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Systems

Reference Manual for IBM 3330 Series Disk Storage

IBM

PREFACE

This publication is intended to acquaint experienced data processing personnel with the characteristics of the IBM 3330 Series Disk Storage. The reader should have prior knowledge of direct access storage devices and concepts.

In the descriptions of the functional capabilities of the IBM 3333 Models 1 and 11 and the IBM 3330 Models 1, 2, and 11, it is assumed that the devices are attached to a proper storage control, such as the Integrated Storage Control (ISC), Integrated File Adapter (IFA), or IBM 3830 Model 2.

This publication is organized by topics as follows:

- *Introduction:* Describes basic units and lists highlights and features, both optional and standard.
- *Configurations and Attachments:* Defines the possible combinations and system attachments for the 3333/3330.
- *Formats:* Describes and illustrates the record and track formats for data. Also provided are Record/Track capacity charts including the formula for capacity calculations of various length records.
- *Input/Output:* Includes addressing methods and access times.
- *Error Recovery:* Includes error recovery information with error condition table and associated error recovery actions.
- *Command Set:* Lists and summarizes the 3330 command set.
- *Operating Instructions:* Describes all switches and indicators associated with the 3333 and 3330 Operator Panels.

The following publications are recommended for detailed information concerning the subjects covered in this manual:

- *Reference Manual for IBM 3830 Storage Control, Model 2,* Order No. GA26-1617.
- *Reference Manual for IBM Integrated Storage Control,* Order No. GA26-1620.
- *IBM System/360 Principles of Operation,* Order No. GA22-6821.
- *IBM System/370 Principles of Operation,* Order No. GA22-7000.
- The functional characteristics manual applicable to the parent system. Order numbers for functional characteristics manuals can be found in *IBM System/360 and System/370 Bibliography,* Order No. GA22-6822.
- *A Data Processing Glossary,* Order No. GC20-1699, defines terms related to direct access storage devices.

Fourth Edition (March 1974)

This manual replaces and makes obsolete *Reference Manual for IBM 3330 Series Disk Storage,* Order No. GA26-1615-2. Extensive information has been added on error recovery procedures, command functions and sense byte formats.

Significant changes or additions to the specifications contained in this publication are continually being made. Before using this publication in connection with the operation of IBM equipment, contact the local IBM Branch Office for revisions.

Copies of this and other IBM publications can be obtained through IBM Branch Offices.

A form for reader's comments is provided at the back of this publication. If the form has been removed, send your comments to the address below.

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IBM Technical Newsletter

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This Technical Newsletter provides replacement pages for the subject publication. Pages to be inserted and/or removed are:

1,2
7 through 10
17 through 22

A change to the text or an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

1. Add attachment information previously omitted.
2. Add changes to the track format, command, and sense information.

Note: *Please file this cover letter at the back of the manual to provide a record of changes.*

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INTRODUCTION

The IBM 3330 Series consists of the IBM 3333 Disk Storage and Control, the IBM 3330 Disk Storage, and the IBM 3336 Disk Pack. Several combinations within the 3330 Series provide direct-access storage for the IBM System/360 Model 195 and the IBM System/370 Models 125, 135, 145, 155, 155-II, 158, 165, 165-II, 168, and 195. Figure 1 shows possible combinations of the 3330 Series using these systems. Together they form a modular, high performance, large capacity storage facility for applications such as:

- Airline reservations.
- Inventory and manufacturing control.
- Graphic processing.
- Time-sharing.
- Message switching.
- Systems residence.
- General purpose storage.
- Other applications requiring either direct or sequential processing.

3333 DISK STORAGE AND CONTROL

The 3333 is the largest module of the 3330 Series. The control portion is coupled with two 3330 drives to create the basic 3330 Series configuration. Currently two models are available: Models 1 and 11. Functional characteristics of the two models are similar except that the Model 11 provides twice the data capacity of the Model 1. The 3333 Model 11 also has a Write Format Release feature which allows Storage Control to disconnect after the last format Write record on a track and to service other drives while the drive "pads" zeros to the end of the track.

3330 DISK STORAGE

When the 3330 is attached to the 3333 it provides a maximum of 4 modules and 8 drives. Three models are available: Models 1, 2, and 11. The Model 1 module has two drives, whereas the Model 2 module has one. The Model 11 module has two drives, each of which has twice the data capacity of either a Model 1 or 2 drive. All drives have:

- 30 millisecond average access time.
- 8.4 millisecond average rotational delay.
- 806,000 bytes-per-second nominal read/write rate.

3336 DISK PACK

The 3336 Model 1 Disk Pack is removable and interchangeable with the 3330 Series Model 1 or 2 drives only. The 3336 Model 11 Disk Pack is removable and interchangeable with other 3330 Series Model 11 drives only. These disk packs provide the following capabilities.

	3336 Model 1	3336 Model 11
Cylinders per pack	404 (plus 7 alternates)	808 (plus 7 alternates)
Tracks per cylinder	19	19
Tracks per pack	7,809 (including 133 alternates)	15,485 (including 133 alternates)
Track capacity (bytes)	13,030	13,030
Cylinder capacity (bytes)	247,570	247,570
Pack capacity (approx bytes)	100 million	200 million

STRING SWITCH FEATURE

This feature allows a 3333 Disk Storage and Control and its attached string of 3330 Disk Storage modules to be dynamically switched between two Storage Controls (see Figure 2). The attachments may be a combination of any of the following: (1) S/370 Model 135 IFA, (2) S/370 Model 145 ISC, (3) S/370 Models 158 and 168 ISC, and/or (4) a 3830 Storage Control Model 2. The 3333 can be dedicated to a single Storage Control with an Enable/Disable switch.

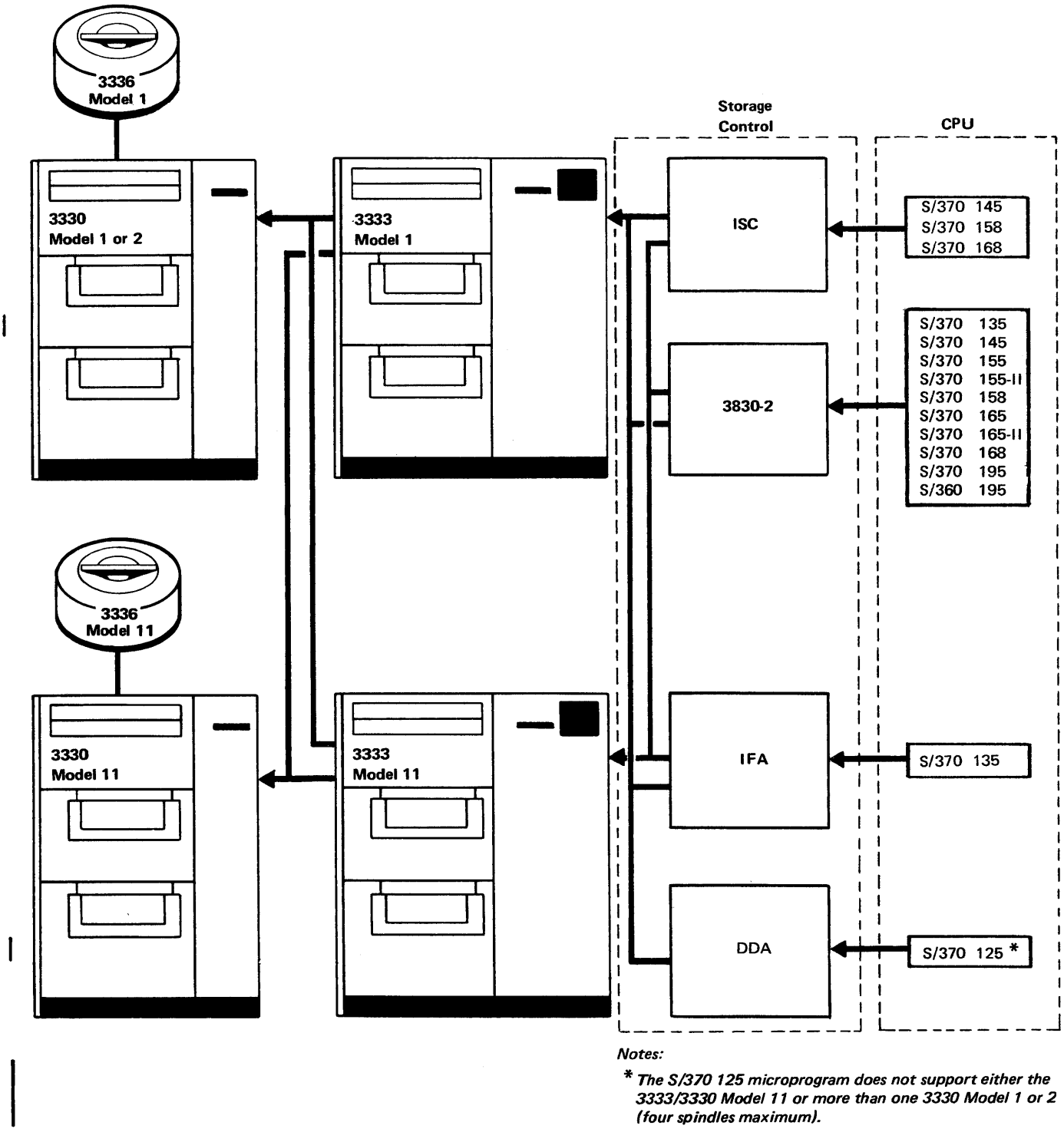
The String Switch is similar to the Two Channel Switch feature for the 3830 Storage Control.

