TECHNICAL MANUAL
FD311 DOUBLE DENSITY
FLOPPY DISK SYSTEM

DATARAM
CORPORATION

TECHNICAL MANUAL
FD311 DOUBLE DENSITY
FLOPPY DISK SYSTEM

06162

IMPORTANT

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

TABLE OF CONTENTS

1.0 INTRODUCTION

This manual contains all the information necessary to install and operate the FD311 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.

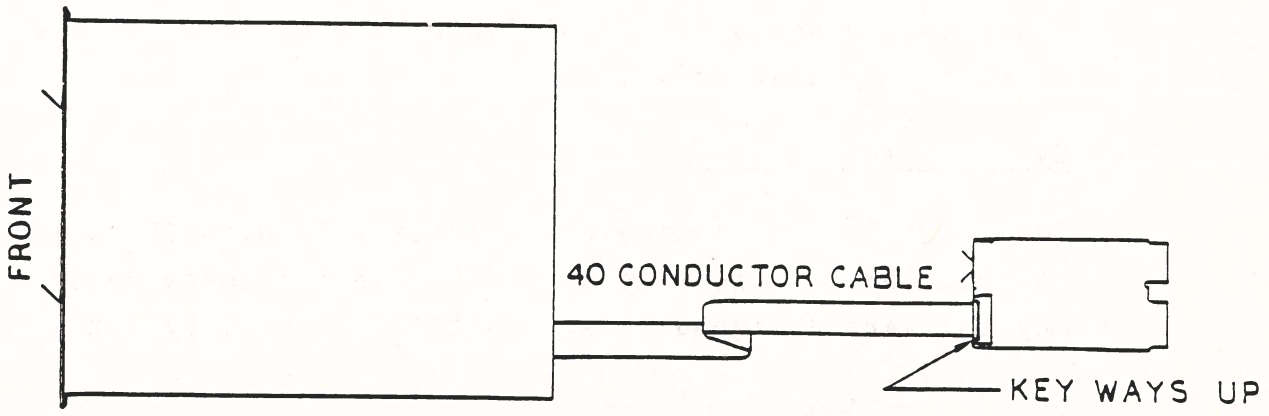
The FD311 is a dual density flexible system compatible with Digital Equipment Corporation's LSI-11* computer family. It is a direct replacement for Digital's* RXV-21 (the LSI-11 version of the RX02) disk system. It provides double density data encoding allowing the storage of 512K bytes on a single diskette.

1.1 System Configuration

All FD311 Systems are shipped with the following parts:

1 Controller and Formatter Card for LSI-11
1 Dual Drive Chassis
1 Chassis Slides and Mounting Hardware
1 A/C Power Cord
1 FD-311 User Guide

The controller/formatter is fully contained on the FO3/A dual height card. The controller is connected to the drive chassis as shown below:



*Registered trademark of Digital Equipment Corporation.

1.2 Controller Card (FO3/A)

The controller card is based around a 2901 microprocessor which controls all reading and writing to the disk drives and emulates DEC*'s RXV21 (RX02) instruction set. In addition, it has the capability of completely formatting diskettes and bootstrapping the system.

This card plugs into any dual slot in any LSI-11 backplane. A 40 conductor shielded ribbon cable connects this card directly to each of 2 disk drives that are daisy-chained.

1.3 FD-311 Dual Drive Chassis

This chassis holds two drives side by side, write protect switches, a circuit breaker, a power supply, and a fan.

1.3.1 Electro-Mechanical

Each drive may be removed individually by removing the 4 machine screws that hold it in place.

Each drive has an activity LED mounted on its bezel which is lit whenever an I/O operation occurs.

1.3.2 Power Supplies

All systems have a power supply that generates +24 volts at 3 amps, -5 volts at 200 milliamps and +5 volts at 2 amps for the floppy disk drives.

1.4 System Compatibility

The FD311 System is completely compatible with DEC's RX02 instruction set and runs with DEC supplied software or with any software designed to work with DEC's RX02 System.

*Registered trademark of Digital Equipment Corporation.

1.5 Media Compatibility

The FD311 is designed to operate with double density diskettes. The double density mode of the FD311 while being interchangeable with RX02 systems, is a standard only to Digital Equipment Corporation. No other main-frame manufacturer uses this particular double density encoding at the present time.

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 rotates.

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

1.5.2 Double Density Format

The FD311 follows the same double density format selected by Digital Equipment Corporation for use in its RX02 System. This format is not compatible with IBM's double density format.

The double density format in the FD311 may be used for double density operation without changing the headers. The principal characteristics of the double density format are shown in Figure 1-2 except for the data field.

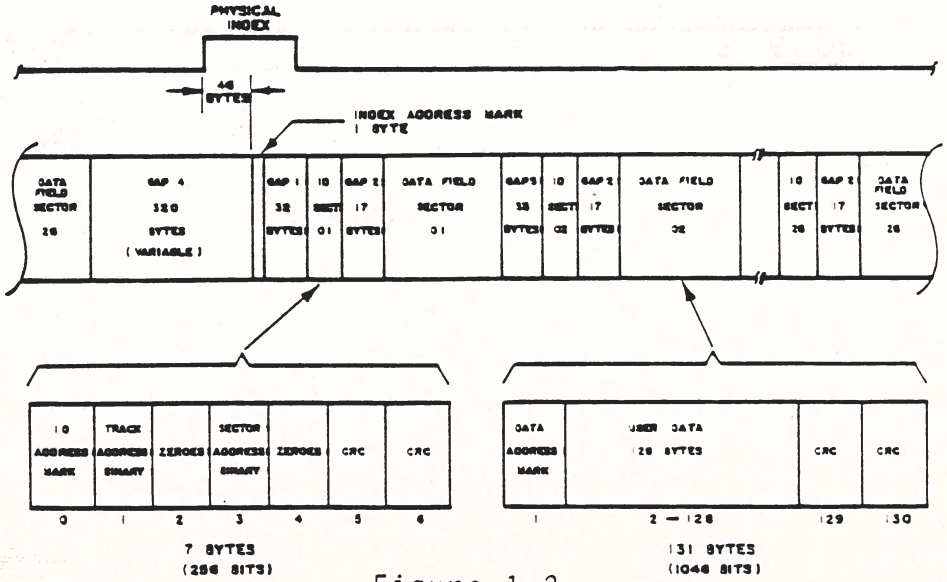


Figure 1-2

Figure 1-3 shows the data field format for double density. The data address mark, which is rewritten on all write commands, designates the density of the data field. The table below gives the different designations used in data address marks.

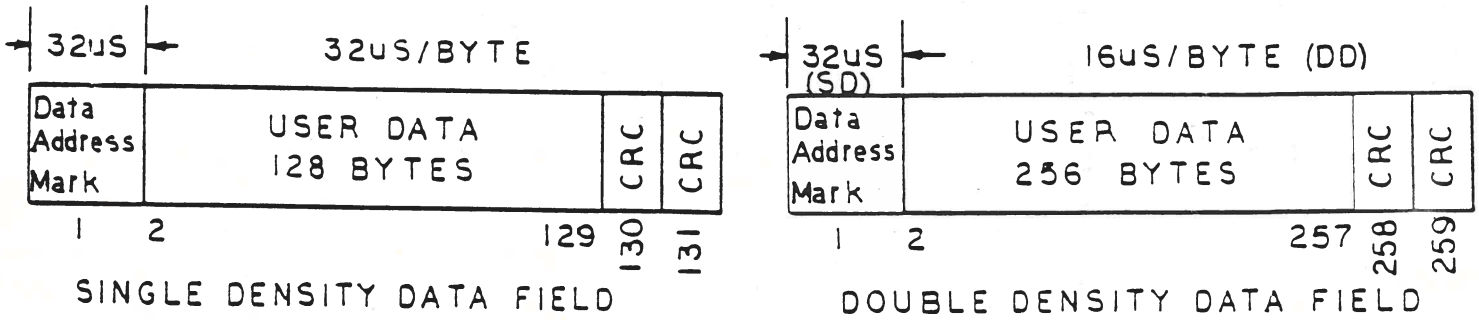


Figure 1-3

The encoding technique used in double density is a variation on the MFM encoding technique used by IBM and other flexible disk manufacturers. The standard MFM encoding technique consists of 2 microsecond bit cells with clock bits only written when there are no data bits in either the present or previous cells. The data bits are written whenever a 1 is to be written. Figure 1-4 gives an example of this.

MARK	DENSITY	DATA BYTE HEX	CLOCK BYTE HEX	STANDARD
DATA				
	DOUBLE	F D	C 7	DEC
DELETED DATA				
	DOUBLE	F 9	C 7	DEC

Figure 1-4

As can be seen from Figure 1-5, spacings of 2, 3 and 4 microseconds between flux changes are all possible. The fact that the address makrs must be written with unique patterns so as to always be distinguishable from data for a soft-sectored controller presents a special problem here. A single density address mark will be detected unwittingly if an appropriate 2 bytes of data is written in a double density data field. This danger is overcome by re-encoding a normal double density data pattern with missing clocks. This is shown in Figure 1-6.

