-11 is accomplished by the proper manipulation of two device registers in the FD-11. The first of these two registers, the FDCS, serves to pass control information from the CPU to the FD-11, and to report status and error information from the FD-11 to the CPU. The second register, the FDDB serves as the data path between the CPU and the FD-11. The information that is present in the FDDB at any given time is a function of the FD-11 operation that is in progress at that time.

Data transfers both to and from the diskette are always one complete sector (128 eight bit bytes) of information per transfer command. Partial sector transfers (less than 128 bytes) are not accomodated by the FD-11.

The FD-11 contains a read/write data buffer of 128 bytes. During write operations, this buffer is first loaded under program control, then the write command is issued which transfers the contents of the buffer to the diskette. During read operations the read instruction is issued and the information from the proper sector and track is read into the buffer. After the buffer is full, the contents of the buffer are read one byte at a time, into the CPU via the FDDB.

3.2 REGISTER AND VECTOR ADDRESSES

The normal address assignments for the FD-11 device registers and the interrupt vector address are as follows:

Function	Address
FDCS	177170
FDDB	177172
Interrupt Vector	264

3.3 FD-11 REGISTER DESCRIPTION

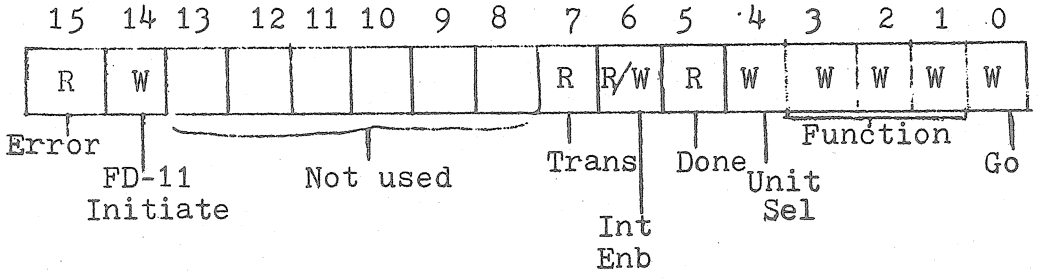
The 2 registers listed above are the only data paths between the CPU and the FD-11. The first of these registers is used to initiate commands and indicate certain status information. The

3.3 FD-11 REGISTER DESCRIPTION (continued)

second of these registers has 5 different uses and which one it serves is determined by the protocol of the operation being performed. These five functions are: (1) for transferring data to and from the 128 byte buffer, in the FD-11, (2) to transfer the sector address for a read or write operation, (3) to transfer the track address for a read or write operation, (4) to indicate certain common error conditions, and (5) to indicate codes for less common errors.

3.3.1 FDCS COMMAND AND STATUS REGISTER (177170)

Commands to the FD-11 are initiated by loading this register with the proper function code accompanied by the "Go" bit provided that the FD-11 is not busy when the command is issued. The operation codes and bit assignments for the FDCS are shown below. Bits designated W are write only, bits designated R are read only, and bits designated R/W can be both written and read by the CPU.



Function Code

000	Fill Buffer
001	Empty Buffer
010	Write A Sector
011	Read A Sector
100	Special Functions (see Chapter 4)
101	Read Status
110	Write Deleted Data Sector
111	Read the Error Register

Figure 3-1 FDCS Bit Assignment

3.3.1 FDCS COMMAND AND STATUS REGISTER (177170) continued

Description of bit assignments for FDCS

Bit number	Function
0	Go bit. Initiates the selected operation in the FD-11.
1-3	Function code. The coding of these three bits select the operation to be performed by the FD-11.
4	Unit select Bit - Selects which of two disk drives is to execute the selected operation.
5	Done Bit. Indicates the completion of an operation. If Interrupt Enable is set when Done is asserted, a program interrupt will occur.
6	Interrupt Enable. When this bit is set, the FD-11 will cause a program interrupt upon the completion of an operation.
7	Transfer Request Bit. This bit indicates to the CPU that the FD-11 requires data from the CPU or that the FD-11 contains valid data for the CPU.
8 - 13	Unused bits.
14	FD-11 Initialize. The FD-11 can be selectively initialized by setting this bit in the FDCS. Other devices connected to the system bus are not affected. The effects of setting this bit in the FDCS are: (a) Reset Done (b) Move the head of drive 1 to track 0. (c) Move the head of drive 0 to track 0. (d) FD-11 clears the Error and Status Register (e) FD-11 sets Initialize Done. (f) FD-11 sets FDES bit 7 (DRV RDY) if drive 0 is ready. (g) Sector 1 of track 1 of the diskette on drive 0 is read into the buffer.

3.3.1 FDCS COMMAND AND STATUS REGISTER (177170) continued

Description of bit assignments for FDCS

Bit number	Function
15	Error. This bit indicates an error of some type occured during a command. It is cleared by a new command or an initialize.

3.3.2 FDDB REGISTER (177172)

As mentioned in paragraph 3.3, this register has five distinct functions determined by the protocol of the operation. Section 3-4 details this protocol. The FDDB can be read when the FD-11 is not executing a command. When the FD-11 is executing a command, the FDDB can be read and written only when the TR bit (FDCS bit 7) is set.

3.3.2.1 DATA BUFFER REGISTER

This register serves as a 1 byte data path between the CPU and the FD-11 when filling or emptying the internal 128 byte buffer.

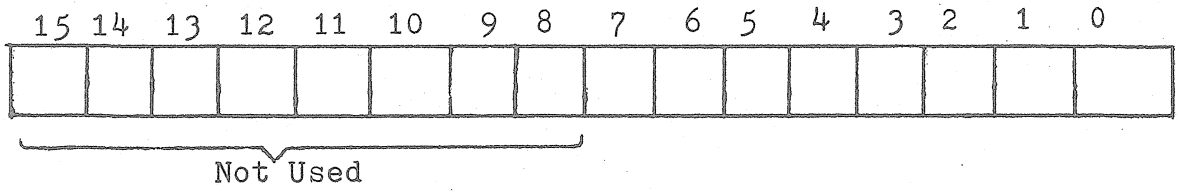


Figure 3-2 Data Buffer Format

3.3.2.2 SECTOR ADDRESS REGISTER

This register indicates which of 26 sectors, numbered 1 through 26 (32 octal), are to be used in a read or write command.

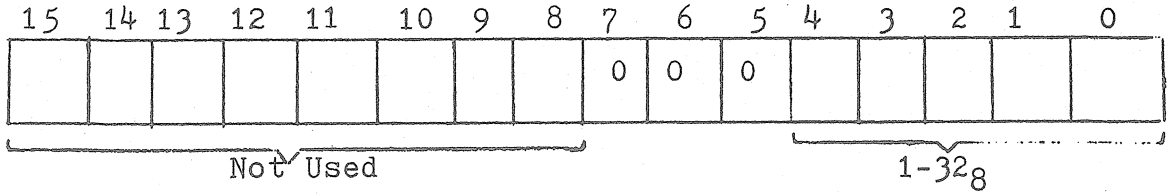


Figure 3-3 Sector Address Format

3.3.2.3 TRACK ADDRESS REGISTER

This register indicates which of 77 tracks, numbered 0 through 76 (114 octal), are to be used in a read or write operation.

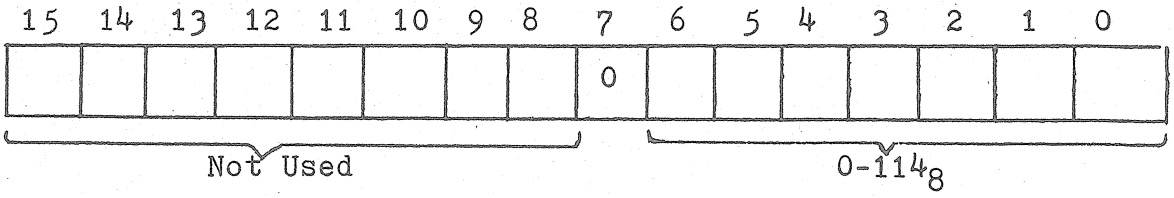


Figure 3-4 track address format.

3.3.2.4 ERROR AND STATUS REGISTER

This register contains certain error and status conditions of the drive selected by the unit select bit. It is always available at the completion of an operation and may also be read by the read status function.

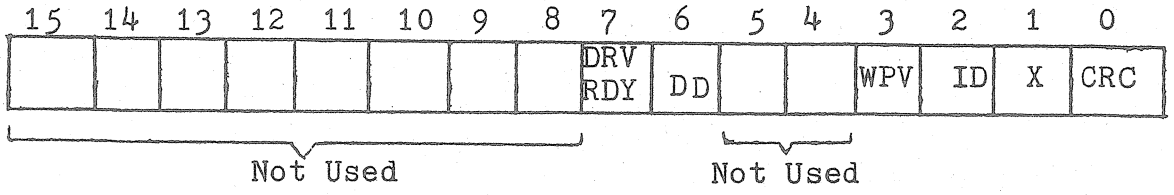


Figure 3-5 Error and Status Format

Bit No.	Code	Description
0	CRC	A cyclic redundancy error has occured in a read operation.
1	X	This is used in DEC systems to indicate a data transfer error between the 2 boards in the controller. This is not used in the FD-11 system because a single board controller design has been used.
2	ID	Initialize, DONE - indicates that an initialization took place. This can be caused by a power failure, programming or a Unibus signal.

