IBM

Storage Subsystem Library

GC26-4497-0

IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2 Introduction and Reference

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In addition to the FCC statement above, the reader of this manual should be aware that the referenced statement applies only to devices manufactured after January, 1981, and used in the United States.

First Edition (September 1987)

This edition applies primarily to the IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2. It also contains information on the IBM 3380 Direct Access Storage Models BJ4 and BK4.

Changes are made periodically to this publication; before using this publication in connection with the operation of IBM systems, consult the latest *IBM System/370, 30xx, and 4300 Processors Bibliography,* GC20-0001, for the editions that are applicable and current.

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Preface

This manual is part of the Storage Subsystem Library (SSL)—a set of manuals that provides information about the hardware components of IBM disk storage subsystems. Although the SSL includes both direct access storage device (DASD) and storage control publications, this manual is part of the SSL subset that is concerned primarily with 3380 DASD.

About This Manual

This manual is written for the storage administrator, system programmer, hardware performance specialist, or operator who is involved in acquiring, configuring, managing or using direct access storage.

Chapter 1, "Introducing the IBM 3380 Model CJ2" on page 1, describes the 3380 Model CJ2, highlights the product capabilities, and provides basic product and string composition information. In addition, characteristics of the 3380 Model CJ2 and 3380 Models BJ4 and BK4 are compared with other IBM DASD.

Chapter 2, "Functional Characteristics" on page 11, describes standard functions of the 3380 Model CJ2 subsystem, internal path capabilities and other CJ2 functions: Device Reserve and Release, Dynamic Path Selection, and Device Level Selection.

Chapter 3, "Configuring and Attaching to the Operating System and Processor" on page 19, describes the options for configuring 3380 Model CJ2 strings and defines operating system and processor support for the CJ2.

Chapter 4, "Planning for Installation and Use" on page 23, describes physical planning considerations such as power, cable, and floor space requirements, and discusses other planning activities that promote efficient installation and use of the 3380 Model CJ2.

Chapter 5, "Operation of the 3380 Model CJ2" on page 27, provides information for using the operator panel on the 3380 Model CJ2 and powering the CJ2 up and down.

Appendix A, "Device Addressing and Identification" on page 35, describes the conventions and requirements for defining device addresses and identifications.

Appendix B, "3380 Model CJ2 Configuration Data Worksheets" on page 41, provides worksheets for use in planning your 3380 Model CJ2 subsystem configurations.

Appendix C, "Record Format, Track Format, and Space Calculations" on page 47, describes the count-key-data track format and provides formulae and tables for space calculation.

"Glossary" on page 67, defines the terms used in this manual.

"Bibliography" on page 71, lists the related publications that you can reference for further information on related topics and hardware.

Terminology

A glossary is provided at the back of this manual that contains terms that pertain to the 3380 Model CJ2 subsystem.

Before reading further, be sure you understand the way the following terms are used within this manual:

3380, unless otherwise indicated, refers to all models of the IBM 3380 Direct Access Storage.

Controller refers to the part of the 3380 Model CJ2 that controls the transfer of data between the devices and the storage control.

Device refers to a uniquely addressable part of the 3380 unit that includes access arms, their associated disks, and the electronic circuitry needed to locate, read, and write data.

Storage Control refers to the part of the 3380 Model CJ2 that handles interactions between the processor channel and the controller.

Volume refers to the storage space that is accessible by a specific device.

The Storage Subsystem Library

The Storage Subsystem Library describes characteristics, capabilities, and features of the hardware and provides instructions for installing, using, and maintaining storage subsystem components effectively in the various operating environments. The library is designed to provide both hardware- and software-related information for both DASD and storage controls.

The DASD subset of the Storage Subsystem Library contains the following manuals:

1. *IBM 3380 Direct Access Storage Introduction*, GC26-4491

   Provides a complete description of the various models of the 3380, including characteristics, features, and capabilities. In addition, the configuration and attachment options are described along with other information that helps in designing a storage subsystem to meet your needs. This manual does *not* cover the 3380 Model CJ2.

2. *IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2 Introduction and Reference*, GC26-4497

   Provides a complete description of the 3380 Direct Channel Attach Model CJ2 characteristics, features, capabilities, and string configuration options.

3. *Using the IBM 3380 Direct Access Storage in an MVS Environment*, GC26-4492

   Provides specific guidance for using the 3380 in an MVS/XA or MVS/370 operating environment. This manual provides detailed instruction for planning the addition of new 3380 devices from a logical and physical point of view, installing devices, moving data to new devices, and performing ongoing activities to maintain a reliable storage subsystem.

4. *Using the IBM 3380 Direct Access Storage in a VM Environment*, GC26-4493

   Provides specific guidance for using the 3380 in a VM/SP, VM/SP HPO, or VM/XA SF operating environment. This manual provides detailed instruction for planning the addition of new 3380 devices, installing devices, moving data to new devices, and performing ongoing storage management activities to maintain reliable performance and availability. In addition, storage considerations related to guest systems are addressed.

5. *Using the IBM 3380 Direct Access Storage in a VSE Environment*, GC26-4494

   Provides specific guidance for using the 3380 in a VSE operating environment. This manual provides instruction for planning the addition of new 3380 devices, installing devices, moving data to new devices, and performing ongoing storage subsystem management.

6. *Maintaining IBM Storage Subsystem Media*, GC26-4495

   Describes how the storage subsystem and the various operating systems handle disk storage errors and provides instruction on using the Environmental Record Editing and Printing (EREP) program and the Device Support Facilities (ICKDSF) program to diagnose and correct disk media errors. Recovery procedures are provided for the various device types. In addition, background material on DASD storage concepts is included.

7. *IBM 3380 Direct Access Storage Reference Summary*, GX26-1678

   Provides a summary of 3380 capacity, performance, and operating characteristics.

The Storage Control subset of the Storage Subsystem Library contains the following manuals:

1. *IBM 3990 Storage Control Introduction*, GA32-0098

   Provides a complete description of the various models of the 3990 Storage Control, including its data availability, performance, and reliability improvements over previous storage controls. In addition, this manual provides descriptions of the configuration attachment options, optional features, performance characteristics, and software support of the 3990 Storage Control.

2. *IBM 3990 Storage Control Planning, Installation, and Storage Administration Guide*, GA32-0100

   Provides a functional description of the 3990 Storage Control. This manual describes the planning, program installation, and storage management tasks used in typical environments. Configuration examples as well as sample programs for controlling the various functions of the 3990 Storage Control are provided.

3. *IBM 3990 Storage Control Reference*, GA32-0099

   Provides descriptions and reference information for the 3990 Storage Control. This manual includes channel commands, error recovery, and sense information.

The *Storage Subsystem Library Master Index*, GC26-4496, provides a central source for information related to storage subsystem topics. Manuals for IBM 3380 Direct Access Storage, 3380 Direct Channel Attach Model CJ2, and 3990 Storage Controls are indexed in this publication. An overview of the material in the Storage Subsystem Library is provided with this index.

Figure 1 on page vii shows the relationships among the Storage Subsystem Library manuals in terms of high-level tasks described in each manual.

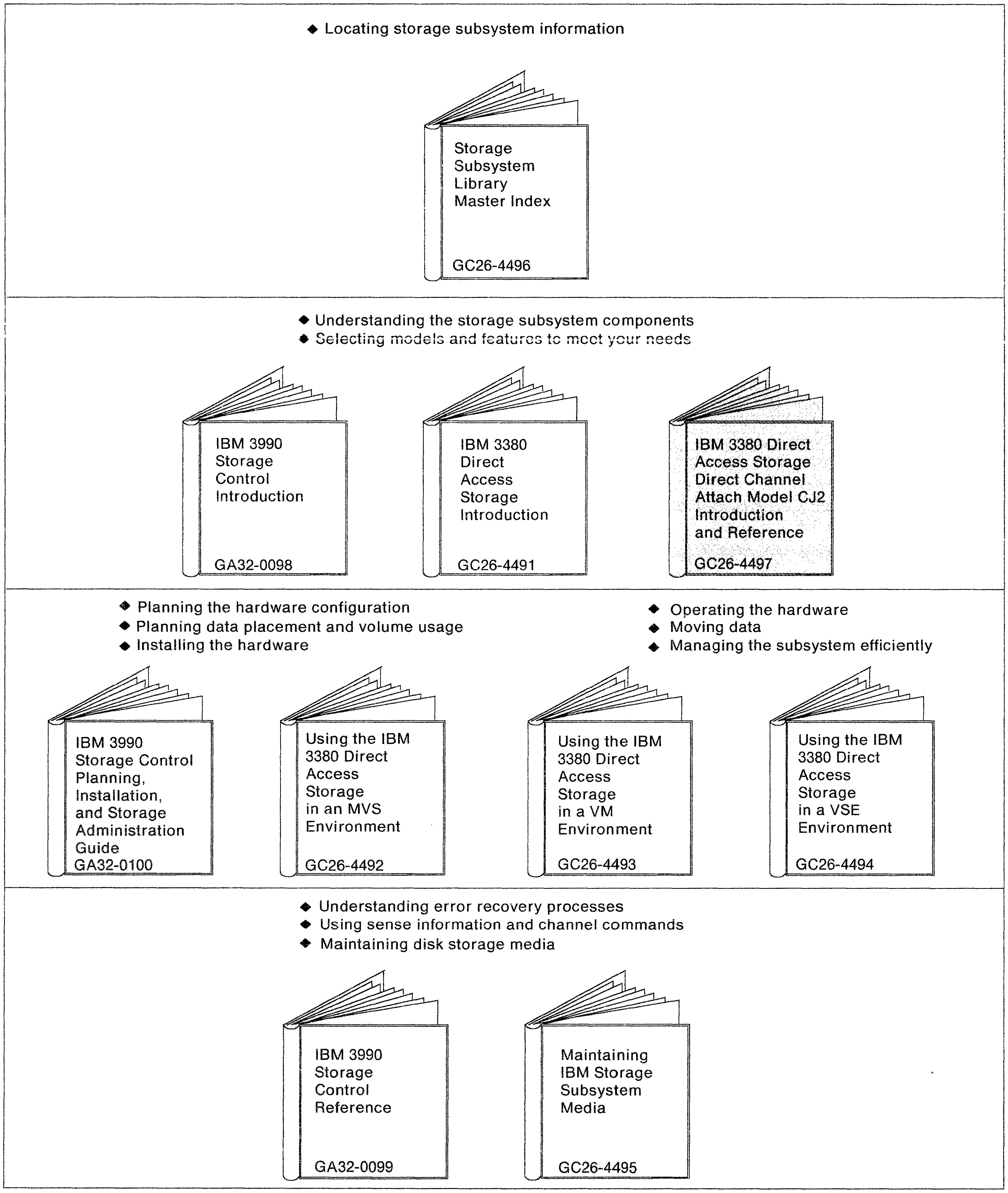

Figure 1. The Storage Subsystem Library

SSL Ordering Information

You can obtain a copy of **every manual** in the SSL using one General Bill of Forms (GBOF) number, **GBOF-1762.** The following GBOF numbers allow you to obtain subsets of the SSL. The columns shown in color in the table below describe the contents of the GBOFs that are intended for use with *IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2 Introduction and Reference,* depending on your operating environment. If you want to order an individual SSL manual, use that manual's order number.

Title	GBOF-1756	GBOF-1757	GBOF-1758	GBOF-1759	GBOF-1760	GBOF-1761	GBOF-0366
IBM 3380 Direct Access Storage Introduction, GC26-4491	X	X	X				
IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2 Introduction and Reference, GC26-4497				X	X	X	
Using the IBM 3380 Direct Access Storage in an MVS Environment, GC26-4492	X			X			
Using the IBM 3380 Direct Access Storage in a VM Environment, GC26-4493		X			X		
Using the IBM 3380 Direct Access Storage in a VSE Environment, GC26-4494			X			X	
*Maintaining IBM Storage Subsystem Media,** GC26-4495	X	X	X	X	X	X	
IBM 3380 Direct Access Storage Reference Summary, GX26-1678	X	X	X	X	X	X	
IBM 3990 Storage Control Introduction, GA32-0098							X
IBM 3990 Storage Control Planning, Installation, and Storage Administration Guide, GA32-0100							X
IBM 3990 Storage Control Reference, GA32-0099							X
Storage Subsystem Library Master Index, GC26-4496	X	X	X	X	X	X	X

* *Device Support Facilities: Primer for the User of IBM 3380 Direct Access Storage,* GC26-4498, is distributed with this manual.

Related Publications

Device Support Facilities: Primer for the User of IBM 3380 Direct Access Storage, GC26-4498, is a new publication intended for use with 3380 manuals in the Storage Subsystem Library.

Other publications that are referenced in this manual or that provide additional related information are included in a bibliography at the back of this book. To help you assess the potential usefulness of each reference, the bibliography includes a short description of the relevant contents of each publication.

Contents

Figures

Chapter 1. Introducing the IBM 3380 Model CJ2

The IBM 3380 Direct Access Storage Direct Channel Attach Model CJ2 is a unique member of the 3380 Direct Access Storage family. By combining storage control functions and 3380 direct access storage device (DASD) functions in a single physical unit, it provides a complete storage subsystem that can be attached directly to a block multiplexer channel.

The 3380 Model CJ2 is one of four model groups that comprise the present 3380 Direct Access Storage family. All twelve models of the 3380, including the CJ2, have the same number of bytes per track and tracks per cylinder. The number of cylinders a particular model contains determines the volume size.

Volume Size	Standard Model Group	Extended Capability Model Group	Enhanced Subsystem Model Group	Direct Channel Attach Model
Single Capacity	A04 B04 AA4	AD4 BD4	AJ4 BJ4	CJ2
Double Capacity		AE4 BE4		
Triple Capacity			AK4 BK4	

The new 3380 Direct Channel Attach Model CJ2 provides both 3380 direct access storage and storage control functions in a single unit called a "C-unit." The direct access storage functions of the Model CJ2 provide two paths for concurrent data transfer, and have improved seek characteristics over 3380 Standard and Extended Capability Models. The inclusion of a two-path storage control function means that this 3380 model can be directly attached to a host processor channel. Figure 2 illustrates the advantage of the CJ2 direct channel attachment eliminating the need for a separate storage control unit.

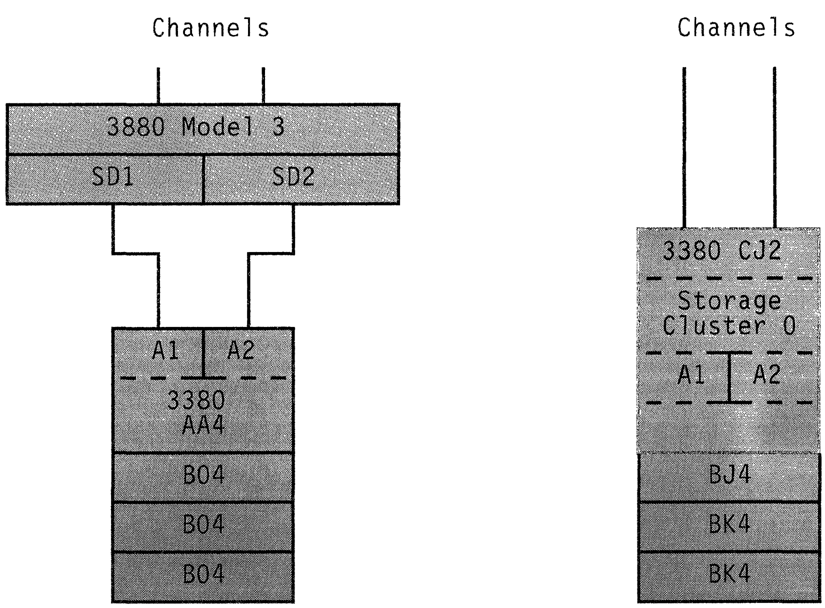

Figure 2. Storage Subsystem Comparison

The 3380 Model CJ2 unit contains two storage paths, two controllers, and two devices. As many as three Enhanced Subsystem B-units may be attached to a Model CJ2, providing from 1.26 gigabytes(Gb) to 23.9 Gb of direct access storage, in a complete storage subsystem. A Gb equals 10^9 bytes. The 3380 B-units that attach to the CJ2 consist of four devices per unit that are serviced by the two data paths. This structure provides simultaneous data transfer for any two devices in the string.

This manual describes the CJ2 and contains detailed information about the Enhanced Subsystem model B-units that attach to it. For further information on other 3380 units, see the *IBM 3380 Direct Access Storage Introduction.*

Highlights

Performance

The 3380 Model CJ2 incorporates functions such as rotational position sensing and command retry which have been proven successful in improving disk storage performance. Like the Enhanced Subsystem models, the CJ2 has faster seek times than other 3380 models, while providing two independent data transfer paths to each single device. See Figure 6 on page 8 and Chapter 2, "Functional Characteristics" on page 11 for detailed descriptions of the DASD and storage subsystem functions that improve performance.

Model Intermix on a CJ2 String

The 3380 Model CJ2 can attach as many as three 3380 Model BJ4 or BK4s, in any order or combination.

Data Capacity

The 3380 Model CJ2 provides approximately 0.630 gigabytes(Gb) per volume. A Gb equals 10^9 bytes. The two volumes of a CJ2 unit contain a total of approximately 1.26 Gb of data capacity. The 3380 Model BJ4 provides approximately 2.52 Gb of data capacity per unit. The 3380 Model BK4 has triple the capacity of the Model BJ4, providing approximately 7.58 Gb of data capacity per unit. For additional details, see "Data Capacity" on page 6.

Two Data Transfer Paths

The 3380 Model CJ2 permits concurrent data transfer, on two paths, to devices within the string. See Chapter 2, "Functional Characteristics" on page 11 for detailed descriptions of the CJ2 storage subsystem functions that support multiple data transfer paths.

Reliability, Availability, and Serviceability (RAS)

The reliability and serviceability of the 3380 Model CJ2 is improved compared to 3380 Standard and Extended Capability models and to previous disk storage products. In addition, it has enhanced reliability and serviceability characteristics compared to the 3880 Storage Control. The 3380 Model CJ2 shares the availability characteristics of previous 3380 models.

- Reliability
  - The 3380 Model CJ2 has been designed with fewer components than comparable previous subsystems.
  - There is improved manufacturing control of media and accessing components.
- Availability
  - Two data transfer paths provide the ability to sustain operation of a device even if one of the paths becomes unavailable.
- Serviceability
  - The intermittent fault isolation procedure has been improved by using an error log in the CJ2 for analyzing intermittent faults.
  - A remote support capability provides the ability to receive microcode patches and maintenance information from a remote support center.
  - Online service information messages (SIMs) provide information on storage control function errors.