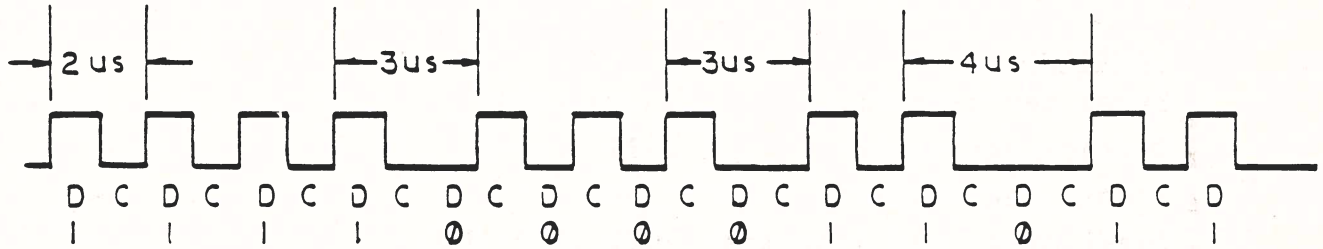


Figure 1-5

When reading double density data fields, the controller checks for a missing clock between 2 zero data cells, and if found, it substitutes in 2 ones for the 2 zero data bits.

An understanding of the format differences between single and double density described above will help the user understand the different format operations available to the user, listed in Section 5 of this manual.

WHENEVER $D_0\ D_1\ D_2\ D_3\ D_4\ D_5$ APPEARS IN A DOUBLE DENSITY
0 1 1 1 1 0 DATA FIELD,

IT IS WRITTEN AS

$D_0\ C_1\ D_1\ C_2\ D_2\ C_3\ D_3\ C_4\ D_4\ C_5\ D_5$
0 1 0 0 0 1 0 0 0 1 0

Figure 1-6

1.5.3 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 format is $G(X) = X^{16} + X^{12} + X^{5} + 1$.

1.6 System Specifications

Capacity

Bytes per sector:	256 (DD)
Sectors per track:	26
Tracks per diskette:	77
Total bytes per diskette:	512,512 (DD)

Access Time and Rates

Diskette to controller buffer:	16 us/byte (DD)
Buffer to CPU:	16 us/byte
Track to track:	6 ms
Seek settle time:	14 ms
Head load time:	41 ms
Rotational speed:	360 RPM +/- 2.5%
Average access (25 track seek and rotational latency):	320 ms

Recording Technique

Method:	MFM Modified (DD)
Maximum bit density:	6400 BPI (DD)
Track density:	48 TPI
Surfaces:	1

Reliability

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

Environmental Restrictions

FD311 operating range:	50 to 100 degrees F
FD311 storage range:	32 to 150 degrees F
Diskette storage range:	50 to +125 degrees F
FD311 humidity constraint:	10 to 80 % without condensation

2.0 INSTALLATION AND OPERATION

2.1 UNPACKING

The FD-311 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).

2.2 Rack Mounting the FD-311

The FD-311 may be mounted in standard 19" relay racks using the hardware provided. The hardware consists of:

1 cabinet slide (right side)
1 cabinet slide (left side)
2 T-bars (rear mounting brackets)
4 10-32X1/2 flat head screws
12 10-32X1/2 pan head screws
10 #10 lock washers
6 10-32 nuts
2 adjustable stops

Figure 2-1 shows the proper assembly and installation of the right side cabinet slide. Using the flat head screws A and B and nuts C and D attach the T-bar to the cabinet slide such that the notches on the end of the T-bar are towards the cabinet slide. Leave the screws loose enough to allow the T-bar to slide freely. Install adjustable stop to T-bar using flat head screw I and nut J. Leave screw loose enough to allow the stop to slide.