32 DRIVE EXPANSION FEATURE

This feature provides for the attachment of up to two additional 3333s to a Storage Control (see Figure 2). The storage controls can be a combination of any of the following: (1) 3830 Storage Control Model 2, (2) S/370 Model 145 ISC, and/or (3) S/370 Models 158 and 168 ISC. The String Switch and 32 Drive Expansion features can be used together, as shown in Figure 2.

REMOTE SWITCH ATTACHMENT FEATURE

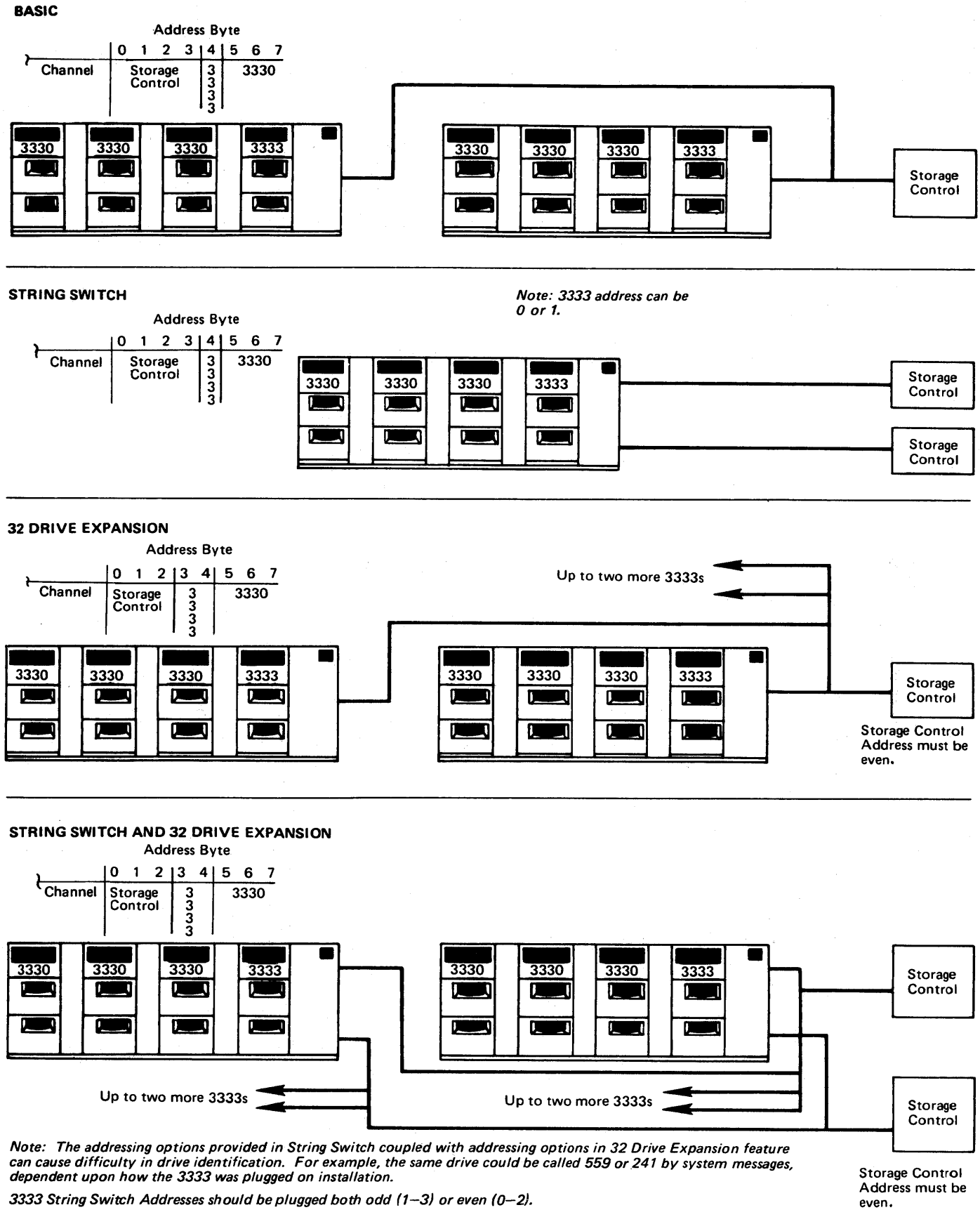
The Remote Switch Attachment allows a 3333 with the String Switch feature to be connected to the configuration control panel of an S/370 Model 158 MP or Model 168 MP.



Notes:

* *The S/370 125 microprogram does not support either the 3333/3330 Model 11 or more than one 3330 Model 1 or 2 (four spindles maximum).*

Figure 1. 3330 Series System Configurations



Note: The addressing options provided in String Switch coupled with addressing options in 32 Drive Expansion feature can cause difficulty in drive identification. For example, the same drive could be called 559 or 241 by system messages, dependent upon how the 3333 was plugged on installation.

3333 String Switch Addresses should be plugged both odd (1–3) or even (0–2).

Figure 2. 3330 Series Feature Configurations

FORMATS

PACK INITIALIZATION

All 3336 Disk Packs are initialized at the factory and shipped error free with a home address and eight-byte track descriptor record (R0) written on all tracks. If the data areas of the disk pack become defective during normal use, an IBM utility program is available to flag defective tracks and assign alternates.

Another IBM utility program is available that writes the volume label, volume table of contents (VTOC), and initial program load (IPL) records; it then determines the number of flagged tracks for entry into the VTOC.

RECORD FORMAT

The basic unit of information recorded by the drive is a byte consisting of eight bits. A group of bytes separated by a special gap is called an area. Areas are combined to make a record, the logical unit of information.

A record consists of three areas: count area, key area (optional), and data area. The significance of the bytes in these areas is shown in Figure 3.

Count Area

The count area contains the location of a data record on a specific track, and defines the size of the key and data areas of that record. The count area is written when the record is formatted and is not changed until the record is reformatted.

Key Area

Use of the key area is at the discretion of the programmer. When used, the key area of the record can contain the primary identification of the data portion of the record (such as social security number, man number, part number).

Once the key area is formatted, the contents -- but not the length -- may be altered. If the key area is altered, the data area of the record must also be rewritten.

Data Area

The data area contains the information identified by the count and key areas of the record. Data information is organized and arranged by the programmer.

The length of the data area is defined by the count area. Once the data area is formatted, the contents—but not the length—may be altered. The contents of the data area may be altered without affecting any other area in the record.

TRACK FORMAT

Track format is shown in Figure 3.

All tracks are formatted beginning at index and ending at the following index. Each track has the same basic format: home address, track descriptor record, and one or more data records. The records – and areas within the records – are separated by gaps.

Home Address

Each track contains one home address, which defines the physical location of the track (track address) and the condition of the track. Home address is the first recorded area following index.

Special commands are used for writing and reading the home address area: Write Home Address and Read Home Address. Writing home addresses is normally done only at the time of manufacture.

Track Descriptor Record (R0)

This record is always the first record on the track following the home address area.

In IBM programming systems, the count field of the defective track provides the address of the alternate track. If it is an alternate track, the count area provides the address of the defective track. An eight-byte data field is used to store the number of records on the track and the number of bytes remaining on the track.

Specific commands, Write R0 and Read R0, are used for writing and reading the track descriptor record.

Data Records

One or more data records may follow R0 on a track. Record format is determined at the time the count, key, and data areas of the record are originally written by execution of a Format Write command. The format of the record is not changed until the entire record is rewritten by another Format Write command.

Data records, as well as track descriptor records, can be formatted with or without keys. Generally, file organization determines whether keys are used.

Track Capacity

The number of records that can be recorded on a track depends on the record size. The following equation can be used to determine the number of equal length records per track. Home address and standard R0 space are taken into account.

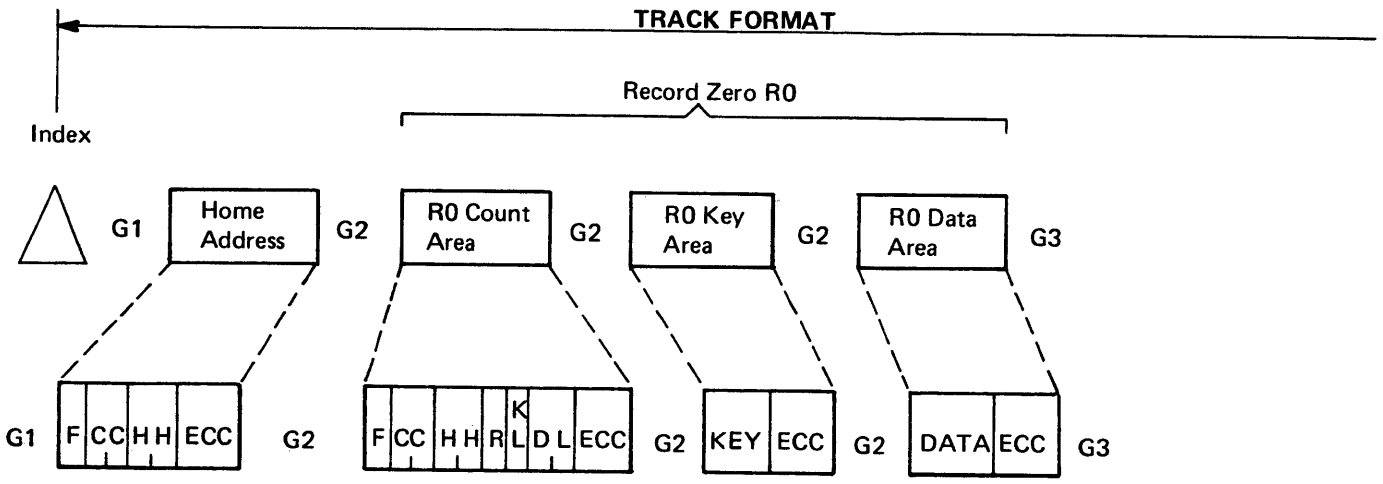
Number of equal length records per track =

$$\frac{13{,}165 \text{ (track capacity)}}{135 + C + KL + DL \text{ (bytes per record)}}$$

where

C (constant) = 0 if KL = 0
= 56 if KL ≠ 0
KL = key length
DL = data length

Additional capacity information is located in the Appendix.