Media Maintenance

With the 3380, you maintain your own storage media. Tools for controlling the assignment of skip displacements allow you to bypass defective areas[1] on a track. Areas that are bypassed do not affect user data space calculations. For further information, see *Maintaining IBM Storage Subsystem Media* and *Device Support Facilities: Primer for the User of IBM 3380 Direct Access Storage.*

Operator Panel

The CJ2 has an operator panel that simplifies problem determination and system recovery procedures. Chapter 5, "Operation of the 3380 Model CJ2" on page 27 illustrates the operator panel and describes its use.

Space and Environment

Floor space and power consumption are significant considerations in today's data processing environment. The 3380 Model CJ2 subsystem can provide more efficient use of floor space. Compared to previous disk storage products and their associated storage controls, the 3380 CJ2 also provides savings in power consumption on a per-byte basis. These factors reduce the total cost of owning a 3380 Model CJ2. "IBM DASD Comparisons" on page 9 provides comparative figures on floor space and power consumption.

Data Transfer Rate

The 3380 Model CJ2 transfers data at 3.0 megabytes per second (Mb/sec).

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[1] A defective area is a part of a data track on which consistently readable data cannot be written.

Product Description

The 3380 Model CJ2 contains one set of magnetic disks and two sets of access arms that position the read/write heads over the disk surfaces. All other 3380 ***units***, including the B-units that attach to the CJ2, contain two sets of magnetic disks and four sets of access arms. The film-head technology used in the 3380 models allows reading and writing of data recorded at higher densities than those of previous disk storage devices.

Each set of magnetic disks and its two sets of access arms with read/write heads are enclosed in a **head-disk assembly (HDA)** to protect the disk surfaces. There is one HDA in a CJ2 and two HDAs in a B-unit. Although permanently mounted within the 3380 unit to maintain critical head and track alignments for normal operation, an HDA can be removed by a service representative for replacement.

Each set of access arms along with its associated disk surfaces and electronic circuitry comprises a storage **device**. Because there are two devices in each HDA, a CJ2 has two devices per unit, while B-units contain four devices per unit. Each device has a unique address and operates independently of other devices in the unit or string. A device on the 3380 Model CJ2 string can be enabled or disabled at the operator panel, independently of the other devices.

A device is supported by the mechanical, electrical, and electronic systems needed to operate the disk and to locate, read, and write user data. Information used by the 3380 for seeking, track following, data clocking, index point signal generation, and rotational position sensing is recorded on a reserved disk surface for each device when the 3380 is manufactured.

The DASD space associated with a device (that is, the disk surfaces accessed by one set of access arms) is referred to as a **volume**. Figure 3 on page 5 shows the relationships of HDAs, access arms, and devices (or volumes) within a CJ2 and a B-unit.

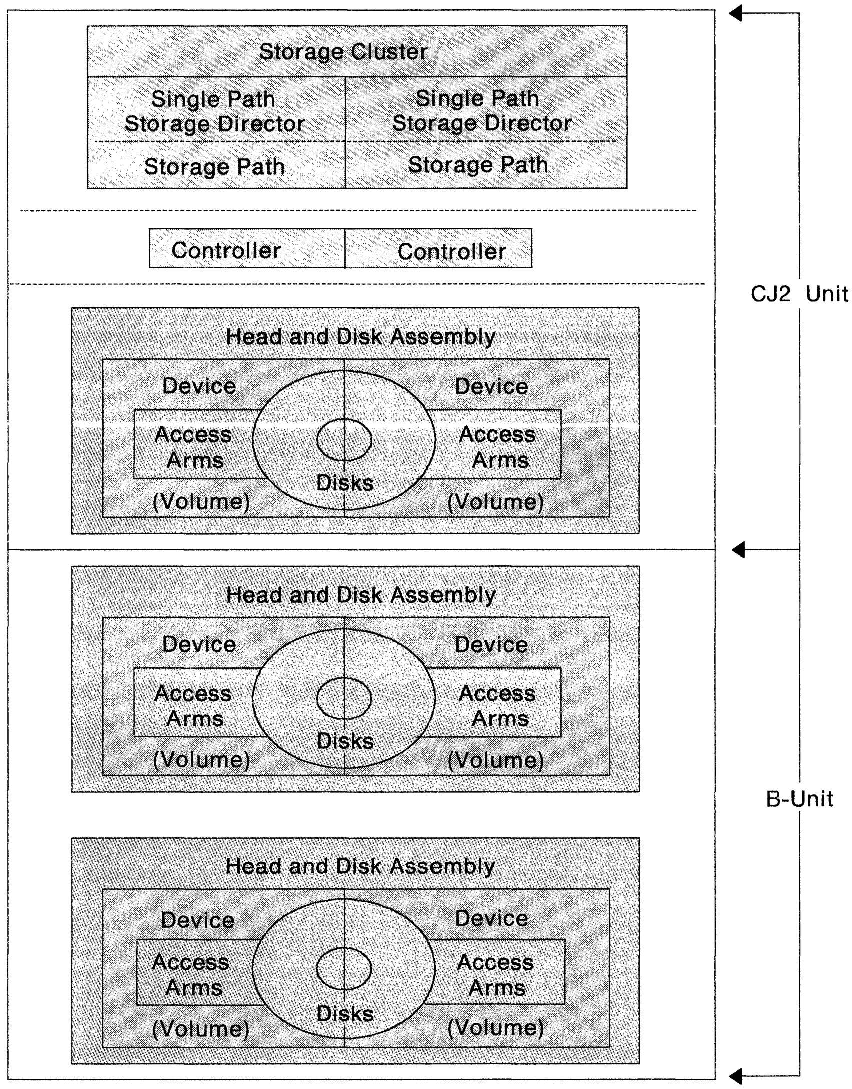


Figure 3. 3380 CJ2 Unit and B-Unit

In addition to two devices enclosed in an HDA, the 3380 CJ2 also contains two **controllers** and one **storage cluster.** The storage cluster contains channel and DASD controls and two **single-path storage directors** each of which contains a **storage path.**

The controller hardware:

- Interprets and processes commands issued by a storage director
- Controls the writing and interpretation of the track format on a field basis
- Clocks and serializes or deserializes data as it is transferred to and from the storage director
- Provides data integrity through error detection
- Furnishes status information to the storage director

The storage cluster:

- Interprets and processes commands issued by the processor channel
- Maintains status information about the storage directors, controllers, and devices
- Presents status to the processor and maintains internal error logs

Strings

Because the 3380 Model CJ2 contains controller functions, as many as three 3380 BJ4 or BK4 units can be attached to the CJ2 in any combination, to form a 2-path string. A CJ2 2-path string consists of two controllers and from two to 14 uniquely addressable devices.

The 3380 Model CJ2 controllers run in device level selection (DLS) mode, and the storage cluster runs in DLS support mode. See Chapter 2, "Functional Characteristics" on page 11 for a description of the DLS function. Two data transfer paths per string are provided, and each device may be accessed on either of two paths. These data transfer capabilities allow ***any*** two devices on the string to transfer data simultaneously.

Upgrading

A service representative can upgrade an attached 3380 Model BJ4 to a Model BK4 to increase the storage capacity of the unit. The 3380 Model CJ2 cannot be upgraded to any other model.

Data Capacity

Figure 4 summarizes data capacity for the 3380 Model CJ2, BJ4 and BK4, when using standard record zero (R0).

Data Capacity	CJ2	BJ4	BK4
Mb per device	630	630	1 890
Mb per Unit	1 260	2 520	7 562
Gb per 4-unit String (1 CJ2 unit, 3 B-units)	—	8.82	23.94

Figure 4. Data Capacity Summary

Note: Mb equals 10^6 bytes and Gb equals 10^9 bytes.

Characteristics Summary

The following tables summarize the physical and performance characteristics of the 3380 Model CJ2, BJ4, and BK4.

Physical Characteristics

Figure 5 summarizes the physical characteristics of 3380 Model CJ2, BJ4, and BK4. Capacity figures assume the use of standard R0.

Physical Characteristic	CJ2	BJ4	BK4
Storage directors per unit	2	—	—
Controllers per unit	2	—	—
Devices per unit	2	4	4
Data cylinders per device	885	885	2 655
Alternate data cylinders per device	1	1	1
Service cylinders per device	1	1	1
Data tracks per cylinder	15	15	15
Data tracks per device	13 275	13 275	39 825
Alternate data tracks per device	15	15	15
Bytes per track	47 476	47 476	47 476
Bytes per cylinder	712 140	712 140	712 140
Mb per device	630	630	1 890
Mb per unit	1 260	2 520	7 562

Figure 5. Physical Characteristics Summary of 3380 Model CJ2, BJ4, and BK4

Note: Mb equals 10^6 bytes.

Performance Summary

Figure 6 compares the performance attributes of 3380 Model CJ2, BJ4, and BK4.

Characteristic	CJ2	BJ4	BK4
Single cylinder seek time (ms)	2	2	2
Average seek time (ms)	12	12	16
Maximum seek time (ms)	21	21	29
Full track rotation time (ms)	16.6	16.6	16.6
Average rotational delay (ms)	8.3	8.3	8.3
Data transfer rate (Mb/sec)	3.0	3.0	3.0

Figure 6. Performance Summary for 3380 Models

Note: ms (milliseconds) equals 10^{-3} seconds, and Mb/sec equals 10^6 bytes per second.

Here are some of the key terms used to describe performance characteristics in Figure 6:

Seek time, or access motion time: The time required to move the access arm from one cylinder to another. More precisely defined, the seek time is the time interval beginning when the channel issues a Seek command (requiring access motion) and ending when the controller responds with a Seek Complete indication to the storage director.

Average seek time: The seek time is obtained by moving the access arm from each individual cylinder to every other individual cylinder and then taking the average move time for all combinations.

An alternative method sometimes used for approximating average seek time is to move the access arm across one-third of the cylinders.

Average rotational delay: The average time required for the disk to rotate, to position the desired data record under the read/write head so data transfer can begin. This is sometimes called *average latency*. Average rotational delay is one half of the time for a full track rotation.

Data transfer rate: The rate at which data is transferred between the controller and the storage director.

IBM DASD Comparisons

The following figures show how IBM 3380 models compare to other IBM DASD and how the latest 3380 models provide continuing improvements.

Performance and Physical Characteristics Comparisons

Figure 7 compares performance and physical characteristic of selected direct access storage models. Capacity figures assume the use of standard R0, where applicable.

Performance and Physical Characteristics	3350	3370 A02 B02	3375	3380 A04 AA4 B04	3380 CJ2	3380 AJ4 BJ4	3380 AK4 BK4
Storage directors per unit	—	—	—	—	2	—	—
Maximum concurrent data transfer paths	1	1	1	2	2	4	4
Average seek time (ms)	25	19	19	16	12	12	16
Full track rotation (ms)	16.6	20.2	20.2	16.6	16.6	16.6	16.6
Average rotational delay (ms)	8.3	10.1	10.1	8.3	8.3	8.3	8.3
Data transfer rate (Mb/sec)	1.198	1.859	1.859	3.0	3.0	3.0	3.0
Mb per device	317.5	364.9	409.8	630	630	630	1 890
Mb per HDA	317.5	729.8	819.7	1 260	1 260	1 260	3 780
Mb per unit	635	729.8	819.7	2 520	1 260	2 520	7 562
Mb per fixed head unit	2.28	—	—	—	—	—	—
Data cylinders per device	555	958	959	885	885	885	2 655
Tracks per cylinder	30		12	15	15	15	15
Bytes per track	19 069	31 744	35 616	47 476	47 476	47 476	47 476
Bytes per cylinder	572 070	380 928	427 392	712 140	712 140	712 140	712 140

Figure 7. Characteristics Comparison of IBM DASD

Note: ms (milliseconds) equals 10^{-3} seconds, and Mb equals 10^{6} bytes.

Power Consumption Comparisons

Figure 8 compares the power characteristics of the 3380 Model CJ2 with subsystems based on other DASD that are listed in Figure 7 on page 9. The comparison is based on subsystems that have approximately 5 Gb of storage. These comparisons assume 200-208 volts at 60 Hz. Information regarding other voltages and frequencies is available in *IBM Input/Output Equipment: Installation—Physical Planning for System/360, System/370, and 4300 Processors.* Capacity figures assume the use of standard R0, where applicable. The floor space includes one-half of the required service clearance.

	1-3880 001 8-3350 x02	**1-3880 001 7-3370 x02**	**1-3880 001 6-3375 x01**	**1-3880 003 2-3380 x04**	**1-3380 CJ2 2-3380 BJ4**
Gb per Subsystem	5.07	5.04	4.91	5.04	6.30
KVA	17.70	7.20	6.50	6.10	4.82
Mb per KVA	284.7	700.0	755.3	826.2	1 307.0

Figure 8. Power Consumption Comparison

Notes to Figure 8:

1. Mb equals 10^6 bytes
2. Gb equals 10^9 bytes
3. KVA (kilovolt x ampere), is the product of the effective values of the voltage and current, and is sometimes referred to as *apparent power*.
4. An **x** in the model designations indicates both **A** and **B** models, to provide valid string configurations for that machine type. For example, 8-3350 x02 would require two 3350 A02 units with three 3350 B02 units attached to each A02.

Floor Space vs. Data Capacity Comparisons

Figure 9 compares floor space requirements of a 3380 Model CJ2 subsystem with the subsystems compared in Figure 8. The basis is the amount of storage in Mb per square area of floor space that includes one-half the required service clearance. Capacity figures assume the use of standard R0, where applicable.

	1-3880 001 8-3350 x02	**1-3880 001 7-3370 x02**	**1-3880 001 6-3375 x01**	**1-3880 003 2-3380 x04**	**1-3380 CJ2 2-3380 BJ4**
Mb per Square Meter	332.6	429.5	451.0	749.2	1 738.8
Mb per Square Foot	30.9	39.9	41.9	69.6	161.6

Figure 9. Floor Space vs. Data Capacity

Notes to Figure 9:

1. Mb equals 10^6 bytes
2. An **x** in the model designations indicates both **A** and **B** models, to provide valid string configurations for that machine type. For example, 8-3350 x02 would require two 3350 A02 units with three 3350 B02 units attached to each A02.

Chapter 2. Functional Characteristics

This chapter describes the following functions and characteristics of the IBM 3380 Model CJ2:

- Count-Key-Data Record Format
- Storage Subsystem Functions
- Internal Paths
- Device Reserve and Release
- Dynamic Path Selection
- Device Level Selection
- Storage Cluster Functions

See the following manuals for specific information on the level of support provided by the operating systems for the various functions described in this chapter:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

Count-Key-Data Record Format

All models of the 3380, including the CJ2, use the count-key-data (CKD) record format. A record written to a 3380 device may contain three areas: count, key, and data. The record always includes a count area and a data area; the key area is optional. Each area within a record is separated by a gap, and two adjacent records are separated by a gap. Figure 10 shows the typical layout of record areas on a track.

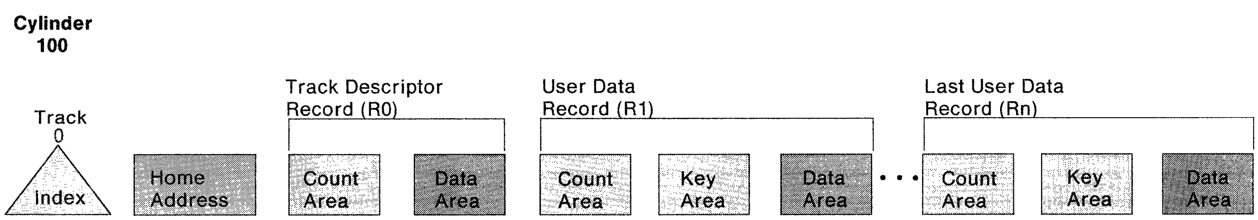


Figure 10. Track and Record Format, Simplified Schematic

When the 3380 is manufactured, each track is initialized with the home address (HA) of the track and the track descriptor record, standard record zero (R0).

I/O operations are initiated when the processor issues a set of channel command words (CCWs), some of which might be read or write CCWs that support the CKD record format. Error checking and correction (ECC) bytes, used for detecting and correcting read errors, are added to each area of the record whenever a record is written.

See Appendix C, "Record Format, Track Format, and Space Calculations" on page 47 for a detailed description of record format considerations.

Storage Subsystem Functions

The 3380 Model CJ2 provides the storage subsystem functions described below.

Command Retry is a channel and storage director procedure that causes a channel command to be retried when some types of errors occur. The command retry does not cause an I/O interrupt in the processor; programmed error recovery procedures are not required. Command retry is used to correct some types of data and seek errors without involving system recovery procedures.

End-of-File is a record that defines the end of a group of records. An end-of-file record is written by issuing a Write Count, Key, and Data (Write CKD) channel command with a data length in the count field set to zero.

Multiple Track Operations allow the searching or reading of several tracks, in sequence. During search operations and most read operations, it is sometimes desirable to continue the operation to the next sequential track. When the end of a track is reached, the storage director can select the next sequentially numbered read/write head during all search and most read commands. This eliminates the need for Seek Head commands in a chain of search or read commands.

Format Write Release (or Write Padding) frees the channel, storage director, and string controller, while the device writes filler characters (pads) to the end of the track after a format write command (Write Home Address, Write R0, or Write CKD).

Rotational Position Sensing (RPS) allows a search command to be started just before the required record comes under the read/write head, instead of starting the search at a random location on the track. RPS is based on a division of the track into evenly spaced sectors. The channel and storage director can disconnect while the track rotates to a specified sector location. This permits some I/O operations to be overlapped. For example, the 3380 can read or write data from one device while waiting for the track under a read/write head of another device to rotate to a specified sector location.

Note that the 3380, including the Model CJ2, does ***not*** support record overflow, sometimes referred to as track overflow.

Device Reserve and Release

The 3380 Model CJ2 supports the Device Reserve and Release function. The Device Reserve channel command causes an entire volume (the data accessible by one device) to be reserved for the channel. This prevents access by any other channel, until the device is released with a Device Release channel command. The device reserve function is handled on a channel path group basis, not just by one unique channel. See "Dynamic Path Selection (DPS)" on page 14 for related information.

The device reserve function is intended to prevent simultaneous attempts to update data on a volume. For example, a Device Reserve channel command is used when a VTOC or a catalog is to be updated. With a Device Reserve command, the device is reserved for use only over the single, selected path (as long as dynamic path selection is not active), or the path group when DPS is active.

An Unconditional Reserve channel command allows the resetting of an existing reserve condition on the original reserving path and applying the reserve to the path over which the Unconditional Reserve was received. This allows access to the device when there is no access over the original reserving path.