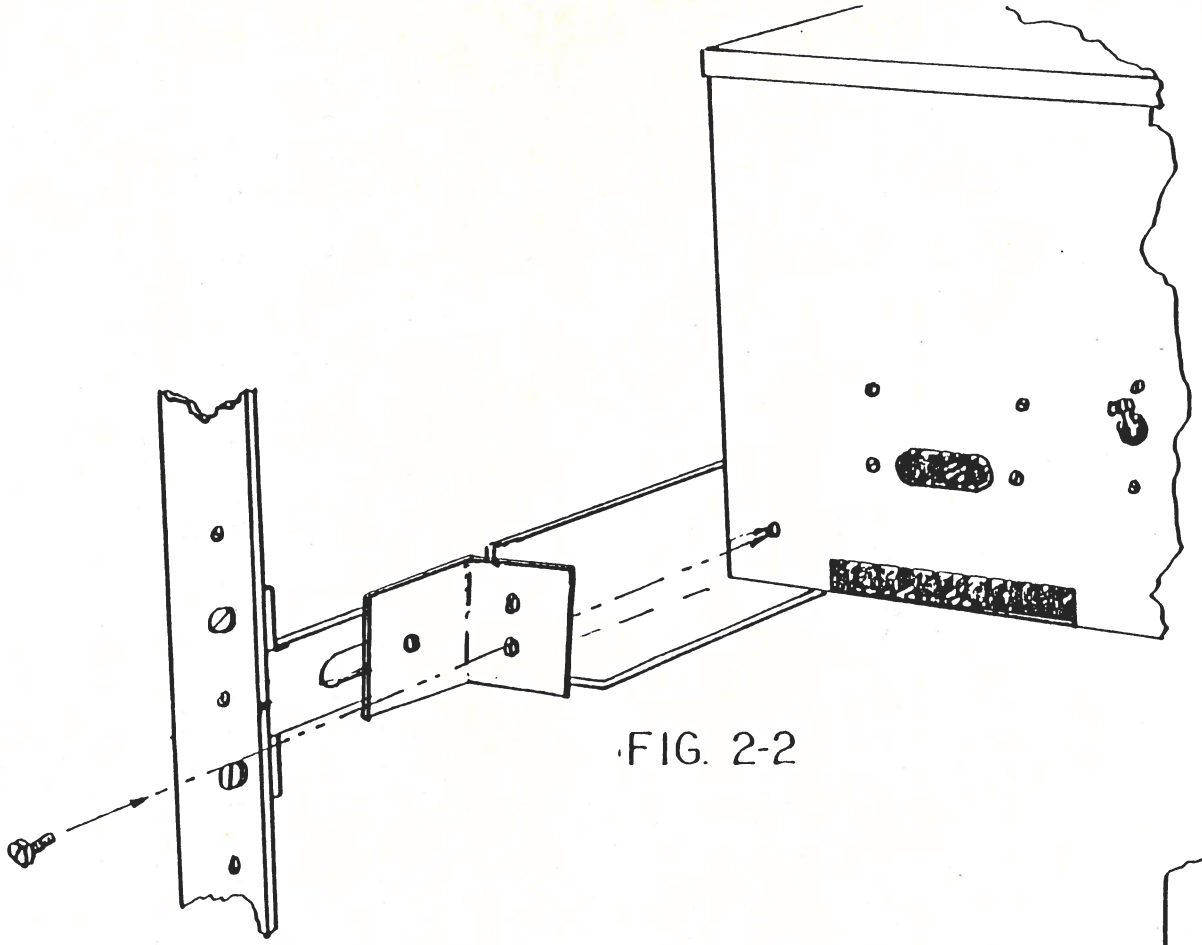


FIG. 2-2

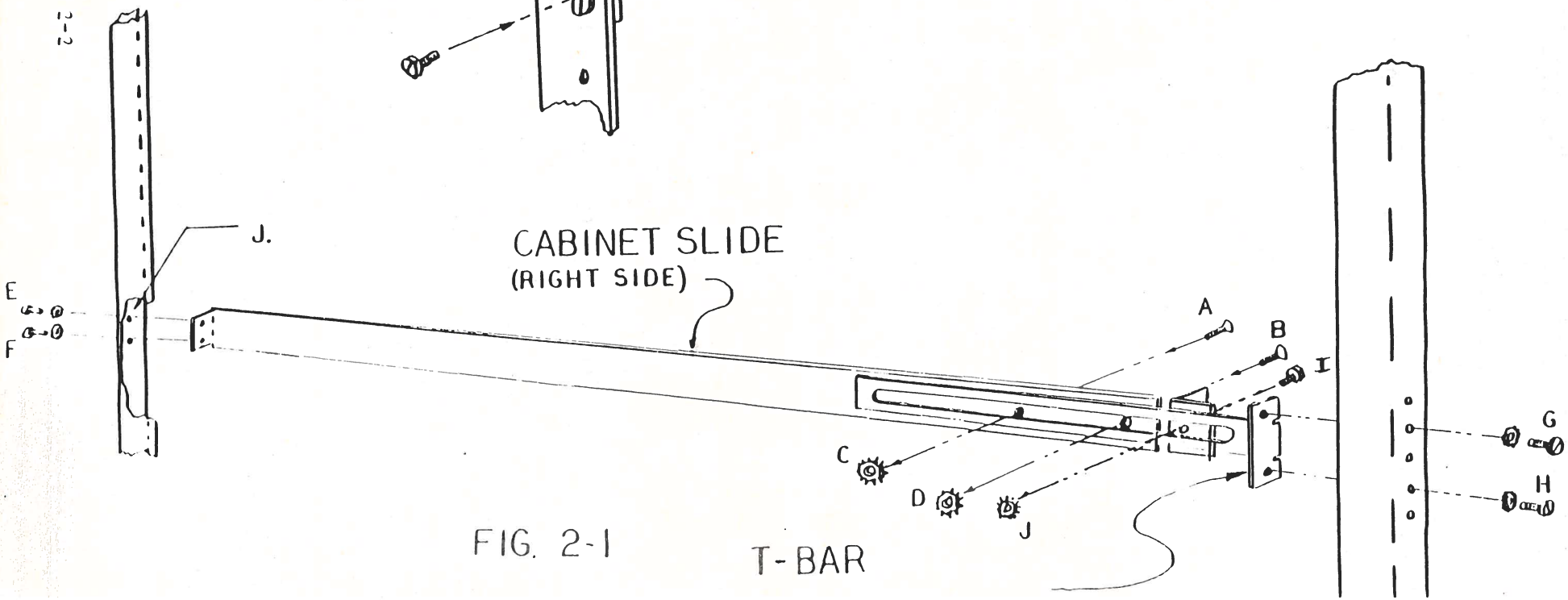


FIG. 2-1 T-BAR

Slide the T-bar to its shortest position. Attach the opposite end of the cabinet slide to the front of the relay rack using pan head screws and lock washers E and F (Figure 2.1). Extend the T-bar until it touches the rear of the relay rack, position the T-bar such that its uppermost hole with align with a hole in the rear of the relay rack at the same height as the hole labeled "J". Attach the T-bar to the rear of the relay rack using pan head screws and lock washers G and H. Tighten screws A and B. Finally, check screws E,F,G, and H for tightness. This procedure is the same for the left side cabinet slide.

Before sliding the FD-311 into the relay rack, be sure that the power and ribbon cables will not interfere with the installation. From the front of the rack, place the FD-311 onto the cabinet slide. Push it fully into the relay rack and adjust the location of the adjustable stops at the rear of the FD-311 and tighten screw I. Secure the FD-311 to the stop as shown in Figure 2.2 using the remaining pan head screw and lock washers.

2.3 Electrical Installation

Next, the controller card should be installed. If a device address or interrupt vector address different from the standard DEC assignment is desired, a request must be made to Dataram for a new PROM set. In addition, any change in these assignments necessitates a change in the system software. The DEC standard assignments are given below:

Device Address:	777170
Interrupt Vector:	264

2.3.1 40 Conductor-Ribbon Cable

The 40 conductor shielded ribbon cable should now be installed. The mating connector and the header connector on the controller board are keyed so that the connector may be inserted in only one way. The 2 key ways should face up when looking at the component side of the controller card (see Figure 1-1).

The cable shield should be placed under and received by the clamping bar on the rear of the FD311 chassis. The shield at the controller end should be secured to the LSI-11 chassis metalwork at the location at which the cable first enters the chassis. To provide proper shielding of the cable, the shield must be clamped to the metal surface.

2.3.2 Controller Card Installation

The controller card can function in any Q-Bus slot after the processor as long as interrupt and DMA continuity is maintained.

Because both interrupt and DMA priority is established by the distance from the processor on a chain that runs along all LSI-11 backpanels, no unused slots between the processor and the floppy disk controller card may exist. To determine the order that the priority chain follows on your particular backpanel, consult the documentation supplied with your LSI-11 System.

2.3.3 Power Cord Installation

The line cord should now be installed. The female end of the cord goes in the oval hole in the rear of the cabinet.

2.4 Diskettes

Diskettes must be treated with 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 strongly recommend that only the media listed below be used. This media has been extensively tested by Shugart, over many sample lots and been found to be of good quality.

	Dysan	ITC
Double Density	3740D	FD34-8000

It does not however, have either the appropriate headers or data fields preformatted on the disk (DEC and IBM double density formats are completely different). This problem can be overcome by formatting headers onto the disk as described in section 3.4.5.2 and then writing data fields onto the disk by either of 2 methods, described in sections 3.4.5.1 and 5.5.

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 aperture.

(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-311 drives with the label up and facing the operator. The diskette should be inserted fully into the drive until it is stopped and a click is heard. The long black door handle may now be pressed down, locking the diskette in place.

The diskette is extracted by simply pressing the black button with the red LED. 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 of off. They should not be removed while in use or anytime the red actibity LED is on nor should the door be opened at this time.

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) Switch the circuit breaker in the rear of the FD-311 to the up or "on" position.

(2) Place the enable/halt switch on the processor to the halt position and turn on the processor's power switch. The processor shold print out an @ signifying it is in ODT mode (octal debugging technique).

(3) Place a scratch diskette in drive 0.

(4) Initialize the FD-311 by depositing the number 40000 in location 777170 (if the standard address assignment is used). This can be accomplished by typing 777170/. The processor will then print the contents of location 777170. Then type 40000 (CR). Both drives should now calibrate themselves. First unit 1 steps out 10 tracks and then steps in one track at a time until 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. This operation is indicated by the red activity LED on the button of the drives. First the LED on drive 1 will come on, and then the LED on drive 0. The LED on drive 0 will stay on for approximately ¼ second after the read is completed.

If after initializing the FD-311 controller, the red LED's do not flash on there is a problem. The cabling should be checked as well as the power supplies.

(5) Read the contents of the FD-311 command and status register at location 777170 (if standard assignment is used). This can be accomplished by using the ODT monitor which allows examination of memory. The contents of this location should be 4040 (octal). Examining the next location, 777172, should yield the number 204 or 244. An explanation of what these bits mean can be found in Chapter 3.

(6) If the above procedures work without any problem, the system should be ready for use. Diagnostics or an operating system may now be booted. For more details on bootstrapping a system, see Section 4.

NOTE:

There have been occasional problems initializing the FD-311 during the power-up sequence with some KD11F processors in use with H780 power supplies (the supply used in 11/03 systems). This has been traced to the BDCOK bus line. This signal should normally be asserted 3-10 ms. after the DC levels have stabilized. However, some H780 power supplies have been set to incorrectly assert their bus signal before the 3 ms. is complete. This problem can be fixed in two ways: (1) replace the KD11F with a KD11HA. The KD11HA has its own wake-up circuit or (2) replace C37 on the H780 power supply with a capacitor twice its value.

3.0 STANDARD INSTRUCTION SET

3.1 General

Program control of the FD-311 is accomplished by the proper manipulation of two device registers in the FD-311. The first of these two registers, the RXCS serves to pass control information from the CPU to the FD-311 and to report status and error information from the FD-311 to the CPU. The second register, the RXDB, transfers additional control and status information between the CPU and the FD-311. The information that is present in the RXDB at any give time is a function of the FD-311 operation that is in progress at that time.

Data transfers both to and from the diskette are always one complete sector (128 (SD) or 256 (DD) eight bit bytes) per transfer command. Partial sector transfers are not accomodated by the FD-311.

The FD-311 contains a read/write data buffer of 256 bytes. During write operations, this buffer is first loaded under a DMA command (fill) and then a 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 out by a DMA command (EMPTY).

3.2 Register and Vector Addresses

The normal address assignments for the FD-311 device registers and the interrupt vector address are as follows:

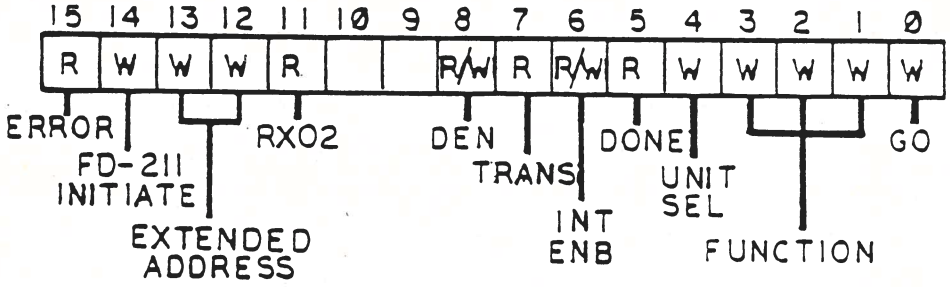
FUNCTION	ADDRESS
RXCS	777170
RXDB	777172
Interrupt Vector	264

3.3 FD-311 Register Description

The 2 registers listed above are used to transfer both command and status information between the CPU and the FD-311. The first of these registers is used to initiate commands and indicate certain status information. The second of these registers has 5 different uses; which one it serves is determined by the protocol of the operation being performed. These five functions are: (1) to transfer the sector address for a read or write operation, (2) to transfer the track address for a read or write operation, (3) to indicate certain common error conditions, (4) to transfer the word count for a DMA command, and (5) to transfer the starting address of a DMA command.

