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Systems

IBM 3370 Direct Access Storage Description

IBM

Preface

This publication is intended to familiarize data processing personnel with the characteristics of IBM 3370 Direct Access Storage. The reader should have prior knowledge of direct access storage devices and concepts.

This manual describes the 3370 storage models, the recording medium used, operator controls and indicators, the fixed block data format, and the methods used to ensure data integrity and privacy.

Because the 3370 Direct Access Storage can be attached to several different systems, the user should order copies of the host system Functional Characteristics or the storage control manual for details pertinent to the installation.

Details of the fixed block command set used with the 3370 are included in the *IBM 3880 Storage Control Description,* Order No. GA26-1661.

Information about the attachment of 3370 to 4300 processors is in the *IBM 4300 Principles of Operation for ECPS: VSE Mode,* Order No. GA22-7070.

Details of the attachment of the IBM 3370 to System/38 are found in *IBM System/38 Installation Manual – Physical Planning,* Order No. GA21-9293. Specifics are contained in Technical News Letter Order No. GN21-0313 applying to the base publication.

The *Data Processing Glossary*, Order No. GC20-1699, defines terms related to direct access storage devices.

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This publication replaces and makes obsolete *Introduction to IBM 3370 Direct Access Storage,* Order No. GA26-1657-0.

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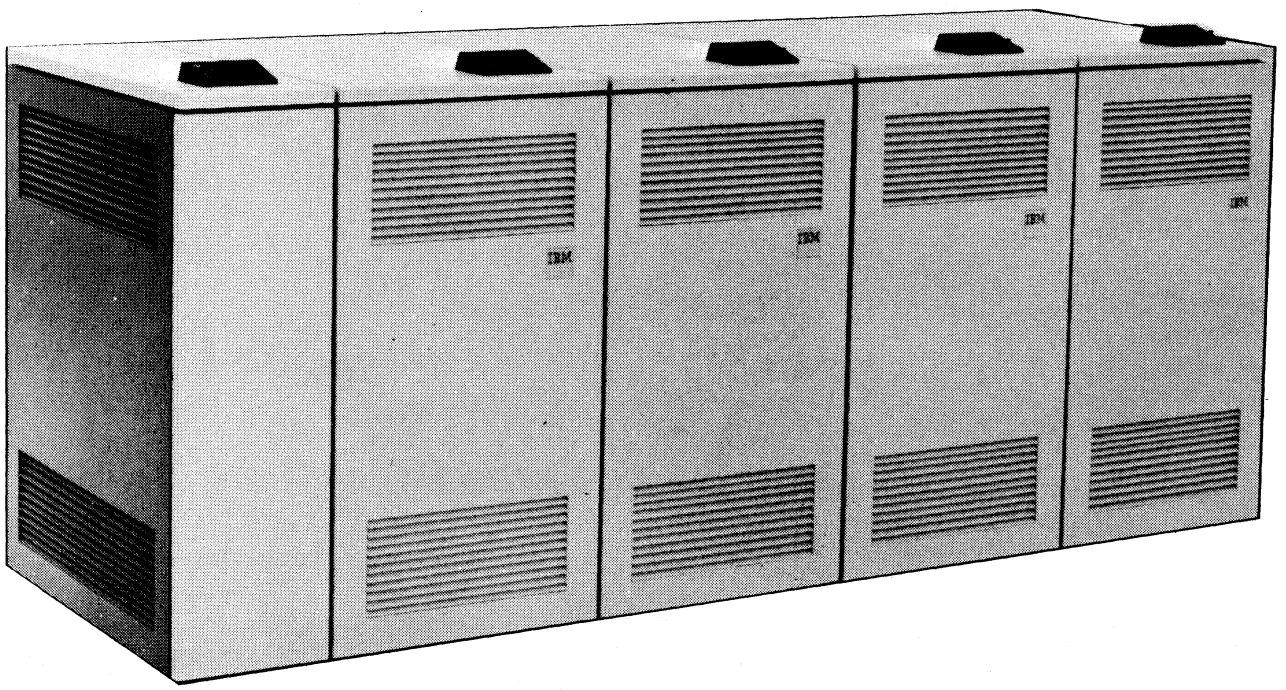

Figure 1. IBM 3370 Direct Access Storage (Design Model)

Introduction

The IBM 3370 Direct Access Storage combines two important concepts: two independent access mechanisms for each magnetic disk unit and a fixed block data architecture.