Internal Paths

The 3380 Model CJ2 contains two controllers and two internal paths for accessing the devices on the string. Any device on the string can be selected by either controller and can be serviced on either of the two controller paths. Thus, when one device is busy, all other devices in the string remain accessible to the other controller via the other internal path. This internal path capability allows the CJ2 to run in Device Level Selection (DLS) mode; that is, ***any two*** devices may read or write data concurrently. Figure 11 shows the internal paths for a 3380 Model CJ2 string.

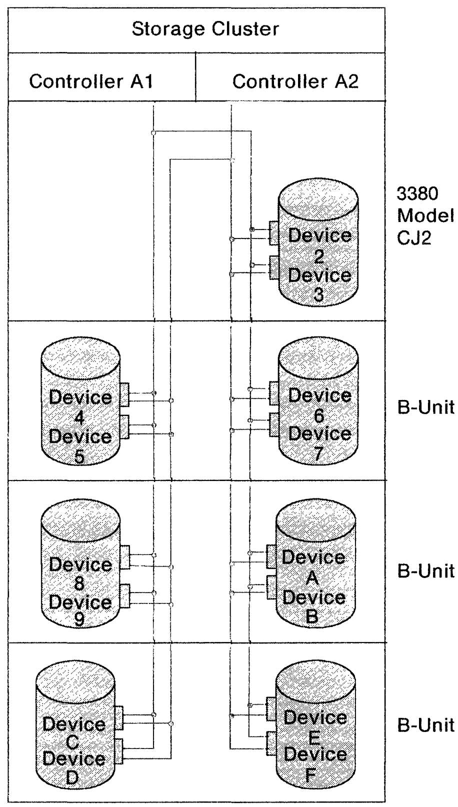


Figure 11. Internal Paths for the 3380 Model CJ2 String. Note: The CJ2 does ***not*** contain Device 0 or 1.

"Dynamic Path Selection (DPS)" on page 14 and "Device Level Selection (DLS)" on page 14 describe the performance and availability functions that are supported by the internal path access capabilities of the Model CJ2.

Dynamic Path Selection (DPS)

Dynamic path selection (DPS) is available on a 3380 Model CJ2 because it has two controllers that have identical functions. The two controllers and two single-path storage directors allow the CJ2 string to communicate with the two attached channels, thereby achieving multiple paths for transferring commands and data. The DPS functions are:

- Simultaneous data transfer for two devices over two paths
- Sharing DASD volumes by using system-related reserve and release
- Dynamic path reconnect to the first available path (on extended architecture hosts only)

With DPS, if a controller designated in the I/O address is busy or inoperative, the operating system or channel subsystem making the request is notified and can then select a path to the other controller to access 3380 data. The DPS function allows an alternate path to be established through the other single-path storage director and the other controller.

Device Level Selection (DLS)

By providing two single-path storage directors and two controllers, two totally independent data transfer paths are available with the 3380 Model CJ2. DLS uses the two independent data transfer paths to read or write data simultaneously to ***any two*** devices in the string.

DLS offers improved data availability and overall system performance. If the selected device is not busy, it may be accessed even if another device on the string is reading or writing data. When one device on the string is busy, ***any*** of the remaining devices can be selected. This can reduce the amount of time an operating system needs to wait for a path to a device to become available.

Storage Cluster Functions

The 3380 Model CJ2 has one storage cluster that contains channel interfaces, storage directors, storage paths, and a support facility for maintenance.

Channel Interface

The storage cluster can be attached to two channels. Each channel is connected to a storage director in the cluster. Therefore, one processor can have two paths to data, or two processors can each have a path to data.

Storage Directors

The storage directors interpret channel commands and control the storage paths and controllers. A 3380 model CJ2 storage director is referred to as a single-path storage director.

Storage Paths

The storage cluster contains two storage paths. Each storage path separately connects to a controller.

There is a one-to-one relationship between the storage director and the storage path. Each storage director and therefore storage path is addressed from the channel by a single unique address. When the storage path is busy, a control-unit-busy status for the storage director address is reported to the channel. There are two storage paths to each device in a 3380 Model CJ2 subsystem.

Support Facility

The storage cluster in the 3380 Model CJ2 contains a support facility. A major RAS benefit, the support facility provides a remote maintenance support capability in installations with modems available to the CJ2. Among other tasks, the support facility also generates the service information messages, runs the maintenance analysis procedures (MAPs) and diagnostics, and maintains logs for the storage cluster.

The microprocessor-controlled support facility provides interfaces to:

- A diskette drive
- The cluster storage paths
- A remote support adaptor
- Cluster power sequence controls
- The operator panel
- The maintenance panel

The support facility provides the following reliability, availability, and serviceability functions:

- Monitors power to the storage cluster
- Maintains a record of errors and reports those errors that exceed established thresholds for the storage control
- Provides maintenance analysis procedure (MAP) interface for a service representative
- Permits support personnel to analyze certain machine conditions from a remote location through an external modem
- Provides nonvolatile microcode update capability
- Provides a capability to disable a defective path

Storage Control Error Logging

Machine-specific information such as sense bytes and the contents of status registers are logged on a diskette that is attached to the support facility. Using this information, the service representative can analyze storage control error log data without disrupting subsystem operations.

The error log information is also used by the support facility to generate a reference code for each service information message. The reference code identifies the error that occurred and the parts that are needed to repair the fault.

Service Information Alert Messages and Service Information Messages (SIMs)

The storage control portion of the 3380 Model CJ2 sends a service information message (SIM) to the host system to report that a storage control error has occurred. The host program displays a SIM Alert message on the operator console, and records the SIM message in the error recording data set (ERDS).

SIM Alert Message: The SIM Alert message is presented to the operator console to inform the operator that an EREP Detailed Edit Report, Type=A must be run. The information in the report is used to identify which storage subsystem reported the error, and provides information to the service representative to determine the replacement parts needed to correct the problem.

Service Information Message (SIM): The SIM contains all the information that the SIM Alert message contains and also provides more detailed information regarding the error, including the severity of the failure, and what effect the service action will have on subsystem performance. This information helps you start appropriate backup procedures as required, and provides you with the data necessary to schedule the maintenance procedure.

The individual who places the service call with IBM should report the machine type, serial number and reference code contained in the SIM, to IBM. This information reduces the time required for the service action.

For more details on SIM Alert and SIM see:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

Remote Support

Remote support allows support personnel in a remote support center to establish communication with the storage cluster portion of the 3380 Model CJ2 through an external modem. Once the communication link is established, the support personnel can analyze the error data and send maintenance information to the on-site service representative.

Microcode patching can be done through a remote support session. This requires significantly less time than physical delivery of a patch diskette. The CJ2 receives the patch over the remote support interface and writes the patch on the diskette. The patch is reloaded each time the subsystem is IMLed.

All remote support sessions are protected by an access code generated by the storage control portion of the CJ2. Having the CJ2 generate the access code ensures the integrity of remote session and prevents unauthorized data links.

Before initiating a remote support session, the on-site service representative requests the CJ2 to generate an access code. The access code is then given to the remote support center which then sends the access code to the CJ2. If the CJ2 receives the correct access code, the remote support session is established.

If the CJ2 receives an invalid access code three times, the access code is purged to prevent any further attempts to establish a remote support session and the CJ2 terminates the remote support session initiation. In addition, you can terminate the remote support session any time by setting the Modem switch on the CJ2 operator panel to Disable.

The remote maintenance support capability of the support facility in combination with the service information messages reduces maintenance activity time.

Chapter 3. Configuring and Attaching to the Operating System and Processor

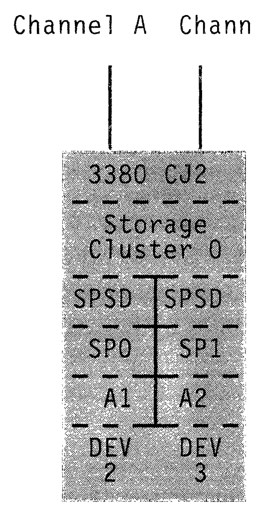
This chapter provides examples of valid attachment configurations for 3380 Model CJ2. It also describes operating systems and processors that support the CJ2.

Configurations

The 3380 Model CJ2 provides the capability of attaching one channel to each storage path, for a total of two channels to the unit. These channels can be from the same or different processors. Channels attached to the CJ2 must be capable of a data transfer rate of 3.0 Mb/sec.

The CJ2 can attach from one to three B-units and the B-units must be 3380 Models BJ4 or BK4.

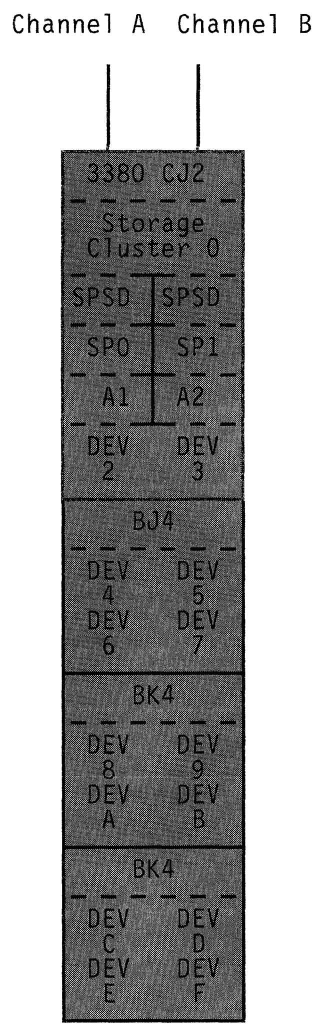
Figure 12 shows the minimum configuration for the CJ2. There are no B-units attached.



SPSD = Single–Path Storage Director
SP0 = Storage Path 0
SP1 = Storage Path 1
A1 = A1 Controller
A2 = A2 Controller
DEV = Device

Figure 12. Example of 3380 Model CJ2 Minimum Configuration. Note: The CJ2 has no Device 0 or Device 1.

Figure 13 shows the maximum configuration for the CJ2. In this example, one BJ4 and two BK4 units are attached to the CJ2, for a total of 14 devices on the string. However, 3380 BJ4 and BK4 units can be attached in any order or combination, for as many as three total B-units.



SPSD = Single-Path Storage Director
SP0 = Storage Path 0
SP1 = Storage Path 1
A1 = A1 Controller
A2 = A2 Controller
DEV = Device

Figure 13. Example of 3380 Model CJ2 Maximum Configuration. Note: The CJ2 has no Device 0 or Device 1.

Operating System and Processor Support

Programming support for the 3380 Model CJ2 is contained in the following IBM operating systems:

- MVS/Extended Architecture (MVS/XA)
- MVS/370
- Virtual Machine/Extended Architecture Systems Facility (VM/XA SF)
- Virtual Machine/System Product (VM/SP)
- Virtual Machine/System Product High Performance Option (VM/SP HPO)
- Virtual Storage Extended/System Package (VSE/SP)
- Virtual Storage Extended/Advanced Functions (VSE/AF)

IBM Environmental Record Editing and Printing (EREP) Version 3 Release 3.2 and Device Support Facilities (ICKDSF) Release 9.0 must be installed to support the 3380 Model CJ2.

For environment-specific information on any support restrictions and minimum software release levels required to support the CJ2 see:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

Because the 3380 Model CJ2 contains storage control functions, it attaches directly through a block multiplexer channel to the following processors:

- 308x
- 3090
- 4381
- 9375 and 9377

Channels on these processors must be capable of a data transfer rate of 3.0 Mb/sec.

Chapter 4. Planning for Installation and Use

This chapter provides information related to physical planning activities associated with the actual installation of 3380 Model CJ2 and associated B-units. Information on overall storage subsystem planning techniques that can help you to accommodate orderly growth of your storage resources is also included. I/O addressing, which is also a key aspect of storage hardware planning, is described in Appendix A, "Device Addressing and Identification" on page 35.

Physical Planning Considerations

Careful physical planning is part of ensuring smooth installation and use of 3380 units. An IBM installation planning representative can assist with this aspect of planning, and you can get detailed physical planning information in *IBM Input/Output Equipment: Installation—Physical Planning for System/360, System/370, and 4300 Processors* or *IBM 9370 System Installation Physical Planning.* The information presented here highlights some of the major considerations that require advance planning so that you can make optimum use of available floor space and accomplish quick and smooth installation of your 3380s.

Power Requirements

Primary AC power for a 3380 Model CJ2 is obtained through a single power attachment from the customer's three-phase power system. Except for the power attachment cord, there is no other provision for supplying primary AC power to the unit. Any power buffering systems (for example, an uninterruptible power system) must be provided by the customer and connected to operate in conjunction with the customer's electrical power outlet.

Power can be controlled at various levels within the CJ2 unit. Main AC power is controlled through the main circuit breaker in the CJ2. A subsystem power switch on the operator panel controls power to the CJ2. Depending on the setting of the Device Power Sequence switch and the A1 and A2 Controller Local/Remote switches (accessible only to a service representative), the subsystem power switch can also control power to any attached B-units.

A subsystem Power Select Local/Remote switch, set by the service representative, provides for local power control at the CJ2 or remote power control from the system operator console. Chapter 5, "Operation of the 3380 Model CJ2" on page 27 has detailed information on the CJ2 operator panel and procedures for power control.

Floor Space Requirements

The base of the 3380 Model CJ2 measures 1 130 millimeters (44.5 inches) in width and 815 millimeters (32 inches) in depth with covers, and occupies an area of 0.92 square meters (9.9 square feet). Additional service clearance areas are required for access by a service representative. See *IBM Input/Output Equipment: Installation—Physical Planning for System/360, System/370, and 4300 Processors* for a description of these clearances. Appropriate placement of the CJ2 and the B-units attached to it can optimize the use of the available space, by overlapping service clearance areas with other equipment. Planning for future growth when placing equipment can minimize movement of installed units as growth occurs.

The Model CJ2 is designed primarily for installation on raised floors to facilitate cabling to attach to processor channels. Alternate means can be used where raised floors are not available.

Cables

Standard cable entry and exit points for CJ2 units are located at the base of the unit. The 3380 Model CJ2 requires channel interface cables to attach to a processor channel. For remote power control from a processor system console a power sequence control cable is required.

Channel Interface Cables

Channel interface cable lengths are dependent on the processor channel to which the CJ2 is attached and the possibility of other control units attached to the channel.

Power Sequence Control Cables

In order to control power to the CJ2 from a processor console, a power sequence control cable is required.

Remote Support Communications Line

Remote support communications requires a customer-supplied analog telephone line (and handset for U.S. and Canada) within 50 feet of the CJ2.

Planning for Effective Use

A variety of factors affect efficient use of storage space, responsiveness and performance of the storage subsystem, and availability of data. Several of the general considerations in planning for effective use of 3380 disk storage are outlined here. However, the specific application workload and the operating system environment create a set of characteristics and needs that influence storage planning decisions. It is essential to use the following manuals in planning for the most effective use of 3380 storage in your specific environment:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

Block Size, or Physical Record Size

Selection of an appropriate block size for data stored on the 3380 is essential for both using space efficiently and for achieving optimum performance. Generally, wasted space on a track is minimized when a larger block size is used because there are fewer inter-record gaps. In addition, performance can be improved with larger block sizes because more data can be read or written with a single I/O operation. The needs of the application must also be considered in selecting an appropriate block size, but in general, larger block sizes are more efficient than smaller ones. See Appendix C, "Record Format, Track Format, and Space

Calculations" on page 47 for a more detailed description of block size considerations and techniques for block size calculation.

Data Placement and Distribution

Depending on the application and on the operating environment, the specific volume on which high-use data is placed, the location of the data on the volume, and the amount of free space on the volume can affect performance.

Spreading high-use data among multiple volumes and placing this data on strings with multiple access capabilities, as provided by DPS and DLS, provides both performance and availability advantages.

The arrangement and amount of data on the volumes themselves are considerations that vary with the different operating environments; for example, with MVS, the free space objectives for a volume and the ratios of used-to-allocated space and allocated-to-available space influence effective use of the disk storage.

Moving Data from an FBA to a CKD Device

When moving data from an FBA device, like the 3370, to a CKD device, like the 3380, it is especially important to consider the block size chosen for the data. The amount of space on a track or cylinder actually occupied by user data depends to a large extent on the block size that is specified. Block sizes that provide 100% utilization on a 3370 FBA DASD may provide less efficient space utilization of a 3380 CKD DASD track or cylinder. The greater data capacity of the 3380 will justify moving data even at less efficient block sizes, however it is important to make appropriate block size adjustments when you are moving data that previously resided on FBA volumes to the 3380.

Figure 14 shows increased efficiency of 3380 utilization with larger blocking factors (assuming fixed-length records without keys), or CI (Control Interval) for VSE/VSAM and sequential files. It compares a 3370 FBA DASD Model A02 or B02, that would provide 100% utilization for the same block size.

Physical Record Size (CI Size)	Percent of a 3380 Utilized	Mb of a 3380 CJ2 Utilized	Mb of a 3370 Utilized
512	50%	312.6	364.9
1024	67%	421.4	364.9
2048	78%	489.3	364.9
4096	86%	543.7	364.9
6144	90%	570.9	364.9

Figure 14. Effects of Blocking Sizes on Efficient Utilization

Appendix C, "Record Format, Track Format, and Space Calculations" on page 47, contains information on how to determine the number of fixed-length physical records that can be written on a 3380 track and cylinder. It also describes a formula used to calculate space requirements.

Chapter 5. Operation of the 3380 Model CJ2

The operator panel on the 3380 Model CJ2 includes a number of switches and lights to assist in monitoring the status of the 3380 string. This chapter illustrates the operator panel for the CJ2 and explains the purpose and use of the various switches.

Most CJ2 operations are controlled from a system operator console instead of from the CJ2 operator panel. System commands are issued from the system operator console to control CJ2 operations and to obtain its operational status. For information on specific operating system commands to make devices available or unavailable to the system or to check the status of a device, see:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

3380 Model CJ2 Operator Panel

The operator panel on 3380 Model CJ2 units is located on the front of the unit. 3380 Model BJ4 and BK4 units do not have an operator panel.

The operator panel gives you the capability to:

- Power on and off the subsystem
- Power on and off the controllers
- Enable or disable the channel interfaces
- Enable or disable each device
- Enable or disable the modem interface
- Monitor the state of the CJ2 indicators

Important: Ensure that 3380 devices and controllers are offline to the operating system before making changes to the current switch settings on the operator panel or before any hardware maintenance is performed.