HOME ADDRESS

Index: Indicates the physical beginning of each track. All tracks on the disk pack are synchronized by the same index.

G1 (Gap 1): Separates index and home address.

F (Flag): Defines the condition of the track and/or indicates a CE disk pack. This is the only flag byte transferred to or from the channel.

Bits 0 through 4 — unused and written as 0s.
Bit 5 — when on, this bit indicates a CE disk pack. This bit must be zero on customer packs or diagnostic routines may destroy customer data.
Bits 6 and 7 — 00 = normal track
01 = alternate track
10 = defective track

CC (Cylinder Number): Specifies the cylinder number (from 0 to 410 for Models 1 and 2, 0–814 for Model 11).

HH (Head Number): Specifies the read/write head within the selected cylinder (from 0 to 18).

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

G2 (Gap 2): Separates home address from R0 count area.

* *See "Track Descriptor Record (R0)"*

Figure 3. Record and Track Format (Part 1 of 2)

RECORD ZERO

R0 Count Area

F (Flag): Defines the condition of the track and indicates whether this is an overflow record.

Bits 0 through 3 — unused and written as 0s.
Bit 4 — when on, indicates that the logical record continues on the next track.
Bit 5 — always 0.
Bits 6 and 7 — 00 = normal track
01 = alternate track
10 = defective track

CC (Cylinder Number): Specifies the cylinder number (from 0 to 410 for Models 1 and 2, 0–814 for Model 11).

HH (Head Number): Specifies the read/write head number within the selected cylinder (from 0 to 18).

R (Record Number): Specifies the sequential number of the record on the track (zero in this case).

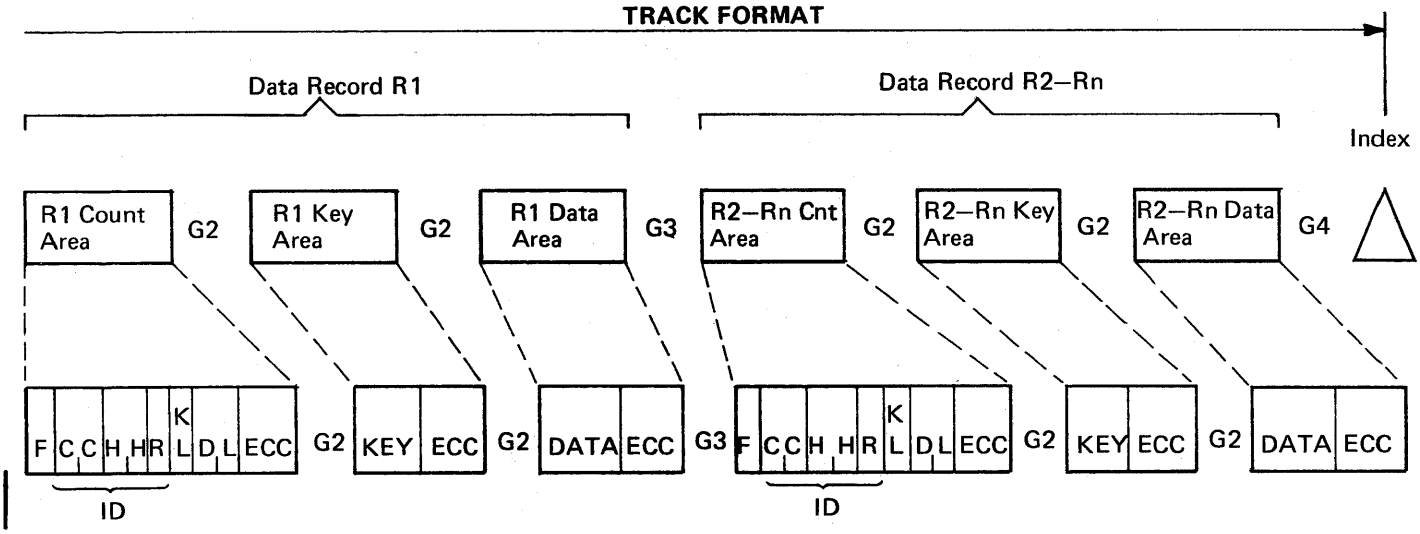
KL (Key Length): Specifies the number of bytes in the R0 key area (from 0 to 255 bytes).

DL (Data Length):* Specifies the number of bytes in R0 data area (from 1 to track capacity).

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

R0 Key Area

G2 (Gap 2): Precedes all key areas.



KEY AREA: Identifies the information in the data field.

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

R0 Data Area

G2 (Gap 2): Precedes all data areas.

DATA AREA:* Contains the information identified by the count and key areas.

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

DATA RECORD

Data Record Count Area

G3 (Gap 3): Precedes all count areas (except R0).

F (Flag): Same as Record Zero.

CC (Cylinder Number): Specifies the cylinder number (from 0 to 410 for Models 1 and 2, 0–814 for Model 11.

HH (Head Number): Specifies the read/write head within the selected cylinder (from 0 to 18).

R (Record Number): Specifies the sequential number of the record on the track.

KL (Key Length): Specifies the number of bytes in the key area (from 0 to 255 bytes).

DL (Data Length): Specifies the number of bytes in the data area (from 1 to track capacity).

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

Data Record Key Area

G2 (Gap 2): Precedes all key areas.

KEY AREA: Identifies information in the data area.

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

Data Record Data Area

G2 (Gap 2): Precedes all data areas.

DATA AREA: Contains the information identified by the count and key areas.

ECC (Error Correction Code): Generated by the 3333 - used for error detection and correction.

G4 (Gap 4): Written from the end of the last data area to index.

* *See "Track Descriptor Record (R0)"*

Figure 3. Record and Track Format (Part 2 of 2)

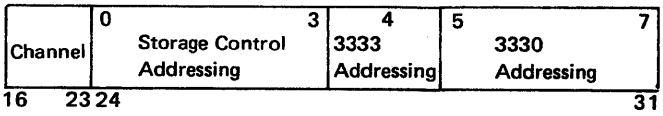
INPUT/OUTPUT OPERATIONS

This section contains a general description of I/O operations related to IBM 3330 Series Disk Storage devices. For detailed information regarding the central processing unit and channel program control of I/O operations, refer to *IBM System/360 Principles of Operation,* Order No. GA22-6821; or *IBM System/370 Principles of Operation,* Order No. GA22-7000.

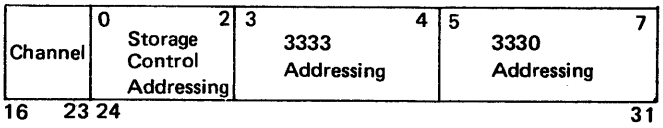
UNIT SELECTION AND DEVICE ADDRESSING

Drive addresses are specified in the I/O instruction. The address of the 3333 is specified in bit 4 of the eight-bit address byte. Bits 5, 6, and 7 identify the 3330/3333 drives, and the remaining bits (0, 1, 2, and 3) identify the IFA, ISC, or storage control unit. The address bit assignments are shown below:

Basic Addressing



32 Drive Expansion Addressing



TIMING

The time required to access and transfer data consists of access motion, head selection, rotational delay, and data transfer.

Access Motion Time

Access motion time is the time required to position the access mechanism at the specified cylinder. If the access mechanism is already at the proper cylinder, access motion time is zero. However, if the access mechanism is moved, the following times are required:

Cylinder to cylinder (average)	=	10 milliseconds.
Maximum	=	55 miliseconds.
Average (entire pack)	=	30 milliseconds.

Head Selection Time

The time required to select the read/write head is negligible.

Rotational Delay

Rotational delay is the time required for the desired record area to reach the read/write head so that data transfer can begin. This time can range from zero to almost a full revolution. Half a revolution (average rotational delay) is generally used for timing purposes. The maximum and average rotational delay is:

Maximum rotational delay	=	16.7 milliseconds.
Average rotational delay	=	8.4 milliseconds.

Data Transfer

The following are nominal read/write rates:

Bytes per second	=	806,000.
Microseconds per byte	=	1.24.

ERROR RECOVERY PROCEDURE

The handling of errors usually involves storage control and system-invoked recovery actions. These recovery actions can vary depending on how and to what system the 3330 is attached.

The following topics are associated with recovery actions involving the 3830 Model 2, or ISC (storage controls) and the 3330.

- Error Correction Function
- Error Condition Table
- Error Recovery Action.

ERROR CORRECTION FUNCTION

The Error Correction Function (ECF) is part of the recovery action procedure. The ECF algorithms and the related procedure are fully described in the 3830 Model 2 and ISC reference manuals. The order number for these manuals and other pertinent publications are given in the Preface.

ERROR CONDITION TABLE

The error condition table shown in Figure 4 identifies unique configurations of sense bits in sense bytes 0, 1, and 2 set by the storage control. In addition, it refers to each of these configurations in a specific recovery action to be invoked by the system.

