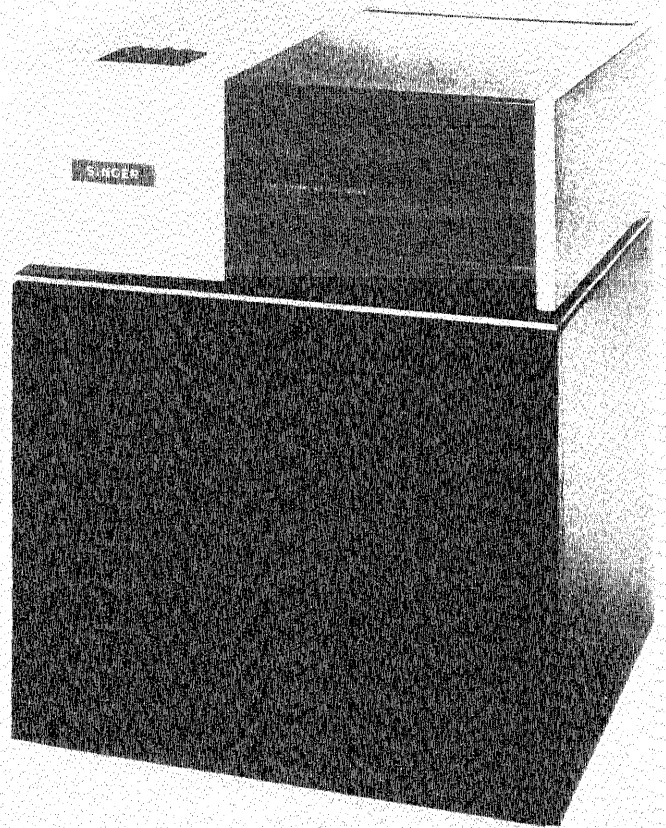# MODELS 40 AND 42 DISC DRIVES

SYSTEM TEN COMPUTER BY SINGER

SINGER
BUSINESS MACHINES

REFERENCE MANUAL

MODELS 40 AND 42 DISC DRIVES

SYSTEM TEN COMPUTER BY SINGER

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Contents

This manual is intended for those who are interested in the operating and programming characteristics of the Models 40 and 42 Disc Drives. Included in the manual are a general description of the Models 40 and 42; a table of specifications; a description of the operator control panel; a thorough discussion of read and write operations; discussions of multi-partition and timing considerations; instructions on how to mount and remove disc packs; plus a summary of all Condition Codes associated with the Models 40 and 42.

Detailed operating instructions may be found in the Model 40 Disc Drive Operator Instructions, Publication No. 40-023, and the Model 42 Disc Drive Operator Instructions, Publication No. 40-332.

The Models 40 and 42 Disc Drives are high speed, random access storage devices designed as peripheral units for the System Ten* computer. Up to ten disc drives may be attached to the central processor through the File Access Channel (FAC). A Disc Controller, consisting of printed circuit cards contained in the central processor, acts as intermediary between the disc drives and the FAC. A particular installation may include both models in any combination. In external appearance, the two models are identical (see Figure 1-1); what differentiates them is the type of disc pack used. Both models use removable disc packs.

The Model 40 uses a disc pack consisting of six magnetic oxide coated discs joined to one another on a common vertical axis. The discs are approximately 14 inches in diameter and there is approximately .4 inches between successive discs. The disc pack (Model 41 Disc Pack) has ten recording surfaces. The top surface of the top disc and the bottom surface of the bottom disc are not used for recording data.
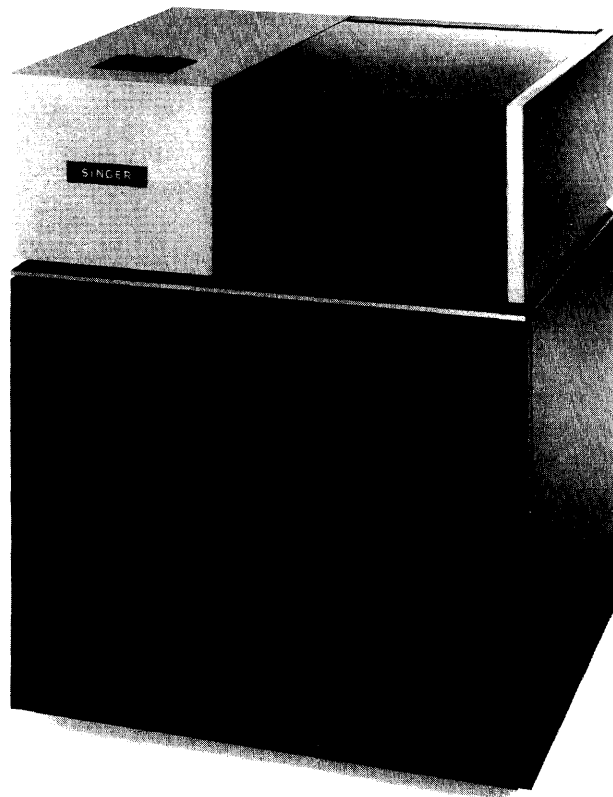