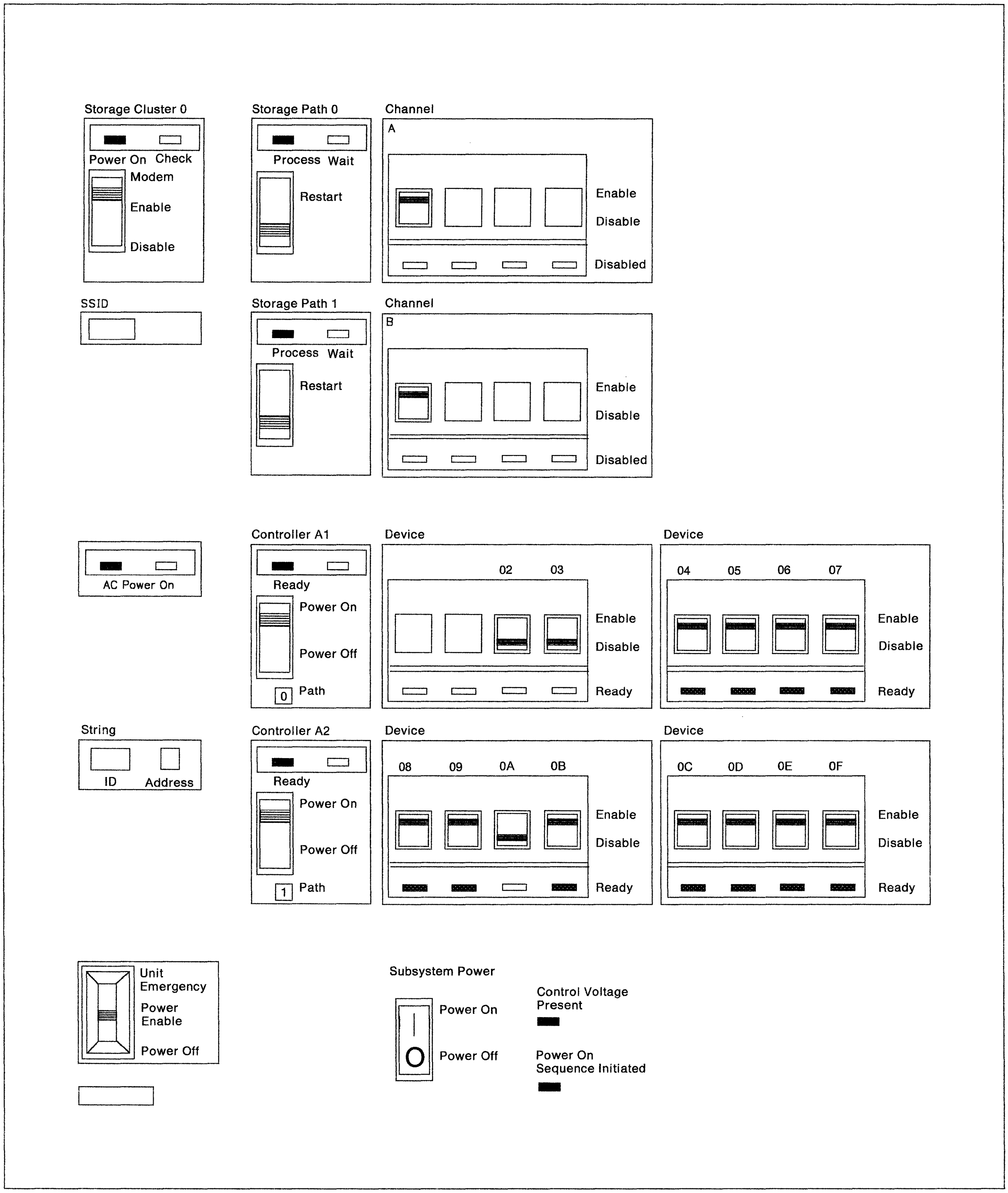


Figure 15. 3380 Model CJ2 Operator Panel

Power Control

Power for CJ2 operations can be controlled remotely from the system operator console when the processor is powered on and off. This remote power control requires installation of a remote power sequence cable between the CJ2 and each processor from which you want remote power control. Alternatively, power can be controlled locally wherever the CJ2 string is located.

The remote or local power control of a CJ2 depends on the position of the subsystem Power Select Local/Remote switch, which is accessible only to the service representative. If power is to be turned on or off remotely from the processor, the Power Select Local/Remote switch must be in the Remote position. If power is to be turned on or off locally from the Subsystem Power switch on the CJ2 operator panel, the Power Select Local/Remote switch must be in the Local position. Ask the service representative to set it to the position you prefer.

There are several levels of power control within a 3380 Model CJ2 unit. Switches inside the CJ2 unit (that are accessible only to a service representative) and switches on the operator panel control which portions of the CJ2 unit and the attached B-units are powered up or down. For normal operations, you should ask the service representative to set the Device Power Sequence switch to Enable and the A1 and A2 Local/Remote switches to Remote. This allows the switches on the operator panel to control power to the CJ2 unit and devices in the attached B-units.

The two controller power switches on the operator panel indirectly control power to all devices in the CJ2 string. If both of these switches are off the devices will not power up. One or both of the controller power switches must be on for the devices to power on. Both controller power switches should be on for normal operation.

There are three indicators that provide status of the power system.

AC Power On: when on, indicates that the 3380 Model CJ2 unit is connected to the AC power supply at the installation and the CJ2 main circuit breaker is on. Even though lit, the AC Power On indicator does not mean that the unit or string has completed its warm-up cycle. It also indicates that the DASD +24 volts is present.

Control Voltage Present: when on, indicates that the +24 volt DC control voltage is present in the the storage control portion of the CJ2.

Power On Sequence Initiated: when on, indicates that the CJ2 power on sequence has started, either locally from the operator panel or remotely from the processor.

Emergency Power Off

The Unit Emergency switch on the CJ2 operator panel should be used to turn off power in an emergency. When the switch is in the Power Off position, power is turned off to the entire string.

The Unit Emergency switch should not be used to turn power back on. An attempt to do this could result in incorrect power sequencing. Call a service representative to restore power. The Unit Emergency switch is not used for normal power off and on by the operator.

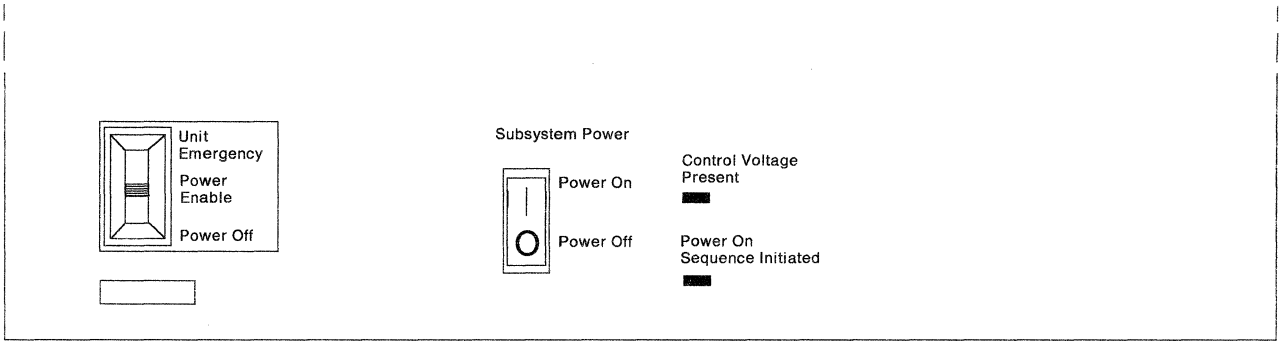


Figure 16. Unit Emergency Switch on the CJ2 Operator Panel

Powering On from the Processor

Make sure the Unit Emergency switch on the CJ2 is in the Power Enable position. Power on the processor. The processor's power on sequence generates the signal to power on the CJ2. The Power On Sequence Initiated indicator will light when the sequence starts.

The devices will also power on depending on the setting of the Device Power Sequence switch and the A1 and A2 Local/Remote switches. These switches are set by a service representative.

Powering On from the Operator Panel

The Unit Emergency switch must be in the Power Enable position to power on the subsystem from the operator panel. Press the Subsystem Power On/Off switch. The Power On Sequence Initiated indicator will light when the sequence starts.

Powering Off from the Processor

Power off the processor. The processor generates a power off signal to power off the CJ2.

Powering Off from the Operator Panel

Press the Subsystem Power On/Off switch to power off the CJ2.

Controller Power On/Off Switch

Each controller in the CJ2 string can be individually powered on and off from the operator control panel. The Controller Ready light is on when the controller is ready.

As a general rule, the Controller Power On/Off switches must be in the "On" position before making the CJ2 string available to the operating system.

A Controller Power On/Off switch should not be set to "Off" until all the devices in the string have been made unavailable to the operating system and are considered offline.

Device Enable/Disable Switch

An Enable/Disable switch on the operator control panel controls the availability of each device on the CJ2 string. The switches can be set to the Enable or Disable position by the operator. A Ready light comes on when the associated device is ready to be accessed.

For normal operation, the switches for all devices in a CJ2 string are in the Enable position. As a general rule, the Enable/Disable switch for a device must be in the Enable position before making the device available to the operating system.

An Enable/Disable switch should not be set to Disable until the device has been made unavailable to all operating systems and is considered to be offline. Ensure that the device is offline to all systems before setting the Enable/Disable switch to the Disable position or before any hardware maintenance is performed. The device is made unavailable (that is, the Ready indicator for the device is not on) as soon as the device is not busy.

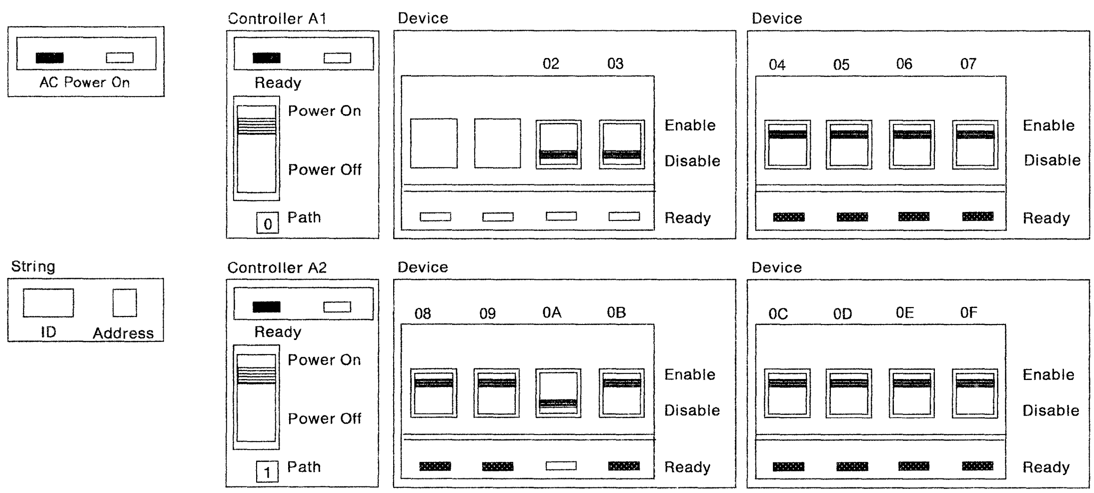


Figure 17. Device Enable/Disable Switches on 3380 Model CJ2 Operator Panel

A device Enable/Disable switch can be used to:

- Provide access to a duplicate copy of the system volume. If a system failure occurs that requires re-IPL, the operator can set the switch to Enable to make the backup system volume available and recover the system more quickly.
- Provide an additional level of data security. For example, personnel and payroll data can be stored on one volume. The operator can be instructed to keep the device that contains a Personnel and Payroll volume switched to Disable, until that volume is needed for processing.

Storage Cluster 0

The storage cluster switches and indicators are:

- Power On indicator
- Check indicator
- Modem Enable/Disable switch

Power On: when on, indicates that the correct voltages are being supplied to the storage cluster.

Check: when on, indicates that an error has occurred in the storage cluster.

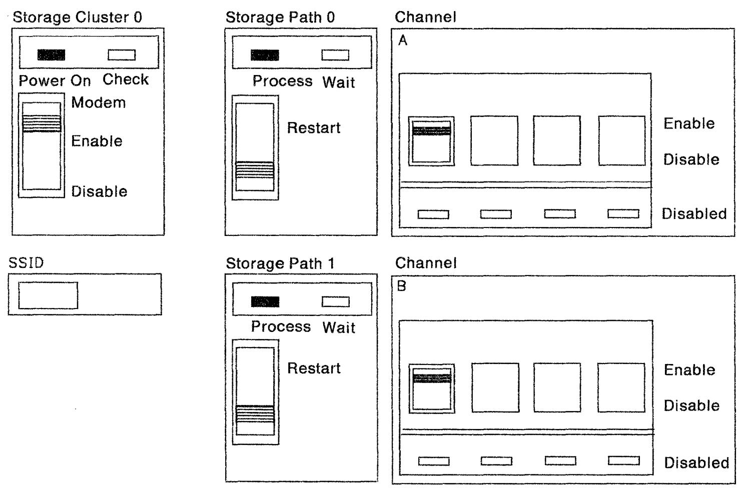


Figure 18. Storage Cluster and Channel Switches on 3380 Model CJ2 Operator Panel

Enabling or Disabling a Remote Support Session

Set the Storage Cluster Modem Enable/Disable switch to Enable to allow a remote support session. Set the Storage Cluster Modem Enable/Disable switch to Disable to prevent or terminate a remote support session.

Storage Paths/Channels

The 3380 Model CJ2 contains two storage paths. Storage path 0 attaches to channel A and storage path 1 attaches to channel B. The status indicators for each storage path and channel are:

Process indicator: when on, indicates that the storage path is processing functional requests.

Wait indicator: when on, indicates that the storage path is waiting for a functional request.

Disabled indicator: when on, the channel is disabled to that storage path; when off, the channel is enabled to that storage path.

Enabling a Channel to a Storage Path

For the appropriate storage path, set the Channel Enable/Disable switch to Enable. The Disabled indicator will not be on, when the channel is enabled.

Disabling a Channel to a Storage Path

For the appropriate storage path, set the Channel Enable/Disable switch to Disable. The Disabled indicator will light when all activity stops on the channel.

Restarting a Storage Path

The storage path Restart switch permits the starting of a storage path during error recovery.

CAUTION
Do not activate a storage path Restart switch unless directed to do so by error recovery procedures.

If the storage path is fenced, the storage path will IML. If the storage path is not fenced, restarting a storage path does the following:

- Stops the current operation
- Performs a state save
- Resets the current operation
- Resets all hardware checks
- Initializes all internal processes
- Resumes storage path operations.

Appendix A. Device Addressing and Identification

Each 3380 device is uniquely addressable and is assigned specific identifiers so that the processor can select the appropriate device and the storage subsystem can handle the data transfer. Devices have the following kinds of identifiers:

- **I/O Address**

  An I/O address is a two-byte designation used by a processor to establish a data transfer path to a specific device. The rightmost byte is often referred to as a *unit address*, and the leftmost byte represents a processor channel. Because multiple channels can be attached to storage directors, a device can be accessed by more than one I/O address. See "I/O Addressing" below for detailed information.

- **Physical Identifier**

  Each physical component of the DASD subsystem has a unique physical identifier. These identifiers are useful in interpreting EREP output and console messages. See "Physical Identifiers" on page 40 for further information on physical identifiers.

- **Device Number**

  The device number designation is used in System/370 Extended Architecture operating environments only. It is recommended that the rightmost byte of the I/O address (unit address) and the device number be the same for a specific device. However, this is not a requirement. See *MVS/XA Installation: System Generation* or *VM/XA SF Installation, Administration, and Service* for additional information on device numbers.

I/O Addressing

The assignment of I/O addresses is an important part of the planning that must take place before new I/O units can be installed. The I/O address for each device in each new 3380 unit must be assigned before the storage devices can be defined to the operating system. See the following manuals for further information on the processes for defining devices to the operating system:

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

In addition, the service representative needs to know the I/O addresses so the 3380 Model CJ2 can be set to recognize the assigned addresses. Appendix B, "3380 Model CJ2 Configuration Data Worksheets" on page 41 provides charts and tables you can use to record configuration and addressing information for your CJ2. If there are plans to install additional 3380 strings or to add additional B-units to existing strings at a later time, the I/O addresses for the planned storage hardware can be predefined to the operating system and will be automatically marked offline or unavailable during IPL of the system.

An I/O address represents a specific access path to the device and is composed of the following elements:

- Processor channel address
- Storage director address
- String (or controller) address
- Device address

For two paths to a device it is essential that the storage director, string, and device portions of the I/O addresses be identical. Only the processor channel portion of the addresses may be different.

Most DASD is configured with multiple channel attachment, and the devices are thereby accessible by multiple I/O addresses.

I/O Addresses for 3380 Model CJ2

A 3380 device and the other hardware elements used to access the device are described by a 2-byte I/O address. The leftmost byte represents the channel. When the channel has a value of 15 (hexadecimal F) or less, the leftmost hexadecimal digit of this byte is sometimes dropped, and three hexadecimal digits are used to specify an I/O address.

Bit assignments for the rightmost byte of the I/O address depend on the address range (8 or 16) being used for the CJ2 string. "I/O Addresses for 3380 Model CJ2 with an Address Range of 8" provides specific requirements, structure, and bit assignments for the address elements for CJ2 strings with an address range of 8. "I/O Addresses for 3380 Model CJ2 with an Address Range of 16" on page 38 provides specific requirements, structure, and bit assignments for the address elements for CJ2 strings with an address range of 16.

I/O Addresses for 3380 Model CJ2 with an Address Range of 8

The bit composition for the rightmost byte of the I/O address for a CJ2 string with an address range of 8 is shown in Figure 19.

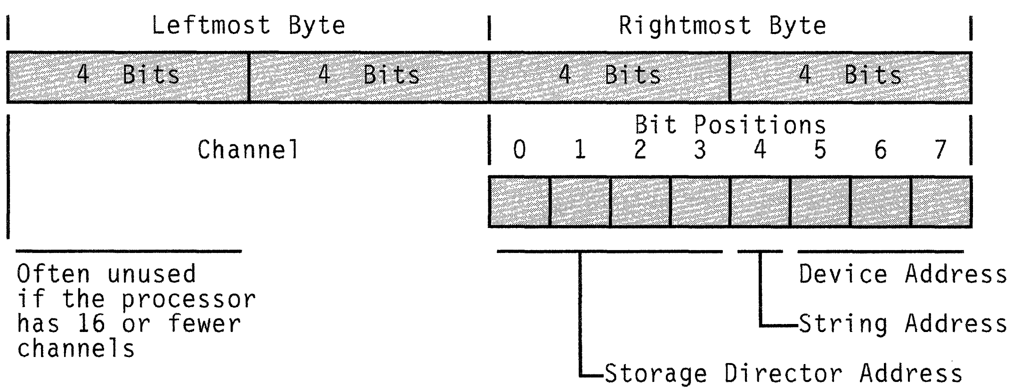


Figure 19. I/O Address Composition for a CJ2 with an Address Range of 8

The storage director address (bits 0, 1, 2, and 3) represents the address of the storage director in the selection path for the device. Each storage director address is set in the 3380 Model CJ2 by the service representative.