The two access mechanisms are separately addressed and operate independently. One access mechanism services one-half of the magnetic disks on the drive unit and the other access mechanism services the other half. Only one access mechanism at a time can transfer data, but while one access mechanism is reading, writing, or seeking, the other access mechanism can be seeking.

In fixed block architecture all data records are the same specified length, and each block of data is accessed by a unique block number. This addressing structure frees the programmer from having to determine data location by cylinders, heads, and record numbers; and permits program support that is independent of the particular physical characteristics of a device type. Track capacity calculations are eliminated since each track contains a fixed number of blocks. The command set used is more encompassing than with the count, key, and data command set in that fewer channel commands are required to accomplish the same result.

The IBM 3370 can be attached to IBM 4300 processors and to IBM System/38, Model 5.

A new service tool, the maintenance device, expedites diagnosis and repair, thus improving 3370 availability.

The 3370 uses a fixed-medium head and disk assembly. The fixed storage eliminates operator handling and exposure to external contamination, and provides high reliability. Because of higher recording density on the storage surfaces, the 3370 provides a larger storage capacity for medium-sized systems than has been previously available. The storage cost per byte is reduced and allows new uses for data base related applications.

3370 Performance Highlights

- Storage capacity: 285 megabytes per access mechanism (571.3 per unit) allowing more than 2 billion bytes per string.
- Cost per byte: below that of a 3330, 3340, 3344, or 3350 storage facility.
- Nominal data rate: 1.859 megabytes per second.
- Average access time: 20 milliseconds (0.02 second).
- Average rotational latency: 10.1 milliseconds (0.0101 second).
- Fixed block data architecture which provides sequential addressing which remains constant in storage devices using different storage technologies or physical recording methods. This minimizes the need to manipulate physical device parameters in the system.

IBM 3370 Models

There are two 3370 models: a Model A1 with a controller and drive and a Model B1 with only the drive. A 3370 string consists of up to three Model B1s attached to the Model A1. The optional string switch feature allows a 3370 string to be connected to, and shared by, two storage controls.

Corresponding Models A11 and B11 are used on System/38 Model 5 installations. Further information on attaching 3370 storage to System/38 installations is available in the System/38 publications.

Input and output data movement is through the controller in the Model A1. The controller is connected to the storage control, adapter, or attachment, which executes commands received from the system and sends macro orders to the controller for drive operations.

Model A1

The Model A1 with the controller contains the storage control connection logic, sequencing controls, a maintenance device port, power control panel, and power supplies to provide string sequencing power. (No power is drawn from the storage control.) The entire storage string power is controlled by the Model A1. Besides the controller, the Model A1 contains one drive with its head and disk assembly, as described for the Model B.

The controller:

- Interprets and execute macro-orders received from the storage control
- Controls the connection between the storage control and the controller
- Controls the writing and interpretation of the track format on a fixed block basis
- Clocks and serializes or deserializes data as it is transferred between the parallel-by-byte processor and the serial-by-bit drive
- Checks data integrity by error detection and error correction analysis
- Furnishes storage subsystem status and sense information to the storage control
- Performs diagnostic subsystem evaluation

Model B1

The 3370 Model B1 is housed in a separate enclosure. When connected to the Model A1 and to other B1s, a string of from one to four devices becomes a 3370 storage string.

The B1 provides the mechanical, electronic, and electromechanical systems necessary to operate the drive and its head and disk assembly. The head and disk assembly has two independently operated access mechanisms. The B1's primary functions are to:

- Interpret and respond to orders from the controller
- Position the access mechanism at a track
- Select the correct head
- Locate a specified block on the selected track
- Record and read serial data
- Provide servicing information for evaluation

The Model B1 contains an electronics gate, power supplies, and controls for two access mechanisms.

