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**Systems**

**Introduction to IBM 3350  
Direct Access Storage**

**IBM**

## PREFACE

This publication is intended to familiarize data processing personnel with the characteristics of IBM 3350 Direct Access Storage. The reader should have prior knowledge of direct-access storage devices and concepts.

The publication lists the functional characteristics and describes the record format, capacity, and timing characteristics. A list of all commands executed by the 3350 is included in the Channel Commands section.

Suggested operator instructions are included in the Operator Controls and Indicators section.

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

- *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 the *IBM System/360 and System/370 Bibliography*, Order No. GA22-6822
- The *Data Processing Glossary*, Order No. GC20-1699, defines terms related to direct access storage devices.

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# INTRODUCTION

The IBM 3350 Direct Access Storage provides fast-access, large-capacity, high data-rate, low-cost, reliable online data storage. The 3350 can be attached to IBM System/370, Models 135, 145, 155-II, 158, 158-3, 165-II, 168, and 168-3.

The 3350 offers significant cost/performance advantages with increased recording density and a faster data-transfer rate. The track formats, tracks per cylinder, and number of cylinders match those of the IBM 3330 Model 1 or the IBM 3330 Model 11 when operating in compatibility modes. Maximum capacity can be used by running the subsystem in the 3350 native mode.

The 3350 provides high-performance, large-capacity storage for a wide range of applications such as:

- Data Base/Data Communications
- Inventory and manufacturing control
- Graphic processing
- Time-sharing
- Message switching
- Systems residence
- Other applications requiring direct or sequential processing

## HIGHLIGHTS

- Cost per byte: lower than any previous IBM disk storage facility.
- Storage Capacity: 200 to 317 million bytes per drive.
- Data Rate: 1198 thousand bytes per second.
- Access Time: an average of 25 milliseconds.
- Average Rotational Delay: 8.4 milliseconds.
- Command Set: similar to the 3330 with a new Read Multiple Count, Key, and Data command.
- Rotational Position Sensing: standard feature.
- Fixed Head Models: up to 1.1 million bytes per drive with zero seek time.
- Security and Privacy: Write Protection control from Operator Panel, File Protection, and Seek Verification.

## GENERAL DESCRIPTION

The 3350 subsystem consists of from one to four dual-drive storage units. Two types of 3350 are used: one with a controller and drives, and one with only the drives. Either type can be obtained with fixed heads on both drives. The units use extensions of the technology of the 3340 disk storage with improvements that increase storage capacity, data rate, and reliability.

The 3350 storage medium is sealed and non-removable. One recording surface contains servo information for seeking, track following, data clocking, generating the index signal, and indicating the rotational position. In fixed-head models, data is also recorded on this surface.

The first unit in each 3350 storage string must be a controller and dual-drive, Model A2 or A2F (with fixed heads). The other units (up to three) consist of dual-drive storage, Model B2 or B2F (with fixed heads).

## IBM 3350 ATTACHMENT

The 3350 can be attached to the following System/370 systems:

Model	Attachment Device
135	3830-2
145	Integrated Storage Control (ISC) or 3830-2
155-II	3830-2
158,*	Integrated Storage Control (ISC) or 3830-2
158-3	
165-II	3830-2
168,	Integrated Storage Control (ISC) or 3830-2
168-3	

\* Also 158 sub model 2 (Japan only)

## **COMPATIBILITY WITH EXISTING STORAGE**

The 3350 incorporates a selective format feature that allows each drive to be operated in one of three modes. Operational modes can vary between drives on the same string or unit.

### **IBM 3330 Model 1 Compatibility Mode**

In the 3330-1 compatibility mode, a single 3350 drive contains two logical 3330-1 volumes of data. Each logical 3330-1 volume is equal to an actual 3330-1 volume in capacity and format.

### **IBM 3330 Model 11 Compatibility Mode**

In the 3330-11 compatibility mode, a 3350 drive holds one logical 3330-11 volume of data. Each logical 3330-11 volume is equal to an actual 3330-11 volume in capacity and format.

### **IBM 3350 Native Mode**

In the 3350 native mode, the drive is used as a single logical device with the full capacity, up to 317,498,850 bytes of storage, being used.

## INITIALIZATION

Each 3350 drive is initialized as either a 3330 compatibility-mode device or a 3350 native-mode device with home address and a standard eight-byte Record Zero (RO) on all tracks. Tracks containing skippable defects have their home addresses written with the appropriate skip displacement bytes, so that automatic surface defect skipping is used during normal data transfer operations on the track. Reformatting may be done at installation if a different operating mode is required.

## RECORD FORMAT

The basic information unit recorded on direct-access devices is eight bits in length and is called a byte. A group of bytes separated by gaps is called an area.

Areas are combined to make a record, the logical unit of information. A record consists of three areas; the Count area, the Key area, and the Data area. The areas are separated by gaps. One or more records are written on a track together with control information used by the storage control.