Figure 1-1. Model 40 Disc Drive

*A trademark of The Singer Company

The Model 42 uses a pair of disc packs, one mounted on top of the other. Both packs must be mounted for the disc drive to be operable. The bottom pack (Model 41A Disc Pack) is referred to as the resident pack and the top pack (Model 41B Disc Pack) is referred to as the removable pack. Regardless of the terminology, both packs can be removed from the disc drive by the operator. When both packs are mounted, they rotate together as though they were one pack. It is anticipated that the resident pack will remain mounted for extended periods of time with the removable pack being changed from run to run, day to day, etc., as dictated by the requirements of each installation. The resident pack and the removable pack each consist of three magnetic oxide coated discs joined to one another on a common vertical axis. The discs are approximately 14 inches in diameter and there is approximately 0.4 inch between successive discs. Each pack has four recording surfaces. The top surface of the top disc of each pack and the bottom surface of the bottom disc of each pack are not used for recording data.

On all three disc packs (Models 41, 41A, and 41B) each recording surface contains 200 concentric tracks and each track is divided into 50 equal parts called sectors. Each sector contains 100 characters. A write or read operation always writes on or reads from a single sector.

The Model 41 Disc Pack has a maximum data storage capacity of 10 million characters. The Models 41A and 41B Disc Packs each have a maximum data storage capacity of 4 million characters.

The read/write head mechanism of the Model 40 Disc Drive has five arms, one for each interdisc gap. Each arm has two heads: one for the surface above the arm and the other for the surface below the arm. All five arms move together.

The read/write head mechanism of the Model 42 Disc Drive has four arms. The mechanism is identical in appearance to the read/write head mechanism of the Model 40 Disc Drive except that the middle of the five arms is missing.

Like all peripheral devices for the System Ten computer, the disc drives are independently powered and are turned on and off from their own operator control panels. Once a pack (or a pair of packs in the case of the Model 42) is mounted and the power is on, the operator starts the pack rotating by moving the START/ STOP switch on the operator control panel to the START position. When the pack is rotating at an acceptable operational speed (2400 rpm ± 2%), the READY indicator light on the operator control panel turns on. With the power on, the disc drive is in either of two states, called local and on-line.

When in local, the disc drive is disconnected from the central processor.

When on-line, the disc drive can perform read and write operations in response to Read and Write instructions executed in the central processor.

The ENABLE/DISABLE switch on the operator control panel serves as a combined ON LINE and LOCAL switch. When the ENABLE/DISABLE switch is in the DISABLE position, the disc drive is in local. When the READY light is on

and the ENABLE/DISABLE switch is in the ENABLE position, the disc drive is on-line.

The Models 40 and 42 Disc Drives operate within the specifications shown in Table 1-1.

Table 1-1. Specifications

Dimensions	Width	Depth	Height	
Inches	30-1/4	24	38	
Centimeters	77	61	97	
Minimum Service Clearances	Front	Rear	Right	Left
Inches	36	36	0	0
Centimeters	91	91	0	0
Approximate Weight Floor	321 lbs (without 10 lb disc pack) 146 kg (without 4.5 kg disc pack)			
Maximum Heat Output/Hour	3,9000 BTU	982.8 kcal		
Electrical Requirements				
Voltage Range	110-130V ± 10%	208-230V ± 10%		
Frequency	60 ± 1 Hz	50 ± 1 Hz		
Current	9.6A	5.0A		
Maximum Current Surge	45A for 5 to 10 secs	25A for 5 to 10 secs		
Phases	single	single		
KVA	1.1	1.1		
Operating Environment				
Temperature	65 to 85°F	18 to 29.5°C		
Relative Humidity	20 to 75%			
Non-Operating (Storage) Environment				
Temperature	-30 to +150°F	-34 to +66°C		
Relative Humidity	8 to 80%			