3.3.2.4 ERROR AND STATUS REGISTER (continued)

Bit No.	Code	Description
3	WPV	Write protect violation - an attempt was made to write on the diskette when the write-protect switch was set.
4 - 5		Not used.
6	DD	A deleted data mark was found during a read, or the last command issued was a write deleted data command.
7	DRV RDY	This bit indicates that the selected drive is ready and has a diskette installed correctly. It is only valid when retrieved after a head Status function or after an initialize when it indicates the status of drive 0.

3.3.2.5 ERROR CODE REGISTER

This register should be read if the error flag (bit 15 of the FDCS) is set but no error condition can be found in the error and status register. It is accessed via the read error register function only. It will contain one of the bit codes listed below:

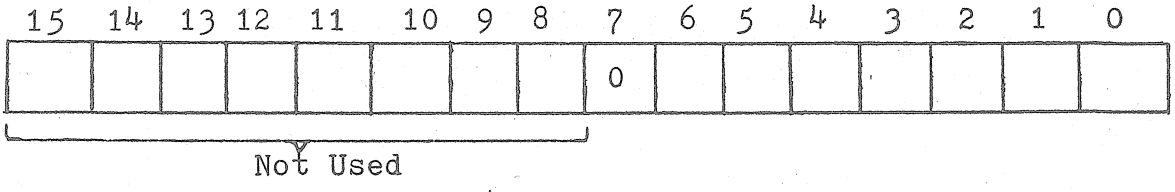


Figure 3-6 Error Code Register

Octal Code	Meaning
10	Drive 0 failed to see home on Initialize.
40	Tried to access a track greater than 77.
60	Data Error found when executing self-diagnostic
70	Desired sector could not be found after looking at 52 headers (2 revolutions).
120	A preamble could not be found.
130	Preamble found but no I/O mark found within allowable time span.
140	CRC error on what we thought was a header.
150	The header track address of a good header does not compare with the desired track.

3.4 COMMAND FUNCTIONS AND THEIR PROTOCOL

The function codes listed in paragraph are described in detail below. The specified protocol of each function must be observed or data loss may result.

3.4.1 FILL BUFFER FUNCTION (000)

This function is used to fill the FD-11 128 byte internal buffer with data from the CPU. The contents of the buffer are usually written onto the disk after completion of this operation. The following procedure is used in executing this function:

(1) Store function code 000 and go bit into FDCS.
(2) Check for the TR bit in the FDCS set on.
(3) Now 1 byte of data may be transferred to the FDDB.
(4) Repeat steps 2 and 3 until exactly 128 bytes of data have been transferred.

The Done bit will then be set and the function is complete.

3.4.2 EMPTY BUFFER ROUTINE (001)

This function is used to empty the FD-11 128 byte internal buffer into the CPU.

This function is usually performed after the completion of a read operation. The following procedure is used in executing this function:

(1) Store function code 001 and go bit into FDCS.
(2) Check for the TR bit in the FDCS set on.
(3) Now 1 byte of data may be transferred from the FDDB.
(4) Repeat steps 2 and 3 until exactly 128 bytes of data have been transferred. The done bit will then be set and the function is complete.

3.4.3 WRITE SECTOR FUNCTION (010)

This function is used to write the contents of the FD-11's internal buffer onto the disk. The following procedure is used in executing this instruction.

(1) Store function code 010 and go bit into FDCS.

3.4.3 WRITE SECTOR FUNCTION (010) (continued)

(2) Check for the TR bit in the FDCS set on.
(3) Now transfer the sector address to the FD-11 via the FDDB.
(4) Check for the TR bit set.
(5) Now transfer the track address to the FD-11 via the FDDB.
(6) On completion of the operation the done bit will be set and the FDDB will contain the error and status register.

3.4.4 READ SECTOR FUNCTION (011)

This function is used to read a diskette sector into the FD-11's internal buffer. The procedure followed by this function is identical to that of the Write sector function described in the previous paragraph. After waiting for the TR bit each time, the sector address and then the track address are deposited into the FDDB, location 177172. The function is then executed.

3.4.5 SPECIAL FUNCTION CODE (100)

These functions are described in detail in Chapter 4.

3.4.6 READ STATUS FUNCTION (101)

When this function is executed the error and status register will be loaded into the FDDB. This register will contain the same status generated from the last operation except bit 7 which will indicate whether the drive selected by the unit select bit is ready or not.

3.4.7 WRITE SECTOR WITH DELETED DATA FUNCTION (110)

This function is identical to the write sector function described in paragraph 3.4.3 except that a deleted data mark is written just before the start of the data field.

3.4.8 READ ERROR CODE REGISTER FUNCTION (111)

This function is used to retrieve the error code information for errors without a bit assignment in the error and status register. This register and the meaning of these codes is described in paragraph 3.3.2.5.After depositing this function into the FDCS register, the done bit should then be checked for completion of this function.

3.4.8 READ ERROR CODE REGISTER FUNCTION (111) continued

At that time the FDDB may be read and will contain an error code (if the error flag was set). Execution of this function clears bits 0 through 6 of the error and status register.

3.4.9 POWER FAIL OR CLEAR

If a power clear is generated by the console, or if the power fail signal is generated, an initialization sequence takes place. This sequence is the same as that given on page 3-3 under bit 14.

3.5 INTERLEAVING SECTORS

In order to gain efficient throughput, access to long data blocks should be made by interleaving sectors. Because the FD-11 is tied up with transferring data to or from its internal 128 byte buffer for every read or write of a sector, it is preferrable to access every other sector in long data transfers. The time spent in-between sectors is used for the empty or fill function.

If sectors are accessed sequentially, the extra time spent emptying or filling the 128 byte buffer will cause the FD-11 to just miss the beginning of the next sector. This results in a worst-case rotational latency each time and can reduce throughput by a factor of 10. Interleaving is built into DEC's operating systems and should be included in any user-developed operating system.

SPECIAL INSTRUCTION SET

In addition to the standard DEC instruction set given in Chapter 3, three instructions have been added that provide additional features to the user. These functions and their op codes are given below:

Bootstrap feature	11
Diagnostic routine	31
Format route	51

When the above numbers are deposited into the FDCS (177170) the appropriate function will be executed. These op codes are not used in the DEC instruction set and therefore will not interfere with the normal operation of instructions.

4.1 BOOTSTRAP FEATURE

An unusual approach was used here that adds no cost to the unit by taking advantage of the PROM already being used with the microprocessor. On execution of this instruction, the FD-11 controller writes bootstrap routine into the bottom of memory one byte at a time under microprocessor control. When the user restarts the processor at location 0 the system will bootstrap in if a system disk is in drive 0. The procedure is given below:

(1) Enter the device address, normally 177170, into the switch register.

(2) Press the LOAD ADDRESS switch down.

(3) Enter the bootstrap op code, 11, into the switch register.

(4) Press the DEPOSIT switch up.

(5) Reset the switch register to all 0's.

(6) Press the LOAD ADDRESS switch again.

(7) Press START.

This procedure must be followed precisely if the bootstrap procedure is to work.

4.2 DIAGNOSTIC ROUTINE

A testing routine has been placed in microprocessor's control ROM that enables the system to test itself without using the processor except for initialization. The routine writes and reads ecery sector of the diskette on all tracks and checks for valid data. If an error is encountered, the routine halts and the type of error may be determined by examining the status registers described in Chapter 3. If no errors are encountered, the routine will continue doing more passes indefinitely. The procedure for initiating this sequence must be followed exactly and is given below:

(1) Place a diskette in the drive to be tested and set the unit select switch to 5.

(2) Initialize the system by turning the DC power switch off and then on.

(3) Enter the device address, 177170, through ODT.

(4) Deposit the diagnostic op code, 31, into location via ODT.

(5) The drive will now step through each track on unit 0 testing all sectors. When it reaches track 76, it automatically goes back to track 0 and makes another pass.

4.2 DIAGNOSTIC ROUTINE (continued)

If the diagnostic halts, an error has occured. The nature of this error can be found by 1 of the 2 procedures given below:

(1) Read the FDDB register (177172). If this contains a one, a CRC error has occured. A new diskette should then be tried to see if the problem is in the system or the media. Bad diskettes will often give CRC errors at the same point on the diskette each time.

(2) If the FDDB contains 0, the read error register function must be used in order to pin-point the error. The op code for the read error register function, 17, must be deposited in the FDCS, location 177170. Location 177172 may now be read and will contain an error code listed on page 3-6. The test should be repeated with new media to see if bad media has been the problem.