Access operations by the access mechanisms can proceed independently because of dual servo control electronics. However, both access mechanisms share a common set of read/write electronic circuits.

Each access mechanism in a string has a unique address that ranges from 0 through 7. Although a normal configuration may assign addresses 0 and 1 to the first Model A1, the addressing can be changed during installation or when being serviced by the customer engineer (CE). (Switches on the controller logic board are used to assign access mechanism addresses.) An area on the operator panel of each drive is used to identify the address of the access mechanism.

Storage Medium

The 3370 storage medium consists of rotating disks, magnetically coated on each side. Two access mechanisms with attached read/write heads, each service a separate group of disks. The head and disk assembly is sealed and not removable by the user.

Maintenance Device

The maintenance device (MD) is a portable micro computer with a hand-held keyboard/display and a diskette reader and storage. It is attached to the 3370 Model A1 and performs diagnostic routines. The device helps the CE to isolate a problem or verify that the unit is operating normally. The MD replaces the permanent CE Panel used on previous IBM storage devices.

IBM 3370 Attachment

When used with the IBM 4341 Processor, the 3370 is attached to the IBM 3880 Storage Control. This storage control is housed in a separate frame. Up to four 3370 strings can be attached to a 3880 Storage Control. If the string switch feature has been installed, two separate storage controls or two storage control paths from the same storage control can be attached to a 3370 string.

When used with the 4331 Processor, the 3370 is attached to the direct access storage device (DASD) adapter, which is housed in the processor enclosure. The adapter is a type of storage control. Up to four 3370 strings can be attached to the DASD adapter.

When used with the System/38, the 3370 is attached to the 3370 Model A11 Disk Storage Attachment, which is housed in the processor enclosure. This attachment is a type of storage control. One 3370 string can be attached. The string switch is not supported by System/38.

Programming

All programming support for the 3370 used with 4300 processors use the command set for 512-byte fixed block architecture (see Channel Commands). The current programming support is DOS/VSE and VM/BSE PP Version 1, Release 2 and VM/SE PP Version 1, Release 2.

Programming support is CPF when the 3370 is attached to the System/38.

String Switch

The string switch is an optional feature. When installed on the 3370 and supported by the processor, a 3370 string can be connected to and shared between two storage controls on a dynamic basis under system program control.

Fixed Block Data Storage

The fixed block architecture data format uses sequential data addresses. Each block of data is separately addressable and separately accessible, either singly or in sequential groups of a variable number of blocks (from one to approximately 65,000 blocks per group). Data block position sensing is automatic. The storage control disconnects during periods of seeking and rotational latency.

All data is processed in fixed-length blocks. Both command chaining and data chaining can be used subject to certain restrictions. Fixed block architecture includes the following capabilities:

- For initial data entry, a logical addressing structure that remains constant regardless of the physical recording characteristics of the particular device.
- For data transfer to another storage medium, an addressing scheme that is not device dependent: common program support for different types of storage, and improved data mobility for migration.

Information and details of the command set used with fixed block architecture are included in the *IBM 3880 Storage Control Description,* Order No. GA26-1661.

Storage Organization

The basic unit of data transfer between the 3370 disk storage and the using system is the 512-byte block of data.

A block consists of two areas, the ID area and the data area, plus the gaps used to separate the areas within the blocks.

Identification Area

The identification (ID) area contains the data block address plus specific control information for the device, if needed. The address is a physical identifier that is used by the storage control. The ID area also includes error correction bytes.

The ID area is monitored by the storage control. This area is generally not available to the system; however, some system operations are permitted for data recovery operations.

Data Area

The data area contains both the fixed length of data (512 bytes) and error correction bytes used for error detection and correction.

3370 Addressing and Capacity

Device Addressing

The I/O device address consists of an 8-bit byte. Each 3370 drive has two separate access mechanisms and two logical addresses.