The operator control panels of the Models 40 and 42 Disc Drives (Figure 2-1) comprise three toggle switches and three indicator lights. The function of each switch and light is discussed in Table 2-1.
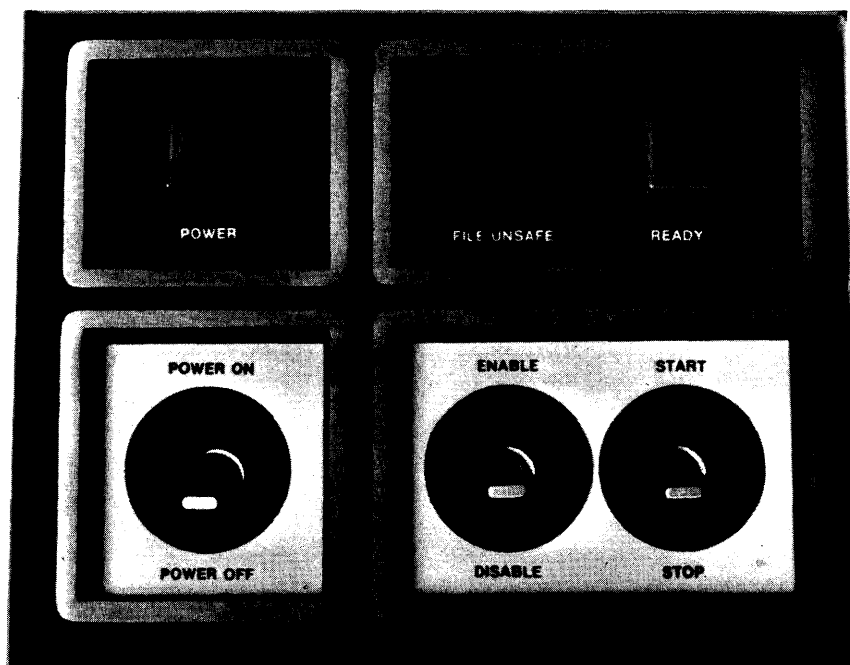

Figure 2-1. Operator Control Panel

Table 2-1. Operator Control Panel

Control	Function
POWER ON/POWER OFF Switch	Turns the power on and off.
POWER Indicator Light	Illuminated whenever the power is on.
ENABLE/DISABLE Switch	When the READY light is on and this switch is in the ENABLE position, the disc drive is on-line. If this switch is in the DISABLE position, the disc drive is in local.
START/STOP Switch	When this switch is moved to the START position, the disc pack begins rotating, a set of brushes cleans any dust from the disc surfaces, and then the head assembly emerges and positions itself at the outer-most track. When this switch is moved to the STOP position, the head assembly retracts into the wall of the disc drive and the pack slows to a halt.
READY Indicator Light	Provided that no FILE UNSAFE condition exists, the READY light is on whenever the disc pack is rotating at the proper speed (2400 rpm $\pm$ 2%).
FILE UNSAFE Indicator Light	The FILE UNSAFE light turns on whenever the disc drive detects a malfunction which could conceivably result in loss of recorded data. When the FILE UNSAFE light turns on, any read or write operation currently in progress is terminated immediately, and the disc drive cannot respond to any further instructions. To turn off the FILE UNSAFE light, the operator must move the START/STOP switch to the STOP position and then (after the pack has slowed to a halt) move the START/STOP switch back to the START position.

READ AND WRITE INSTRUCTIONS

A Read or Write instruction which addresses a disc drive has the following characteristics:

- Both the LA-field and the LB-field must be zero.

- The A-field specifies the address of a 100-location segment of memory. For a Read instruction, the segment is the input area into which the record will be read. For a Write instruction, the segment is the output area from which the record will be written.

- The B-field specifies the address of a six-character segment of memory. The segment contains a six-character disc address (discussed as a separate topic below).

- Both the A-field and B-field may be modified by the contents of an index register if the programmer so desires.

SIX-CHARACTER DISC ADDRESS

The six-character segment of memory which is pointed to by the B-field of the Read or Write instruction contains the following pieces of information:

- The disc drive device number (0-9).

- The arm number (0-4; on the Model 40, 0 specifies the top arm; on the Model 42, 0 specifies the bottom arm).

- The track number (000-199, where 000 specifies the outermost track).