It should be noted that the write-protect switches are not examined by the diagnostic routine. This will prevent writing on the diskette, but it will not present a status bit. If the diagnostic is run in write-protect mode it will either (1) show no errors if the disk has previously been written with the diagnostic pattern, or (2) show a 60 or self-diagnostic type error indicating that when reading the diskette, the information read back was not what was expected. The write-protect switch may be used to run the diagnostic routine in a read-only mode on a diskette previously written with the diagnostic pattern.

The internal diagnostic does not test all aspects of the controller card, but may be a helpful tool in locating problems and in running data reliability tests. It cannot test the Unibus logic nor certain instruction set functions.

The diagnostic routine normally does, of course, write on the diskette and therefore destroys any data previously written on the diskette.

4.3 FORMAT ROUTINE

The format function allows the recovery of certain media on which the format information may inadvertently become erased. The

4.3 FORMAT ROUTINE (continued)

format information includes those sections of the diskette called headers which contain the track and sector number of each 128 byte sector. Reformatting a diskette will destroy all data on a diskette but may make certain diskettes reusable that give the error codes listed on page 3-6. It is unlikely to help a diskette that gives continual CRC errors. The procedure below must be followed exactly in order to format a diskette.

(1) Place the diskette you wish to format in a drive and set its unit select switch to 5.

(2) Initialize the system by turning the DC Power Switch off and then on.

(3) Enter the device address, 177170, into ODT.

(4) Deposit this register with the format routine op code, 51.

(5) The controller will now format the diskette in drive 1. This takes less than a minute.

(6) After the disk drive halts, the diagnostic routine described in section 4-2 must be used to write data fields on the diskette and also to check that the format has been correctly written. Go to section 4-2 and run the diagnostic routine on the newly formatted diskette.

Though most diskettes are purchased with the IBM format already written on the diskette, the format function does allow the user to do this operation himself.

MAINTENANCE

This section contains the basic maintenance information on the FD-11 needed to service the system by spare parts. It is suggested that only large volume users of the FD-11 attempt to service the system to the component level. It is far better for the majority of users to swap out either a controller card or a drive in the event of a failure. We have included here the diagnostic and maintenance procedures necessary to do this.

5.1 PREVENTIVE MAINTENANCE

Though the controller card and other electronics require no preventive maintenance, all mechanical devices do. Preventive maintenance of the disk drive, however, is minimal due to the efficient design, reliability, and manner in which the unit is operated.

5.1.1 VISUAL INSPECTION

During normal operating conditions, periodically inspect the unit for signs of dirt, wear, or loose latching hardware on the handle. When servicing the unit, check all areas for signs of loose connections, abnormal wear, and dirt accumulation on the flexible disk guide.

5.1.2 CLEANLINESS

A clean disk drive, external and internal, will extend the operating life of the equipment and enchance the appearance. The importance of periodic visual inspection and normal cleanliness of the unit cannot be over-emphasized.

5.1.3 ROUTINE MAINTENANCE SCHEDULE

A systematic routine operating check is recommended. The checks should be performed in accordance with Figure 5-1

Inspect	Check	Frequency
R/W Head	For Dirt	Every
Head Pad	For Wear	six
Drive Belt	For Tension	months

Figure 5-1. Routine Maintenance Schedule

5.2 DIAGNOSING THE PROBLEM

There are really only 2 basic elements in the FD-11: the controller card and the drives. It is most important to isolate the problem to one of these 2 elements. The only other possible problems are the power supply, switches and cabling. The following procedures may be used to isolate a problem.

5.2.1 CHECKING POWER SUPPLY VOLTAGES

There are 4 voltages used in the FD-11 system: +5, +24, +12, and -5 volts. The +24 volts and -5 volts are generated by a power supply in the FD-11 drive chassis. These 2 voltages, -5 and +24, along with the +5 volts supplied by the processor or the optional power supply in the chassis, are all used by the drives. The +24 volts is wired into the red power light so that a failure in this supply is immediately evident.

The +24 volts and -5 volts are also used in very small amounts (under 150 milliamps) by the controller card. The +24 volt is regulated down to +12 volts by a 3 pin regulator on the controller card. The +12 volts and -5 volts can be checked by looking at 2 LED's in the corner of the controller card near the cable connector. If the LED near the handles is out, the +12 volt supply is not working. The other LED is tied to the -5 volt supply.

There is another LED in the corner of the controller card diagonally opposite the LED's mentioned above. It is tied to +5 volts and will indicate a failure on that supply. If all three LED's are not on, a power supply problem surely exists.

These LED's do not indicate that the power supply is in range, they merely indicate complete failures. If a power supply problem is suspected, these voltages should be checked with a meter measuring the drop across both the LED and the dropping register. It is particularly important to check the +5 volts in this manner because the heavy drain of 4.2 amps needed by the system may overtax the processor's power if the +5 volt option has not been purchased.

5.2.2 TESTING EACH DRIVE SEPERATELY

A technique is available for bypassing the normal unit select circuitry that can be useful in isolating a problem. If a drive's unit select switch is set to 5, it becomes selected no matter whether unit 0 or 1 is called for. In this case, the other drive must be set to an unused number such as 6. Selecting units this way will cause a problem as soon as unit 1 is called, however. Because there is a seperate track register that remembers where each unit is, an error will occur as soon as a read on unit 1 takes place. The self-diagnostic program will run one pass as unit 0 but will fail when unit 1 is accessed.

5.2.3 TESTING THE SYSTEM

The first test that should be run in any circumstance is to try the initialization function. When a reset function is sent to the controller both drives will calibrate and sector 1 of track 1, unit 0 will be read. Successful completion of this function leaves the number 40 in location 177170 and 204 in location 177172. If this function fails, it should be attempted with one unit set to 5 and the other 6 (see section 5.2.2) and then vice-versa. If it works on 1 unit but not the other a drive problem is likely. If both units fail, a controller or cabling problem is the likely cause.

If both drives pass this test, the self-diagnostic routines should be run on each unit seperately. When running these tests be sure that the media is good. Poor media is responsible for many of the intermittent-type failures such as CRC errors.

Certain problems with controller card, for example the interrupt locic, can only be found by running the DEC floppy diagnostics or running an operating system. Failures of this type usually lead to replacement of the controller card.

5.2.4 CABLING CONSIDERATIONS

It is possible for one drive in the system to hold down the daisy-chained bus and make it appear that either both drives are defective or the controller is defective. By using just one of the 50 pin edge connectors, a drive may be completely isolated from the system.

5.3 REPLACING A DRIVE

If a drive is removed from the chassis in order to be worked on or replaced, the following procedure should be carefully followed:

(1) Remove the edge connector from the drive's PC board.
(2) Remove the top cover of the unit.
(3) There are 2 screws that hold each drive in place by screwing into tapped holes in the rear of the drive's casting. These are the innermost 2 of a set of 6 screws when veiwed from the rear. The other 4 screws hold the drive slides in place and must not be removed.
(4) The drive may now be pulled out along the slides taking care that the cable harness does not get snagged.
(5) The drive should now be free of the unit and may even be operated in this condition if the edge connector of the ribbon cable is reattached to the drive's PC board.
(6) To completely replace the drive 3 additional connectors must now be removed: the switch cabling the DC connector, and the AC connector. Care must be taken, especially with the 4 pin switch function connector. This connector must be replaced with the side with the 4 small holes facing away from the PC card (the side with rectangular holes towards the PC card).

The removal of the drives is necessary for any drive maintenance. The belt, the head, and the pressure pad can easily be checked after the drive is removed. Insertion of the drives is accomplished by simply reversing the above procedure. It is suggested that it is sometimes easier to insert drives with the doors closed. Placing a diskette in a drive will allow the door to close.

5.4 REPLACING THE CONTROLLER CARD

This operation is quite simple. After unplugging the card, the ribbon cable and the power cable may be easily removed. The ribbon cable may be pulled gently to remove it. Excessive

5.4 REPLACING THE CONTROLLER CARD (continued)

force will damage the cable.

It is important to note that both the processor power and the on/off switch on the FD-11 should be off when this operation is performed.

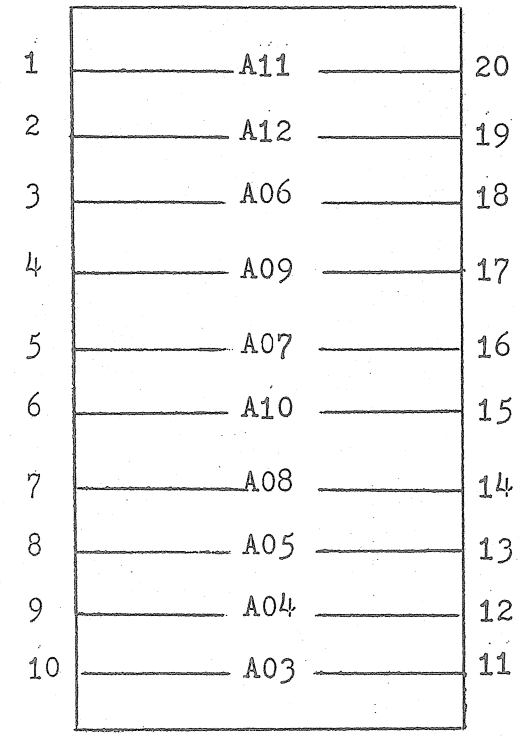
5.5 ADDITIONAL MAINTENANCE

Additional information on maintenance and alignment procedures used on the disk drive is available on request.