When attached to the 4341 Processor using an 3880 Storage Control, bits 0 and 1 specifiy the storage control, bit 2 is always zero, bits 3 and 4 indicate the string controller, bits 5 and 6 specify the drive address, and bit 7 indicates the access mechanism.

When attached to a 4331 Processor using a DASD adapter, bits 0 and 4 are not used; bits 1, 2, and 3 specify the string controller; bits 5 and 6 are the drive address; and bit 7 indicates the access mechanism. (The 4331 Processor can attach up to four strings of 3370 storage.)

Data Addressing

A command specifying a block ID number, or range of block ID numbers (see Locate command), to be processed is sent to the storage control. The storage control converts the block ID to the correct physical location.

Data Capacity

Each 3370 drive contains the following:

Primary Capacity	Bytes	Blocks
Per access mechanism	285 696 000	558 000
Per drive	571 392 000	1 116 000

Input/Output Operations

This section describes the input/output operations used with the 3370. Additional information on the processing unit and channel program control of I/O operations is found in the publication *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode,* Order No. GA22-7070.

Data Integrity

The 3370 protects data integrity by error detection and error correction.

Error Detection and Correction

Information traveling from the processor, to the storage control, and to the controller is verified by the use of odd parity. A ninth bit is added to each byte, either a 0 or a 1, so that the total number of ones in the nine bits is always an odd number. This parity bit is removed following the check of each byte by the controller; the parity bit is not sent on to, or sent from the drive. When data is read from storage, the controller adds the appropriate parity bit which is included when the byte is forwarded to the processor. In the controller, the ID area and the data block are inspected and error correction codes are calculated and added to their respective areas, then stored. The error codes are used to verify the validity of the data in the ID and data areas when the record is transferred between the drive and the controller.

The correction code can detect all single error bursts of 16-bits span or less, and can correct single error bursts that span no more than one byte boundary.

Data Verification

Unless corrected immediately, write errors cause read errors. Therefore, verification should be incorporated within the program. Thus, in the event of a write error, the record can be rewritten and reverified before the original data is destroyed.

Either of three programming verification methods may be used: full read-back check, correction code check, or the write and check data subcommand. The choice of the method that is most efficient depends on the particular system configuration.

Full Read-Back Check

All of the data after writing is read back into main storage and compared, byte-for-byte, with the original information.

Correction Code Check

The record that was written is read back with the skip bit on (this keeps the data from being placed back in main storage). The correction code bytes that are appended to the data area are compared by the controller with the correction code bytes that were written. If a discrepancy is found, the command retry procedure is automatically activated by the storage control. This retry procedure makes 82 attempts to read the data that was stored. If correct data cannot be read, the data is logged as uncorrectable and error recovery procedures are used to recover it.

Write and Check Data

The write and check data subcommand is part of the Locate command. When used in a Locate, the same procedure as described for the correction code check is executed.

Write Protect

The Read/Write or Read Only rocker switches are used to protect specific drives from being rewritten or erased. A switch for each access mechanism is located on the drive operator panel. The switch position can be changed at any time, but its state will not change until the current operation is complete. This prevents accidental destruction of essential data. When the switch is set to Read Only, any Write command is rejected. The sense information indicates that the writing was inhibited and that the command was rejected.

Locate Verification

The 3370 track format includes bytes in each ID area that are used for Locate verification. During a read or write operation, the controller compares the ID bytes with the address sent by the storage control. If the two values are not equal, any further reading or writing is inhibited.

Channel Commands

The 3370 executes commands from DASD fixed block command set. This command set is used for 4300 processors and does not apply to System/38. The listing of commands on this page and the command summaries on the pages that follow are completely described in the *IBM 3880 Storage Control Description,* Order No. GA26-1661.