- The sector number (00-99, where sectors 00-49 are accessed by the upper head and sectors 50-99 by the lower head).

The format of the six-character disc address is shown in Figure 3-1.

Only the numeric portions (1-4) of each character are used for specifying this information. Bit 7 may be either 0 or 1; bit 5 must always be 1. The information is specified as follows:

CHARACTER	1	2	3	4	5	6	Bit
	D	A	T	T	S	S	4
	D	A	T	T	S	S	3
	D	A	T	T	S	S	2
	D	T	T	T	S	S	1

1️⃣ DEVICE NUMBER (0-9)

2️⃣ HUNDREDS DIGIT (0 or 1) OF A THREE DIGIT TRACK NUMBER

3️⃣ TENS DIGIT (0-9) OF A THREE DIGIT TRACK NUMBER

4️⃣ UNITS DIGIT (0-9) OF A THREE DIGIT TRACK NUMBER

5️⃣ TENS DIGIT (0-9) OF A TWO DIGIT SECTOR NUMBER

6️⃣ UNITS DIGIT (0-9) OF A TWO DIGIT SECTOR NUMBER

7️⃣ ARM NUMBER (0-4)

NOTE:

• The bits in characters 1,3,4,5, and 6 have the following values:

Bit 1 has the value 1 when it is ON.
Bit 2 has the value 2 when it is ON.
Bit 3 has the value 4 when it is ON.
Bit 4 has the value 8 when it is ON.

• The bits in character 2 have the following values:

Bit 1 has the value 1 when it is ON.
Bit 2 has the value 1 when it is ON.
Bit 3 has the value 2 when it is ON.
Bit 4 has the value 4 when it is ON.

Figure 3-1. Six-Character Disc Address

A Write instruction which addresses a disc drive causes 100 characters to be accessed from memory and written onto a sector.[1]

If a Write instruction addresses a disc drive which is not on-line, the instruction is terminated and Condition Codes 4 and 1 (Fault) in the central processor are set on.

When attached to the Disc Controller of a System Ten computer, the Models 40 and 42 Disc Drives automatically performed a "read after write" to check for errors. After a record (100 characters) has been written, the next time the sector passes the read/write heads the sector is read and compared against the Write instruction's output area. If the content of the sector exactly matches the content of the Write instruction's output area, the write operation is considered successful. If the operation is unsuccessful, writing (and reading) is repeated up to two more times. If, after a total of three attempts, the write operation still has not been successfully performed, the sector is marked "bad," the operation is terminated, and Condition Code 3 (Flag) in the central processor is set on.

If a Write instruction addresses a Model 42 Disc Drive and the requested sector is one which would be accessed by the middle arm (arm 2), the instruction is terminated and Condition Code 3 (Flag) in the central processor is set on.

If a FILE UNSAFE condition occurs during a write operation, the operation is terminated and Condition Codes 4 and 1 (Fault) in the central processor are set on.

NOTE: If the Disc Controller is addressed by a Write Control instruction, the instruction is acted upon as though it were a Write instruction.

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[1] A write operation also records the track address on the particular sector. This track address is used for track address verification during disc read operations.

A Read instruction which addresses a disc drive causes the 100 characters contained in a sector to be read into main memory.

If a Read instruction addresses a disc drive which is not on-line, the instruction is terminated and Condition Codes 4 and 1 (Fault) in the central processor are set on.

If the specified sector cannot be successfully read, reading is retried up to three more times. If, after a total of four attempts, the sector still cannot be successfully read, the operation is terminated and Condition Code 1 (Error) in the central processor is set on.

If a Read instruction addresses a Model 42 Disc Drive and the requested sector is one which would be accessed by the middle arm (arm 2), the operation is terminated and Condition Code 3 (Flag) in the central processor is set on.

If a FILE UNSAFE condition occurs during a read operation, the operation is terminated and Condition Codes 4 and 1 (Fault) in the central processor are set on.

Track address verification is performed automatically at the beginning of a System Ten disc read operation.

If an attempt is made to read a sector which has been marked "bad" or if address verification reveals that the sector has not been initialized, the operation is terminated and Condition Code 3 (Flag) in the central processor is set on.

If address verification reveals that the read/write heads have been positioned at the wrong track, the operation is terminated, Condition Code 1 (Error) in the central process is set on, and the read/write head mechanism is repositioned to the outermost track (track 000).

NOTE: If the Disc Controller is addressed by a Read Control instruction, the instruction is acted upon as though it were a Read instruction.