APPENDIX A
JUMPER SELECTION GUIDE

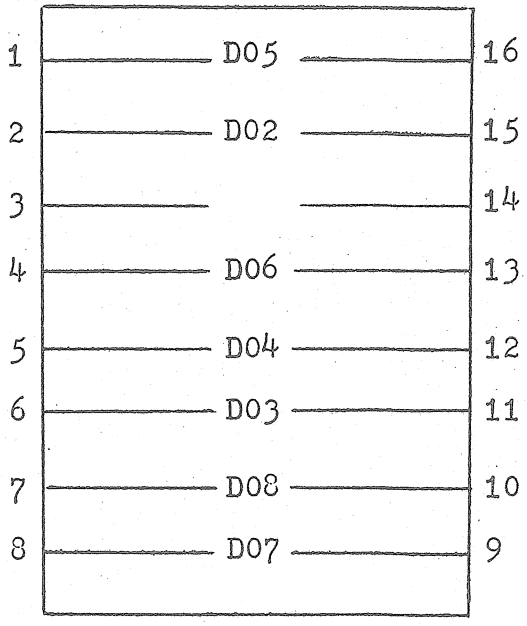
Device Address Selector

Z26



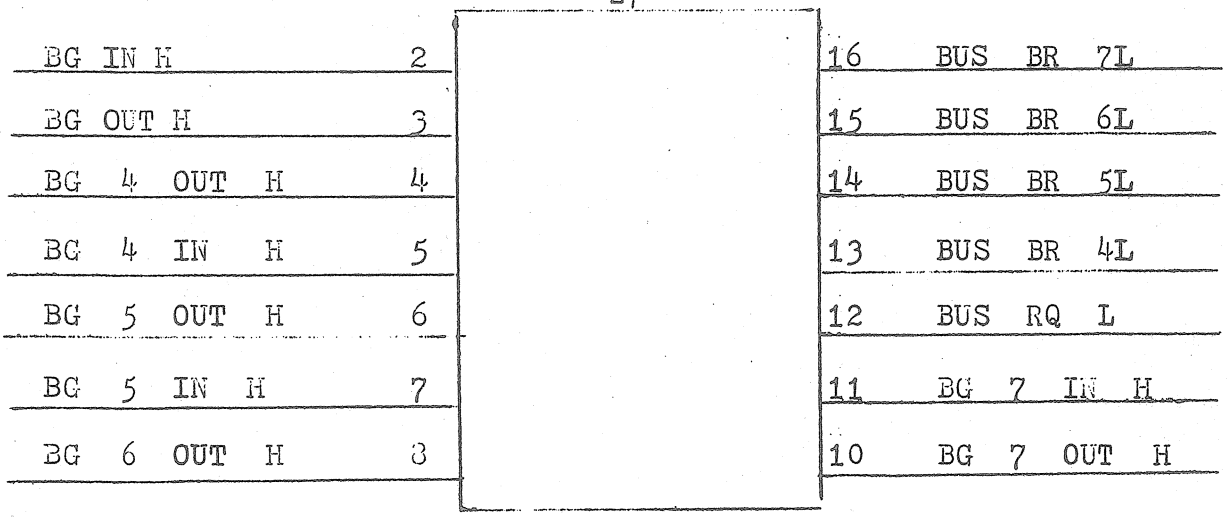
Vector Address Selector

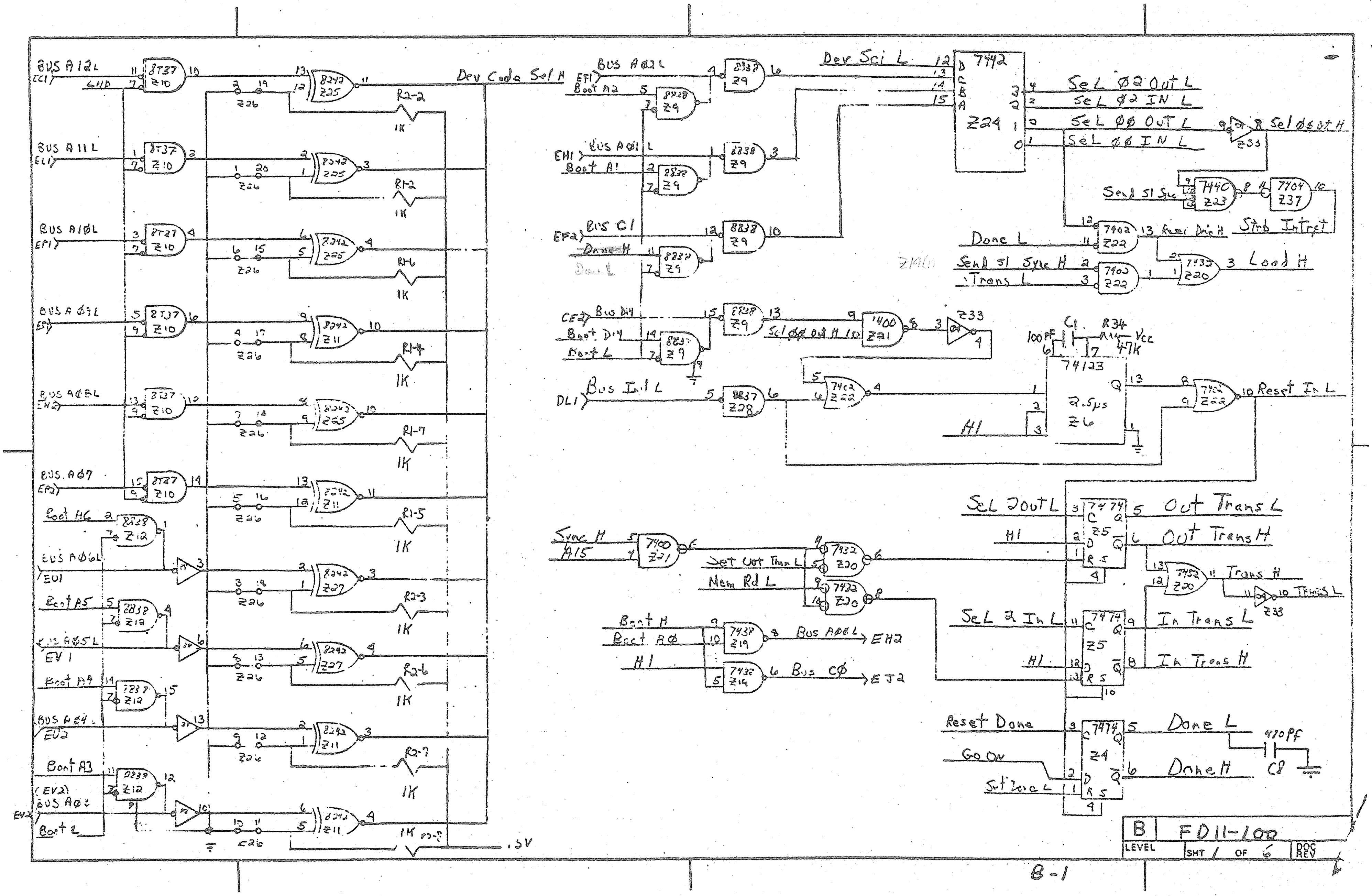
Z13

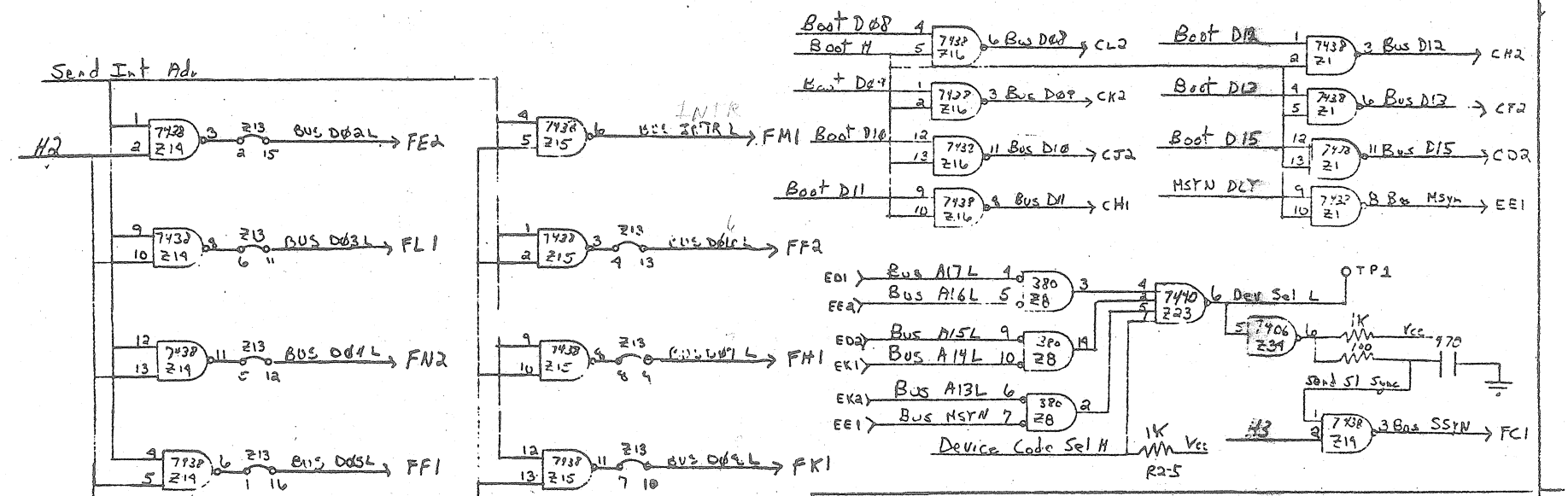


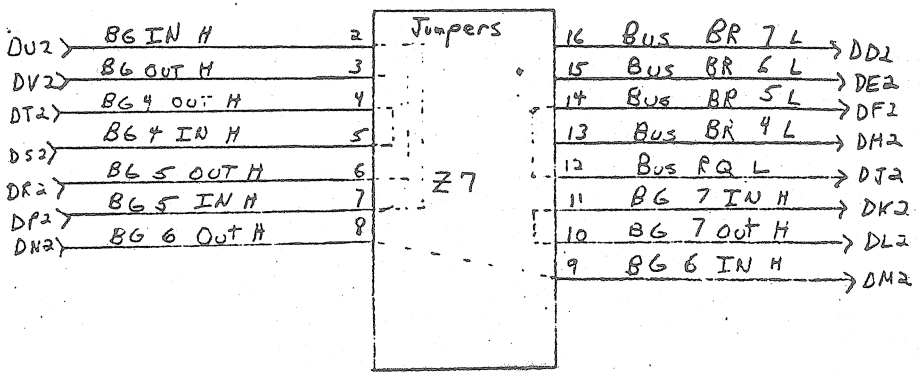
Priority Level Selector

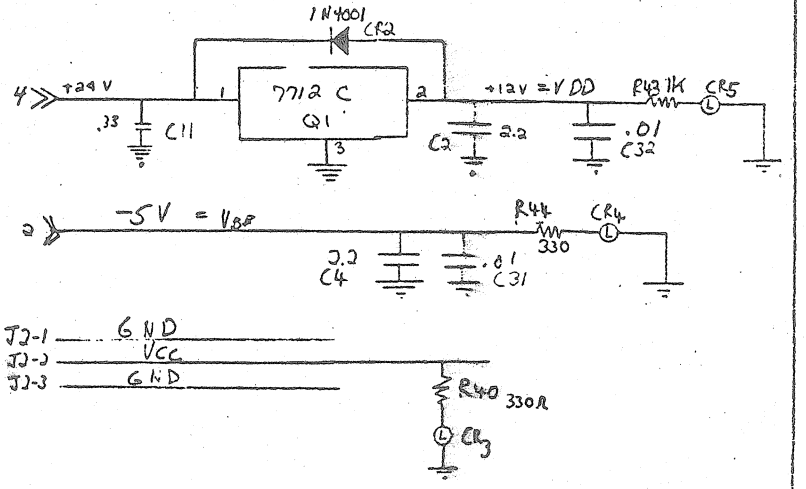
Z7



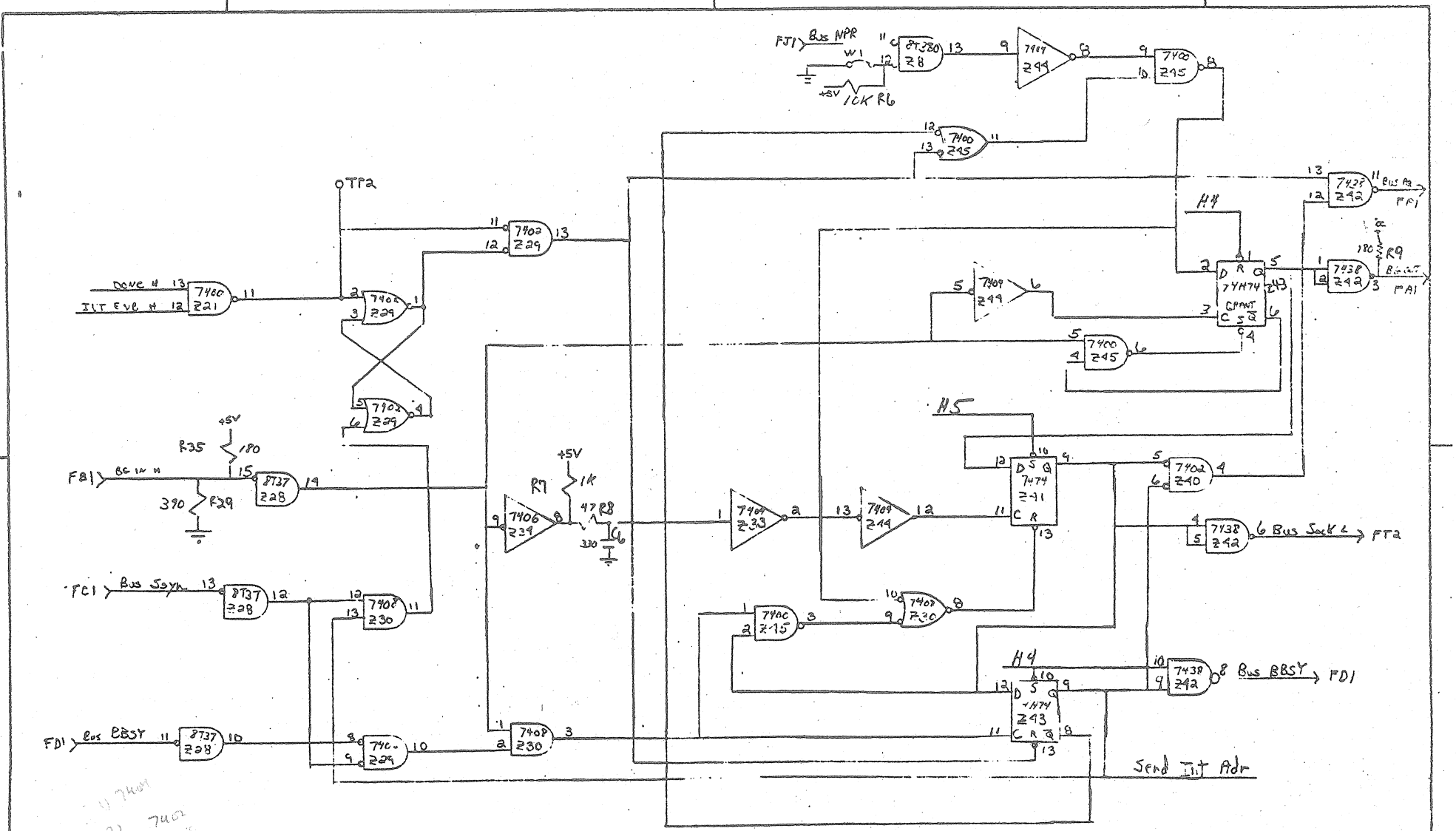

BUS A12L
BUS A11L
BUS A10L
Dev Code Sel H
BUS A02L
Boot A2
Boot A1
Bus C1
Done H
Done L
Bus D14
Boot D14
Boot L
Bus Init L
DL1
Dev Sel L
7442
Z24
Sel 02 Out L
Sel 02 IN L
Sel 00 Out L
Sel 00 IN L
Sel 00 Out H
Send S1 Sync
Strb Intrpt
Reset Done H
Load H
Send S1 Sync H
Trans L
74123
2.5µs
Z6
100pF
C1
R34
47K
Vcc
Reset In L
Sel 2 Out L
Out Trans L
Out Trans H
Sync H
A15
Set Out Trans L
Mem Rd L
Trans H
Trans L
Sel 2 In L
In Trans L
In Trans H
Boot H
Boot A0
Bus A00L
Bus C0
EH2
EJ2
Reset Done
Go On
Set Done L
Done L
Done H
470pF
C8
Boot A6
Boot A5
Boot A4
Boot A3
Boot 2
1K
+5V
B
FD11-100
LEVEL
SHT 1 OF 6
DOC REV