ERROR RECOVERY ACTION

The error recovery action table (Figure 5) specifies actions to be taken for error conditions listed in the error condition table. A necessary part of the recovery action is the construction of Restart CCWs 1 and 2.

CONSTRUCTION OF RESTART CCWs

If Operation Incomplete (byte 1, bit 7) is set in the sense information, it indicates that an error or unusual condition occurred during a logical operation after data transfer had been initiated. By constructing Restart Channel Command Words, the error recovery procedures can correct the unusual condition and continue the operation in progress from the point of interruption to the normal ending point.

Restart CCW 1

Restart CCW1 is constructued as follows:

1. The command code byte is provided in sense byte 3.
2. The data address is that of the interrupted CCW, plus the count of that CCW, minus the residual count in the channel status word (CSW).
3. The flags (except Program Controlled Interrupt – PCI) are those of the interrupted CCW.
4. The count is the residual count in the CSW. If the residual count is zero, a count of one must be used. If a Write command is in progress, the data address should specify a byte containing '00'. If a Read command is in progress, the skip bit should be on.

Restart CCW 2

Restart CCW 2 is constructed as follows:

1. The command code is provided in sense byte 3.
2. The count is constructed as follows:
   a. Fetch the count of the CCW designated by CSW – 8 and set a pointer to this CCW.
   b. Subtract the restart displacement from the count obtained in step a. If this result is positive, go to step f; otherwise go to step c.
   c. Check the chain data flag of the CCW designated by the pointer. If the flag is not set, go to step e; otherwise go to step d.
   d. Advance the pointer to the next non-Transfer In Channel (non-TIC) CCW in the data chain and add the count of this CCW to the counts of all preceding non-TIC CCWs in the data chain. Return to step b.
   e. Truncation occurs. Set the restart CCW 2 count equal to 1. Go to step 3 and include the skip bit in the Restart CCW flags.
   f. Set the Restart CCW 2 count equal to the result of the subtraction in step b. Go to step 3.
3. The flags (except PCI) are those of the CCW designated by the pointer in step 2. The skip bit is also set if step 2e was previously executed.
4. The data address is that of the CCW designated by the pointer in step 2, plus the count of that CCW, minus the Restart CCW count generated in step 2.

If another Operation Incomplete occurs while executing the Restart CCW, a new Restart CCW may be generated from the old Restart CCW.

Note: *Be sure to avoid destroying the old Restart CCW before generating the new one.*

3330 Error Correction Table					
Byte	Bit	Name	General Description	Action	Logged
0	0	Command Reject	Programming error.	2	No
0	1	Intervention Required	Drive offline or no address plug with desired address.	3	No
0	2	Bus Out Parity	Bus Out Parity Error.	3	Yes
0	3	Equipment Check	Equipment malfunction.	4	Yes
0 1	3 0	Equipment Check Permanent Error	Equipment malfunction. Control unit retry exhausted or undersirable.	1	Yes
0 1	4 0	Data Check Permanent Error	Uncorrectable data check. Control unit retry exhausted.	1	Yes
0 2	4 1	Data Check Correctable	Correctable data check in data area of overflow segment, not last segment.	5	No
0 2 1	4 1 7	Data Check Correctable Operation Incomplete	Correctable Data Check in data area of overflow segment, not last segment.	6	No
0 1	4 7	Data Check Operation Incomplete	Data check in second or subsequent overflow segment other than a data area correctable error.	6A	No
0 1	5 0	Overrun Permanent Error	Control unit retry exhausted on a service overrun.	1	Yes
0	5	Overrun	Service overrun in second or subsequent overflow segment or during a format write.	4	Yes
1	1	Invalid Track Format	Track capacity exceeded.	2	No
1	2	End of Cylinder	Cylinder boundary detected during a basic multitrack operation.	8	No
1 1	2 7	End of Cylinder Operation Incomplete	Cylinder boundary detected during a basic overflow operation.	9	No
1	4	No Record Found	Record not found during basic command sequence.	2	No
1	5	File Protected	The seek command or read/search multitrack operation violated file mask.	10	No
1 1	5 7	File Protected Operation Incomplete	A read or write overflow operation violated file mask.	11	No
1	7	Operation Incomplete	One of the following was detected after initiation of data transfer during an overflow operation: a. A defective or alternate track condition. b. A seek error in the second or subsequent segment.	7	No
2	3	Environmental Data Present	Statistical usage/error log information present.	3	Yes
0 1	0 6	Command Reject Write Inhibit	A Write command received with Write Inhibit switch in read only position.	1	No

Figure 4. Error Correction Table

3330 Recovery Action Table	
Action	Explanation
1	Print message 1 for operator and/or customer engineer notification.
2	Exit with programming error or unusual condition indication.
3	a. Repeat the operation one time. b. If error condition persists, do action 1.
4	a. Repeat the operation. b. If the error condition persists after ten retries, do action 1.

Figure 5. Error Recovery Procedures (Part 1 of 3)

3330 Recovery Action Table (continued)	
Action	**Explanation**
5	a. Perform error correction function. b. Examine bit 7 of the file mask. If this bit is off, go to step (c). If this bit is on, return to user with indication that data has been corrected. (User is operating in PCI fetch mode and must, therefore, supply his own restart recovery action.) c. If the user's chain has not been completed, examine the next non-TIC command in the user's chain. If bit 3 of this command is on (count area), go to step (d). If bit 3 is off, do action 5A. d. Continue the user's chain by executing the following CCW chain: Seek * Set File Mask (same as original) Set Sector (Sector data provided in sense byte 13) Search ID Equal (CCHHR provided in sense bytes 8-12) TIC*-8 TIC (channel status word)
5A	Continue the user's chain by executing the following command chain: Seek * Set File Mask (same as original) Set Sector (Sector data provided in sense byte 13) Search ID Equal (CCHHR provided in sense bytes 8-12) TIC*-8 Read Count (skip bit on) TIC (channel status word)
6	a. Perform error correction function. b. Examine bit 7 of the file mask. If this bit is off, go to step (c). If this bit is on, return to user with indication that data has been corrected. (User is operating in PCI fetch mode and must supply his own restart recovery action.) c. Construct restart CCW 2. d. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following command chain. Seek * Set File Mask (same as original) Set Sector (argument 0) Search ID Equal (record 1) TIC * -8 Restart CCW 2 TIC (channel status word) *Note: If the modified seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, then IOS must perform action 2.*
6A	a. Examine bit 7 of the file mask. If this bit is off, go to step (b). If this bit is on, return to user with indication that data has been corrected. (User is operating in PCI fetch mode and must supply his own restart recovery action.) b. Construct restart CCW 2. c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following command chain. Seek * Set File Mask (same as original) Set Sector (argument 0) Search ID Equal (record 1) TIC * -8 Restart CCW 2 TIC (channel status word)
7	a. Construct restart CCW 1. b. Continue the user's chain by executing the following command chain: Seek * Set File Mask (same as original) Set Sector (argument 0) Search ID Equal (record 1) TIC * -8 Restart CCW 1 TIC (channel status word)

* Cylinder bytes and high-order head byte obtained from user.
Low-order head byte obtained from bits 3 thru 7 of sense byte 6.

Figure 5. Error Recovery Procedures (Part 2 of 3)

3330 Recovery Action Table (continued)

Action	Explanation
8	a. Increment the cylinder address of the user's seek argument by one. Reset the head address. b. Continue the operation by executing the following command chain: Seek (argument from step a) Set File Mask (same as original) TIC (channel status word –8) ***Note: If the modified seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, then IOS must perform action 2.***
9	a. Increment the cylinder address of the user's seek argument by one. Reset the head address. b. Construct restart CCW 1. c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following command chain: Seek (argument from step a) Set File Mask (same as original) Set Sector (argument 0) Search ID Equal (record 1) TIC*–8 Restart CCW 1 TIC (channel status word) *Note: If the modified seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, this IOS must perform action 2.*
10	a. Determine if the interrupted command is a seek. If yes, go to step b. If no, do action 10A. b. Continue the operation by executing the following command chain: Seek (user's argument) Set File Mask (same as original) TIC (channel status word) ***Note: If the seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, then IOS must perform action 2.***
10A	a. This is a multitrack operation. Increment the user's seek argument by one. b. Continue the operation by executing the following command chain: Seek (argument from step a) Set File Mask (same as original) TIC (channel status word –8) *Note: If the modified seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, then IOS must perform action 2.*
11	a. Increment the user's seek argument by one. b. Construct restart CCW 1. c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following command chain: Seek (argument from step a) Set File Mask (same as original) Set Sector (argument 0) Search ID Equal (record 1) TIC*–8 Restart CCW 1 TIC (channel status word) *Note: If the modified seek argument is not within the user's extent, then IOS must supply the correct seek argument before issuing the seek. If that is impossible, then IOS must perform action 2.*

Messages

Message 1 (should be printed on all permanent errors).

A. Message Code.

b. Error type–read, write, or control.

c. Module designation, cylinder number, and head number (that is, device address and seek address).

d. Channel designation.

e. Status and sense bytes sent to CPU.

Message 2 (should be printed periodically, upon completion of an application run or in response to operator request).

a. Unit designation.

b. Number of entries into error routine.

c. Number of uncorrectable errors.

Figure 5. Error Recovery Procedures (Part 3 of 3)

CHANNEL COMMANDS

The command set used to perform operations with the 3330 Series is described in the reference manual for the storage control, ISC, or IFA.