A disc drive is free for use if it is not <u>bound</u> to a partition. A disc drive is bound to a partition as soon as the partition initiates a seek[1] upon that drive. A drive which is bound to a partition remains so until the associated input or output operation is complete. When a disc drive is bound to a partition, no other partition may initiate a seek upon that drive.

In an installation containing several disc drives, all the drives may be performing seeks simultaneously; however, only one drive may be transmitting data at a time.

The Disc Controller remembers which disc drives are bound to which partitions. If several seeks are being performed simultaneously, the first partition to gain control of the central processor after that partition's seek is complete pre-empts the FAC for data transmission. Once data transmission is begun, the partition may read and/or write sectors as long as the partition maintains control of the central processor and does not try to move the read/write head mechanism to another track. If the partition attempts to move the read/write head mechanism, the partition relinquishes control of the central processor and the disc drive is freed.

If an instruction addresses a disc drive which is bound to another partition, the partition in which the instruction is executed relinquishes control of the central processor and does not regain control until the disc drive is free.

If an instruction addresses a disc drive which is free but the operation requires that the read/write head mechanism be moved, the seek is initiated (the drive becomes bound) and the partition in which the instruction is executed relinquishes control of the central processor and does not regain control until the seek is complete.

---

[1] The term "seek" refers to the act of moving the read/write head mechanism to the proper track in response to a Read or Write instruction executed in the central processor.

Table 7-1 shows some of the more important operational timings for the Models 40 and 42 Disc Drives.

Table 7-1. Timings

Rotation Time	25.0 ms.
Arm Positioning Times	
Minimum	2.5 ms.
Average	73.0 ms.
Maximum	135.0 ms.

Minimum arm positioning time is the amount of time required to move the read/write head mechanism from one track to the next sequential track. Average arm positioning time is the amount of time required to move the read/write mechanism from track 000 to track 099. Maximum arm positioning time is the amount of time required to move the read/write head mechanism from tack 000 to track 199.

Once the read/write head mechanism is positioned at the proper track, a read operation takes 0.5 to 25.5 ms. These figures include the rotational delay time[1] (0 to 25 ms.) and the time needed to read a sector (0.5 ms.). If retries are necessary, each retry takes 25 ms.

Once the read/write head mechanism is positioned at the proper track, a write operation takes 26.5 to 51.5 ms. These figures include:

- the rotational delay time (0 to 25 ms.)

- the amount of time required for the Disc Controller to execute a special timing algorithm (1 ms.)

- the amount of time required to write a sector (0.5 ms.)

- the amount of time required to rotate to the sector and then to read the sector (25 ms.).

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[1] Rotational delay time is the amount of time needed for the desired sector to move to the read/write heads.

The disc is formatted as shown in Figure 7-1.

NOTE: Sector 0-49 are accessed by the upper head on each arm, and sectors
50-99 are accessed by the lower head.

Figure 7-1. Disc Sector Layout

After reading or writing a sector, the first subsequent sector on the same track which may be read or written without requiring an additional revolution of the disc is the fifth sector following the one read or written. Notice that the disc is formatted such that sector 2 is the fifth sector following sector 1, sector 3 is the fifth sector following sector 2, etc. This means that it is very efficient to read and write a series of consecutively numbered sectors.

When performing any of the pairs of read/write operations shown in Table 7-2 using consecutively numbered sectors (e.g., sectors 1 and 2, 48 and 49, etc.) on the same track, it takes 2 ms. for the second sector to move to the read/write heads after the first operation is finished. If the two disc I/O instructions are executed consecutively, the entire 2 ms. is wasted time. However, if computational instructions are inserted between the two disc I/O instructions, the amount of time wasted can be significantly reduced. The figures shown in the right column of Table 7-2 specify the absolute maximum amount of time available for computation between the two disc I/O instructions. If the times are exceeded, an additional revolution of the disc (25 ms.) will be required for the second operation.

Table 7-2. Overlap Timings

Read Read	1.6 ms.
Write Write	.6 ms.
Write Read	1.6 ms.
Read Write	.6 ms.

NOTE: The Disc Controller takes 1 ms. to perform the special timing algorithm at the start of a write operation. Therefore, only 0.6 ms. is available for computation when a Write instruction is the second in the pair of disc I/O instructions.

The Models 41, 41A, and 41B Disc Packs each have their own carrying cases.
See Figure 8-1, 8-2, and 8-3.