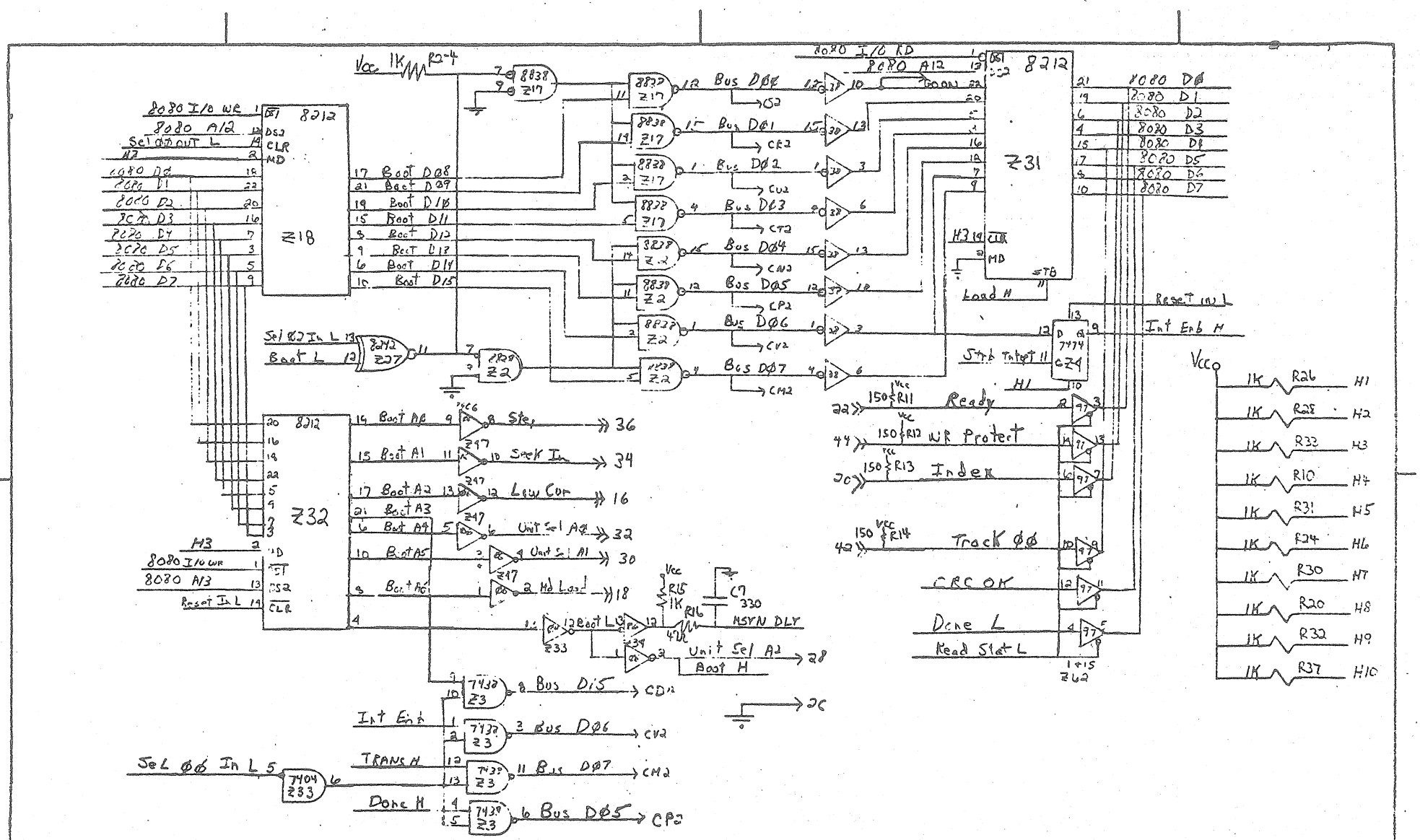






B	FD11-100
LEVEL	SHT 2 OF 6


FJ1 Bus MPR
W1
+5V 1CK R6
8T380 Z8
7409 Z99
7400 Z45
7400 Z45
TP2
7402 Z29
7402 Z29
7438 Z42
Bus RQ
FP1
H4
7474 Z43
CPRNT
180 R9
7438 Z42
FP1
7409 Z99
7400 Z45
H5
+5V
R35 180
FB1 BG IN H
390 R29
8T37 Z28
+5V
1K R7
47 R8
330
7406 Z29
7474 Z41
7402 Z40
7438 Z42
6 Bus SACK FT2
7404 Z33
7409 Z44
FC1 Bus SSYN
8T37 Z38
7408 Z30
7400 Z15
7408 Z30
H4
7438 Z42
8 Bus BBSY FD1
FD1 Bus BBSY
8T37 Z08
7400 Z29
7408 Z30
7474 Z43
Send Init Adr
B FD11-100
LEVEL SHT 3 OF 6
B-3



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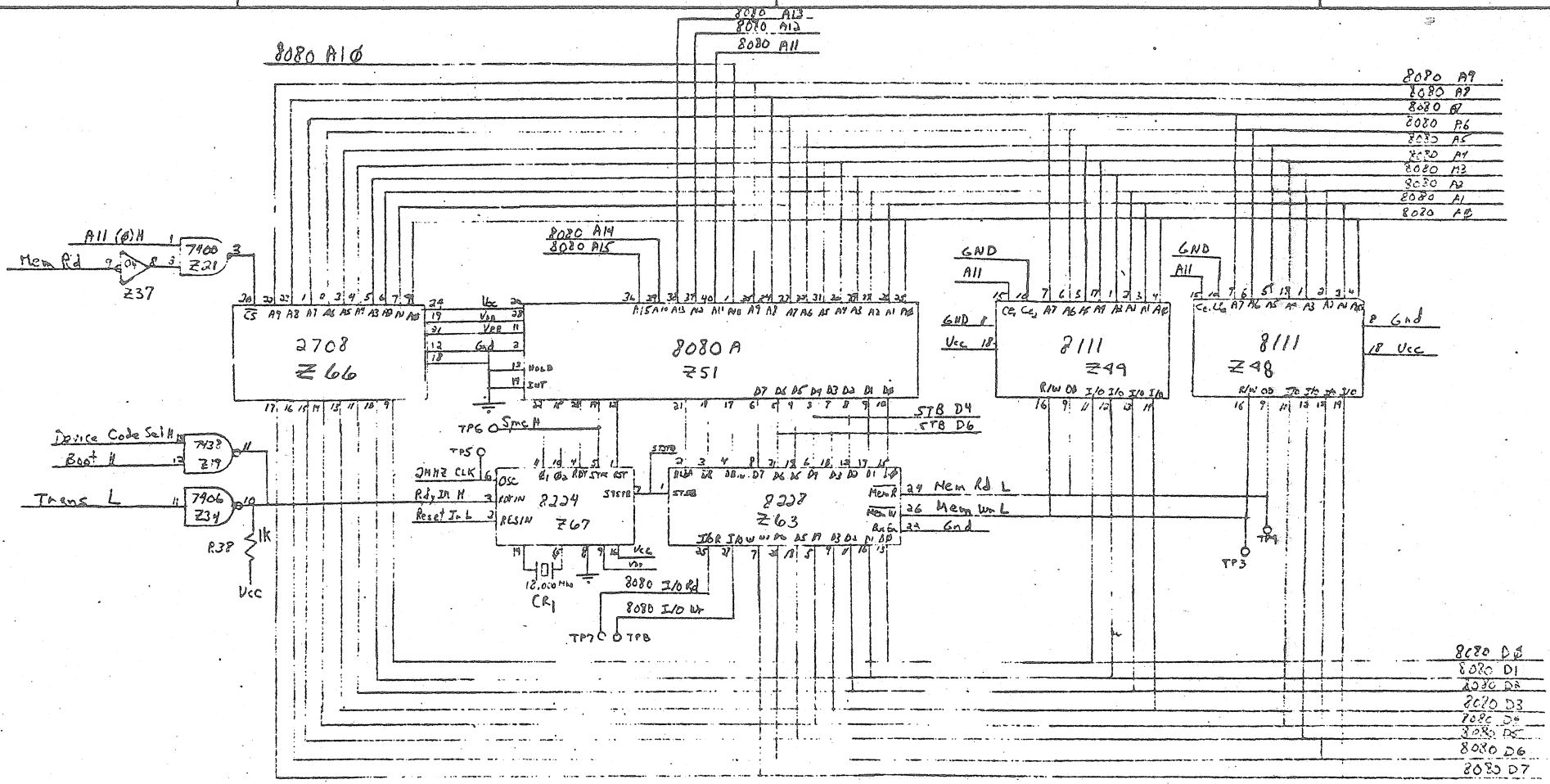