3.3.1 RXCS Command and Status Register (777170)

Commands to the FD-311 are initiated by loading this register with the proper functions code accompanied by the "Go" bit provided that the FD-311 is not busy when the command is issued. The operation codes and bit assignments for the RSCS 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.



RXCS Bit Assignments and Function Codes
FIGURE 3-1

Binary Function Code

000	Fill Buffer
001	Empty Buffer
010	Write A Sector
011	Read A Sector
100	Format Functions
101	Read Status
110	Write Deleted Data Sector
111	Read the Error Register

Description of Bit Assignments for RXCS

Bit Number	Function
0	Go bit. Initiates the selected operation in the FD-311.
1-3	Function code. These three bits select the operation to be performed by the FD-311.
4	Unit Select Bit. Selects which of the 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-311 will cause a program interrupt upon the completion of an operation.
7	Transfer Request Bit. This bit indicates to the CPU that the FD-311 requires data from the CPU.
8	Density. This bit determines the density of the function to be executed when a command is given. It is valid only when done is set at which time it indicates the density of the last command executed.
9-10	Not Used at the Present Time.
11	RX02. This bit indicates that a FD-311, DMA Dual Density System is on-line. It is valid at all times.
12-13	Extended Address. These bits determine on a DMA command the higher order address bits of the starting address. These bits allow expansion above the normal 32K addressing to 128K for this peripheral. These bits will be used with the introduction of new microcomputers to the LSI-11 family.

Description of Bit Assignments for RXCS

Bit Number	Function
14	FD-311 Initialize. The FD-311 can be selectively initialized by setting this bit in the RXCS. Other devices connected to the system bus are not affected. The effects of setting this bit are the same as a bus init signal. The FD-311 will: (a) Reset Done Bit. (b) Move the head of the drive 1 to track 0 (LED on drive will flash). (c) Move the head of the drive 0 to track 0 (LED on dirve will flash). (d) FD-311 clears the error and status register. (e) FD-311 sets Initialize Done. (f) FD-311 sets RXES 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.
15	Error. This bit indicates an error of some type occurred during a command. It is cleared by a new command or an initialize.

3.3.2 RXDB Register (777172)

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 RXDB can be read only when the FD-311 is not executing a command, the RXDB can be written only when the TR (transfer) bit (RXCS Bit 7) is set.

3.3.2.1 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.

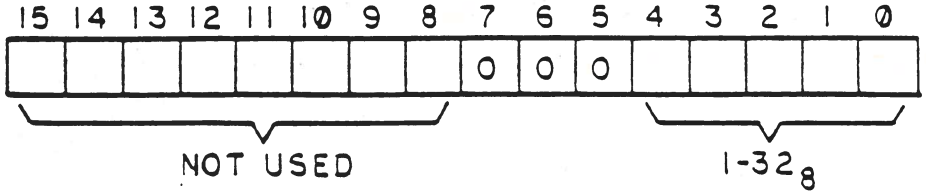


FIGURE 3-3
Sector Address Format

3.3.2.2 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.

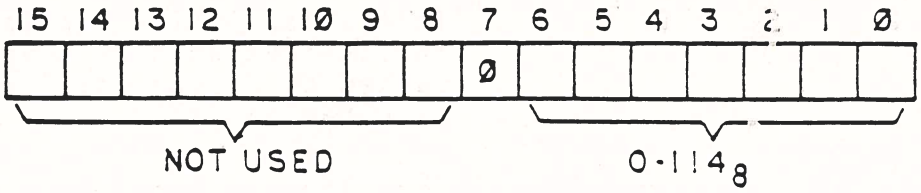


FIGURE 3-4
Track Address Format

3.3.2.3 Error and Status Register

This register contains certain error and status flags for 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.

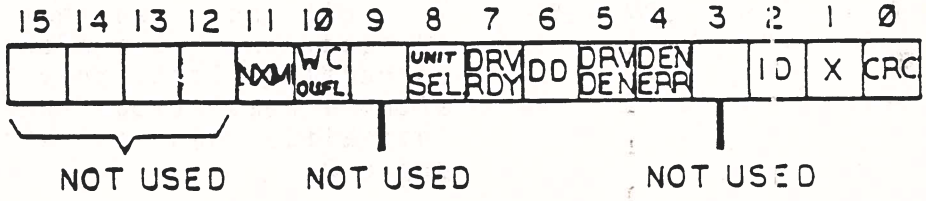


FIGURE 3-5
Error and Status Format

Bit No.	Code	Description
0	CRC	A cyclic redundancy error has occurred in a read operation.
1	X	Not used.
2	ID	Initialize DONE - indicates that an initialization took place. This can be caused by a power failure, programming or a bus signal.
3	X	Not used.
4	DEN EER	Density error. Indicates that the density of a read or write command was different than the density of the diskette in the selected drive. The read or write operation is terminated.
5	DRV DEN	This bit indicates the density of the diskette in the drive selected by a read or write operation.
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 read status function or after an initialize when it indicates the status of drive 0.
8	UNIT SEL	This bit indicates which drive was selected by the last read or write operation.
9		Not used.
10	WC OVFL	Wordcount overflow indicates that the wordcount specified by a fill or empty command was greater than sector size for the density selected. The operation is terminated.
11	NXM	Non-existent memory error. This bit is set if during a DMA transfer, the controller did not receive a reply when it attempted to read or write memory. The operation is terminated.

3.3.2.4 Word Count Register

This register indicates how many words are to be transferred in a Fill Buffer or Empty Buffer operation. The maximum word count is 128_{10} for a double density sector. This write-only register is loaded with the actual word count and not the 2's complement.

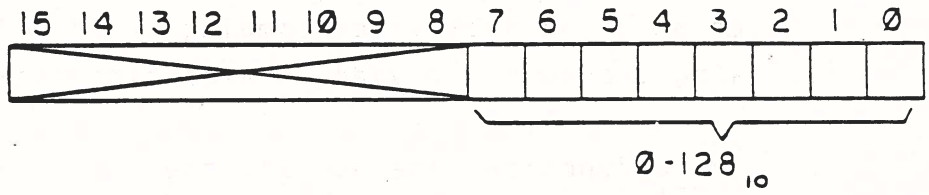


FIGURE 3-6
Word Count Format

3.3.2.5 Bus Address Register

This 16-bit, write-only register indicates the starting bus address of data transferred during Fill Buffer, Empty Buffer, and Read Error Register operations.

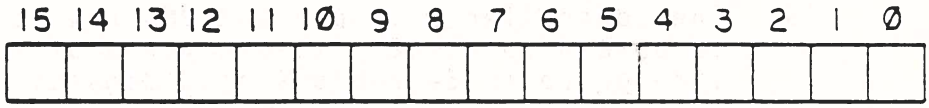


FIGURE 3-7
Bus Address Format

3.4 Command Functions and Their Protocol

The function codes listed in Figure 3-1 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-311 internal buffer with data from the memory. 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 the Go bit into the RXCS (777170).

(2) Check that the TR bit in the RXCS is on.

(3) Deposit the wordcount in the RXDB register (777172). This number will be 100 (Octal) for a full single density sector and 200 (Octal) for a full double density sector. Wordcounts less than these numbers are permissable for partial sector transfers. The remainder of the buffer will be set to 0.

(4) Again, check that the TR bit in the RXCS is on.

(5) Deposit the starting address in the RXDB register. This address may be anywhere in the 30K memory address range of the LSI-11. For addressing above 32K, set the extended address bits in the RXCS during step 1 (see Section 3.3.1).

(6) The controller will perform DMA read operations on memory to obtain up to 128 16-bit words of memory (double density or up to 64 words single density).

(7) 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-311 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 the Go bit into RXCS.

(2) Check that the TR bit in the RXCS is on.

(3) Deposit the wordcount in the RXDB register (777172). This number will be 100 (octal) for a full single density sector and 200 (octal) for a full double density sector. Word-counts less than these numbers are permissable for partial sector transfers.

(4) Again, check that the TR bit in the RXCS is on.

(5) Deposit the starting address in the RXDB register. This address may be anywhere in the 30K memory address range of the LSI-11. For addressing above 32K, set the extended address bits in during step 1 (see Section 3.3.1).

(6) The Controller will perform DMA write operations on memory to unload up to 128 16-bit words (double density).

(7) The Done bit will then be set and the operation is complete.

3.4.3 Write Sector Function (010)

This function is used to write the contents of the FD-311's internal buffer onto the disk. The following procedure is used in executing this instruction.

(1) Store function code 010 and the Bo bit into RXCS. The setting of the density bit will determine if a single or double density operation is to be performed.

(2) Check that the TR bit in the RXCS is on.

(3) Now transfer the sector address to the FD-311 via the RXDB.

(4) Check that the TR bit in the RXCS is on.

(5) Now transfer the track address to the FD-311 via the RXDB.