To mount a disc pack (Model 41) on a Model 40 Disc Drive, proceed as follows:

a. Lift the carrying case by the top handle.

b. Holding the pack upside down, turn the knob on the bottom of the case
counterclockwise until the bottom of the case comes off.

c. Place the pack on the spindle in the center of the disc pack compartment.

d. Turn the handle on the top of the case clockwise.

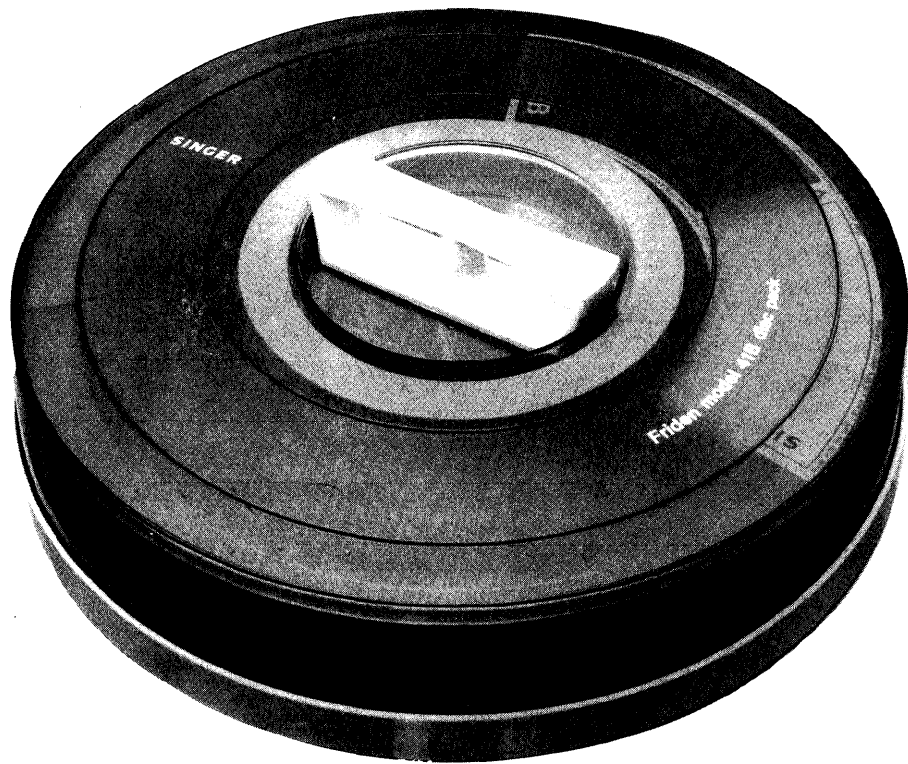e. When the handle will no longer turn, lift the case out of the compartment.

Figure 8-1. Top View of a Model 41B Disc Pack in Its Carrying Case
(Model 41 is identical except for identification marking)

To mount the bottom pack (Model 41A) on a Model 42 Disc Drive, proceed as follows:

a. Lift the Carrying case by the top handle.

b. Holding the pack upside down, turn the knob on the bottom of the case counterclockwise until the bottom of the case comes off.

c. Place the pack on the spindle in the center of the disc pack compartment.

d. Lift the release knob on the top of the carrying case and lift the case out of the compartment.