The string address (bit 4) refers to the address (binary 0 or 1) associated with the controllers in the CJ2. Both controllers in the unit must have the same string address. The string address is also set by a service representative when the CJ2 is installed.

The device address within a string (bits 5 through 7) is specified by a binary value between 000 through 111 (hexadecimal 0 through 7). In a CJ2 string, device addresses must start with 0 and run sequentially from the beginning of the string. Although there is no device 0 and 1, device address in the CJ2 must start with 0. Device 2 and 3 are actually the first devices on the string. The device addresses of devices in other units of the string have sequential values, depending on their position in the string. An individual device address cannot be changed.

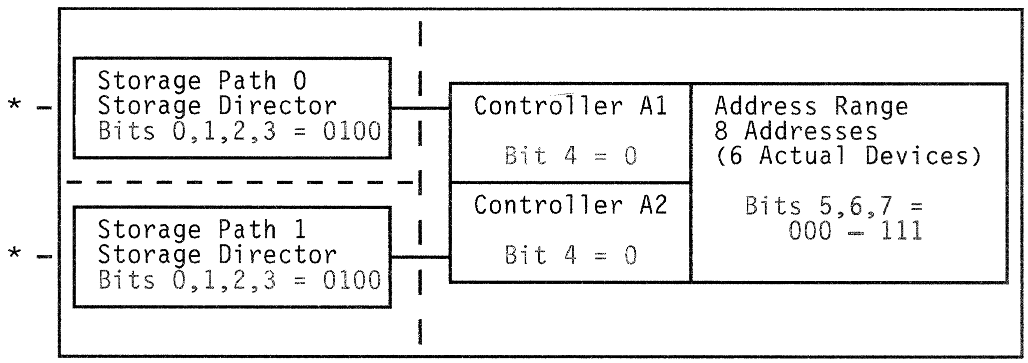
Figure 20 shows the valid address ranges for a CJ2 string with an address range of 8. Only the rightmost byte of the I/O address is shown. The leftmost byte can be any valid channel address.

String Address 0	String Address 1
00 – 07	08 – 0F
10 – 17	18 – 1F
20 – 27	28 – 2F
30 – 37	38 – 3F
40 – 47	48 – 4F
50 – 57	58 – 5F
60 – 67	68 – 6F
70 – 77	78 – 7F
80 – 87	88 – 8F
90 – 97	98 – 9F
A0 – A7	A8 – AF
B0 – B7	B8 – BF
C0 – C7	C8 – CF
D0 – D7	D8 – DF
E0 – E7	E8 – EF
F0 – F7	F8 – FF

Figure 20. Valid Ranges for a CJ2 8-Address String

The example shown in Figure 21 shows an example of a CJ2 string with an address range of 8. The storage directors have a binary address of 0100; the resulting hexadecimal value of 4 is the leftmost hexadecimal digit for accessing the devices on the string. The rightmost hexadecimal digits in the valid address range are derived from the string binary address of 0 and the sequential device addresses, binary 000 through 111, or hexadecimal 0 through 7. The hexadecimal address of 0 and 1 are not actually used for the CJ2 string, as hexadecimal address 2 is the first device on the string. However, hexadecimal addresses of 0 and 1 ***cannot*** be used for other devices

3380 Model CJ2 and 1 Model BK4
Addresses 40 – 47 via both storage directors and storage paths



* = One processor channel

Figure 21. Addressing Example for an Address Range of 8. A CJ2 and one BK4 (6 Devices) requiring a minimum address range of 8.

I/O Addresses for 3380 Model CJ2 with an Address Range of 16

The bit composition for the rightmost byte of the I/O address for a CJ2 string with an address range of 16 is shown in Figure 22.

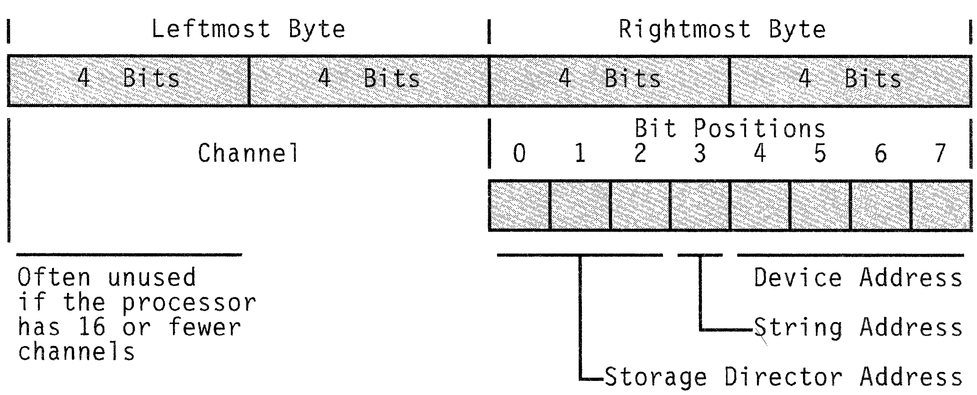


Figure 22. I/O Address Composition for a CJ2 with an Address Range of 16

The storage director address (bits 0, 1, and 2) represents the address of the storage director in the selection path for the device. Each storage director address is set in the 3380 Model CJ2 by the service representative.

The string address (bit 3) refers to the address (binary 0 or 1) associated with the controllers in the CJ2. Both controllers in the unit must have the same string address. The string address is also set by a service representative when the CJ2 is installed.

The device address within a string (bits 4 through 7) is specified by a binary value between 0000 through 1111 (hexadecimal 0 through F). In a CJ2 string, device address ranges must start with 0 and run sequentially from the beginning of the string. Although there is no device 0 and 1, device address ranges in the CJ2 must start with 0. Device 2 and 3 are actually the first devices on the string. The device addresses of devices in other units of the string have sequential values, depending on their position in the string. An individual device address cannot be changed. If a string with fewer than 14 physical devices is attached to a storage director, the unused device addresses cannot be assigned to devices on another string.

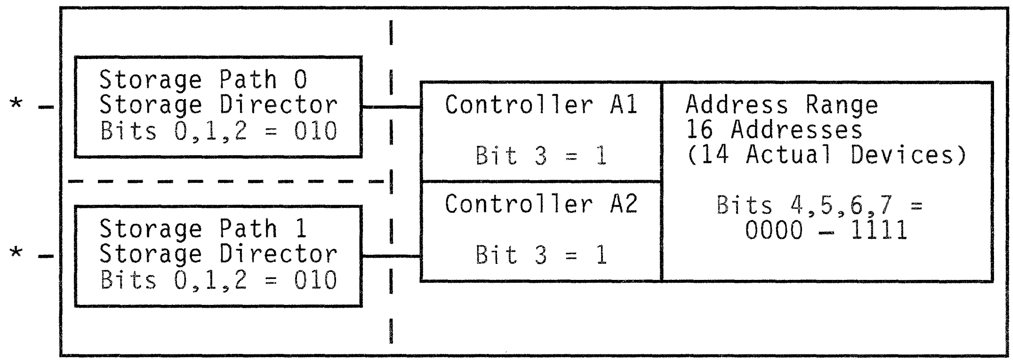
Figure 23 shows the valid address ranges for a CJ2 string with an address range of 16. Only the rightmost byte of the I/O address is shown. The leftmost byte can be any valid channel address.

String Address 0	String Address 1
00 – 0F	10 – 1F
20 – 2F	30 – 3F
40 – 4F	50 – 5F
60 – 6F	70 – 7F
80 – 8F	90 – 9F
A0 – AF	B0 – BF
C0 – CF	D0 – DF
E0 – EF	F0 – FF

Figure 23. Valid Ranges for a CJ2 16-Address String

The example shown in Figure 24 shows a CJ2 string. The storage directors have a binary address of 010, and the string has a binary address of 1. The resulting hexadecimal value of 5 is the leftmost hexadecimal digit for the valid address range (50 - 5F) for accessing the devices on the string. The rightmost hexadecimal digits in the valid address range are derived from the sequential device addresses, binary 0000 through 1111, or hexadecimal 0 through F. The hexadecimal address of 0 and 1 are not actually used for the CJ2 string, as hexadecimal address 2 is actually the first device on the string. However, hexadecimal addresses of 0 and 1 ***cannot*** be used for other devices

```
3380 Model CJ2 and 3 Model BK4s
  Addresses 50 - 5F via both storage directors and storage paths
```



* = One processor channel

Figure 24. Addressing Example for an Address Range of 16

Physical Identifiers

A 3380 Model CJ2 string can be accessed by two channels from one or two processors. As a result, a 3380 device can be accessed by any of several different I/O addresses.

To simplify the identification of a specific component, the storage subsystem sense bytes include a one-byte physical identifier to pinpoint the component that may have a problem. There are unique identifiers established for each storage subsystem, string, and device.

Devices have pre-assigned physical identifiers that are determined by their physical relationship to the CJ2 unit. Physical identifiers for the storage subsystem and for the string (that is, the controller) are set with switches by the service representative at the time that the I/O addresses are set during installation. Space is provided on the 3380 Model CJ2 operator control panel to affix labels for the subsystem identifier (SSID) and the string identifier.

Appendix B. 3380 Model CJ2 Configuration Data Worksheets

This appendix contains a series of charts and tables that describe and record the subsystem configuration data fields. Appendix A, "Device Addressing and Identification" on page 35 contains detailed information on addressing that you use with these charts. During the installation procedure, and during subsequent updates, 3380 Model CJ2 softcopy Maintenance Analysis Procedures (MAPs) instruct the service representative to enter the configuration data into the CJ2's vital product data storage. The MAPs also store a copy of the subsystem configuration data in a "backup" record on the diskette.

How to Record Your Subsystem Configuration Data

1. Copy and complete the user part of the Subsystem Layout Charts.
2. Copy the Vital Product Data tables and transcribe the subsystem configuration data from the Subsystem Layout Charts to the Configuration Data column of the appropriate tables.
3. Give a copy of the tables to the service representative who installs your CJ2.

Subsystem Layout Charts

3380 Model CJ2 Channel Interface (CHL-I) Configuration

Customer supplied information

```
************************************************
CPU ID ________________ | CPU ID ________________
A CHANNEL _____________ | B CHANNEL _____________
SD 0 CUA ______________ | SD 1 CUA ______________
************************************************
```

Installation Planning Representative (IPR) supplied information

From______		To______		From______		To______	
K______		K______		K______		K______	
L______		L______		L______		L______	
Bus	Tag	Bus	Tag	Bus	Tag	Bus	Tag
In		Out		In		Out	
Channel A				Channel B			

LEGEND

P = Processor Identifier　　K = Key
CUA = Control Unit Address　　L = Length
SD = Storage Director

3380 Model CJ2 Storage Cluster and String Configuration

Address Range for the Subsystem (8 or 16): ________

Note: Both storage directors have the same SSID.
Both controllers have the same String Address and String Identifier.

3380 Model CJ2 S/N __________		
SSID ______	Storage Cluster 0 SD 0 : SP 0	SD 1 : SP 1
A1 Controller		A2 Controller
Device 2		Device 3
Device 4 Device 6	3380 B__4 S/N________	Device 5 Device 7
Device 8 Device A	3380 B__4 S/N________	Device 9 Device B
Device C Device E	3380 B__4 S/N________	Device D Device F

String Address (0 or 1) ______

String Identifier ________

LEGEND

SD = Storage Director
SP = Storage Path
SSID = Subsystem Identifier

S/N = Serial Number

Vital Product Data Tables

Machine Type and Data Link Type

Field Name	Field Description	Configuration Data
Machine Type	3380 Model CJ2 = 3380	3380
Data Link	1 = US and Canada 3 = Other countries	

Subsystem Identifiers (SSIDs)

Field Name	Field Description	Configuration Data
SSID for Storage Directors (SD) 0 and 1	The SSID can be in the range 0001 to 00FF. Assign an SSID for Storage Director 0. The CJ2 copies the Storage Director 0 SSID to Storage Director 1.	

Assigning a Channel to CJ2 Storage Directors through Control Unit Addresses

You assign one channel to **one and only one** of the storage directors in a 3380 Model CJ2. Assigning a storage director control unit address assigns the channel to that storage director. When you assign a channel to one CJ2 storage director, you cannot assign that channel to the other storage director.

Assigning a Channel to CJ2 Storage Director 0 (Channel/Device Configuration Data)

Field Name	Field Description	Configuration Data
Address Range Value for the CJ2 Logical DASD Subsystem	Specify a device address range value for the logical DASD subsystem. It is best to use the maximum planned number of devices on the subsystem, rather than the actual number. This eliminates the need to IML the CJ2 when you add other B-units. The address range can be 8 or 16.	Address Range
Control Unit Address Values for CJ2 Storage Director 0	The hexadecimal control unit (CU) address is the high-order part of each device address. **Specify a control unit address for the channel that you want to assign to Storage Director 0.** The string address (0 or 1) and the address range determines the control unit addresses you can assign each storage director. For **address range 8 and string address 0,** the CU address can be: 00, 10, 20, 30, 40, 50, 60, 70, 80, 90, A0, B0, C0, D0, E0, or F0. For **address range 8 and string address 1,** the CU address can be: 08, 18, 28, 38, 48, 58, 68, 78, 88, 98, A8, B8, C8, D8, E8, or F8. For **address range 16 and string address 0,** the CU address can be: 00, 20, 40, 60, 80, A0, C0, or E0. For **address range 16 and string address 1,** the CU address can be: 10, 30, 50, 70, 90, B0, D0, or F0.	CU Address SD 0 A Channel:

Assigning a Channel to CJ2 Storage Director 1 (Channel/Device Configuration Data)

Field Name	Field Description	Configuration Data
Address Range Value for the CJ2 Logical DASD Subsystem	Specify a device address range value for the logical DASD subsystem. This is the same number you specified on the table for Storage Director 0. The address range can be 8 or 16.	Address Range
Control Unit Address Values for CJ2 Storage Director 1	The hexadecimal control unit (CU) address is the high-order part of each device address. **Specify a control unit address for the channel that you want to assign to Storage Director 1.** The string address (0 or 1) and the address range determines the control unit addresses you can assign each storage director. For **address range 8 and string address 0,** the CU address can be: 00, 10, 20, 30, 40, 50, 60, 70, 80, 90, A0, B0, C0, D0, E0, or F0. For **address range 8 and string address 1,** the CU address can be: 08, 18, 28, 38, 48, 58, 68, 78, 88, 98, A8, B8, C8, D8, E8, or F8. For **address range 16 and string address 0,** the CU address can be: 00, 20, 40, 60, 80, A0, C0, or E0. For **address range 16 and string address 1,** the CU address can be: 10, 30, 50, 70, 90, B0, D0, or F0.	CU Address SD 1 B Channel:

Appendix C. Record Format, Track Format, and Space Calculations

This appendix describes the physical record format and the track format for the 3380. In addition, a technique for effective space calculation is presented, along with tables to help you select an efficient physical record size for meeting your needs. The information in this appendix applies to all models of the 3380.

Physical Record Format

A ***physical record*** is the structure for physically storing data on the 3380. Usually each physical record contains both user data and other types of data for control purposes. The organization of user data in a physical record is not relevant to how the 3380 reads and writes the record.

A ***logical record*** is the structure for data that is recognized and used by the application. One or more logical records might be stored in a physical record. Alternatively, a logical record might be split among two or more physical records. The format of a logical record may be fixed length or variable length.

To use the 3380 effectively, it is important to understand the format of the physical record. A physical record can contain three areas: count, key, and data. Because the key area is optional, records can consist of only two areas: count and data. Each area within a record is separated by a gap, and two adjacent records are separated by a gap. Error checking and correcting (ECC) code bytes that are used to detect and correct read/write errors are added to each area whenever a record is written.

Count Area: The count area indicates the location of a physical record. Each record location is defined by:

- Cylinder number (CC), 2 bytes that represent the following decimal values:
  - 0 to 884 for single capacity models (BJ4 and CJ2)
  - 0 to 2654 for triple capacity models (BK4)
- Read/Write Head number (HH), 2 bytes that represent a decimal value from 0 to 14. A record is located on the track (in a cylinder) accessible by read/write head HH.
- Record number (R), one byte value (0 or greater) that specifies the record location relative to other records on the track.

Each count area also specifies the length of the other two areas:

- The key length (KL), or length in bytes of the key area. If the record is written without a key area, the KL value is 0.
- The data length (DL), or the length in bytes of the data area. For an end-of-file (EOF) record, the DL value is 0; see "How Many Records per Track?" on page 50 for additional information on EOF records.

The count area is written when the record is formatted (initially written to the disk) and is not changed until the record is reformatted (written with a modified key length or data length).

Key Area: The key may be used by the application and is optional.

Once you format the key area, you may rewrite its contents without reformatting the record. If you rewrite the key area, you must also rewrite the data area.

If you lengthen or shorten the key area, you must reformat the track with modified count, key, and data areas.

Data Area: The data area contains user data; that is, the logical records of an application.

After the data area is formatted (initially written to the disk), the contents may be rewritten without reformatting the record. If you do not change the data length, you may rewrite the data area without changing or rewriting any other area.

If you lengthen or shorten the data area, you must reformat the track with modified count, key (if any), and data areas.

Track Format

The start and end of each track are defined by a magnetic mark on the disk surface called the *index point*. (Because a track is circular, the same index point defines both the start and end points.) All tracks are written with formatted records, beginning at the index point and ending when the index point comes around again. Each track has the same basic format (as shown in Figure 25): index point, home address (HA), record zero (R0, also called the track descriptor record), and one or more data records (R1 through Rn). All DASD units leave the factory with home address and a standard record zero on every track.