### Count Area

The count area contains information defining the length and format of the record. This information is written when the record is first originated and is not changed until the record is rewritten. The process of writing an entire record, including the count area, is called formatting. The record size is determined when the record is formatted.

### Key Area

The key area is used to identify the information recorded in the data area and is used at the discretion of the programmer. Once formatted, the contents (but not the length) can be changed. If the key area is changed, the data area must be rewritten.

### Data Area

The data area contains the information identified by the count and key areas of the record. This information is organized and arranged by the programmer. The data area length is defined by the count area. The data area can have its contents changed but not its

length. Changing the information in the data area does not affect any other area in the record.

## TRACK FORMAT

All tracks are formatted beginning at an index point, which is a physical location on the disk. When the subsystem is operating in 3330-1 or 3330-11 compatibility modes, the logical track length is the same as that of an actual 3330.

Each track consists of a home address, record zero, and one or more data records, depending on the space remaining on the track. The records and areas within the records are separated by gaps.

### Home Address

Each track has one home address which gives basic information about the track: its location and condition. If skippable defects were found when the disk was formatted, skip displacement distances are given. Skip displacement bytes are used to skip the defects during normal operations.

The home address is the first information following the physical index point. Special commands used in this area are: Write Home Address, Read Home Address, and Search Home Address Equal.

### Record Zero

Record zero is always the first record following the home address. It is usually reserved for non-user functions, but can be used for normal data storage. Special commands are needed to read or write data in the record zero area.

### Data Records

One or more data records may follow the record zero area on a track. The number of data records depends on the length of the count, key, and data areas (formatting). Data records and record zeros can be formatted with or without keys. The storage file organization method determines whether keys are used.

## Track Capacity

The number of records that can be recorded per track depends on their length. Equations can be used to determine the number of equal length records that can be placed on a track. Because the 3350 can be operated in either the 3330-1 or -11 compatibility mode or in native mode, methods for finding both capacities are shown.

### 3330 COMPATIBILITY MODES

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

where:

$$\begin{aligned} C &= 135 \text{ if } KL = 0 \\ &= 191 \text{ if } KL \neq 0 \\ KL &= \text{Key Length} \\ DL &= \text{Data Length} \end{aligned}$$

An allowance is made for home address, Record Zero, and defect skipping in the above equation.

### 3350 NATIVE MODE

$$\frac{\text{Equal length records}}{\text{track}} = \frac{19,254 \text{ (track capacity)}}{C+KL+DL \text{ (bytes per record)}}$$

where:

$$\begin{aligned} C &= 185 \text{ if } KL = 0 \\ &= 267 \text{ if } KL \neq 0 \\ KL &= \text{Key Length} \\ DL &= \text{Data Length} \end{aligned}$$

An allowance is made for home address, Record Zero, and defect skipping in the preceding equation.

## Gaps

A gap is a string of bytes written to separate records and areas within the records. Gaps usually include a unique combination of bits and recording areas that are used for timing. There are several different gaps that differ in length and configuration.

## Defect Skipping

The 3350 avoids data recording errors by skipping surface defects in the magnetic coating on the disks. This technique places recording areas on each side of the defects and makes them invisible to the system.

If a surface defect is in a home address, count, or at the start of a key or data area, the area is moved to bypass the defect. If the defect is found within a key or data area, either the data is split and recorded on each side of the defect, or the data is moved until the defect falls in a lengthened normal gap or a specially created gap.

# INPUT/OUTPUT OPERATIONS

This section describes the Input/Output operations used with the 3350. Additional central processing unit (CPU) information and channel program control of I/O operations is found in the publication, *IBM System/370 Principles of Operation*, Order No. GA22-7000.

## UNIT SELECTION

The device address (I/O Unit Address) used by the system to select a specific unit is an 8-bit byte (plus a parity bit). In this 8-bit byte, bits 0 and 1 are the storage control address and bit 2 selects the logical drive if the physical drive is in the 3330-1 compatibility mode. Bits 3 and 4 indicate the storage string address and bits 5–7 are the drive address in the group of eight physical drives within each string.

## TRACK SELECTION

A specific track is selected by the Seek Address command together with a Seek instruction. The seek address consists of six bytes: bytes 2 and 3 specify the logical cylinder; byte 5 specifies the logical track; and bytes 0, 1, and 4 are used for data protection.

## DATA INTEGRITY

The 3350 protects data integrity by error detection and error correction.

### Error Detection and Correction

An odd parity bit is added to each byte of information transferred between the storage control and the 3350. After the byte has been checked, the parity bit is discarded.

Validity of the data recorded by the 3350 is checked by adding six bytes to each record area. These bytes indicate any errors detected in the home address, count, and key areas. The six bytes added to the data areas provide for error correction as well as detection.



## MODELS AND FEATURES

The 3350 dual-drive storage units are available in four models and can incorporate special features when required.

### 3350 MODELS

Four 3350 models are available: the A2 (dual-drive storage with controller), the A2F (same as the A2 but with the fixed head standard feature), the B2 (dual-drive storage) and the B2F (dual-drive storage with the fixed head standard feature).