Control Commands

- No Operation
- Define Extent
- Locate

Read Commands

- Read
- Read IPL

Write Command

- Write

Sense Commands

- Sense I/O Type
- Sense I/O
- Read and Reset Buffered Log
- Read Device Characteristics
- Device Reserve (string switch or channel switch* only)
- Device Release (string switch or channel switch* only)
- Unconditional Reserve (string switch or channel switch* only)

Diagnostic Commands

- Diagnostic Control
- Diagnostic Sense/Read

*Channel switch is an optional feature of the 3880 storage control.

Control Commands

Command	Hex Code	Function	Data Transferred Across Channel
No Operation	'03'	No action. Immediate command with channel end and device end presented during initial status.	None
Define Extent	'63'	Defines location and size of data boundaries where subsequent chained commands can operate. Contains file mask to control execution of the following channel commands.	16 bytes
Locate	'43'	Specifies location and amount of the data to be processed by a Read or Write command that is chained from it.	8 bytes

Figure 2. Control Commands

Read Commands

Command	Hex Code	Function	Data Read
Read	'42'	Causes data to be transferred from the device to the channel. Must be chained from a Locate or Read IPL command.	One or more complete 512-byte data blocks
Read IPL	'02'	Reads block 0. If command is chained from a Define Extent that includes specifications from block 0, orients to and reads block 0. Must be first command in chain or be chained from another Read IPL command. Command assumes maximum extent, offset of zero, and mask byte of zeros; then orients to block 0 and reads entire block.	512-byte data block maximum

Figure 3. Read Commands

Write Command

Command	Code	Function	Data Written
Write	'41'	Causes data to be transferred from channel to device. Must be chained from a Locate command.	Data blocks from channel

Figure 4. Write Command

Sense Commands

Command	Hex Code	Function	Data Transferred Across Channel
Test I/O	'00'	Determines status of drive. Generated automatically by channel when status information is required.	1 byte
Sense I/O Type	'E4'	Transfers 7 bytes of data indicating the storage control type, device type, and model.	7 bytes
Sense	'04'	Determines cause of last unit check. Sense data is reset on transfer.	24 bytes
Read and Reset Buffered Log	'A4'	Supplies usage or error log data about the addressed drive. Data is reset on transfer.	24 to 64 bytes
Read Device Characteristics	'64'	Supplies 32 bytes of device characteristics to the channel.	32 bytes
Device Reserve	'B4'	Includes all functions of Sense command and reserves device for channel issuing command. Cannot be chained from a Define Extent. Valid only with channel switch or string switch feature.	24 bytes
Device Release	'94'	Includes all functions of Sense command and ends previous device reservation. Cannot be chained from a Define Extent. Valid only with channel switch or string switch feature.	24 bytes
Unconditional Reserve	'14'	Same as Device Reserve except terminates primary path and establishes communication through alternate path. Valid only with a channel switch or string switch feature.	24 bytes

Figure 5. Sense Commands

Diagnostic Commands

Command	Hex Code	Function	Data Transferred Across Channel
Diagnostic Control	'F3'	Transfers four bytes defining operation to be done and indicates if more bytes are to be transferred. Must be chained from a Define Extent command.	4 bytes of operation specifics
Diagnostic Sense/Read	'C4'	Transfers diagnostic information from storage control to channel. Must be chained from a Diagnostic Control which requested additional information.	6 bytes

Figure 6. Diagnostic Commands

Sense Conditions

The sense information consists of 24 bytes that identify the condition that caused the last unit check and provide secondary data that may be required for error recovery. Additional information is used by the customer engineer in diagnosing and isolating subsystem malfunctions.

Sense byte definitions used with the 3370 are found in the appropriate storage control manual. When attached to the 3880 Storage Control, this information is in the *IBM 3880 Storage Control Description,* Order No. GA26-1661. When attached to an IBM 4331 DASD adapter, the host system manual should be used. The error condition table and recovery action table are also included in the storage control manual.

Operator Controls and Indicators

Two types of controls are on a 3370 string: individual controls and indicators for each drive, and controls and indicators located on the controller that affect the entire string of up to four drives.