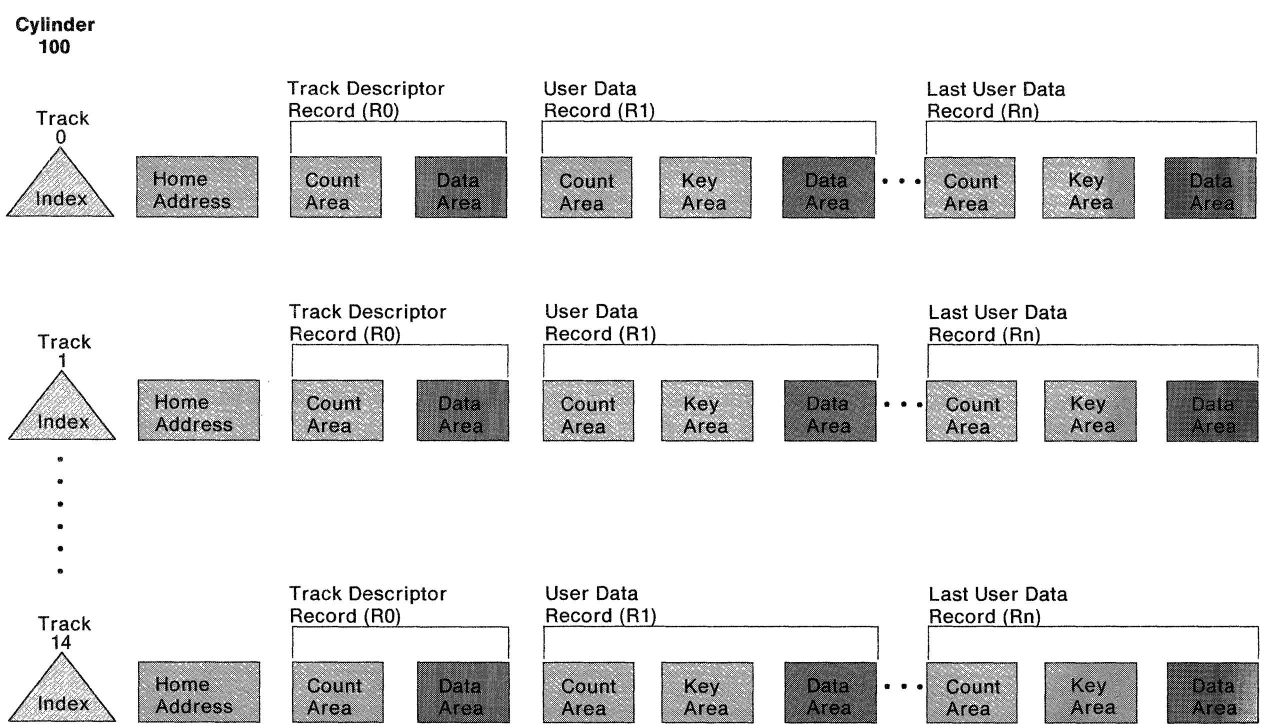


Figure 25. Track and Record Format, Simplified Representation (Standard R0)

Home Address (HA): Each track contains a home address (HA) following the index point. The HA contains the track address, as defined by the track cylinder (CC) and read/write head (HH) used to access the track data. The home address flag byte (F) contains information describing the status of the track and indicates whether the track is usable, defective, or is an alternate track. The home address is an integral part of the DASD logic that is required for correct operation.

Record Zero (R0), the Track Descriptor Record: The record zero (R0), or track descriptor record, is always the first data record on the track following the home address. A standard R0, written on every track before the DASD unit leaves the factory, has a key length of 0 and a data length of 8 bytes. A nonstandard R0 can be used as a normal data record with the key length and data length determined by the user.

If the track home address flag indicates that the track is defective, the count area of the track R0 must contain the track address of an alternate track. The alternate track R0 count area contains the track address of the defective track it replaces.

The channel command words (CCWs) used for writing and reading an R0 are Write Record 0 and Read Record 0.

Data Records (R1 through Rn): One or more data records (physical records other than the home address and record zero) may follow the R0 on a track. A data record must be contained entirely on one track; that is, the record cannot begin on one track and continue on the following track.

Data records can be formatted with or without key areas, as determined by the file organization specified by the application that uses the data.

Data Records per Track

The number of equal-length data records that can be placed on a track depends on the size of the records, the track capacity, and whether or not the records include key areas. The size of each data record is determined by the application that formats the record.

Data record size can be specified by the programmer who prepares CCW chains to write and read the records. Another way of specifying data record size is for the programmer to define data characteristics to an application or operating system and let the application or operating system determine the record size, format the data, and write and read the data records to the 3380.

On any given track, the maximum record size is determined by the track capacity, with overhead subtracted. Track overhead is the sum of the space required for element such as:

- Home address
- Record zero
- Count field
- Inter-record gaps
- Gaps between count, key and data areas
- ECC bytes

"Calculating Space Requirements" on page 50 provides guidelines for making overhead allowances when calculating records per track.

Calculating Space Requirements

In selecting an appropriate physical record size (block size) for an application, it is useful to understand how efficiently a specific physical record size uses the space on a 3380 volume. More specifically, you need to consider:

- The number of equal-length physical records of a specified length that can fit on a track and a cylinder
- The amount of user data a track or cylinder can contain when it is filled with equal-length physical records of a specific length

While you are planning for the installation of new 3380 units, consider the blocking factors for the data that will be stored on the new volumes. As you migrate to your new hardware, you may want to reblock your data for more efficient use of 3380 storage space. Further information and guidelines for determining optimum block sizes for particular operating environments can be found in :

- *Using the IBM 3380 Direct Access Storage in an MVS Environment*
- *Using the IBM 3380 Direct Access Storage in a VM Environment*
- *Using the IBM 3380 Direct Access Storage in a VSE Environment*

To help you in optimum block size selection, the tables at the end of this appendix show the percentage of storage space that is utilized with physical record sizes of various data lengths (DLs). These tables also show the maximum track and cylinder capacity for the various physical record sizes. The calculations that follow are provided to help you understand how the table values are derived.

How Many Records per Track?

Each 3380 track is divided into 1499 user data cells, each of which has a length of 32 bytes. Records written on a 3380 track are always written at the beginning of a 32-byte cell and continue through one or more contiguous 32-byte cells. Gaps (areas that contain no data) occur between physical records and between the count, key, and data areas of records, but no gaps occur between 32-byte cells.

Each file is terminated with an end-of-file (EOF) record. An EOF record is a unique record; the key-length (KL) field and the data length (DL) field in the count area have a value of zero, but there will be a data area of one cell that contains 12 ECC bytes and zeros. Each EOF record requires 16 cells of track space. In the unique case of the MVS Partitioned Access Method (PAM), several files can exist on a single track; thus, there can be several EOF records on a single PAM track.

In the following formulae and sample calculations, elements or values that are variables are shown in red, and constants are shown in black.

Equal-Length Physical Records

The number of equal-length physical records that can be stored on a track can be determined by:

```
Equal-length       1499
  records     = -----------  (with fractional remainder dropped)
 per track       C + K + D
```

where:

1499 is the number of 32-byte user data cells per track available for physical records (R1 through Rn).

C is the number of 32-byte cells used for the count area and for gaps (between the count area and the previous record and between the count area and the key or data area)

C = 15

K is the number of 32-byte cells used for the key area and for the gap between the key area and the data area.

K = 0 if there is no key area.

If there is a key area,

```
        key length + E    (rounded to the
K = G + ----------------   next higher integer)
              32

     where
     G = Gap before key field  = 7
     E = ECC bytes = 12
```

D the number of 32-byte cells used for the data area.

```
     data length + E    (rounded to the
D = -----------------    next higher integer)
           32

     where
     E = ECC bytes = 12
     Note: Inter-record gaps for "data length" are included in C = 15
```

For example, an MVS partitioned data set (PDS) directory record is written as a physical record that has:

```
Key length = 8 bytes
Data length = 256 bytes
```

To determine the number of PDS directory records that can fit on a track:

```
Number          1499
of PDS   = ---------------
Records     C  +  K  +  D

                      1499
         = ----------------------------------
                      (8 + 12)    (256 + 12)
            15 + (7 + --------) + ----------
                         32           32

                    1499
         = -------------------------
                        20      268
            15 + (7 + ----) + -----
                        32      32

                  1499
         = ---------------------
            15 + (7.63) + (8.38)
```

... next, round K and D to the next higher integer:

```
                  1499
             = ------------ = 46.8
                15 + 8 + 9
```

... and, finally, remove the fraction remaining:

```
             = 46 PDS directory records per track
```

Twelve bytes are added to the key length (K + 12) and data length (D + 12) values, to account for the 12 bytes of error checking and correction (ECC) code data the 3380 appends to each key and data area. The key length (KL) and data length (DL) values are then rounded up to multiples of 32 because each key area and data area is written in one or more contiguous 32-byte cells.

Unequal-Length Physical Records

To determine the number of physical records that can be stored on a track, first calculate the length of each physical record to be stored on the track. Next, subtract the length of each record from the amount of available space that remains, until the track capacity is reached.

To determine the number of 32-byte cells that comprise a physical record, use the following formula:

```
Record length = C + K + D
```

where:

C is the number of 32-byte cells used for the count area and for gaps (between the count area and the previous record and between the count area and the key or data area)

C = 15

K is the number of 32-byte cells used for the key area and for the gap between the key and data area

K equals = 0 if there is no key area.

If there is a key area,

```
           key length + E     (rounded to the
K = G + ----------------      next higher integer)
                32

    where
    G = Gap before key field = 7
    E = ECC bytes = 12
```

D is the number of 32-byte cells used for the data area

```
     data length + E     (rounded to the
D = -----------------     next higher integer)
           32

    where
    E = ECC bytes = 12
    Note: Inter-record gaps for "data length" are included in C = 15
```

If the track descriptor record is an IBM standard R0 (an R0 with no key and an 8-byte data area), track capacity (the amount of space available for physical records that contain user data) is 1499 32-byte cells. If there is no R0, the track capacity contains 16 additional cells.

If the first record on the track is not an IBM standard R0, the track might begin with a track descriptor record designed by the user, or might not include a track descriptor record at all. Without the IBM standard R0 record, track capacity (for records R0 or R1 through Rn) is 1515 32-byte cells.

Tables for Space Calculation: Without and With Keys

The number of records that can be placed on a track depends on the data length of each record and whether or not the record includes a key area. Because partial records cannot be written on a track, the number of equal-length records that can fit on a track is the same over a range of data lengths.

The percentage of track space used for data assumes the track contains the maximum number of records, each of which is the largest possible for the given data-length range. The track and cylinder capacity values in the tables specify the number of bytes available for user data.

Figure 26 on page 55 shows the number of equal-length records that can be written on a track when the records do not include keys. Figure 27 on page 57 through Figure 35 on page 65 show the number of equal-length records that can be written on a track for records with keys in different size ranges.

Equal-Length Physical Records Without Keys

Use Figure 26 on page 55 to find out how track (or cylinder) space is utilized for fixed-length physical records of a specific data length (DL):

1. Use the Data Length Range column on the left side of the table to select the range that includes the length of the record.
2. Use the Percent Space Used column to determine what percentage of the track would be occupied with user data if the track contains the maximum number of records, each of which has the maximum data length for the data length range.
3. Read the number of records that can fit on a track or a cylinder from the Maximum Track Capacity and Maximum Cylinder Capacity columns located at the right-hand side of the table.

For example, consider a data record of 4096 bytes. The data length of the record is between 3861 and 4276. This means that 10 records can be written per track and 150 records can be written per cylinder.

Now, observe that with a 4096-byte record, the percentage of track space actually used for data is 86.2, whereas with the maximum data length in the range (4276), 90 percent of the track space is used.

```
4096 x 10       ((data bytes per record) * records)
--------- =
   47476        (maximum data per track)

 40960
-------- =  .862  =  86.2 percent
 47476
```

Finally, note the maximum track and cylinder data capacity. If a track is filled with 4276-byte data records (10 records have been written), the maximum capacity of the track is 42760 bytes of user data. The data capacity of a cylinder, 641400 bytes of user data, is approximately 626K bytes of user data (1K byte = 1024 bytes). Smaller records in the 3861 to 4276 range would yield a user data capacity for a track and a cylinder somewhat less than the value listed in the table. The track or cylinder would continue to contain the same number (10 or 150) equal-length physical records.

Data Length Range Min	Data Length Range Max	Percent Space Used *	Maximum Track Capacity * Records	Maximum Track Capacity * Bytes	Maximum Cylinder Capacity * Records	Maximum Cylinder Capacity * Bytes
23 477	47 476	100.0	1	47 476	15	712 140
15 477	23 476	98.9	2	46 952	30	704 280
11 477	15 476	97.7	3	46 428	45	696 420
9 077	11 476	96.6	4	45 904	60	688 560
7 477	9 076	95.5	5	45 380	75	680 700
6 357	7 476	94.4	6	44 856	90	672 840
5 493	6 356	93.7	7	44 492	105	667 380
4 821	5 492	92.5	8	43 936	120	659 040
4 277	4 820	91.3	9	43 380	135	650 700
3 861	4 276	90.0	10	42 760	150	641 400
3 477	3 860	89.4	11	42 460	165	636 900
3 189	3 476	87.8	12	41 712	180	625 680
2 933	3 188	87.2	13	41 444	195	621 660
2 677	2 932	86.4	14	41 048	210	615 720
2 485	2 676	84.5	15	40 140	225	602 100
2 325	2 484	83.7	16	39 744	240	596 160
2 165	2 324	83.2	17	39 508	255	592 620
2 005	2 164	82.0	18	38 952	270	584 280
1 877	2 004	80.2	19	38 076	285	571 140
1 781	1 876	79.0	20	37 520	300	562 800
1 685	1 780	78.7	21	37 380	315	560 700
1 589	1 684	78.0	22	37 048	330	555 720
1 493	1 588	76.9	23	36 524	345	547 860
1 397	1 492	75.4	24	35 808	360	537 120
1 333	1 396	73.5	25	34 900	375	523 500
1 269	1 332	72.9	26	34 632	390	519 480
1 205	1 268	72.1	27	34 236	405	513 540
1 141	1 204	71.0	28	33 712	420	505 680
1 077	1 140	69.6	29	33 060	435	495 900
1 045	1 076	67.9	30	32 280	450	484 200
981	1 044	68.1	31	32 364	465	485 460
949	980	66.0	32	31 360	480	470 400
917	948	65.8	33	31 284	495	469 260
853	916	65.6	34	31 144	510	467 160
821	852	62.8	35	29 820	525	447 300
789	820	62.1	36	29 520	540	442 800
757	788	61.4	37	29 156	555	437 340
725	756	60.5	38	28 728	570	430 920
693	724	59.4	39	28 236	585	423 540
661	692	58.3	40	27 680	600	415 200
629	660	57.0	41	27 060	615	405 900
597	628	55.5	42	26 376	630	395 640
565	596	55.2	44	26 224	660	393 360
533	564	53.4	45	25 380	675	380 700
501	532	51.5	46	24 472	690	367 080
469	500	50.5	48	24 000	720	360 000
437	468	48.3	49	22 932	735	343 980
405	436	46.8	51	22 236	765	333 540
373	404	45.1	53	21 412	795	321 180
341	372	43.1	55	20 460	825	306 900
309	340	40.8	57	19 380	855	290 700
277	308	38.2	59	18 172	885	272 580
245	276	36.0	62	17 112	930	256 680
213	244	33.4	65	15 860	975	237 900
181	212	30.3	68	14 416	1 020	216 240
149	180	26.9	71	12 780	1 065	191 700
117	148	23.0	74	10 952	1 110	164 280
85	116	19.0	78	9 048	1 170	135 720
53	84	14.6	83	6 972	1 245	104 580
21	52	9.6	88	4 576	1 320	68 640
1	20	3.9	93	1 860	1 395	27 900

* Calculations are made using maximum size record in range.

Figure 26. Equal-Length Physical Records Without Keys

Equal-Length Physical Records With Keys

To find out how track (or cylinder) space is utilized for keyed fixed-length physical records of a specific data length (DL):

1. First, turn to the appropriate table for the key length (KL) in use:

   Figure 27 on page 57 for KL = 1 to 20
   Figure 28 on page 58 for KL = 21 to 52
   Figure 29 on page 59 for KL = 53 to 84
   Figure 30 on page 60 for KL = 85 to 116
   Figure 31 on page 61 for KL = 117 to 148
   Figure 32 on page 62 for KL = 149 to 180
   Figure 33 on page 63 for KL = 181 to 212
   Figure 34 on page 64 for KL = 213 to 244
   Figure 35 on page 65 for KL = 245 to 255

2. Use the Data Length Range column to select the range that includes the data length of the record.
3. Use the Percent Space Used column to determine the percentage of the track that would be occupied with user data if the track contains the maximum number of records, each of which has the maximum data length for the data length range.
4. Read the number of records that can fit on a track or a cylinder from the Maximum Track Capacity and the Maximum Cylinder Capacity columns at the right-hand side of the table.

For example, consider a keyed data record that has a key length of 10 bytes and a data length of 1024 bytes. The appropriate table is Figure 27 on page 57, covering key lengths from 1 to 20 bytes. The data length of the record is between 1013 and 1076; this means that 26 records can be written per track and 390 records can be written per cylinder.

Next, observe that (at best) 58.9% of the track can be occupied by user data. In our example, the percentage of track space actually used for data is 56.1%:

```
1024 x 26       ((data bytes per record) * records)
--------- =
  47476         (maximum data per track)

 26264
-------- =  0.5607  =  56.1 percent
 47476
```

Finally, note the maximum track and cylinder data capacity. If a track is filled with 1076-byte data records (26 records have been written) the maximum capacity of the track is 27976 bytes of user data. The data capacity of a cylinder, 419640 bytes of user data, is approximately 410K bytes of user data (1K byte = 1024 bytes). Smaller records in the 1013 to 1076 range would yield a user data capacity for a track and a cylinder somewhat less than the value listed in the table. The track or cylinder would continue to contain the same number (26 or 390) of equal-length physical records.