SENSE COMMANDS

- Sense I/O
- Read and Reset Buffered Log
- Device Reserve
- Device Release

CONTROL COMMANDS

- No Operation
- Seek
- Seek Cylinder
- Seek Head
- Recalibrate
- Restore (executed as a no-operation)
- Set File Mask
- Space Count
- Set Sector

READ COMMANDS

- Read Data
- Read Key and Data
- Read Count, Key, and Data
- Read Home Address
- Read Count
- Read Initial Program Load
- Read Sector
- Read Record Zero

WRITE COMMANDS

- Write Data
- Write Key and Data
- Write Count, Key, and Data
- Write Special Count, Key, and Data
- Write Home Address
- Write Record Zero
- Erase

SEARCH COMMANDS

- Search ID Equal
- Search Key Equal
- Search Home Address Equal
- Search ID High
- Search Key High
- Search ID Equal or High
- Search Key Equal or High

SENSE COMMANDS

Command	Code		Function	Data Transferred
	Single Track	Multi-Track		
Test I/O (see Note 1)	00	–	Determine the status of a device on a channel.	One status byte
Sense I/O (see Note 2)	04	–	Determine the type of error or unusual condition that caused the last unit check .	24 bytes of sense information
Read and Reset Buffered Log (see Note 3)	A4	–	Supply usage or error statistics on the addressed drive.	24 bytes of statistics on the drive
Read Diagnostic Status 1 (see Note 4)	44	–	Determine the type of error(s) found on running a diagnostic test (part of a diagnostic write command). Transfer a diagnostic test from the storage control unit to the system (after a diagnostic load command).	16 bytes of error code message. 512 bytes of diagnostic test data.
Device Reserve (see Note 5)	B4	–	Set bits in control storage and in controller (with string switch feature) to reserve addressed devices. Transfer 24 bytes of sense data to the channel.	24 bytes of sense information
Device Release (see Note 5)	94	–	Store null value in control storage and in controller (with string switch feature) to cancel reservation for devices addressed. Transfer 24 bytes of sense data to the channel.	24 bytes of sense information

Note 1: Status byte is normally zero.

Note 2: Sense data is reset after transfer.

Note 3: Data is reset after transfer.

Note 4: If the command is not preceded by a Diagnostic Write or Load command, 16 bytes of data from the error code message area are transferred.

Note 5: If command is not the first one in the chain, Command Reject will be set in sense data.

CONTROL COMMANDS

Command	Code	Function	Data Transferred Across Channel
Seek	07	1. Move the access to the cylinder specified by the seek address. 2. Select the head specified by the seek address.	Six address bytes. Only the five low-order bits of the sixth byte are used for the seek address.
Seek Cylinder	0B		
Seek Head	1B	Select the head specified by the seek address.	
No Operation	03	No action. Channel End and Device End are presented during initial status.	None
Recalibrate	13	Move the access to cylinder zero and select head zero.	
Restore	17	No action. Zero initial status is followed by final status of Channel End and Device End.	
Set File Mask	1F	Set file mask to indicate permitted Write and Seek commands.	One byte of file mask data.
Space Count	0F	When chained from a Read, Search, Write, or Space Count command this command locates the start of the next count area (including R0), spaces over the count area, and ends with Channel End and Device End in the gap before the Key area. When not chained, Space Count searches for index, spaces over gap 1, home address, gap 2, and R0 count. Ends operation in gap following R0 count with Channel End and Device End.	Three bytes used as key length (one byte) and data length (two bytes) for the next command.
Set Sector	23	Used on disconnected command chaining channels to eliminate the need for the channel to maintain connection with the control unit while waiting for the selected record to reach the head.	One byte specifies angular track position (0–127 for 3330 series drives).
Diagnostic Load	53	Transfer the specified 512-byte block from the read only storage to the control storage buffer.	One byte of control information addresses one sector on the read only storage.
Diagnostic Write	73	Transfer an inline test from main storage to the CU and executes the test.	A maximum of 512 bytes of inline diagnostic microprogram.

READ COMMANDS

Command	Code		Function	Data Read
	Single Track	Multi-Track		
Read Data	06	86	Transfer data area of a record from drive to main storage.	First data area after address marker or the data area of the record that was chained from the count or key area of the same record.
Read Key Data (see Note 1)	0E	8E	Transfer key and data areas of a record from drive to main storage.	First key and data areas after address marker or the key and data areas that were command-chained from the count area of the same record.
Read Count Key Data	1E	9E	Transfer count, key, and data areas of a record from drive to main storage.	Next record or first record after R0.
Read Record Zero (R0) (see Note 2)	16	96	Transfer R0 (count, key and data) from the drive to main storage.	R0
Read Count	12	92	Transfer next count area (eight bytes) from the drive to main storage.	Next record count area or first count area after R0
Read Home Address	1A	9A	Transfer five bytes (FCCHH) to channel	Byte 0 = Flag. Byte 1 = Cylinder address. Byte 2 = Cylinder address. Byte 3 = 0. Byte 4 = Head address.
Read Initial Program Load (see Note 3)	02	—	Recalibrate to cylinder 0 and head 0, search for index point, and read R1 data from the drive to main storage.	First data area after R0
Read Sector (see Note 4)	22	—	Provide one byte of angular position information, which is used by a subsequent Set Sector command. When not chained from a Read, Write, or Search CCW, the byte transferred is the angular position required to access the last record processed on the drive. When chained, the byte transferred is the angular position of the record used in the previous CCW.	

Note 1: If the KL equals 0 the command is executed the same as a Read Data command.

Note 2: When chained from a Search HA or Read HA command, the Read R0 command is executed immediately and does not initiate a search for index point.

Note 3: A Read IPL command cannot be preceded by a Set File Mask command in the same chain.

Note 4: Causes loss of orientation.

WRITE COMMANDS

Command	Code		Function	Data Written
	Single Track	Multi-Track		
Write Count, Key, Data (see Note 1)	1D	–	Write one complete record on the selected drive and track.	Count, key, and data areas of next record on the track. Data for the areas comes from the system. The count area flag byte, ECC, and gap data come from the SCU.
Write Special Count, Key, Data (see Note 2)	01	–	Same as Write Count, Key, Data command except a 1 is written in bit 4 of the flag byte to indicate a record overflow segment	Same as that of Write Count, Key, Data command.
Erase (see Note 3)	11	–	Erase remainder of track.	Zeros
Write Home Address (HA)	19	–	Write the five-byte (FCCHH) home address area on the selected drive and track.	Five-byte (FCCHH) home address area transferred from the system.
Write Record (R0) (see Note 4)	15	–	Write count, key, data of R0.	Flag byte from HA area. CCHHR$K_L D_L D_L$ from system written in count area. Key and data from system.
Write Data (see Note 5)	05	–	Change the data area of a record.	Data from the system. Write the number of bytes specified by the $D_L D_L$ bytes of the count area of the same record.
Write Key-Data (see Note 6)	0D	–	Change the key and data areas of a record.	Data from the system. Write the number of bytes specified by the K_L and $D_L D_L$ bytes of the count area of the same record.

Note 1: If file mask is violated, set Command Reject. Must be chained from Write R0; Write Count, Key, Data; Erase; or a successful Search Equal ID or Search Equal Key command. After last Count, Key, Data command on a track, write 0's to index.

Note 2: Same as Write Count, Key, Data. Not used for last segment of an overflow record.

Note 3: The CU skips writing an address marker, sync byte, or ECC.

Note 4: Same as Write Count, Key, Data except must be chained from a Write HA or a successful Search HA Equal command.

Note 5: If file mask is violated, set Command Reject. Must be chained from a successful Search Equal ID or Search Equal Key command.

Note 6: If file mask is violated, set Command Reject. Must be chained from a successful Search Equal ID command. If $K_L = 0$, operation is the same as Write Data.

SEARCH COMMANDS

Command	Code		Function	Data Compared
	Single Track	Multi-Track		
Search Home Address Equal	39	B9	Locate a home address area selected by the system.	Four bytes (CCHH) of home address area from the selected drive and track, with CCHH from the system.
Search ID Equal	31	B1	Locate a count area selected by the system.	Five bytes (CCHHR) of the next count area from the selected drive and track, with CCHHR from the system.
Search ID High (see Note 1)	51	D1	Locate a count area selected by the system.	Five bytes (CCHHR) of the next count area from the selected drive and track, with CCHHR from the system.
Search ID Equal or High (see Note 2)	71	F1	Locate a count area selected by the system.	Five bytes (CCHHR) of the next count area from the selected drive and track, with CCHHR from the system.
Search Key Equal (see Note 3)	29	A9	Locate a key area selected by the system.	The key area bytes from the selected drive and track, with key from the system.
Search Key High (see Note 4)	49	C9	Locate a key area selected by the system.	The key area bytes from the selected drive and track, with key from the system.
Search Key Equal or High (see Note 5)	69	E9	Locate a key area selected by the system.	The key area bytes from the selected drive and track, with key from the system.

Note 1: Locates any ID from the track that is higher than the ID from the system.

Note 2: Locates the ID from the track that is equal to, or any ID that is higher than the ID from the system.

Note 3: The key area compared is key area of the next record (excluding R0), unless chained from a Read Count or Search ID command. If chained from a count operation the key area searched is in the same record.

Note 4: Same as Search Key Equal, except the key area located is any key area on the track that is higher than the key from the system.

Note 5 : Same as Search Key Equal, except the key area located is equal to or higher than the key from the system.

SENSE DATA

The status and condition of the 3330 is reported in the sense bytes. There are 24 bytes and seven different formats, 0–6. Four formats, 1, 4, 5, and 6 describe the 3330. The remaining three formats, 0, 2, and 3 are associated with the storage control. Only the formats dealing with the 3330 are explained. Refer to the following manuals for formats 0, 2, 3, and a detailed description of Unit Status.