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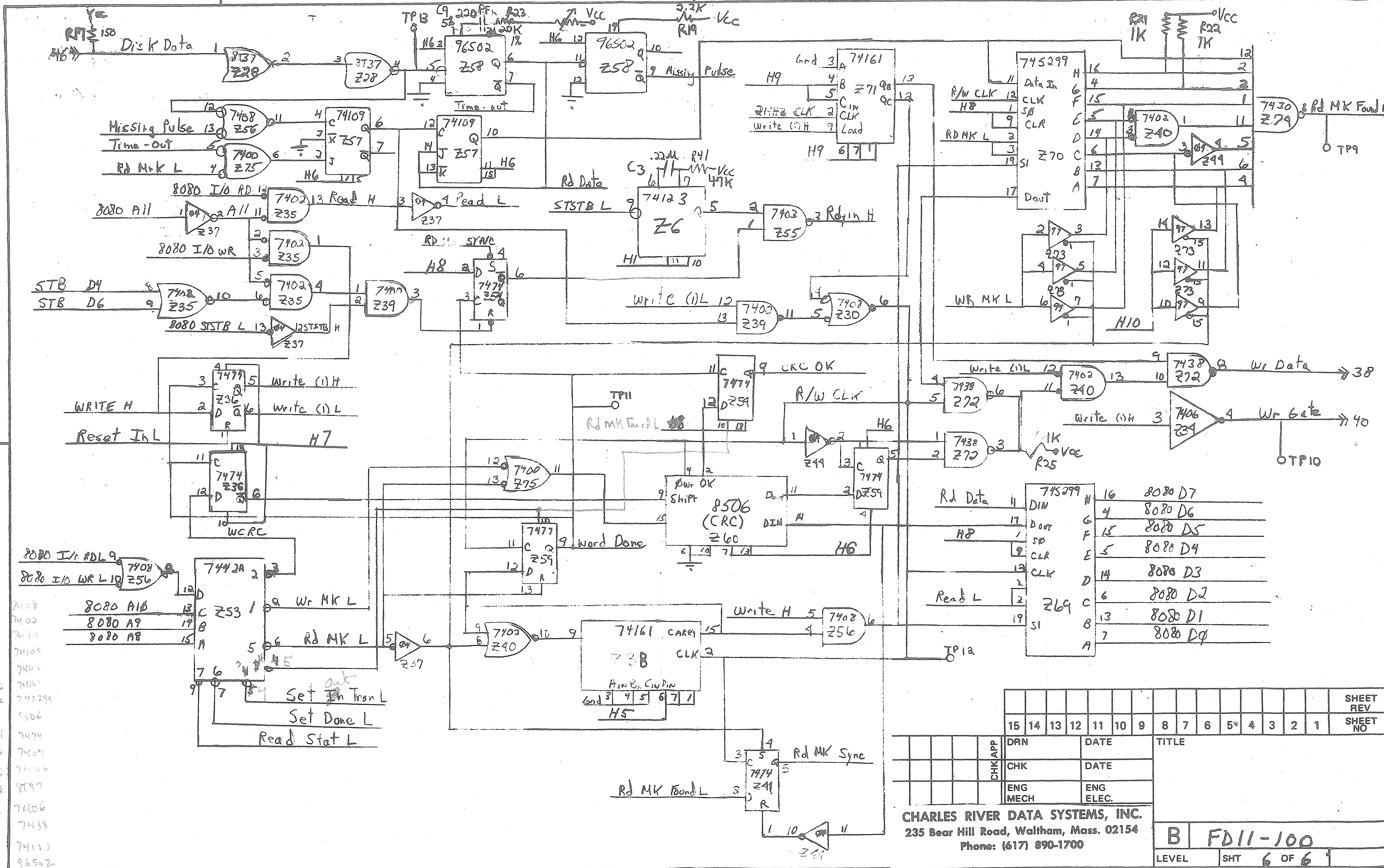

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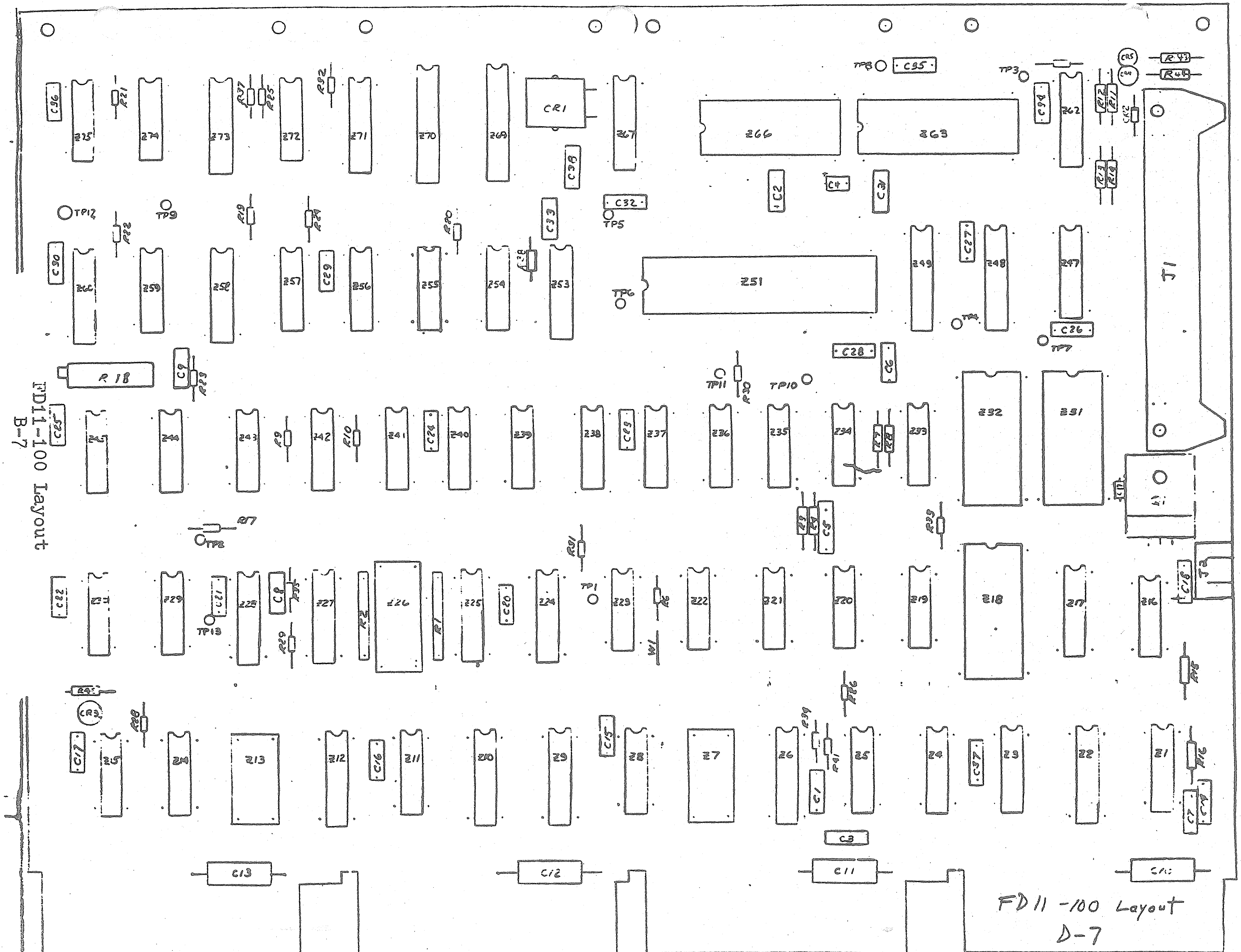
Phone: (617) 890-1700

LEVEL	TITLE	SHT
B	FD11-100	6 OF 6

B-6



FD11-100 Layout
B-7

FD11 -100 Layout
D-7

I.C.PARTS LIST

FD11-100

I.C. No.	TYPE
Z1	7438
Z2	8838
Z3	7438
Z4	7474
Z5	7474
Z6	74123
Z7	Jumper
Z8	8T380
Z9	8838
Z10	8T37
Z11	8242
Z12	8838
Z13	Jumper
Z14	7438
Z15	7438
Z16	7438
Z17	8838
Z18	8212
Z19	7438
Z20	7432
Z21	7400
Z22	7402
Z23	7440
Z24	7442
Z25	8242
Z26	Jumper
Z27	8242
Z28	8T37
Z29	7402
Z30	7408
Z31	8212
Z32	8212
Z33	7404

FD11-100 I.C. PARTS LIST

I.C. No.	TYPE
Z34	7406
Z35	7402
Z36	7474
Z37	7404
Z38	74161
Z39	7400
Z40	7402
Z41	7474
Z42	7438
Z43	74H74
Z44	7404
Z45	7400
Z46	----
Z47	7406
Z48	8111
Z49	8111
Z50	----
Z51	8080A (Socket)
Z52	----
Z53	7442
Z54	7474
Z55	7403
Z56	7408
Z57	74109
Z58	96S02
Z59	7474
Z60	8506 CRC (Socket)
Z61	----
Z62	8T97
Z63	8228 (Socket)
Z64	----

FD11-100 I.C. PARTS LIST

I.C. No.	TYPE
Z65	----
Z66	2708 (Socket)
Z67	8224
Z68	----
Z69	74S299
Z70	74S299
Z71	74161
Z72	7438
Z73	8T97
Z74	7430
Z75	7400