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 221	47 220	99.5	1	47 220	15	708 300
15 221	23 220	97.8	2	46 440	30	696 600
11 221	15 220	96.2	3	45 660	45	684 900
8 821	11 220	94.5	4	44 880	60	673 200
7 221	8 820	92.9	5	44 100	75	661 500
6 101	7 220	91.3	6	43 320	90	649 800
5 237	6 100	89.9	7	42 700	105	640 500
4 565	5 236	88.2	8	41 888	120	628 320
4 021	4 564	86.5	9	41 076	135	616 140
3 605	4 020	84.7	10	40 200	150	603 000
3 221	3 604	83.5	11	39 644	165	594 660
2 933	3 220	81.4	12	38 640	180	579 600
2 677	2 932	80.3	13	38 116	195	571 740
2 421	2 676	78.9	14	37 464	210	561 960
2 229	2 420	76.5	15	36 300	225	544 500
2 069	2 228	75.1	16	35 648	240	534 720
1 909	2 068	74.1	17	35 156	255	527 340
1 749	1 908	72.3	18	34 344	270	515 160
1 621	1 748	70.0	19	33 212	285	498 180
1 525	1 620	68.3	20	32 400	300	486 000
1 429	1 524	67.4	21	32 004	315	480 060
1 333	1 428	66.2	22	31 416	330	471 240
1 237	1 332	64.5	23	30 636	345	459 540
1 141	1 236	62.5	24	29 664	360	444 960
1 077	1 140	60.0	25	28 500	375	427 500
1 013	1 076	58.9	26	27 976	390	419 640
949	1 012	57.6	27	27 324	405	409 860
885	948	55.9	28	26 544	420	398 160
821	884	54.0	29	25 636	435	384 540
789	820	51.8	30	24 600	450	369 000
725	788	51.5	31	24 428	465	366 420
693	724	48.8	32	23 168	480	347 520
661	692	48.1	33	22 836	495	342 540
597	660	47.3	34	22 440	510	336 600
565	596	43.9	35	20 860	525	312 900
533	564	42.8	36	20 304	540	304 560
501	532	41.5	37	19 684	555	295 260
469	500	40.0	38	19 000	570	285 000
437	468	38.4	39	18 252	585	273 780
405	436	36.7	40	17 440	600	261 600
373	404	34.9	41	16 564	615	248 460
341	372	32.9	42	15 624	630	234 360
309	340	31.5	44	14 960	660	224 400
277	308	29.2	45	13 860	675	207 900
245	276	26.7	46	12 696	690	190 440
213	244	24.7	48	11 712	720	175 680
181	212	21.9	49	10 388	735	155 820
149	180	19.3	51	9 180	765	137 700
117	148	16.5	53	7 844	795	117 660
85	116	13.4	55	6 380	825	95 700
53	84	10.1	57	4 788	855	71 820
21	52	6.5	59	3 068	885	46 020
1	20	2.6	62	1 240	930	18 600

* Calculations are made using maximum size record in range.

Figure 27. Equal-Length Physical Records with Key Length 1 to 20 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 189	47 188	99.4	1	47 188	15	707 820
15 189	23 188	97.7	2	46 376	30	695 640
11 189	15 188	96.0	3	45 564	45	683 460
8 789	11 188	94.3	4	44 752	60	671 280
7 189	8 788	92.6	5	43 940	75	659 100
6 089	7 188	90.8	6	43 128	90	646 920
5 205	6 068	89.5	7	42 476	105	637 140
4 533	5 204	87.7	8	41 632	120	624 480
3 989	4 532	85.9	9	40 788	135	611 820
3 573	3 988	84.0	10	39 880	150	598 200
3 189	3 572	82.8	11	39 292	165	589 380
2 901	3 188	80.6	12	38 256	180	573 840
2 645	2 900	79.4	13	37 700	195	565 500
2 389	2 644	78.0	14	37 016	210	555 240
2 197	2 388	75.4	15	35 820	225	537 300
2 037	2 196	74.0	16	35 136	240	527 040
1 877	2 036	72.9	17	34 612	255	519 180
1 717	1 876	71.1	18	33 768	270	506 520
1 589	1 716	68.7	19	32 604	285	489 060
1 493	1 588	66.9	20	31 760	300	476 400
1 397	1 492	66.0	21	31 332	315	469 980
1 301	1 396	64.7	22	30 712	330	460 680
1 205	1 300	63.0	23	29 900	345	448 500
1 109	1 204	60.9	24	28 896	360	433 440
1 045	1 108	58.4	25	27 700	375	415 500
981	1 044	57.2	26	27 144	390	407 160
917	980	55.7	27	26 460	405	396 900
853	916	54.0	28	25 648	420	384 720
789	852	52.0	29	24 708	435	370 620
757	788	49.8	30	23 640	450	354 600
693	756	49.4	31	23 436	465	351 540
661	692	46.6	32	22 144	480	332 160
629	660	45.9	33	21 780	495	326 700
565	628	45.0	34	21 352	510	320 280
533	564	41.6	35	19 740	525	296 100
501	532	40.3	36	19 152	540	287 280
469	500	39.0	37	18 500	555	277 500
437	468	37.5	38	17 784	570	266 760
405	436	35.8	39	17 004	585	255 060
373	404	34.0	40	16 160	600	242 400
341	372	32.1	41	15 252	615	228 780
309	340	30.1	42	14 280	630	214 200
277	308	28.5	44	13 552	660	203 280
245	276	26.2	45	12 420	675	186 300
213	244	23.6	46	11 224	690	168 360
181	212	21.4	48	10 176	720	152 640
149	180	18.6	49	8 820	735	132 300
117	148	15.9	51	7 548	765	113 220
85	116	13.0	53	6 148	795	92 220
53	84	9.7	55	4 620	825	69 300
21	52	6.2	57	2 964	855	44 460
1	20	2.5	59	1 180	885	17 700

* Calculations are made using maximum size record in range.

Figure 28. Equal-Length Physical Records with Key Length 21 to 52 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 157	47 156	99.3	1	47 156	15	707 340
15 157	23 156	97.6	2	46 312	30	694 680
11 157	15 156	95.8	3	45 468	45	682 020
8 757	11 156	94.0	4	44 624	60	669 360
7 157	8 756	92.2	5	43 780	75	656 700
6 037	7 156	90.4	6	42 936	90	644 040
5 173	6 036	89.0	7	42 252	105	633 780
4 501	5 172	87.2	8	41 376	120	620 640
3 957	4 500	85.3	9	40 500	135	607 500
3 541	3 956	83.3	10	39 560	150	593 400
3 157	3 540	82.0	11	38 940	165	584 100
2 869	3 156	79.8	12	37 872	180	568 080
2 613	2 868	78.5	13	37 284	195	559 260
2 357	2 612	77.0	14	36 568	210	548 520
2 165	2 356	74.4	15	35 340	225	530 100
2 005	2 164	72.9	16	34 624	240	519 360
1 845	2 004	71.8	17	34 068	255	511 020
1 685	1 844	69.9	18	33 192	270	497 880
1 557	1 684	67.4	19	31 996	285	479 940
1 461	1 556	65.6	20	31 120	300	466 800
1 365	1 460	64.6	21	30 660	315	459 900
1 269	1 364	63.2	22	30 008	330	450 120
1 173	1 268	61.4	23	29 164	345	437 460
1 077	1 172	59.3	24	28 128	360	421 920
1 013	1 076	65.7	25	26 900	375	403 500
949	1 012	55.4	26	26 312	390	394 680
885	948	53.9	27	25 596	405	383 940
821	884	52.1	28	24 752	420	371 280
757	820	50.1	29	23 780	435	356 700
725	756	47.8	30	22 680	450	340 200
661	724	47.3	31	22 444	465	336 660
629	660	44.5	32	21 120	480	316 800
597	628	43.7	33	20 724	495	310 860
533	596	42.7	34	20 264	510	303 960
501	532	39.2	35	18 620	525	279 300
469	500	37.9	36	18 000	540	270 000
437	468	36.5	37	17 316	555	259 740
405	436	35.0	38	16 568	570	248 520
373	404	33.2	39	15 756	585	236 340
341	372	31.3	40	14 880	600	223 200
309	340	29.4	41	13 940	615	209 100
277	308	27.3	42	12 936	630	194 040
245	276	25.6	44	12 144	660	182 160
213	244	23.1	45	10 980	675	164 700
181	212	20.5	46	9 752	690	146 280
149	180	18.2	48	8 640	720	129 600
117	148	15.3	49	7 252	735	108 780
85	116	12.5	51	5 916	765	88 740
53	84	9.4	53	4 452	795	66 780
21	52	6.0	55	2 860	825	42 900
1	20	2.4	57	1 140	855	17 100

* Calculations are made using maximum size record in range.

Figure 29. Equal-Length Physical Records with Key Length 53 to 84 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 125	47 124	99.3	1	47 124	15	706 860
15 125	23 124	97.4	2	46 248	30	693 720
11 125	15 124	95.6	3	45 372	45	680 580
8 725	11 124	93.7	4	44 496	60	667 440
7 125	8 724	91.9	5	43 620	75	654 300
6 005	7 124	90.0	6	42 744	90	641 160
5 141	6 004	88.5	7	42 028	105	630 420
4 469	5 140	86.6	8	41 120	120	616 800
3 925	4 468	84.7	9	40 212	135	603 180
3 509	3 924	82.7	10	39 240	150	588 600
3 125	3 508	81.3	11	38 588	165	578 820
2 837	3 124	79.0	12	37 488	180	562 320
2 581	2 836	77.7	13	36 868	195	553 020
2 325	2 580	76.1	14	36 120	210	541 800
2 133	2 324	73.4	15	34 860	225	522 900
1 973	2 132	71.9	16	34 112	240	511 680
1 813	1 972	70.1	17	33 524	255	502 860
1 653	1 812	68.7	18	32 616	270	489 240
1 525	1 652	66.1	19	31 388	285	470 820
1 429	1 524	64.2	20	30 480	300	457 200
1 333	1 428	63.2	21	29 988	315	449 820
1 237	1 332	61.7	22	29 304	330	439 560
1 141	1 236	59.9	23	28 428	345	426 420
1 045	1 140	57.6	24	27 360	360	410 400
981	1 044	55.0	25	26 100	375	391 500
917	980	53.7	26	25 480	390	382 200
853	916	52.1	27	24 732	405	370 980
789	852	50.3	28	23 856	420	357 840
725	788	48.1	29	22 852	435	342 780
693	724	45.8	30	21 720	450	325 800
629	692	45.2	31	21 452	465	321 780
597	628	42.3	32	20 096	480	301 440
565	596	41.4	33	19 668	495	295 020
501	564	40.4	34	19 176	510	287 640
469	500	36.9	35	17 500	525	262 500
437	468	35.5	36	16 848	540	252 720
405	436	34.0	37	16 132	555	241 980
373	404	32.3	38	15 352	570	230 280
341	372	30.6	39	14 508	585	217 620
309	340	28.7	40	13 600	600	204 000
277	308	26.6	41	12 628	615	189 420
245	276	24.4	42	11 592	630	173 880
213	244	22.6	44	10 736	660	161 040
181	212	20.1	45	9 540	675	143 100
149	180	17.4	46	8 280	690	124 200
117	148	15.0	48	7 104	720	106 560
85	116	12.0	49	5 684	735	85 260
53	84	9.0	51	4 284	765	64 260
21	52	5.8	53	2 756	795	41 340
1	20	2.3	55	1 100	825	16 500

* Calculations are made using maximum size record in range.

Figure 30. Equal-Length Physical Records with Key Length 85 to 116 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 093	47 092	99.2	1	47 092	15	706 380
15 093	23 092	97.3	2	46 184	30	692 760
11 093	15 092	95.4	3	45 276	45	679 140
8 693	11 092	93.5	4	44 368	60	665 520
7 093	8 692	91.5	5	43 460	75	651 900
5 973	7 092	89.6	6	42 552	90	638 280
5 109	5 972	88.1	7	41 804	105	627 060
4 437	5 108	86.1	8	40 864	120	612 960
3 893	4 436	84.1	9	39 924	135	598 860
3 477	3 892	82.0	10	38 920	150	583 800
3 093	3 476	80.5	11	38 236	165	573 540
2 805	3 092	78.2	12	37 104	180	556 560
2 549	2 804	76.8	13	36 452	195	546 780
2 293	2 548	75.1	14	35 672	210	535 080
2 101	2 292	72.4	15	34 380	225	515 700
1 941	2 100	70.8	16	33 600	240	504 000
1 781	1 940	69.5	17	32 980	255	494 700
1 621	1 780	67.5	18	32 040	270	480 600
1 493	1 620	64.8	19	30 780	285	461 700
1 397	1 492	62.9	20	29 840	300	447 600
1 301	1 396	61.8	21	29 316	315	439 740
1 205	1 300	60.2	22	28 600	330	429 000
1 109	1 204	58.3	23	27 692	345	415 380
1 013	1 108	56.0	24	26 592	360	398 880
949	1 012	53.3	25	25 300	375	379 500
885	948	51.9	26	24 648	390	369 720
821	884	50.3	27	23 868	405	358 020
757	820	48.4	28	22 960	420	344 400
693	756	46.2	29	21 924	435	328 860
661	692	43.7	30	20 760	450	311 400
597	660	43.1	31	20 460	465	306 900
565	596	40.2	32	19 072	480	286 080
533	564	39.2	33	18 612	495	279 180
469	532	38.1	34	18 088	510	271 320
437	468	34.5	35	16 380	525	245 700
405	436	33.1	36	15 696	540	235 440
373	404	31.5	37	14 948	555	224 220
341	372	29.8	38	14 136	570	212 040
309	340	27.9	39	13 260	585	198 900
277	308	26.0	40	12 320	600	184 800
245	276	23.8	41	11 316	615	169 740
213	244	21.6	42	10 248	630	153 720
181	212	19.7	44	9 328	660	139 920
149	180	17.1	45	8 100	675	121 500
117	148	14.3	46	6 808	690	102 120
85	116	11.7	48	5 568	720	83 520
53	84	8.7	49	4 116	735	61 740
21	52	5.6	51	2 652	765	39 780
1	20	2.2	53	1 060	795	15 900

* Calculations are made using maximum size record in range.

Figure 31. Equal-Length Physical Records with Key Length 117 to 148 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 061	47 060	99.1	1	47 060	15	705 900
15 061	23 060	97.1	2	46 120	30	691 800
11 061	15 060	95.2	3	45 180	45	677 700
8 661	11 060	93.2	4	44 240	60	663 600
7 061	8 660	91.2	5	43 300	75	649 500
5 941	7 060	89.2	6	42 360	90	635 400
5 077	5 940	87.6	7	41 580	105	623 700
4 405	5 076	85.5	8	40 608	120	609 120
3 861	4 404	83.5	9	39 636	135	594 540
3 445	3 860	81.3	10	38 600	150	579 000
3 061	3 444	79.8	11	37 884	165	568 260
2 773	3 060	77.3	12	36 720	180	550 800
2 517	2 772	75.9	13	36 036	195	540 540
2 261	2 516	74.2	14	35 224	210	528 360
2 069	2 260	71.4	15	33 900	225	508 500
1 909	2 068	69.7	16	33 088	240	496 320
1 749	1 908	68.3	17	32 436	255	486 540
1 589	1 748	66.3	18	31 464	270	471 960
1 461	1 588	63.6	19	30 172	285	452 580
1 365	1 460	61.5	20	29 200	300	438 000
1 269	1 364	60.3	21	28 644	315	429 660
1 173	1 268	58.8	22	27 896	330	418 440
1 077	1 172	56.8	23	26 956	345	404 340
981	1 076	54.4	24	25 824	360	387 360
917	980	51.6	25	24 500	375	367 500
853	916	50.2	26	23 816	390	357 240
789	852	48.5	27	23 004	405	345 060
725	788	46.5	28	22 064	420	330 960
661	724	44.2	29	20 996	435	314 940
629	660	41.7	30	19 800	450	297 000
565	628	41.0	31	19 468	465	292 020
533	564	38.0	32	18 048	480	270 720
501	532	37.0	33	17 556	495	263 340
437	500	35.8	34	17 000	510	255 000
405	436	32.1	35	15 260	525	228 900
373	404	30.6	36	14 544	540	218 160
341	372	29.0	37	13 764	555	206 460
309	340	27.2	38	12 920	570	193 800
277	308	25.3	39	12 012	585	180 180
245	276	23.3	40	11 040	600	165 600
213	244	21.1	41	10 004	615	150 060
181	212	18.8	42	8 904	630	133 560
149	180	16.7	44	7 920	660	118 800
117	148	14.0	45	6 660	675	99 900
85	116	11.2	46	5 336	690	80 040
53	84	8.5	48	4 032	720	60 480
21	52	5.4	49	2 548	735	38 220
1	20	2.6	51	1 020	765	15 300

* Calculations are made using maximum size record in range.

Figure 32. Equal-Length Physical Records with Key Length 149 to 180 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
23 029	47 028	99.1	1	47 028	15	705 420
15 029	23 028	97.0	2	46 056	30	690 840
11 029	15 028	95.0	3	45 084	45	676 260
8 629	11 028	92.9	4	44 112	60	661 680
7 029	8 628	90.9	5	43 140	75	647 100
5 909	7 028	88.8	6	42 168	90	632 520
5 045	5 908	87.1	7	41 356	105	620 340
4 373	5 044	85.0	8	40 352	120	605 280
3 829	4 372	82.9	9	39 348	135	590 220
3 413	3 828	80.6	10	38 280	150	574 200
3 029	3 412	79.1	11	37 532	165	562 980
2 741	3 028	76.5	12	36 336	180	545 040
2 485	2 740	75.0	13	35 620	195	534 300
2 229	2 484	73.3	14	34 776	210	521 640
2 037	2 228	70.4	15	33 420	225	501 300
1 877	2 036	68.6	16	32 576	240	488 640
1 717	1 876	76.2	17	31 892	255	478 380
1 557	1 716	65.1	18	30 888	270	463 320
1 429	1 556	62.3	19	29 564	285	443 460
1 333	1 428	60.2	20	28 560	300	428 400
1 237	1 332	58.9	21	27 972	315	419 580
1 141	1 236	57.3	22	27 192	330	407 880
1 045	1 140	55.2	23	26 220	345	393 300
949	1 044	52.8	24	25 056	360	375 840
885	948	49.2	25	23 700	375	355 500
821	884	48.4	26	22 984	390	344 760
757	820	46.6	27	22 140	405	332 100
693	756	44.6	28	21 168	420	317 520
629	692	42.3	29	20 068	435	301 020
597	628	39.7	30	18 840	450	282 600
533	596	38.9	31	18 476	465	277 140
501	532	35.9	32	17 024	480	255 360
469	500	34.8	33	16 500	495	247 500
405	468	33.5	34	15 912	510	238 680
373	404	29.8	35	14 140	525	212 100
341	372	28.2	36	13 392	540	200 880
309	340	26.5	37	12 580	555	188 700
277	308	24.7	38	11 704	570	175 560
245	276	22.7	39	10 764	585	161 460
213	244	20.6	40	9 760	600	146 400
181	212	18.3	41	8 692	615	130 380
149	180	15.9	42	7 560	630	113 400
117	148	13.7	44	6 512	660	97 680
85	116	11.0	45	5 220	675	78 300
53	84	8.1	46	3 846	690	57 960
21	52	5.3	48	2 496	720	37 440
1	20	2.1	49	980	735	14 700

* Calculations are made using maximum size record in range.