- *Reference Manual for Integrated Storage Control,* Order No. GA26-1620.
- *Reference Manual for 3830 Model 2 Storage Control,* Order No. GA26-1617.

Some sense byte formats may vary for the different attachment methods. Therefore, the 3330 user should also order companion manuals in order to have a complete set of sense byte information. The following manuals are recommended for S/370 models 115, 125, and 135 users:

- *IBM System/370 Model 115 Functional Characteristics,* Order No. GA33-1510.
- *IBM System/370 Model 125 Functional Characteristics,* Order No. GA33-1506.
- *IBM System/370 Model 135 Functional Characteristics,* Order No. GA33-3005.

SENSE BYTE SUMMARY

In all the formats, the first eight bytes, 0–7, give high-level information concerning status and condition. Sense byte 7 identifies the format in which the remaining bytes, 8 through 24, are arrayed as follows:

Byte 7

- Bits 0–3 = The format array of bytes 8–24

0	1	2	3	Format
0	0	0	1	1
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6

- Bits 4–7 = Define a message.

4	5	6	7	Message
0	0	0	0	0
↓	↓	↓	↓	↓
1	1	1	1	F

Each of the formats 1, 4, 5, and 6 (including the possible messages) is summarized in the charts on the following pages.

SENSE BYTES 0–7 SUMMARY

	Bit 0	1	2	3	4	5	6	7
Byte 0	Command Reject	Intervention Required	Channel Bus Out Parity	Equipment Check	Data Check	Overrun	Not Used	Not Used
1	*Permanent Error	Invalid Track Format	End of Cylinder	Not Used	No Record Found	File Protected	Write Inhibited	Operation Incomplete
2	Not Used	Correctable	Not Used	Environmental Data Present	Not Used	Not Used	Not Used	Not Used
3	RESTART COMMAND (Provided only when byte 1 bit 7, Operation Incomplete, is active)							
4	Controller Identification			Physical Drive Identification				
5	LOW-ORDER LOGICAL CYLINDER ADDRESS							
	128	64	32	16	8	4	2	1
6	Models 1 & 2 256 HIGH-ORDER LOGICAL CYLINDER ADDRESS			HEAD ADDRESS				
	Model 11 512		256	16	8	4	2	1
7	FORMAT (bits 0–3 hex)				MESSAGE CODE (bits 4–7 hex)			
	8	4	2	1	8	4	2	1

* Set by Error Recovery Procedures

SENSE BYTE FORMAT 1 SUMMARY

FORMAT 1 – DISK DRIVE EQUIPMENT CHECK	
SENSE BYTE 8 – MODULE STATUS	
Bit 0	Index error.
Bit 1	Offset active.
Bit 2	Seek incomplete.
Bit 3	Seek complete.
Bit 4	Online.
Bit 5	Attention.
Bit 6	Busy.
Bit 7	Record ready.
SENSE BYTE 9 – MONITOR MODE	
Bit 0	Not used.
Bit 1	Diagnostic 4.
Bit 2	Diagnostic 2.
Bit 3	Diagnostic 1.
Bit 4	Not used.
Bit 5	Mode 4.
Bit 6	Mode 2.
Bit 7	Mode 1.
SENSE BYTE 10 – MONITOR STATE	
Bit 0	Monitor state 8.
Bit 1	Monitor state 7.
Bit 2	Monitor state 6.
Bit 3	Monitor state 5.
Bit 4	Monitor state 4.
Bit 5	Monitor state 3.
Bit 6	Monitor state 2.
Bit 7	Monitor state 1.
SENSE BYTE 11 – CHECK STATUS	
Bit 0	CE program stop.
Bits 1 thru 3	Not used.
Bit 4	CUDI bus-out parity.
Bit 5	Monitor Check.
Bit 6	Not used.
Bit 7	Drive command reject.
SENSE BYTE 12 – SAFETY	
Bit 0	Data safety.
Bit 1	Servo safety.
Bit 2	Not used.
Bit 3	Pad safety (Model 11 only).
Bit 4	Power on reset.
Bit 5	Not used.
Bit 6	No head loaded.
Bit 7	Even latch.

SENSE BYTE 13	
	Reflects contents of TA* register when an error is detected for message codes 3 and C. For message codes 1, 6, 7, 8, and 9, this byte indicates the expected data value on readback or status checking. For other message codes this byte is zero.

SENSE BYTE 14	
	Reflects the contents of the MA* register (bus in) at the time an error is detected for message codes 1, 3, 6, 7, 8, and C. For message code 9, this byte indicates drive status. For other message codes this byte is zero.

SENSE BYTE 15	
	Reflects the contents of the TD* register (tag bus) at the time an error is detected for message codes 1, 3, 6, 7, 8, 9, and C. For other message codes this byte is zero.

SENSE BYTE 16 – 3333 CHECK 1	
Bit 0	PLO error.
Bit 1	Write parity error.
Bit 2	Read parity error.
Bit 3	Bit ring error.
Bit 4	Write compensation error.
Bit 5	Data transfer control error.
Bit 6	Missing PLO pulses.
Bit 7	VFO phase error.

SENSE BYTE 17 – 3333 CHECK 2	
Bit 0	ECC no input data.
Bit 1	ECC P0 or write.
Bit 2	ECC P1 or P3.
Bit 3	ECC P2.
Bit 4	Sync out check.
Bit 5	PLO counter check.
Bit 6	Gap counter check.
Bit 7	Gap control check.

SENSE BYTE 18 – 3333 CHECK 3		
Bit 0		3333 check.
Bit 1		Select active check.
Bit 2		Buffer (bus in) check.
Bit 3		Reserved.
Bits 4 through 7 define the following errors:		
Bit 4 – 7	0000	Not used.
Bit 4 – 7	0001	Tag valid missing (read/write).
Bit 4 – 7	0010	Normal end/check end missing (control).
Bit 4 – 7	0011	Normal end missing (control).
Bit 4 – 7	0100	No index after 40 ms, or solid index.
Bit 4 – 7	0101	Unexpected status with check end.
Bit 4 – 7	0110	3333 selection address check.
Bit 4 – 7	0111	Preselection check. (With String Switch, may indicate short busy timer expired).
Bit 4 – 7	1000	Zero pattern alignment error.
Bit 4 – 7	1001	Repetitive command overrun indication.
Bit 4 – 7	1010	Drive interrupt during busy.
Bit 4 – 7	1011	Drive status not as expected after Seek or Set Sector.
Bit 4 – 7	1100 – 1110	Not used.
Bit 4 – 7	1111	Always active bus in bit.

**3830-2/ISC nomenclature.*

SENSE BYTE 19 – 3333 CHECK 4	
Bit 0	Drive selection error.
Bit 1	CI tag bus check.
Bit 2	Device check.
Bit 3	CI bus out check.
Bit 4	Write sense check.
Bit 5	Write valid check.
Bit 6	Device bus out check.
Bit 7	3333 bus in assembler check.

SENSE BYTES 20 AND 21
NOT USED – SET TO 0

SENSE BYTES 22 AND 23
ERROR SYMPTOM CODE

MESSAGE TABLE – FORMAT 1

Sense byte 7– bits 4 thru 7 =	
0000	No message.
0001	Set target error.
0010	Microprogram detected error (See SENSE BYTE 18).
0011	Not used.
0100	Not used.
0101	String switch error in resetting a primed interrupt.*
0110	Transmit cylinder error.
0111	Transmit head error.
1000	Transmit difference error.
1001	File status not as expected.
1010	Seek error.
1011	Seek incomplete on retry.
1100	No interrupt from drive.
1101	ECC P2 or P3 compare failure.
1110	ECC P1 compare failure.
1111	Retry byte count/sector value incorrect.

**Only for a 3333 with string switch feature*

SENSE BYTE FORMAT 4 SUMMARY

<table>
<tr><th colspan="2">FORMAT 4 – DATA CHECKS NOT PROVIDING DISPLACEMENT INFORMATION
(See Note)</th></tr>
<tr><td colspan="2">SENSE BYTE 8 – CYLINDER (1)</td></tr>
<tr><td>Bits 0 thru 7</td><td>High-order cylinder byte of last seek address.</td></tr>
<tr><td colspan="2">SENSE BYTE 9 – CYLINDER (2)</td></tr>
<tr><td>Bits 0 thru 7</td><td>Low-order cylinder byte of last seek address.</td></tr>
<tr><td colspan="2">SENSE BYTE 10 – HEAD (1)</td></tr>
<tr><td>Bits 0 thru 7</td><td>High-order head byte of last seek address.</td></tr>
<tr><td colspan="2">SENSE BYTE 11 – HEAD (2)</td></tr>
<tr><td>Bits 0 thru 7</td><td>Low-order head byte of last seek address.</td></tr>
<tr><td colspan="2">SENSE BYTE 12 – RECORD</td></tr>
<tr><td>Bits 0 thru 7</td><td>Record number of record in error.</td></tr>
<tr><td colspan="2">SENSE BYTE 13 – SECTOR</td></tr>
<tr><td>Bits 0 thru 7</td><td>Sector number of record in error.</td></tr>
<tr><td colspan="2">SENSE BYTE 14 – OFFSET</td></tr>
<tr><td>Bits 0 thru 7</td><td>Amount of offset used to recover from error.</td></tr>
<tr><td colspan="2">SENSE BYTE 15 – RETRIES</td></tr>
<tr><td>Bits 0 thru 7</td><td>Number of retries required to recover from error.</td></tr>
<tr><td colspan="2">SENSE BYTE 16 – SOURCE DRIVE IDENTIFICATION</td></tr>
<tr><td>Bits 0 and 1</td><td>Identifies the storage control that was used to record the data in which the error occurred.</td></tr>
<tr><td>Bits 2 thru 7</td><td>Identifies the disk drive that was used to record the data in which the error occurred. Drive ID is as follows:
<table>
<tr><td>Drive G =
001110</td><td>Drive E =
011100</td><td>Drive C =
101010</td><td>Drive A =
111000</td></tr>
<tr><td>Drive H =
000111</td><td>Drive F =
010101</td><td>Drive D =
100011</td><td>Drive B =
110001</td></tr>
</table></td></tr>
<tr><td colspan="2">SENSE BYTES 17 THRU 21
NOT USED – SET TO 0</td></tr>
</table>

SENSE BYTES 22 AND 23
ERROR SYMPTOM CODE

Note: Contents of bytes 8–12 are unreliable if message code in byte 7 is either 0 or 4 (error occurred in HA), 1 or 5 (error occurred in count area), or 9 (AM detection on retry).