FD11-100 RESISTORS - PARTS LIST

R31	1K
R32	1K
R33	1K
R34	47K
R35	180
R36	----
R37	1K
R38	1K
R39	----
R40	330
R41	47K
R42	----
R43	1K
R44	330

FD11-100 RESISTORS - PARTS LIST

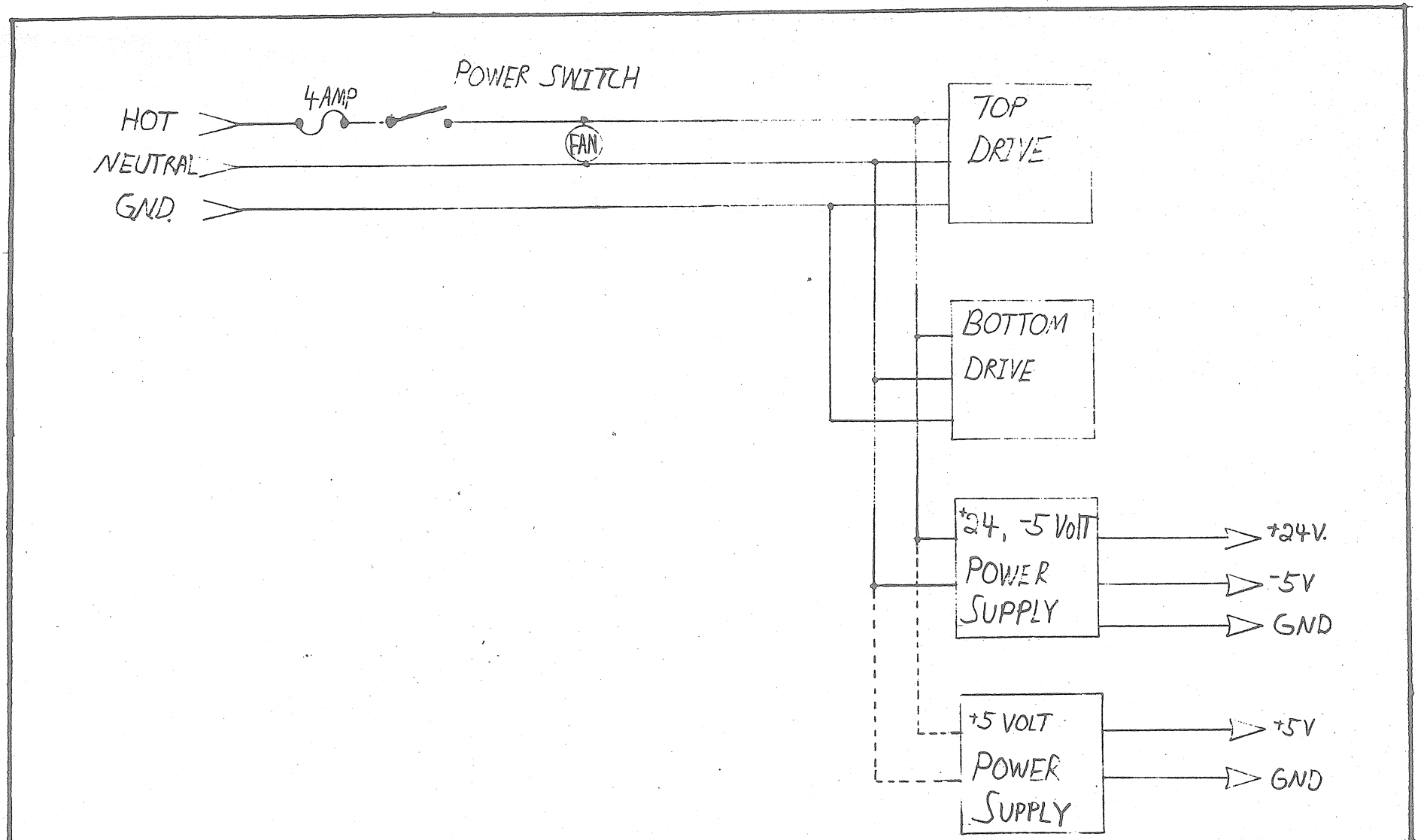
R1	1000Ω SIP
R2	1000Ω SIP
R3	1K
R4	100
R5	----
R6	1K
R7	1K
R8	47
R9	180
R10	1K
R11	150
R12	150
R13	150
R14	150
R15	1K
R16	47
R17	150
R18	Trimpot 5K
R19	2.2K
R20	1K
R21	1K
R22	1K
R23	20.0K 1% 1/8 watt
R24	1K
R25	1K
R26	1K
R27	----
R28	1K
R29	390
R30	1K

FD11-100 CAPACITORS PARTS LIST

C1	100 pf
C2	2.2 mfd tantalum
C3	.1 mfd
C4	2.2 mfd tantalum
C5	470 pfd
C6	330 pfd
C7	330 pfd
C8	470 pfd
C9	220 pfd 1% silver mica
C10	10 mfd 12V electrolytic
C11	10 mfd 12V electrolytic
C12	10 mfd 12V electrolytic
C13	10 mfd 12V electrolytic
C14 - C18	.01 mfd disc
C19	.33 mfd tantalum
C20 - C38	.01 mfd capacitor

MISCELLANEOUS

CR1	18.000 MHZ crystal
CR2	1N4001
CR3	LED
CR4	LED
CR5	LED
Q1	7712 Regulator
J1	3433-3M connector
J2	3 pin Amp connector



A.C. POWER WIRING

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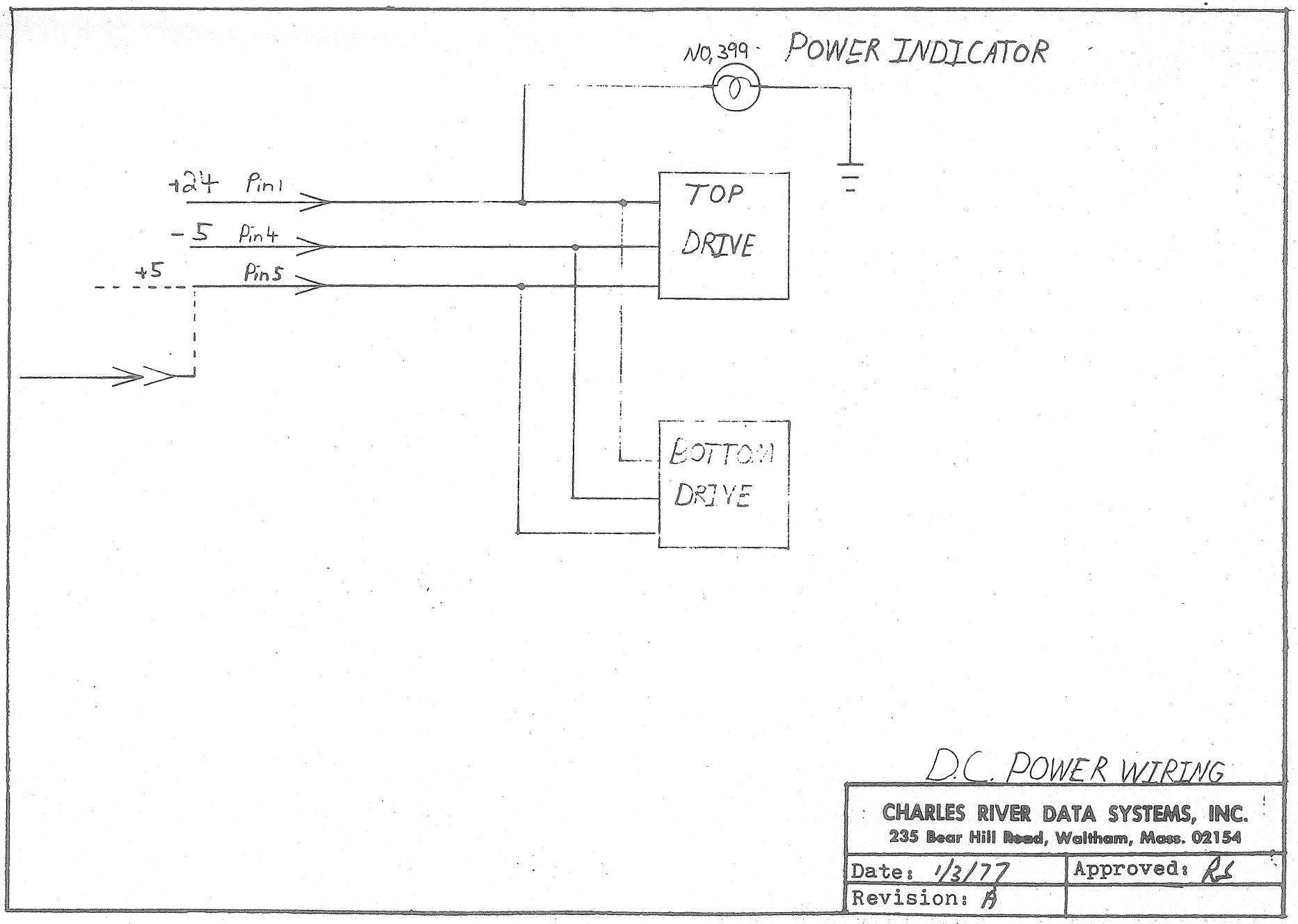
235 Bear Hill Road, Waltham, Mass. 02154

Date: 1/3/77	Approved: RK
Revision: A	



C-2

D.C. POWER WIRING

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Date: 1/3/77	Approved: RS
Revision: A	