Figure 33. Equal-Length Physical Records with Key Length 181 to 212 Bytes

Data Length Range Min	Data Length Range Max	Percent Space Used *	Maximum Track Capacity * Records	Maximum Track Capacity * Bytes	Maximum Cylinder Capacity * Records	Maximum Cylinder Capacity * Bytes
22 997	46 996	99.0	1	46 996	15	704 940
14 997	22 996	96.9	2	45 992	30	689 880
10 997	14 996	94.8	3	44 988	45	674 820
8 597	10 996	92.6	4	43 984	60	659 760
6 997	8 596	90.5	5	42 980	75	644 700
5 877	6 996	88.4	6	41 976	90	629 640
5 013	5 876	86.6	7	41 132	105	616 980
4 341	5 012	84.5	8	40 096	120	601 440
3 797	4 340	82.3	9	39 060	135	585 900
3 381	3 796	80.0	10	37 960	150	569 400
2 997	3 380	78.3	11	37 180	165	557 700
2 709	2 996	75.7	12	35 952	180	539 280
2 453	2 708	74.2	13	35 204	195	528 060
2 197	2 452	72.3	14	34 328	210	514 920
2 005	2 196	69.4	15	32 940	225	494 100
1 845	2 004	67.5	16	32 064	240	480 960
1 685	1 844	66.0	17	31 348	255	470 220
1 525	1 684	63.9	18	30 312	270	454 680
1 397	1 524	61.0	19	28 956	285	434 340
1 301	1 396	58.8	20	27 920	300	418 800
1 205	1 300	57.5	21	27 300	315	409 500
1 109	1 204	55.8	22	26 488	330	397 320
1 013	1 108	53.7	23	25 484	345	382 260
917	1 012	51.2	24	24 288	360	364 320
853	916	48.2	25	22 900	375	343 500
789	852	46.7	26	22 152	390	332 280
725	788	44.8	27	21 276	405	319 140
661	724	42.7	28	20 272	420	304 080
597	660	40.3	29	19 140	435	287 100
565	596	37.7	30	17 880	450	268 200
501	564	36.8	31	17 484	465	262 260
469	500	33.7	32	16 000	480	240 000
437	468	32.5	33	15 444	495	231 660
373	436	31.2	34	14 824	510	222 360
341	372	27.4	35	13 020	525	195 300
309	340	25.8	36	12 240	540	183 600
277	308	24.0	37	11 396	555	170 940
245	276	22.1	38	10 488	570	157 320
213	244	20.0	39	9 516	585	142 740
181	212	17.9	40	8 480	600	127 200
149	180	15.5	41	7 380	615	110 700
117	148	13.1	42	6 216	630	93 240
85	116	10.8	44	5 104	660	76 560
53	84	8.0	45	3 780	675	56 700
21	52	5.0	46	2 392	690	35 880
1	20	2.0	48	960	720	14 400

* Calculations are made using maximum size record in range.

Figure 34. Equal-Length Physical Records with Key Length 213 to 244 Bytes

Data Length Range Min	Max	Percent Space Used *	Maximum Track Capacity * Records	Bytes	Maximum Cylinder Capacity * Records	Bytes
22 965	46 964	98.9	1	46 964	15	704 460
14 965	22 964	96.7	2	45 928	30	688 920
10 965	14 964	94.6	3	44 892	45	673 380
8 565	10 964	92.4	4	43 856	60	657 840
6 965	8 564	90.2	5	42 820	75	642 300
5 845	6 964	88.0	6	41 784	90	626 760
4 981	5 844	86.2	7	40 908	105	613 620
4 309	4 980	83.9	8	39 840	120	597 600
3 765	4 308	81.7	9	38 772	135	581 580
3 349	3 764	79.3	10	37 640	150	564 600
2 965	3 348	77.6	11	36 828	165	552 420
2 677	2 964	74.9	12	35 568	180	533 520
2 421	2 676	73.3	13	34 788	195	521 820
2 165	2 420	71.4	14	33 880	210	508 200
1 973	2 164	68.4	15	32 460	225	486 900
1 813	1 972	66.5	16	31 552	240	473 280
1 653	1 812	64.9	17	30 804	255	462 060
1 493	1 652	62.6	18	29 736	270	446 040
1 365	1 492	59.7	19	28 348	285	425 220
1 269	1 364	57.5	20	27 280	300	409 200
1 173	1 268	56.1	21	26 628	315	399 420
1 077	1 172	54.3	22	25 784	330	386 760
981	1 076	52.1	23	24 748	345	371 220
885	980	49.5	24	23 520	360	352 800
821	884	46.6	25	22 100	375	331 500
757	820	44.9	26	21 320	390	319 800
693	756	43.0	27	20 412	405	306 180
629	692	40.8	28	19 376	420	290 640
565	628	38.4	29	18 212	435	273 180
533	564	35.6	30	16 920	450	253 800
469	532	34.7	31	16 492	465	247 380
437	468	31.5	32	14 976	480	224 640
405	436	30.3	33	14 388	495	215 820
341	404	28.9	34	13 736	510	206 040
309	340	25.1	35	11 900	525	178 500
277	308	23.4	36	11 088	540	166 320
245	276	21.5	37	10 212	555	153 180
213	244	19.5	38	9 272	570	139 080
181	212	17.4	39	8 268	585	124 020
149	180	15.2	40	7 200	600	108 000
117	148	12.8	41	6 068	615	91 020
85	116	10.3	42	4 872	630	73 080
53	84	7.8	44	3 696	660	55 440
21	52	4.9	45	2 340	675	35 100
1	20	1.9	46	920	690	13 800

* Calculations are made using maximum size record in range.

Figure 35. Equal-Length Physical Records with Key Length 245 to 255 Bytes

Glossary

This glossary contains disk storage subsystem terms that are used in this manual and in other manuals in the Storage Subsystem Library.

A

A-unit. The direct access storage unit that contains the controller functions to attach to the storage control. An A-unit controls the B-units that are attached to it and is often referred to as a head of string.

access mechanism. See actuator.

actuator. A set of access arms and their attached read/write heads, which move as an independent component within a head and disk assembly (HDA). For example, the 3380 Model BK4 has two HDAs, each containing two actuators. See also device and volume.

alternate track. On a direct access storage device, a track designated to contain data in place of a defective primary track.

B

B-unit. A direct access storage unit that attaches to the subsystem through an A-unit or a C-unit. A B-unit has no controller functions.

C

C-unit. A direct channel attach 3380 direct access storage unit that contains both the storage control functions and the DASD controller functions. A 3380 C-unit functions as a head of string and controls the B-units that are attached to it.

channel interface (CHL-I). The circuitry of a storage control that attaches storage paths to a host channel.

check-1 error. In the storage control and DASD, an error that does not allow the use of normal machine functions to report details of the error condition.

check-2 error. In the storage control and DASD, an error that can be reported using the normal machine functions.

connection check alert. The electronic signal used by the 3380 to indicate a check-1 error condition to the storage control. See check-1 error.

control interface (CTL-I). The hardware connection between the storage control function and the DASD controller function.

controller. The hardware component of a DASD head of string unit that provides the path control and data transfer functions. For example, there are two controllers in a 3380 Model AE4 or AK4.

count-key-data (CKD). A DASD data recording format employing self-defining record formats in which each record is represented by a count area, that identifies the record and specifies its format, an optional key area that may be used to identify the data area contents, and a data area that contains the user data for the record. CKD is also used to refer to the set of channel commands that are accepted by a device that employs the CKD recording format.

D

DASD. Direct access storage device; for example, a 3380.

DASD subsystem. One or more DASD strings and the storage control(s) to which the the DASD are attached.

device. A uniquely addressable part of a DASD unit that consists of a set of access arms, the associated disk surfaces, and the electronic circuitry required to locate, read, and write data. See also volume.

device address. Three or four hexadecimal digits that uniquely define a physical I/O device on a channel path in System/370 mode. The one or two leftmost digits are the address of the channel to which the device is attached. The two rightmost digits represent the unit address.

device ID. An 8-bit identifier that uniquely identifies a physical I/O device.

device level selection (DLS). A DASD function available with 3380 Models AD4, BD4, AE4, BE4, AJ4, BJ4, AK4, BK4, and CJ2. With DLS, each of the two controllers in the DASD string has a path to all devices in the string (as many as 14 addresses for a CJ2 or 16 addresses for other string types), and any two devices in the 2-path DASD string can read or write data simultaneously. See DLS support mode.

device number. Four hexadecimal digits that logically identify an I/O device in a System 370/Extended Architecture system.

device release. A command that terminates the reservation of the device from the channel issuing the command or from all channels on the interface path group.

device reserve. A command that reserves the device for the channel issuing the command, or for all channels in the same interface path group.

device support facilities program (ICKDSF). A program used to initialize DASD at installation and provide media maintenance.

device support tracks. Reserved tracks of a DASD volume that store defect skipping information. This information is used by the subsystem (for example, at IML time) and by host utility programs such as ICKDSF.

diagnostic tracks. Tracks used by the diagnostic programs for testing the read/write function.

diskette drive. A direct access storage device that uses diskettes as the storage medium. A 3880 uses a read-only diskette drive for microcode storage; a 3990 and a 3380 Model CJ2 use a read/write diskette drive for microcode storage and storage control error logs error logs.

DLS support mode. A mode of operation in a 3380 Model CJ2 that supports 3380 2-path strings. See single-path storage director.

dynamic path reconnect. A function of dynamic path selection (DPS) that allows disconnected DASD operations to reconnect over any available channel path rather than being limited to the one on which the I/O operation was started. It is available only on System 370/Extended Architecture systems.

dynamic path selection (DPS). DASD subsystem functions available with all 3380 heads of string except Model A04. These functions include:

- Two controllers providing data paths from the 3380 strings to the storage directors
- Simultaneous transfer of data over two paths to two devices, providing the two devices are on separate internal paths within the string
- Sharing DASD volumes by using System-Related Reserve and Release
- Providing dynamic path reconnect to the first available path (with System 370/Extended Architecture hosts only)

E

error burst. A sequence of bit errors counted as one unit, or burst.

error correcting code (ECC). A code designed to detect and correct error bursts by the use of check bytes.

extended count-key-data (ECKD) architecture. A set of channel commands that use the CKD track format. This architecture employs the Define Extent and Locate Record commands to describe the nature and scope of a data transfer operation to the storage control to optimize the data transfer operation. The 3380 Model CJ2 supports the ECKD architecture.

F

fence. To separate one or more paths or elements from the remainder of the logical DASD subsystem. The separation is by logical boundaries rather than power boundaries. This separation allows isolation of failing components so that they do not affect customer operation.

G

gigabyte (Gb). 10^9 bytes.

H

head and disk assembly (HDA). A field replaceable unit in a direct access storage device containing the disks and actuators. A 3380 Model AK4 has two HDAs.

head of string. The unit in a DASD string that contains controller functions. For example, a 3380 Model AE4, AK4, or CJ2.

home address (HA). The first field on a CKD track that identifies the track and defines its operational status. The home address is written after the index point on each track.

I

ICKDSF. See Device Support Facilities program.

IDCAMS. A Data Facility Product program for MVS that is also referred to as access method services.

identifier (ID). A sequence of bits or characters that identifies a program, device, controller or system.

index point. The reference point on a disk surface that determines the start of a track.

initial microcode load (IML). The act of loading microcode.

I/O device. An addressable input/output unit, such as a direct access storage device, magnetic tape device, or printer.

L

logical DASD subsystem. Two storage directors attached to the same DASD strings together with those DASD strings.

M

maintenance analysis procedure (MAP). A step-by-step procedure for tracing a symptom to the cause of a failure.

megabyte (Mb). 10^6 bytes.

O

orientation. A control state within a storage path that indicates the type of area (home address, count, key, or data field) that has just passed under the read/write head of the device.

P

physical ID. A unique designation to identify specific components in a data processing complex.

primary track. On a direct access storage device, the original track on which data is stored. See also alternate track.

R

rotational position sensing (RPS). A function that permits a DASD to reconnect to a block multiplexer channel when a specified sector has been reached. This allows the channel to service other devices on the channel during positional delay.

S

service information message (SIM). A message, generated by the host processor upon receipt of sense information from a 3380 Model CJ2, that contains notification of a need for repair or customer action. The SIM identifies the affected area of the storage control and the effect of the expected service action. A host Error Recovery Procedure (ERP) causes a SIM Alert to be sent to the operator console.

SIM Alert. An operator console message that alerts the operator that an action requiring attention has occurred. The service information message (SIM) can be obtained from the EREP exception report.

single-path storage director. A storage director in a 3990 or 3380 Model CJ2 operating in DLS support mode. Each single-path storage director in the storage cluster is associated with one storage path. A storage path on a single-path storage director responds to a unique control unit address on the channel.

storage cluster. In the 3380 Model CJ2, a power and service region containing two independent transfer paths and two single-path storage directors. See also storage director and single-path storage director.

storage control. The component in a DASD subsystem that connects the DASD to the host channels. It performs channel commands and controls the DASD devices.

storage director. In the 3380 Model CJ2, a logical entity consisting of one physical storage path in the same storage cluster. In a 3880, a storage director is equivalent to a storage path. See also storage path and single-path storage director.

storage path. The hardware within the 3380 Model CJ2 that transfers data between the DASD and a channel. See also storage director.

storage subsystem. One or more storage controls and their attached storage devices.

string. A series of connected DASD units sharing one or more controllers (or heads of string).

string address. The 1-bit address used by the storage control to direct commands to the correct DASD string on the CTL-I.

string ID. An 8-bit identifier that uniquely identifies the physical string regardless of the selection address. It identifies to the service representative, by means of EREP, a failing subsystem component (controller, device) without his having to translate a selection address (which may have little relation to a physical address) to a physical component. The string ID is the number shown on the operator panel.

subsystem identifier (SSID). In a 3380 Model CJ2 configuration, a number that identifies the physical components of a logical DASD subsystem. This number is set by the service representative at time of installation, and is included in the vital product data in the support facility. This number is identified on the operator panel.

support facility (SF). A component of the 3380 Model C2 storage cluster that provides initial microcode load, error logging, maintenance panel, MAPs, and microdiagnostic functions for that cluster.

U

unit address. The last two hexadecimal digits of a DAS device address. This identifies the storage control and DAS string, controller, and device to the channel subsystem. Often used interchangeably with channel unit address and device address in System/370 mode.

V

volume. The DASD space that is accessible by a single actuator. A 3380 Model AK4 contains four volumes, each with 1.89 gigabytes of space.

Numeric

2-path string. A series of physically connected DASD units in which the head of string unit provides two data transfer paths that can operate simultaneously.

Bibliography

The manuals listed in the table below contain more detailed information on the subjects discussed in this book. For each manual referenced, the table shows the short and expanded title with the manual's order number, and a short description of relevant contents.

For information on how to order these manuals, contact your local IBM branch office.

Short Title	Full Title	Order Number	Contents
Hardware			
3380 DASD Features, Installation and Conversion	*3380 DASD Features, Installation and Conversion*	GG22-9308	Describes standard 3380 hardware features, how to prepare for installation of 3380 and migration of data
IBM 3380 Direct Access Storage Introduction	*IBM 3380 Direct Access Storage Introduction*	GC26-4491	Overview of 3380 A-unit and B-unit functions
IBM 3380 Direct Access Storage Reference Summary	*IBM 3380 Direct Access Storage Reference Summary*	GX26-1678	Summary of 3380 device characteristics
IBM 3031, 3032, 3033 Processor Complex Channel Configuration Guidelines	*IBM 3031, 3032, 3033 Processor Complex Channel Configuration Guidelines*	GG22-9020	Provides guidance on configuring 303X processor channels
IBM 9370 System Installation Physical Planning	*IBM 9370 System Installation Physical Planning*	GA24-4031	Description of physical planning for 9370 systems
IBM Input/Output Equipment: Installation – Physical Planning for System/360, System/370, and 4300 Processors	*IBM Input/Output Equipment: Installation – Physical Planning for System/360, System/370, and 4300 Processors*	GC22-7064	Description of physical planning for I/O hardware
IBM Input/Output Equipment: Installation Reference – Physical Planning for System/360, System/370, and 4300 Processors	*IBM Input/Output Equipment: Installation Reference – Physical Planning for System/360, System/370, and 4300 Processors*	GC22-7069	Description of physical planning for I/O hardware
Introduction to IBM Direct Access Storage Devices	*Introduction to IBM Direct Access Storage Devices*	SR20-4738	Textbook describing large IBM early DASD and data storage theory and methods
Maintaining IBM Storage Subsystem Media	*Maintaining IBM Storage Subsystem Media*	GC26-4495	Description of DASD media maintenance and error handling
Storage Subsystem Library Master Index	*Storage Subsystem Library Master Index*	GC26-4496	Index to information in 3380 and 3990 manuals
Using the IBM 3380 Direct Access Storage in an MVS Environment	*Using the IBM 3380 Direct Access Storage in an MVS Environment*	GC26-4492	Discussion of 3380 use under MVS/XA and MVS/370
Using the IBM 3380 Direct Access Storage in a VM Environment	*Using the IBM 3380 Direct Access Storage in a VM Environment*	GC26-4493	Discussion of 3380 use under VM
Using the IBM 3380 Direct Access Storage in a VSE Environment	*Using the IBM 3380 Direct Access Storage in a VSE Environment*	GC26-4494	Discussion of 3380 use under VSE
Software			
EREP User Guide and Reference	*Environmental Record Editing and Printing (EREP) User Guide and Reference*	GC28-1378	Description of EREP functions and commands for DASD media reporting
ICKDSF Primer for the User of IBM 3380 Direct Access Storage	*Device Support Facilities: Primer for the User of IBM 3380 Direct Access Storage*	GC26-4498	Description of specific ICKDSF usage considerations for the 3380 family of DASD, with guidelines on using ICKDSF commands
ICKDSF User's Guide and Reference	*Device Support Facilities User's Guide and Reference*	GC35-0033	Description of ICKDSF functions and commands for DASD initialization and maintenance
MVS/XA SML: Configuring Storage Subsystems	*MVS/Extended Architecture Storage Management Library: Configuring Storage Subsystems*	GC26-4262	Describes evaluating hardware configurations, developing capacity plans, and performance, availability and space utilization considerations

Short Title	Full Title	Order Number	Contents
MVS/XA SML: Managing Data Sets	*MVS/Extended Architecture Storage Management Library: Managing Data Sets*	GC26-4263	Describes managing data sets, catalogs and control data sets, establishing and enforcing data set policy, and data set security
MVS/XA SML: Managing Storage Pools	*MVS/Extended Architecture Storage Management Library: Managing Storage Pools*	GC26-4264	Describes storage requirements for groups of data sets, designing storage pools, making transition to pooled storage, and maintaining and monitoring storage pools
MVS/XA Installation: System Generation	*MVS/Extended Architecture Installation: System Generation*	GC26-4009	Describes how to do a complete sysgen, iogen, or edtgen in MVS/XA and includes information on device numbers
VM/XA SF Installation, Administration, and Service	*VM/XA SF Installation, Administration, and Service*	GC19-6217	Describes VM/XA SF installation considerations, including information on device numbers

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U

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W

Numerics

IBM 3380 Direct Access Storage
Direct Channel Attach Model CJ2
Introduction and Reference
GC26-4497-0

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