MESSAGE TABLE – FORMAT 4

Sense byte 7– bits 4 thru 7 =	
0000	HA area ECC uncorrectable.
0001	Count area ECC uncorrectable.
0010	Key area ECC uncorrectable.
0011	Data area ECC uncorrectable.
0100	HA area no sync byte found.
0101	Count area no sync byte found.
0110	Key area no sync byte found.
0111	Data area no sync byte found.
1000	Not used.
1001	AM detection failure on retry.
1010-1111	Not used.

SENSE BYTE FORMAT 5 SUMMARY

FORMAT 5 – DATA CHECKS PROVIDING DISPLACEMENT INFORMATION (See Note)	
SENSE BYTE 8 – CYLINDER (1)	
Bits 0 thru 7	High-order cylinder byte of last seek address.
SENSE BYTE 9 – CYLINDER (2)	
Bits 0 thru 7	Low-order cylinder byte of last seek address.
SENSE BYTE 10 – HEAD (1)	
Bits 0 thru 7	High-order head byte of last seek address.
SENSE BYTE 11 – HEAD (2)	
Bits 0 thru 7	Low-order head byte of last seek address.
SENSE BYTE 12 – RECORD	
Bits 0 thru 7	Record number of record in error.
SENSE BYTE 13 – SECTOR	
Bits 0 thru 7	Sector number of record in error.
SENSE BYTE 14 – ACCESS OFFSET	
Bits 0 thru 7	Amount of offset used to recover from error.
SENSE BYTES 15 thru 17 – RESTART DISPLACEMENT	
	Specifies the number of bytes processed by the storage control to end of data area in error.
SENSE BYTES 18 and 19 – ERROR DISPLACEMENT	
	Displacement of first byte in error relative to end of the data area where error occurred.
SENSE BYTES 20 thru 22 – ERROR PATTERN	
	Contain error pattern used for error correction function. See "Error Correction Function."
SENSE BYTE 23	
Bits 0-6 Bit 7	Not used – set to 0. Channel truncation.
Note: Contents of bytes 8-12 are unreliable if message code in byte 7 is either 0 or 4 (error occurred in HA), or 5 (error occurred in count area), or 9 (AM detection on retry).	
Sense byte 7– bits 4 thru 7	MESSAGE TABLE – FORMAT 5
0000	HA area correctable.
0001	Count area correctable.
0010	Key area correctable.
0011	Data area correctable.
0100-1111	Not used.

SENSE BYTE FORMAT 6 SUMMARY

FORMAT 6 – USAGE/ERROR STATISTICS	
SENSE BYTES 8 thru 11 – BYTES READ/SEARCHED	
	These four bytes provide an accumulated count of the number of bytes processed by the storage control in read or search operations. Bytes processed during retry operations are not included in this count. Only key and data field areas are accumulated.
SENSE BYTES 12 and 13 – CORRECTABLE DATA CHECKS	
	These two bytes provide an accumulated count of the number of ECC correctable data checks which were detected by the storage control.
SENSE BYTES 14 and 15 – RETRY DATA CHECKS	
	These two bytes identify the number of ECC uncorrectable data checks which were successfully retried by the storage control.
SENSE BYTES 16 and 17 – SEEKS	
	These two bytes provide a count of the number of access motions initiated by the channel.
SENSE BYTE 18	
	Bit 0 set to zero = bytes 20-23 contain information for interfaces A and B. Bit 0 set to one = bytes 20-23 contain information for interfaces C and D.
SENSE BYTE 19 – SEEK ERRORS	
Bits 0 thru 7	Identifies the total number of seek errors which were successfully retried by the storage control.
SENSE BYTE 20 – COMMAND OVERRUN A or C	
Bits 0 thru 7	Provides a count of the number of command overruns which were retried by the storage control for channel A or C.
SENSE BYTE 21 – DATA OVERRUN A or C	
Bits 0 thru 7	Provides a count of the number of data overruns which were retried by the storage control for channel A or C.
SENSE BYTE 22 – COMMAND OVERRUN B or D	
Bits 0 thru 7	Provides a count of the number of command overruns which were retried by the storage control for channel B or D.
SENSE BYTE 23 – DATA OVERRUN B or D	
Bits 0 thru 7	Provides a count of the number of data overruns which were retried by the storage control for channel B or D.
MESSAGE TABLE – FORMAT 6	
Sense byte 7– bits 4 thru 7 = 0000 0001-1111	 No message. Not used.

OPERATING INSTRUCTIONS

DISK PACK LOADING

1. Place the Start/Stop switch on the operator panel in the Stop position.
2. Place the Open/Close switch on the operator panel in the Open position.
3. Remove the bottom cover of the disk pack by pressing the two handles on the bottom cover together.
4. Place the disk pack (in its top cover) on the drive spindle. See Note 1.
5. Turn the top cover in a *clockwise* direction until it comes to a full stop.
6. Lift the top cover from the disk pack.
7. Place the Open/Close switch in the Close position.
8. Place the Start/Stop switch in the Start position to return the drive to normal operation.
9. Reassemble the top and bottom covers.

With the pack identification label facing forward, place the reassembled cover in the recessed "well" on top of the drive. The cover for the pack in the upper drive should be placed in the well on the left, and the cover for the pack in the lower drive in the well on the right. When stored in this manner, the pack identification is over the logical address plug associated with the drive in which the pack is mounted.

Do not store disk packs on top of the disk drives.

Note 1: *IBM 3336 Model 11 Disk Packs cannot be mounted on Model 1 or 2 disk drives. They are color coded and mechanically interlocked to prevent mounting on the wrong drive.*

DISK PACK UNLOADING

1. Place the Start/Stop switch on the operator panel in the Stop position.
2. Place the Open/Close switch on the operator panel in the Open position.
3. Place the top cover on the disk pack and turn the cover in a *counterclockwise* direction for two full turns.
4. Lift the top cover (now containing the disk pack) from the spindle.
5. *Immediately* attach the bottom cover.
6. Unless another pack is being loaded, place the Open/Close switch in the Close position.
7. Store the removed disk pack in a clean cabinet or on a clean shelf.

CHANGING A DRIVE ADDRESS

To change the address of a drive:

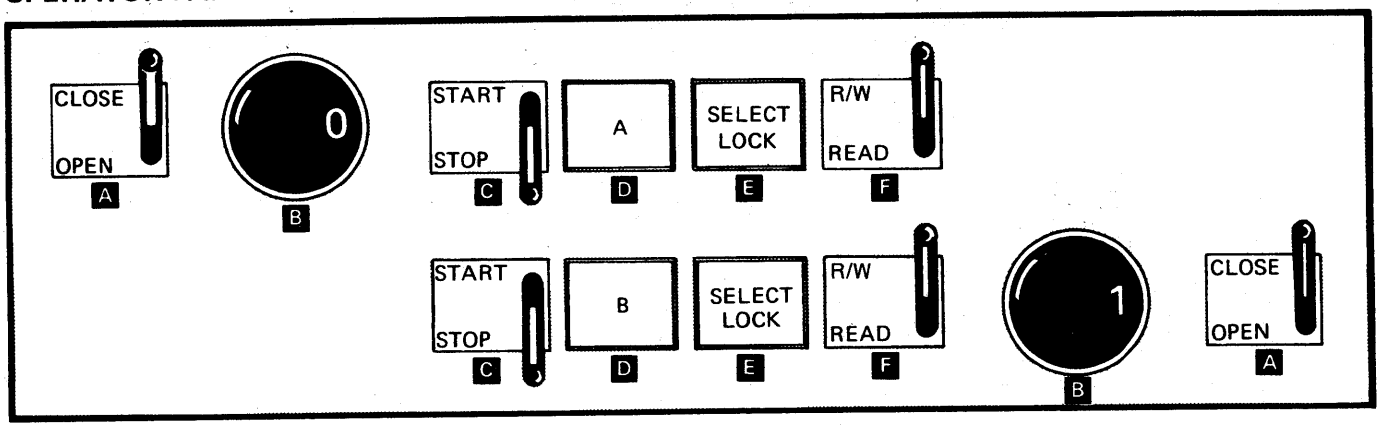
1. Make sure that the program controlling the facility is in a wait state, or that the existing conditions allow removal of the logical address plug.
2. Remove the logical address plug from the affected operator panel and perform any necessary pack changes.
3. Place the desired address plug in the socket on the operator panel. See Note 2.

The drive is now ready to resume normal (or CE) operation.

Note 2: *The logical address plugs for Model 11 disk drives cannot be used on Model 1 or 2 disk drives. They are color coded and mechanically interlocked to prevent plugging into the wrong drive.*

There is one operator panel for each disk storage module.