The fixed head standard feature on Models A2F and B2F provides up to 1.144 million bytes of zero seek time storage per drive. The fixed head storage capacity takes the place of an equal amount of storage under the moving heads.

When a Model A2F or B2F drive is used in the 3330-1 compatibility mode, the fixed head storage capacity is associated with the primary logical 3330-1 volume.

The fixed head storage capacity of a Model A2F or B2F is:

	<b>3350 Native Mode</b>	<b>3330-1 or 11 Compatibility Mode</b>
Logical Cyls	1-2	1-3
Tracks	0-29	0-18
Capacity/drive (bytes)	1,144,140	742,710
Capacity/unit (bytes)	2,288,280	1,485,420

### STRING SWITCH

The string switch feature allows a 3350 Model A2 or A2F and attached Model B2 or B2F units to be dynamically shared by two storage controls. The 3350 can be dedicated to a single storage control with an Enable/Disable switch.

This feature is also available with a remote switch attachment.

### Remote Switch Attachment

The remote switch allows the string switch to be attached to the configuration control panel of a System/370 Model 158 or 168 Multiprocessor.

# CHANNEL COMMANDS

The following commands are recognized and executed by the 3350:

*The three diagnostic commands are only used when microdiagnostics from the System/370 are required.*

## CONTROL COMMANDS

- No Operation
- Recalibrate
- Seek
- Seek Cylinder
- Seek Head
- Space Count
- Set File Mask
- Set Sector
- Restore
- Diagnostic Load
- Diagnostic Write

## SEARCH COMMANDS

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

## READ COMMANDS

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

## SENSE COMMANDS

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

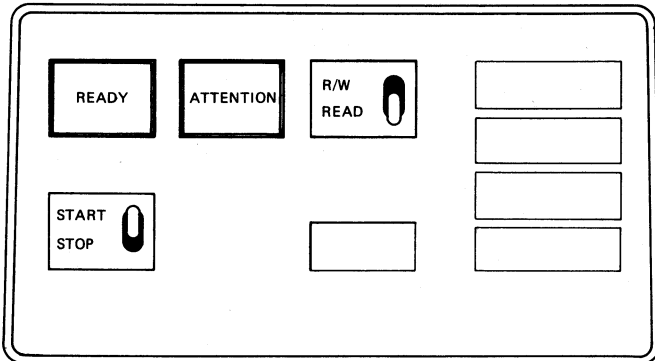
## WRITE COMMANDS

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

# OPERATOR CONTROLS AND INDICATORS

## OPERATOR PANEL

Each 3350 unit has two operator panels, one for each drive. The indicators and controls for each operator panel are as follows.



### Ready Lamp

The Ready lamp turns on when the drive is on, the disk drive speed is up to normal, and the head is on a track.

### Attention Pushbutton

When pressed, the Attention pushbutton starts a Rezero operation. Rezero moves the heads to cylinder zero, resets the address registers, and signals Attention to the controller.

### R/W or Read Switch

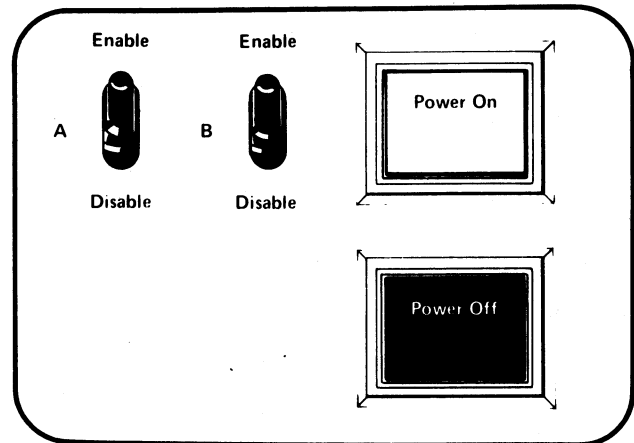
When in the Read position, no write or erase operation can be done. If set to R/W, all normal operations are possible. If the switch position is changed during an operation, the condition does not change until the operation is completed.

### Start/Stop Switch

The drive Start/Stop toggle switch starts and stops a drive. When set to Start, the brake is released, the disks start spinning, and the heads move to Cylinder 0. When set to Stop, the heads retract, the brake engages, and the disks stop. An electrical interlock in the Stop position prevents a stop if the drive is busy.

## POWER CONTROL PANEL

One power control panel is mounted on the front cover of each A2 or A2F dual-drive unit. This unit controls power for all the dual-drive units attached to the A2 or A2F.



### Power On/Off Switches

AC power application is controlled by the Power On/Off switches for all 3350 units (up to four) in the string.

### Interface A and Interface B Enable/Disable Switches

These interface enabling switches are used to select the active interface in 3350 systems that have the optional string switch feature.

## READER'S COMMENT FORM

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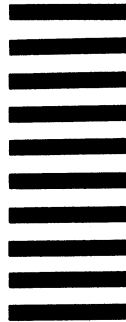
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