(6) A write operation will now occur if no error conditions appear. Write protection is sensed and the operation terminated if set. Any track seeking required now takes place. If the head of the selected unit was loaded at the time the operation was initiated, then there can be no danger of a density error and the write operation is performed. If the head was unloaded at the time the operation was initiated the diskette may have been changed. The controller, therefore, performs a quick density check of the next sector to come, lasting on the average only 4 to 5 milliseconds. If the density of the operation agrees with the density of the diskette, the write operation is performed.

(7) On completion of the operation, the Done bit will be set and the RXDB 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-311'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 RXDB, location 777172. The function is then executed.

3.4.5 Format Function (100)

Two separate and distinct format functions are provided with the FD-311 system.

3.4.5.1 Format Data Fields

The first of these is identical to DEC's "Set Media Density" operation. It rewrites the data fields of all sectors on a diskette with either single or double density marks, as specified by bit 8 (density bit) in the command register. These marks are in fact always rewritten during any write operation but the write operation does not allow the user to write a mark with a density different from other marks on the diskette (see write function, Section 3.4.3). This is to prevent diverse densitites on one diskette.

Therefore, in order to change the density of a diskette, all data field marks must be rewritten to the new density. This operation will destroy all data on the diskette, leaving data fields of all zeros. The location of these data field marks is shown in Figure 1-2.

The format function can be performed by using the format command under RT-11 (See Section 5) or directly through the use of ODT. This is done by the following sequence of operations.

(1) Store function code 100, the Go bit, the density bit (1 for double density), and the unit select bit into RXCS. The possible combinations of bits are listed below:

Format	Code
Unit 0, double density	411
Unit 1, double density	431

(2) Wait for the trans bit to be set.

(3) Deposit the key word 111 (octal) into the RXDB. This key word is to help prevent accidental initiation of this function.

(4) The FD-311 will start the selected drive at track 0, sector 1 and rewrite all sectors through track 76, sector 26. If the operation is interrupted at any time during the 25 seconds needed to complete this operation, the operation must be restarted and allowed to complete, otherwise an "illegal" diskette has been created.

(5) If the operation does not complete normally, and ends with the error flag on, a difficulty was encountered in reading the headers of the sectors. This may be due to defective media. The user may attempt to re-write these headers using the instructions given in Section 3.4.5.2.

(6) If the operation completes successfully, the Done bit will be set and no error condition will be flagged.

3.4.5.2 Format Headers

Although it is possible to buy diskettes preformatted with the standard IBM 3740 headers, these diskettes are intended for single density, not double density operation. These diskettes have not been certified for double density, and in some cases they lack the superior oxide coating that diskette manufacturers place on double density media. It is therefore

suggested that the user purchase double-density certified media. Because no other mainframe manufacturer besides DEC uses a single density header format for double density operation, at the present time diskette suppliers do not supply double density media with formats compatible with the FD-311 and the RX02.

In the case of the RX02, this media is unusable. However, the FD-311 provides a function to write headers. These headers are never written by the RX02 and only written by the FD-311 during this format operation.

This format function cannot be activated from RT-11 but can easily be activated through ODT.

(1) Store the function code 100, the Go bit and the unit select bit into RXCS.

    Format the headers of the diskette in unit 0: 11
    Format the headers of the diskette in unit 1: 31

    This accomplished by typing 777170/ and after the LSI-11 states the contents, type 11 (or 31) (CR).

(2) The key word is now used to avoid accidental initiation of this function. It also differentiates this function from the format data fields function. The key word is 1111 (octal) and should be deposited in the RXDB. Type 777172/ and after the LSI-11 gives the contents type 1111 (CR).

(3) This operation takes approximately 25 seconds to complete. If interrupted, it must be reinitiated or an "illegal" diskette will have been created. This routine does not format the data fields. At the completion of this function, the user must write either single or double density data fields using the other format function described in Section 3.4.5.1. The disk in unusable until this is accomplished.

3.4.6 Read Status Function (101)

When this function is executed the error and status register will be loaded into the RXDB. This register will contain the same status generated from the last operation except that bit 7 will now 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 marks is written just before the start of the data field.

3.4.8 Read Error Code (111)

This function is used after an error occurs to determine the exact nature of the error and the contents of certain registers at the time the error occurred. It is initiated by the following sequence:

(1) Deposit the Go bit and the function code 111 (17) into the RXCS.

(2) Wait for the trans bit in the RXCS to set.

(3) Deposit the starting address of an unused 4 word block in memory into the RXDB.

(4) The FD-311 will now DMA the following words into memory (LSB=least significant byte, MSB=most significant byte):

Definitive error code	Word Ø, LSB
Word count register	Word Ø, MSB
Current track address of drive Ø	Word 1, LSB
Current track address of drive 1	Word 1, MSB
Target track of command	Word 2, LSB
Target sector of command	Word 2, MSB

It should be noted that the word count register is only valid after DMA commands and that the target track and sector registers are only valid after disk I/O commands.

The definitive error codes given by the FD-311 are defined below:

Octal Code	Error Code Meaning
0010	Drive 0 failed to see home on Initialize.
0020	Drive 1 failed to see home on Initialize.
0100	Write protect violation attempted.
0120	A preamble could not be found or no ID mark found within allowable time span.
0150	The header track address of a good header does not compare with the desired track.
0160	Too many tries for header identification routine.
0170	Data AM not found in allotted time.
0200	CRC error on reading the sector from the disk.
0230	Word count overflow.
0240	Density error.
0250	Wrong key word for set media density command.

4.0 SPECIAL FUNCTIONS: BOOTSTRAP AND SELF-TEST

The FD-311 has the ability to bootstrap system and diagnostic diskettes without the aid of a bootstrap card such as the REV-11 or the BDV-11.

4.1 Enabling and Disabling the Bootstrap

The bootstrap feature may be enabled or disabled by means of a jumper on the FO3/A as shown in Figure 4-1.

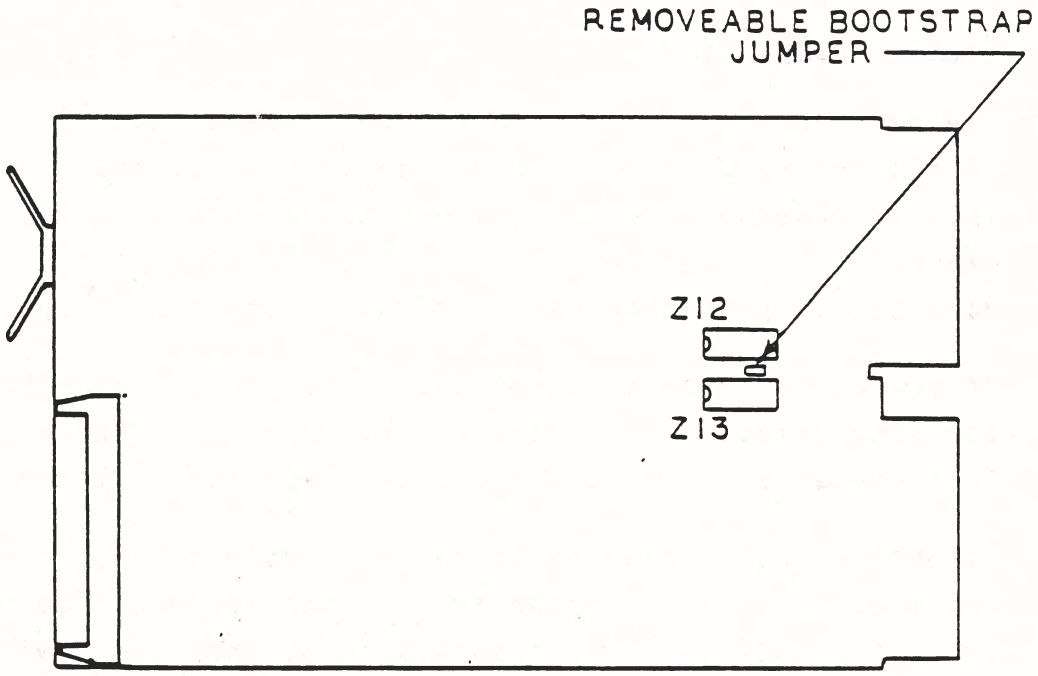


FIGURE 4-1

All cards are shipped with the jumper installed, that is, the boot enabled. If an REV-11, BDV-11, or other bootstrap card is used, the bootstrap must be disabled by removing the jumper.

4.2 Using the Bootstrap

The procedure is quite simple. We suggest that you strap the LSI-11 processor card to power up in mode 2, that is, when an init or power up occurs, the processor automatically starts execution at location 773000. The location of the jumper on your LSI-11 processor can be found in the Microcomputer Handbook.

If you do not wish to strap the processor as described above, the same effect may be obtained by typing 773000G while in ODT. This causes a bus init and starts execution at location 773000.

To boot a double density diskette, simply place the diskette in drive Ø. If the processor is strapped for power up mode 2, cycle the INIT switch (on some systems the "boot switch", the restart switch", or the "DC power switch"). The system should then boot. If the processor is not strapped appropriately, from ODT, type 773000G.