Drive Operator Panel

Each drive has an operator panel mounted on the front top surface. The controls and indicators for the device are on this panel. There are separate controls for each access mechanism. One side of the panel controls one access mechanism and the other side, the other. Each side has six square indentations for the access mechanism address labels.

Ready Switches

When a Ready switch is pressed to prepare the drive for use, the selected drive read/write heads are moved to track zero, the head address register and cylinder address register are reset, and an attention signal is sent to the storage control.

Ready Indicators (green)

The Ready indicator turns on when its associated access mechanism is on track, track following, and ready to operate (not seeking).

Read/Write or Read Only Switches

The Read/Write or Read Only switch inhibits writing by the selected access mechanism when set to Read Only. When set to Read/Write, any legitimate write operation may be performed on the selected access mechanism.

If the switch position is changed during an operation, the status of the write inhibit logic remains in its previous condition until the current operation is complete.

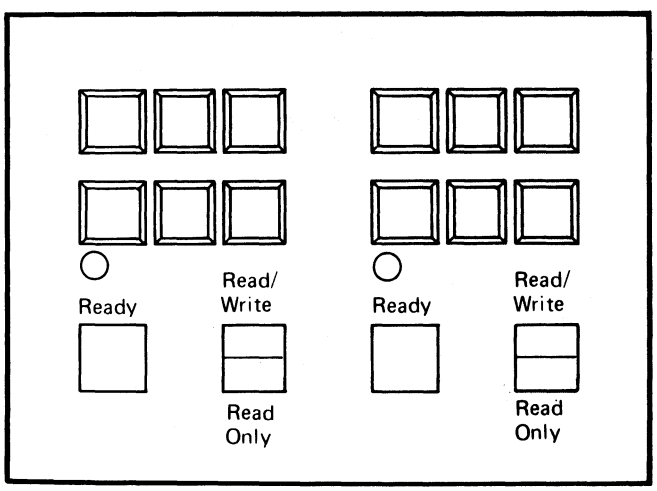

Figure 7. 3370 Operator Panel (Design Model)

Controller Operator Panel

The controller operator panel is mounted on the front top surface of the Model A1 (A11) controller.

Delayed Power Off/Enable Switch

The Delayed Power Off/On switch is used to power on and power off the string. When the switch is set to delayed power off, there is approximately a 12-second delay before power is removed from the string.

Power On Indicator

The Power On indicator is on when power is present in the A1(A11) device. It is activated by setting the Delayed Power Off/On switch to On and by the subsystem power sequencing operation.

Data Path A and B Enable/Disable Switches

If a 3370 string controller has the optional string switch feature, the A and B Enable/Disable switches are also located on the controller operator panel. These switches allow either storage control path to be manually enabled or disabled from the string. An interlock prevents the data path from changing until the current operation is complete. These switches are not present if the string switch feature is not installed.

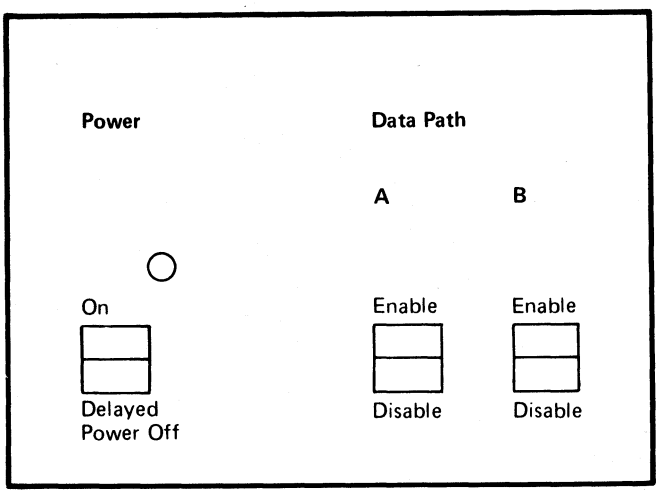

Figure 8. Controller Operator Panel

IBM 3370 Direct Access Storage
Description

Order No. GA26-1657-1

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