OPERATOR PANEL FOR 3330 SERIES DISK STORAGE MODEL 1



A Opens and closes the drawer of one disk drive to permit operator access.

B A logical address plug with one unique address must be inserted in the socket associated with each drive. Addresses 0-7 are used for drives attached to one 3333, and addresses 8-F are used for drives attached to the other 3333. The plugs are interchangeable among drives attached to the same 3333 except when a Model 11 is used. Plugs for Model 11 cannot be used in Model 1 or 2 drives and vice versa. Simply remove the plug and insert the desired one in its place.

C Starts or stops one disk drive. When the switch is on Start, the drive motor starts, a brush cycle is taken, and the read/write heads load. When the switch is on Stop, the heads unload and the drive motor stops.

D Ready indicator. On when the drive is ready for use.

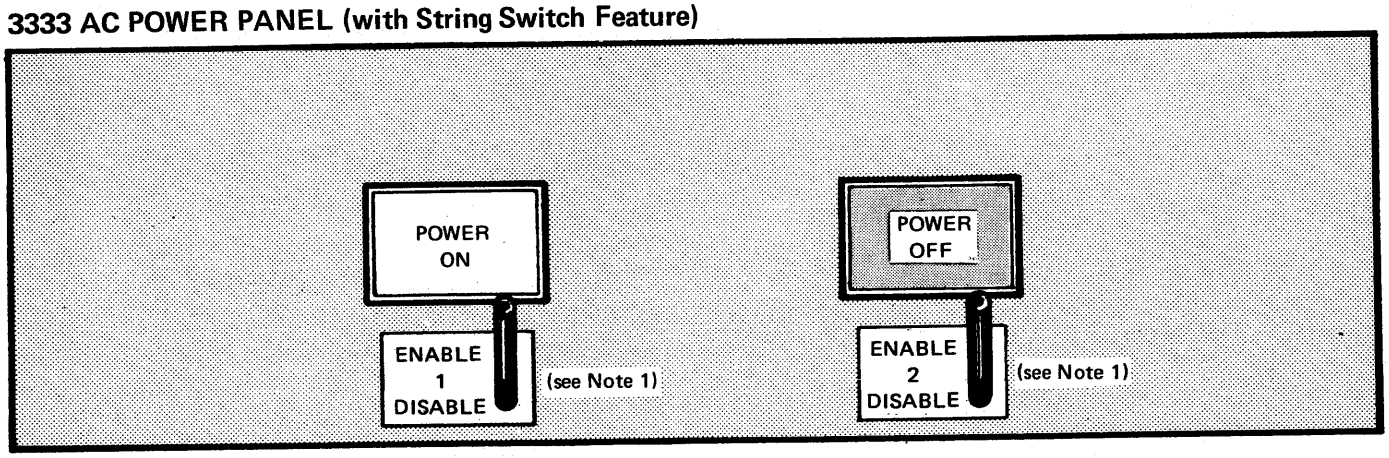
E This indicator comes on if a read/write malfunction occurs in the drive.

F Write inhibit. In Read position, only Read operations can be performed on the disk.

Note: Upper elements are for upper drive; lower elements are for lower drive.

For Model 2 modules, only the lower portion is used.

3333 AC POWER PANEL (with String Switch Feature)



Power On: A momentary pushbutton that can be used to reverse the effect of the power off switch. If system power is on, and the power off switch is pressed to remove ac power from the drives, then pressing the power on switch will restore ac power to the 3333 and attached drives.

Whenever system power is brought up, ac power is applied to the drives, regardless of what was previously done to the two pushbuttons.

Enable/Disable: Toggle switch that can be used to dedicate the 3333 and associated drives to a single interface. Interlocking is provided.

Power Off: A momentary pushbutton that can be used to remove ac power from the 3333 and attached drives.

If system power is on when the pushbutton is pressed, ac power is removed from the drives. If system power is later turned off, then on, ac power is reapplied to the drives; operation of the power on pushbutton is not required.

Note 1: Machines without String Switch feature or Remote Switch Attachment feature do not have these switches.

Figure 5.

APPENDIX. RECORD/TRACK CAPACITIES

Bytes Per Record				Records Per			
Without Keys		With Keys (KL + DL)					
Minimum	Maximum	Minimum	Maximum	Track	Cylinder	3336 Model 1	3336 Model 11
6448	13030	6392	12974	1	19	7676	15352
4254	6447	4198	6391	2	38	15352	30704
3157	4253	3101	4197	3	57	23028	46056
2499	3156	2443	3100	4	76	30704	61408
2060	2498	2004	2442	5	95	38380	76760
1746	2059	1690	2003	6	114	46056	92112
1511	1745	1455	1689	7	133	53732	107464
1328	1510	1272	1454	8	152	61408	122816
1182	1327	1126	1271	9	171	69084	138168
1062	1181	1006	1125	10	190	76760	153520
963	1061	907	1005	11	209	84436	168872
878	962	822	906	12	228	92112	184224
806	877	750	821	13	247	99788	199576
743	805	687	749	14	266	107464	214928
688	742	632	686	15	285	115140	230280
640	687	584	631	16	304	122816	245632
597	639	541	583	17	323	130492	260984
558	596	502	540	18	342	138168	276336
524	557	468	501	19	361	145844	291688
492	523	436	467	20	380	153520	307040
464	491	408	435	21	399	161196	322392
438	463	382	407	22	418	168872	337744
414	437	358	381	23	437	176548	353096
392	413	336	357	24	456	184224	368448
372	391	316	335	25	475	191900	383800
353	371	297	315	26	494	199576	399152
336	352	280	296	27	513	207252	414504
319	335	263	279	28	532	214928	429856
304	318	248	262	29	551	222604	445208
290	303	234	247	30	570	230280	460560
277	289	221	233	31	589	237956	475912
264	276	208	220	32	608	245632	491264
253	263	197	207	33	627	253308	506616
242	252	186	196	34	646	260984	521968
231	241	175	185	35	665	268660	537320
221	230	165	174	36	684	276336	552672
212	220	156	164	37	703	284012	568024
203	211	147	155	38	722	291688	583376
195	202	139	146	39	741	299364	598728
187	194	131	138	40	760	307040	614080
179	186	123	130	41	779	314716	629432
172	178	116	122	42	798	322392	644784
165	171	109	115	43	817	330068	660136
158	164	102	108	44	836	337744	675488
152	157	96	101	45	855	345420	690840
146	151	90	95	46	874	353096	706192
140	145	84	89	47	893	360772	721544
134	139	78	83	48	912	368448	736896
129	133	73	77	49	931	376124	752248
124	128	68	72	50	950	383800	767600
119	123	63	67	51	969	391476	782952
114	118	58	62	52	988	399152	798304
109	113	53	57	53	1007	406828	813656
105	108	49	52	54	1026	414504	829008
101	104	45	48	55	1045	422180	844360

Bytes Per Record				Records Per			
Without Keys		With Keys (KL + DL)					
Minimum	Maximum	Minimum	Maximum	Track	Cylinder	3336 Model 1	3336 Model 11
96	100	40	44	56	1064	429856	859712
92	95	36	39	57	1083	437532	875064
89	91	33	35	58	1102	445208	890416
85	88	29	32	59	1121	452884	905768
81	84	25	28	60	1140	460560	921120
78	80	22	24	61	1159	468236	936472
74	77	18	21	62	1178	475912	951824
71	73	15	17	63	1197	483588	967176
68	70	12	14	64	1216	491264	982528
65	67	9	11	65	1235	498940	997880
62	64	6	8	66	1254	506616	1013232
59	61	3	5	67	1273	514292	1028584
56	58	2	2	68	1292	521968	1043936
54	55	0	0	69	1311	529644	1059288
51	53	0	0	70	1330	537320	1074640
48	50	0	0	71	1349	544996	1089992
46	47	0	0	72	1368	552672	1105344
43	45	0	0	73	1387	560348	1120696
41	42	0	0	74	1406	568024	1136048
39	40	0	0	75	1425	575700	1151400
36	38	0	0	76	1444	583376	1166752
34	35	0	0	77	1463	591052	1182104
32	33	0	0	78	1482	598728	1197456
30	31	0	0	79	1501	606404	1212808
28	29	0	0	80	1520	614080	1228160
26	27	0	0	81	1539	621756	1243512
24	25	0	0	82	1558	629432	1258864
22	23	0	0	83	1577	637108	1274216
20	21	0	0	84	1596	644784	1289568
19	19	0	0	85	1615	652460	1304920
17	18	0	0	86	1634	660136	1320272
15	16	0	0	87	1653	667812	1335624
13	14	0	0	88	1672	675488	1350976
12	12	0	0	89	1691	683164	1366328
10	11	0	0	90	1710	690840	1381680
9	9	0	0	91	1729	698516	1397032
7	8	0	0	92	1748	706192	1412384
6	6	0	0	93	1767	713868	1427736
4	5	0	0	94	1786	721544	1443088
3	3	0	0	95	1805	729220	1458440
1	2	0	0	96	1824	736896	1473792

Track Capacity

The number of records that can be recorded on a track depends on the record size. The following equation is used to determine the number of equal length records per track. Home address and standard R0 space are accounted for.

Number of equal length records per track =

$$\frac{13{,}165}{135 + C + KL + DL} \quad \begin{matrix}\text{(track capacity)} \\ \text{(bytes per record)}\end{matrix}$$

where

C (constant) = 0 if KL = 0
56 if KL ≠ 0

KL = key length

DL = data length

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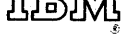

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