4.3 How the Bootstrap Function Works

The FD-311 bootstrap function works differently than a standard ROM bootstrap. This feature utilizes the high speed microprocessor on the FO3/A controller card instead of a ROM.

The user may notice that if one attempts to read location 773000, it is found to be non-existent. The FD-311 only responds to this address immediately after a bus init. At that time it responds with instruction data that:

(1) Clears processor register Ø.

(2) Places the device address (177170) in register 2.

(3) Deposits 777 (PDP-11 jump to present location instruction) into location Ø.

(4) Causes processor to jump to location Ø.

(5) Reads sector 1, track 1 of drive Ø and DMA's this into locations Ø through 377.

(6) Reads sector 3, track 1 of drive Ø and DMA's this into location 400 through 777.

(7) DMA's location Ø with 240 (PDP-11 NOP instruction) freeing processor.

4.4 Self-Test Function

This function may be used to both diagnose problems with the FD-311 system as well as certify that all sectors of a particular diskette are readable. When initiated this function starts reading each sector of the diskette starting with track Ø, sector 1 and ending with track 76, sector 26. If at any time a CRC or other error is encountered, this microcode routine will halt with the error and done bits set. If no error is found, a halt occurs after reading track 76, sector 26 and the done bit is set. The function in initiated in the following manner.

(1) Store function code 100, the Go bit, the density bit (1 for double density) and the unit select bit into RXCS. The possible combinations of bits are listed below.

Format	Code
Unit 0, double density	411
Unit 1, double density	431

(2) Wait for the trans bit to be set.

(3) Deposit the key word 2111 (octal) into the RXDB.

(4) The FD-311 will start the selected drive at track 0, sector 1 and read all sectors through track 76, sector 26.

(5) If the operation does not complete normally, and ends with the error flag on, a difficulty was encountered in reading the headers of the sectors. This may be due to defective media.

(6) If the operation completes successfully, the Done bit will be set and no error condition will be flagged.

5.0 USE OF THE FD-311 WITH RT-11

The introduction of new products in the computer industry often brings questions from users on compatibility with previous equipment, software, and media. This product is no exception.

The FD-311 (and the RX02) is compatible with single density media but has a different instruction set than its predecessor, the FD-11 (and RX01). This has led to much confusion. The FD-311 allows the user access to all of his old single density programs, the ability to store twice as much data in double density mode, and the use of DMA to transfer data to and from the disk.

The FD-311 (and the RX02) does however require a different handler than the single density systems. This handler utilizes DMA to transfer data rather than using program controlled data transfers. This handler is available in RT-11-V03B and later software revisions. From the point of view of the operating system, the FD-311 is a new device designated "DY". The single density system designation for floppy disk is "DX".

The new handler does have one unusual feature. It will read both single and double density disks without any need for the user to tell the system which density disk it is using. A difference in the format of the diskette's data field automatically informs the handler of the density of the disk. Both single and double density disks are designated "DY".

5.1 Generation of DY-Compatible RT-11 System Disks

In order to use RT-11 with the FD-311 (or the RX02), it is necessary to have or generate a system with a DY monitor built-in rather than a DX monitor. The easiest option for the user is to obtain his RT-11 system on double-density media. The system will then already have the DY monitor built in. The diskette can be placed in drive Ø and will boot with an init as described in Section 4.

Many users however have RT-11 system distribution media in single density format with a DX monitor built into the system. These diskettes have to be rebuilt to boot on an FD-311 (or RX02). In order to build a DY-based system, access to an FD-11 or an RX01 is required. If one is not available, either a DY-based monitor system diskette must be obtained or an FD-311 may be used in RX01 emulation mode as described in Section 6.

5.2 Creating a DY-Based System on an FD-11

The DX-based system disk has a system monitor file on it: either DXMNSJ, DXMNFB, or DXMNXM. (It may have more than one of these, but you are only using one. If you do not know which one you are using, boot the system. The first thing printed on the terminal will be either RT-11SJ, RT-11FB, or RT-11XM. The last two letters of that are the same as the last two letters of the monitor you are using). This system monitor file is written for use with single density systems.

The system disk you are now using also has a bootstrap program on it. It is not accessible as a file (you will not see it in the directory, for instance), but it is there nonetheless. This bootstrap is also written for single density systems. Everything eles on your system disk is compatible with double density systems (unless you have put something unusual on it).

To generate a DY-based system diskette, you must create a system disk identical to the first, except that it will have a version of the monitor and the bootstrap written for use on a double density system. (This new disk is still single density- it is not the one you will be using on your double density system, but is a step to creating that one).

If a SYSGEN was done to create your current system disk, you must do another SYSGEN to create a new (still single density) system disk equivalent to the first. (If you do not know whether a SYSGEN was done, bring up the system. If the first thing it types out has an "(S)" in it (for example, RT-11SJ (S) (V03-00), then SYSGEN was done. While doing the SYSGEN, the program will ask you "What is the name of the system device?" Tell it DY. See the RT11 SYSTEM GENERATION MANUAL for further details.

If a SYSGEN was <u>not</u> done to create your current system disk, that means that the monitor file was used just as it appeared on one of the distribution disks. Also on one of the distribution disks (disk 5/8, probably) is a version of the monitor written for double density systems. Its name is DYMNSJ if you are currently using DXMNSJ and is DYMNFB if you are using DXMNFB. (DXMNSM is created with a SYSGEN). To create the new (still single density) system disk, do the following:

```
    Bring up your FD-11 system in the usual way
    Insert a blank disk in drive 1 and initialize it:
              .INIT/NOQUERY   DX1:
  Copy SWAP:SYS (the most used file) onto it first:
              . COPY/SYS  DXØ:SWA:.SYS   DX1:*.*
  Prepare to copy the new monitor on to it :
              .R   PIP
```

Replace the system disk in drive Ø with distribution disk 5/8 (the one with the double density monitor on it) and copy the monitor onto the new disk:

```
*DX1:*.* = DXØ:DYMNSJ.SYS/Y
                or
*DX1:*.* = DXØ:DYMNFB.SYS/Y
```

Put the system disk back in drive Ø and return to the monitor

```
*↑C
```

Copy the rest of the system disk, excluding the old monitor:

```
.COPY/SYS/EXCLUDE  DXØ:DXMNFB.SYS  DX1:*.*
                   or
.COPY/SYS/EXCLUDE  DXØ:DXMNFB.SYS  DX1:*.*
```

Finally, install the new bootstrap:

```
.COPY/BOOT  DX1:DXMNSJ.SYS   DX1:
                or
.COPY/BOOT  DX1:DXMNFB.SYS   DX1
```

If any patches had been made to DXMNSJ (or DXMNFB) they should also be made to DYMNSJ (or DYMNFB).

5.3 Creating a DY-Based Double Density Diskette

The diskette created by the instructions in paragraph 5.2 is a DY-based single density system diskette. In order to create a double density DY-based system diskette, the single density diskette must be booted on the FD-311 system and copied to a double density diskette.

The single density DY-based system diskette is easily bootable if the user has a BDV11 bootstrap card. The bootstrap function on the FD-311 will not bootstrap single density system diskettes. This is a feature that is really ony required once, and then only if the user does not have a double density system diskette. Section 5.3.1 describes a method of booting a single density DY-based system diskette without the aid of a bootstrap. Those users with a bootstrap card should proceed to section 5.4.

5.3.1 Booting Single Density DY-Based Diskettes in the FD-311

To bootstrap the single density system created above without the aid of a BDV-11, two alternatives are available. Dataram will supply on request a diskette that is in double density format and contains a single density bootstrap routine. The procedure used with this diskette is described in section 5.3.1.1. Without this diskette, the user can still get started with the technique described in section 5.3.1.2.

5.3.1.1 Supplied Single Density Bootstrap Bridge Diskette

Place this diskette in drive Ø of the FD-311 and bootstrap the diskette by issuing an init or 173000G as described in section 4. The following should be printed or displayed on the terminal:

```
ØØØØØ4
@
```

Now replace the diskette in drive Ø with the single density DY-based system diskette generated previously and type:

```
P
```

The system should now boot. Skip to paragraph 5.4.

5.3.1.2 Manual Booting of Single Density DY-Based System Diskettes

Another method of booting single density DY-based system diskettes is through the use of ODT. A list follows of the series of deposits necessary to accomplish this along with explanations is given below:

Location of deposit	Value of deposit	Explanation
777170	40000	Init and read sector 1, track 1
777170	3	Transfer the sector
777172	100	(100_8 words) to memory
777172	0	Starting at loc 0
777170	7	Read
777172	3	Sector 3
777172	1	track 1
777170	3	Transfer the sector
777172	100	(100_8 words) to memory
777172	200	starting at loc 200
777170	7	Read
777172	5	Sector 5
777172	1	Track 1
777170	3	Transfer the sector
777172	100	(100_8 words) to memory
777172	400	starting at loc 400
777170	7	Read
777172	7	Sector 7
777172	1	Track 1
777170	3	Transfer the sector
777172	100	(100 words) to memory
777172	600	starting at loc 0
R0	0	Zero R0
R7	0	and R7
RS	200	Disable interrupts

Then with the halt/enable switch enabled, type P, and the system should boot.