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                    CAUTION

Do not under any circumstances mount Model 41A
and 41B Disc Packs on a Model 40 Disc Drive.
Disc packs are not interchangeable between Model
40 and Model 42 Disc Drives.
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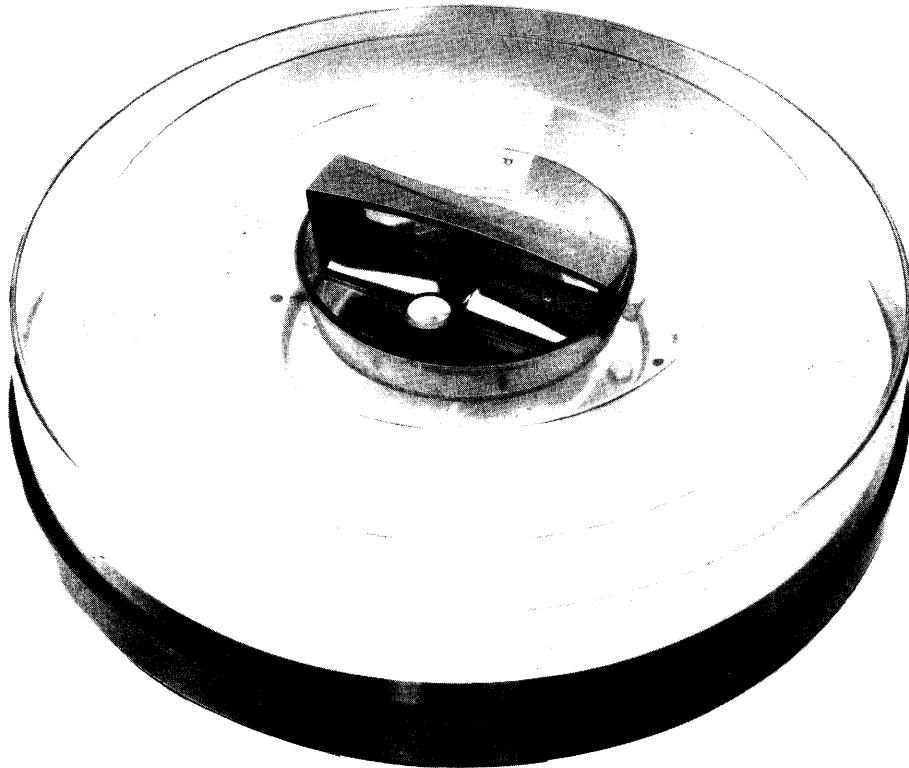

Figure 8-2. Top View of a Model 41A Disc Pack in Its Carrying Case (note the release button).

To mount the top pack (Model 41B) on a Model 42 Disc Drive, proceed as follows:

a. Lift the carrying case by the top handle.

b. Holding the pack upside down, turn the knob on the bottom of the case counterclockwise until the bottom of the case comes off.

c. Place the pack on top of the resident pack so that the large arrows on the two packs are aligned. There is a pin protruding from the top of the resident pack and this pin should fit into a hole in the bottom of the removable pack. When the pin is in the hole, the two packs are locked together. The operator may have to turn the removable pack slightly in one direction or the other to cause the pack to drop into place.

d. When the packs are properly joined, press the top handle down and turn it clockwise.

e. When the handle will no longer turn, lift the case out of the compartment.

Figure 8-3. Bottom View of a Model 41, 41A, or 41B Disc Pack in Its Carrying Case

To remove a disc pack (Model 41) from a Model 40 Disc Drive or to remove the top pack (Model 41B) from a Model 42 Disc Drive, proceed as follows:

a. Place the top of the carrying case on the pack.

b. Turn the handle on the top of the case counterclockwise.

c. When the pack begins to turn freely, lift the case out of the compartment.

d. Holding the pack upside down, place the bottom of the carrying case on the pack and turn the knob on the bottom of the case clockwise.

To remove the bottom pack (Model 41A) from a Model 42 Disc Drive, proceed as follows:

a. Place the top of the carrying case on the pack.

b. Press the release knob on the top of the carrying case and then lift the case out of the compartment.

c. Holding the pack upside down, place the bottom of the carrying case on the pack and turn the knob on the bottom of the case clockwise.

CAUTION

Before lifting the cover to the disc pack compartment, check to be sure that the START/STOP switch is in the STOP position and that the pack has come to a halt. If the cover is raised while the pack is rotating, a locking pin tries to extend into holes in the bottom of the pack and the pin could be sheared off. If the locking pin is sheared off, the disc drive is unusable.

Never turn the POWER switch to the OFF position when the disc pack is rotating. If the power is turned off when the read/write head mechanism is extended from the wall of the drive, the heads could come in contact with the disc pack recording surfaces causing permanent damage to the pack. Always move the START/STOP switch to the STOP position and wait for the pack to come to a halt before turning off the power.

Table 9-1 summarizes the various Condition Codes associated with the Models 40 and 42 Disc Drives.

Table 9-1. Condition Code Summary

Condition Codes	Meaning
1 (Error)	Sector could not be read. OR Read/write heads positioned at wrong track.
2 (Normal)	O.K.
3 (Flag)	Instruction addressed the non-existent arm (arm 2) of a Model 42 Disc Drive. OR Sector could not be written on. OR Attempted to read a sector which was marked "bad." OR Attempted to read or write a sector which had not been initialized.
4 and 1 (Fault)	Disc drive not on-line. OR FILE UNSAFE condition sensed during a read or write operation.

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