The sequence of key strokes the user must perform to accomplish this follows:

```
777170/40000 <CR>
/3 <LF>
100 <CR>
/0 <CR>
777170/7 <LF>
3 <CR>
/1 <CR>
777170/3 <LF>
100 <CR>
/200 <CR>
777170/7 <LF>
5 <CR>
/1 <CR>
777170/3 <LF>
100 <CR>
/400 <CR>
777170/7 <LF>
7 <CR>
/1 <CR>
777170/3 <LF>
100 <CR>
/600 <CR>
R0/0 <CR>
R1/177170 <CR>
R7/0 <CR>
R5/340 <CR>
P
```

" ⟨CR⟩ " is a carriage return and not "left angle bracket, C, R, right angle bracket," same for ⟨LF⟩ . " ^ " is "up arrow" and is over the "6" on DEC keyboards. It looks like " ↑ " and is over the "K" or "N" on other keyboards.

Then with the halt/enable switch enabled, type P, and the system should boot.

Figure 5-1 is a printout of what this, together with the computer's responses, would look like.

```
173000
@777170/004040 40000
@/004040 3
177172/000300 100
@/000000 0
@777170/004040 7
177172/000000 3
@/000000 1
@777170/004040 3
177172/000000 100
@/000000 200
@777170/004040 7
177172/000000 5
@/000000 1
@777170/004040 3
177172/000000 100
@/000000 400
@777170/004040 7
177172/000000 7
@/177170 1
@777170/004040 3
177172/000000 100
@/000000 600
@R0/000000 0
@R1/000000 177170
@R7/173000 0
@PS/000200 340
@P

RT-11FB     V04.00
```

FIGURE 5-1

5.4 Creating a Double Density DY-Based System Disk

Now that you have the system booted, put a blank double density disk in drive 1. (The term double density diskette refers to a diskette that has been formatted with double density field marks. See section 2.4 on how to make a double density diskette). Now execute the following sequence:

```
Initialize the disk in drive 1:
     .INIT/NOQUERY     DY1:
Copy the system disk onto it:
     .COPY/SYS   DYØ:*.*    DY1:*.*
Load the boostrap block:
     .COPY/BOOT  DY1:DYMNSY.SYS  DY1:
                      or
     .COPY/BOOT  DY1:DYMNFB.SYS  DY1:
```

The disk in drive 1 should now boot if you put it in drive Ø and INIT the system.

You can use any single or double density disks as user disks with this double density disk as the system disk. All system programs should run, and any user program that do not expect an RX01 on the system should run (i.e., programs that do not reference files with "DX0:" as part of the file name and that do not reference 77717X expecting to find an RX01 there, should run).

5.5 Using the Format Command Under RT-11

In order to format the data fields of a diskette, an RT-11 utility program called FORMAT may be used. In order to use this utility type:

```
.R     FORMAT   <CR>
```

The program will type an asterisk after which the user should type the device name, either DYØ: or DY1:

```
*DYØ:  <CR>
```

After checking to be sure you wish to do this (the format operation of course, destroys all data), the drive specified will write double density data fields on all sectors of the diskette. If you wish to format the diskette to be single density, type DYØ:/S instead.

If the operation is interrupted it should be restarted or an "illegal" diskette of mixed densitits will be created. If the operation fails to complete successfully, a problem was encountered in reading the headers of the diskette. The user may attempt to reformat these headers by the procedure given in section 3.4.5.2. This feature is an additional feature offered by Dataram but not by DEC, therefore it is not contained in RT-11's format utility program.

6.0 MAINTENANCE

This section contains the basic maintenance information on the FD-311 needed to service the system by spare parts. It is suggested that only large volume users of the FD-311 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.

6.1 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.

6.1.1 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.

6.1.2 Cleanliness

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

6.1.3 Routine Maintenance Schedule

A systematic routine operating check is recommended. The checks should be performed in accordance with Figure 6-1.

UNIT	FREQ MONTHS	CLEAN	OBSERVE
Read/Write Head	12	Clean Read/Write Head ONLY IF NECESSARY	Oxide build up
R/W Head Load Button	12*	Replace	
Stepper Motor and Lead Screw	12 12	Clean off all oil, dust, and dirt	Inspect for nicks and burrs
Belt	12		Frayed or weakened areas
Base	12	Clean base	Inspect for loose screws, connectors, and switches
Read/Write Head	12		Check for proper alignment

*Assumes normal usage Figure 6-1 Routine Maintenance Schedule

6.2 Diagnosing the Problem

There are really only 2 basic elements in the FD-311: the controller card and the drives. It is 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.

First refer to the section 6.2.1. This section lists some common problems with FD-311 systems. If this does not help, check the power supply (Sections 6.2.2) and run the diagnostics (Sections 6.2.3 and 6.2.4).

6.2.1 Common Problems

PROBLEM	POSSIBLE CAUSE	REMEDY
LED on drive "0" stays on, run LED is off, no terminal response (when booting)	No disk in drive "0"	Insert Diskette
	DMA chain broken	Check card placement
	No double density boot on volume	Replace diskette
Processor is in ODT Run LED off LED'S on drives flash once (when booting)	Interrupt chain broken	Check card placement
	Halt/enable switch in halt position	Switch to run
	Processor is not strapped to come up in mode 2	See section 4.2.
Many retries on a write	Diskette is write protected	Write enable the diskette
	Enable/protect switch in protect position	Switch to enable
	Bad diskette (headers not readable)	Try a /K in DUP
	Head dirty	Check, clean
	Worn load pad	Check, replace
Many retries on a read	Bad Diskette	Try a /K in DUP
	Dirty head	Check, clean
	Worn load pad	Check, replace

6.2.2 Power Supplies

The FD-311 power supply provides 3 voltage levels: +24 volts, +5 volts, and -5 volts. These voltages are bussed by yellow, orange, and blue wires respectively. Green wire is used for ground. The outputs of the supply are marked and may be easily tested with a voltmeter. Below each output is a pot which adjusts the voltages. If the voltages are off more than 5%, try to bring them back into spec with these pots.

To replace the power supply, it is easiest to disconnect the power connectors at the drive and the AC terminal block thereby removing the supply with the harness. Dataram provides spare power supplies with the harness attached making replacement easier.

6.2.3 FD-311 Diagnostics

Several useful diagnostics are available to the user. The simplest one is built into the microcode of the F03/A controller. Place a good diskette into drive "0" and init the system with the halt switch in the halt mode. Examine location 777170 using ODT. If the error bit, bit 15 is set, the nature of the error can be determined by looking at location 777172 for simple errors, and performing the read error code function for other errors are described in section 3.4.8.

For problems that are not solid, the self-test function as described in section 4.4 should be performed. Try to isolate the problem to a single drive or the media.

For more difficult problems, the DEC diagnostic ZRXDA is suggested.

6.2.4 ZRXDA Diagnostic

This diagnostic will provide a thorough test of the FD-311 system. The diagnostic may be loaded from diskette only when the line time clock is disabled. This may be done with a front panel switch on the PDP-11/03. On the PDP-11/03-L, the BDV11A, which is provided with all systems, automatically disables the line time clock.

The diagnostic provides many modes selectable by the user, in which to test the FD-311. This diagnostic is especially useful for testing data reliability.

120, 160, or 200 (CRC) errors are often caused by defective media, drive or read/write circuitry on the controller card. Try to isolate the problem to either the media or a single drive. Other error messages usually indicate a faulty controller card.

6.2.5 Drive Replacement

Problems with a single drive in a dual drive system usually indicate a problem in the failing drive, rather than the controller. If the problem can be isolated to one drive, the drive should be removed for repair or replacement. The remaining drive can be configured to respond as drive "0" or drive "1" (see Section 6.2.5.1). Follow the procedure outlined below to remove drives:

(1) Remove the 50 pin ribbon cable edge connector from the drive.

(2) Unplug the 3 terminal AC power connector from the drive.

(3) Unplug the 6 terminal DC power connector from the drive.

(4) Remove the 2 screws that hold the drive in place from the bottom of the unit.

(5) Remove the 2 screws that hold the drive in place from the side of the unit.

(6) Slide the unit backwards one inch so that the write-protect switch clears its hole in the front panel.

(7) Remove the drive by pulling it up out of the chassis.

(8) A replacement drive may be installed by reversing the above procedures. The proper jumper configuration of such a drive is given below.

6.2.5.1 Drive Configuration

The Shugart SA-800R drive contains a PC card with silk screen designations for various jumpers. There are two differences between the jumper configuration in the FD-311 and the standard configurations used by Shugart.

(1) The jumper marked HL is moved to DS.

(2) The jumper marked DS1 is removed. If one wishes the drive to respond as unit 0, place this jumper at DS3. For response as unit 1, the jumper should be placed at DS4.

(3) The write protect switch is wired between Test point 25 and Vcc (see Figure 6-2).

6.2.6 FO3/A Controller Card Replacement

The controller card consists of a 6 MHz bipolar bit slice microprocessor that controls almost all functions performed by the controller. DMA bus cycles, reading and writing of the disk, and RX02 instruction set emulations are handled by this processor. The few functions in hard logic include DMA grant arbitration, interrupt acknowledge arbitration, and the phase-locked loop, used to track data from the disk on read operations.

The phase-locked loop is the only analog circuitry on the board and contains an inductor and capacitor to isolate the VCO chip from the digital logic. The effective isolation may be checked by placing a scope on Z45 pin 16, AC coupled. There should be less than 30 millivolts of noise. Other checks that may be made on this circuitry are listed below. These checks should be performed when the reliability of reading data is in question.

(1) Check the single density bit cell divider one-shot at Test point 5 (Z44 pin 12). During read operations this one-shot will be triggered and using a scope set on negative-edge triggering, the one-shot should stay low for 1000 $\pm$ 70 nanoseconds.

(2) Check the double density bit cell divider one-shot at Test point 6 (Z44 pin 4). During read operations this one-shot will be triggered and using a scope set on negative-edge triggering, the one-shot should stay low for 500 $\pm$ 20 nanoseconds.

(3) Check the voltage level of Test point 2 with a digital voltmeter while the FD-311 is idle. It should read 3.0 $\pm$ .3 volts DC.

The F03/A controller card should be swapped first when trying to isolate any problem that does not appear to be drive dependent or media dependent, or if it fails any of the above tests. Turn off the power, remove the card, and inspect it for contaminated gold fingers or any contaminants that might have caused a short. If the card is still not working, it should be returned to Dataram.

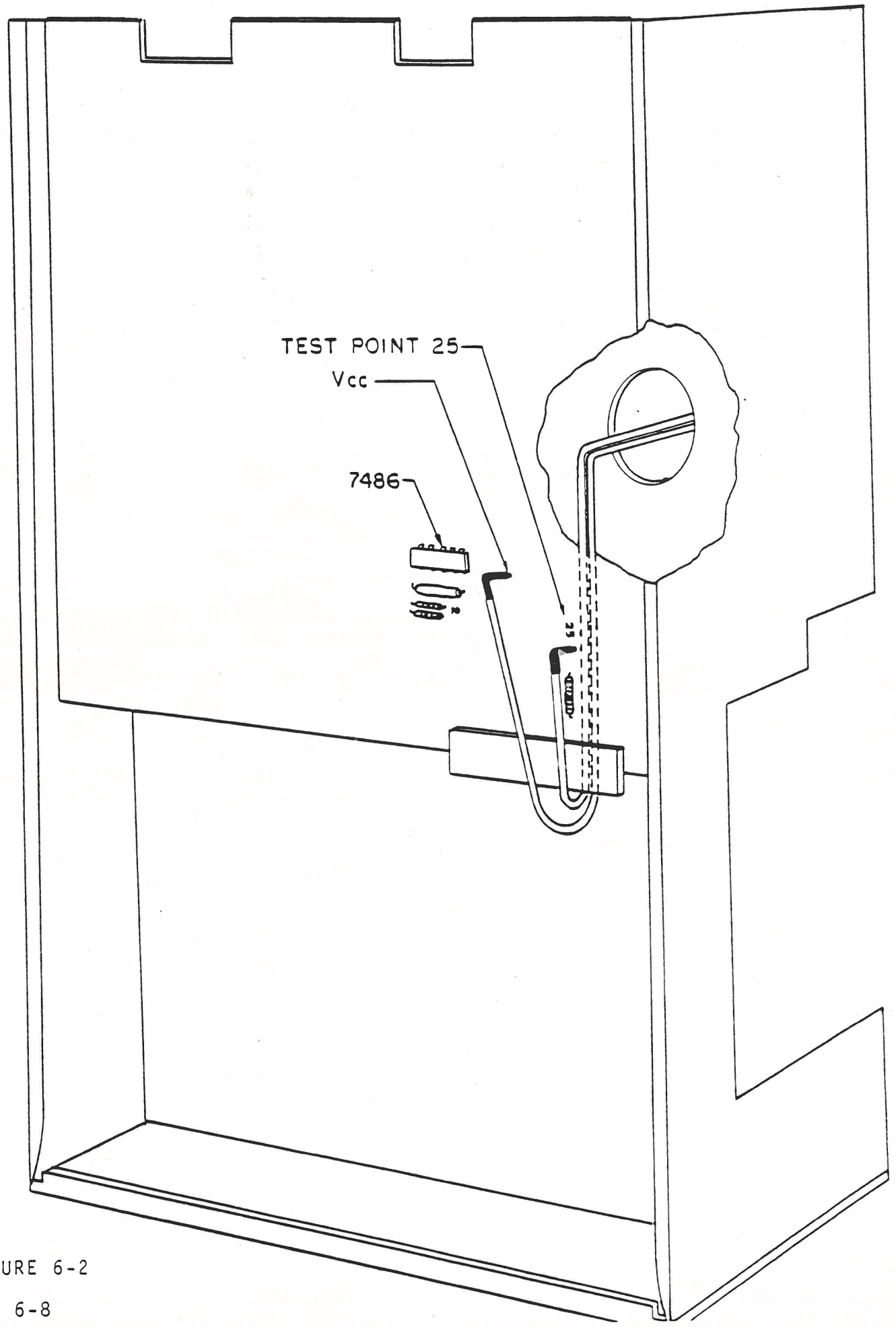
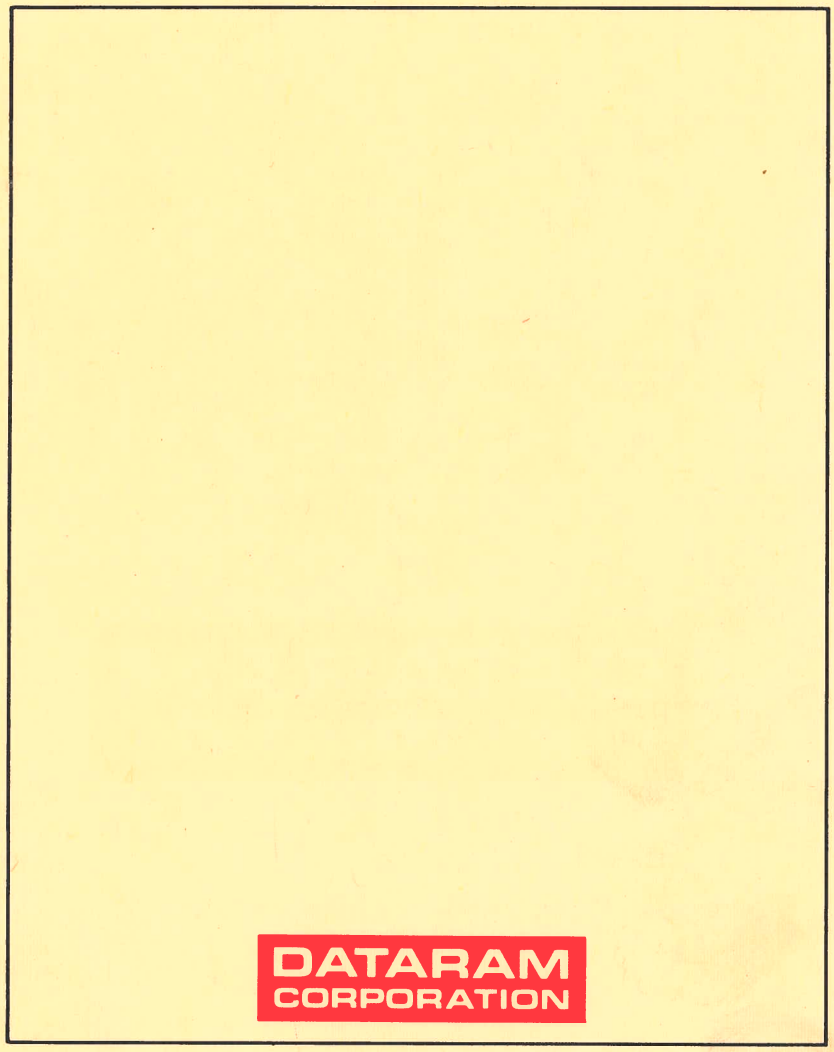


FIGURE 6-2

7.0 DOCUMENTATION

PART NUMBER	DESCRIPTION
65120	F03 Master Assembly (LSI-11)
03396	F03/A Schematic Diagram
65124	F03/A Bill of Materials
69705	FD-311 115V, 60HZ (LSI-11, Dual Drive, Sgl Side)
69706	FD-311 230V, 50HZ (LSI-11, Dual Drive, Sgl Side)
69707	FD-311 110V, 50HZ (LSI-11, Dual Drive, Sgl Side)
69717	Chassis Assembly, FD-311/511 (w/o P.S. & drive)



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