Systems

IBM 4361 Processor

DASD Compatibility Feature

IBM®

Preface

This publication is intended for users of the System/360 and System/370 with attached IBM 2311, 2314, 2319, 3330, or 3340 disk devices, who wish to transfer their current programs to the IBM 4361 Processor for operation by disk devices with fixed block architecture.

The chapters of the manual are:

1. General information

2. 2311/2314 emulated on the IBM 3310 Direct Access Storage

3. 2311/2314 emulated on the IBM 3370 Direct Access Storage

4. 3330/40 emulated on the IBM 3370 Direct Access Storage

Prerequisite Reading

IBM 4361 Processor Functional Characteristics, GA33-1566

Related Publications

Program Directory/Memo To Users for program 5747-SA1, stand-alone utilities

DOS/VSE System Utilities, GC33-5381

Device Support Facilities, GC35-0033

Device Support Facilities - SCP Specifications, GC35-0042

IBM System/360 Component Description, 2841 and Associated DASD, GA26-5988

IBM System/360 Component Description, 2314 DASD and 2844 Auxiliary Storage Control, GA26-3599

Reference Manual for IBM 3830 Storage Control Model 2, GA26-1617

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Chapter 1. General Information

The disk compatibility feature consists of microcode that is loaded during IPL time.

It is designed to facilitate the migration from 360/370 systems to this processor, and is used to transfer existing 360/370 disk data sets without any change to 3310/3370 DASDs.

The /360 and /370 migrators can take the full advantage of the capacity of FBM devices without changing or reassembling programs, data sets, files, or access methods used to access 231x and 3330/40 files. The storage space required for buffers and tables is taken away from machine storage and is not accessible by user programs.

The disk compatibility feature allows:

1. The emulation of 360/370 DASD data formats on devices which operate in fixed block mode (FBM). The following devices are emulated:

   ```
   2311        on 3310 or 3370
   2314        on 3310 or 3370
   3330-1,2    on 3370
   3340 (70MB) on 3370
   ```

   The disk compatibility feature accepts the original 231x and 3330/40 commands (CCWs) and produces the same logical results as the 231x or 3330/40 would have produced on the count-key-data files.

2. The emulation of four types of devices (2311, 2314, 3330, and 3340), but only one type may be active at a time. The type to be emulated is specified by the operator at IPL time. For the specified EMU address range, no FBA operation is possible, even if not all EMU addresses are used in the specified address range.

3. The usage of operating systems without FBM support:

   Existing system control programs (which do not offer the support required by 3310 and 3370 disk files) can be used. In these environments, however, stand-alone programs such as the initialize disk FBM/DSF, format emulator extent (INITEM), and initialize disk CKD/DSF utilities have to be available.

System Mode and Operational Environment

The disk compatibility feature can be used in /370 mode and VSE mode. It allows processing in the old 360/370 operational environment even if 360/370 disk devices are not physically attached. 231x/3330/40 data management can be used.

Handling of 360/370 Programs

Data Conversion from 2311/14 or 3330/40 to 3310/70

Conversion can best be made by use of magnetic tape units.

1. On the old system, dump 2311/14 or 3330/40 volumes on magnetic tape.

2. On the processor, load the stand-alone utility program that IBM provides to initialize the fixed block host disks and to subsequently format the emulated packs (count-key-data extents). The program can be ordered under program number 5747-SA1 and is resident on magnetic tape. The utility prompts you on the operator console. A description of the jobs, the messages, and the required responses can be found in the program directory.

3. On the processor, load the program DSF to initialize (under control of the compatibility feature) as many 2311/14 or 3330/40 packs as required for your installation. To initialize disks for VS1 use, use device support facilities to write an OS-VTOC on the emulated device. Partial volumes can be initialized under control of program "Device Support Facilities Stand Alone," program number 5747-DS1 for use with DOS/VSE. For OS/VS1 or VM /370, partial volumes cannot be used.

    CKD initialize:

    *   SA and On-Line utilities of any level
    *   DSF (for minidisks DSF only)

4. Now mount the magnetic tape containing the dumped volumes. Then run the same dump/restore program (previously used for dumping) to restore the 2311/14 or 3330/40 volumes onto the physical 3310/70 (under control of the compatibility feature). However, the appropriate emulated device address (e.g. 290) must be assigned in the program (see figures for emulated device addresses). The dump/restore program must be the same to avoid format problems. Thereafter, normal job processing can begin.

At IPL time, the customer has to specify in the PROGRAM LOAD picture:

- The EMU DISK: .... 2311, 2314, 3330, 3340 (ONLY ONE) device type (compatibility feature) may be used at a time.

- Address of the disk device on which the emulated space starts. This disk device is called the "first host" (and it may be the only one). The address is entered under the heading "EMU HOST: .../... ADDR OF FIRST/LAST HOST DEVICE" (no string switch host).

On this processor the first and last host device that bears an emulated volume has to be specified. This range of addresses has the following effect on the device within the range:

- The devices within the host range can no longer be addressed under their assigned addresses. Only the emulated volumes on them are addressable.

- A ready interrupt from the host is not presented to the operating system.

- Error conditions are always logged on the CE-cylinders of the host device.

Unit check incidents from the host device are logged by the compatibility feature, therefore the 3370 'READ ONLY SWITCH' should not be set to R/O.

Notes:

1. When using DOS releases (prior to release 27), it is recommended to set HARDSTOP check control mode so that machine-check interruptions or limited channel logouts cause a check-stop when the program is interrupted by such events.
2. On PER Handling: In order to get address compare stops due to a change of the customer I/O area by the compatibility feature, 'Any' must be specified instead of 'I/O' during normal I/O processing.
3. An emulated device can be the IPL device, that is, any of the emulated addresses that are valid for the specific compatibility feature can be entered into the PROGRAM LOAD picture under LOAD DEVICE ADDRESS.

Method of Emulation

There is no physical 2311/14 or 3330/40 device and the CKD commands are executed through the compatibility feature.

All emulated devices share one subchannel. The compatibility feature may be block-multiplexed with host operation, working on the same channel, but on different subchannels.

The execution of emulated commands is briefly described as follows:

1. A START I/O instruction which addresses a 2311/14 or 3330/40 device (emulated device address) is decoded by the SIO/TIO interpreter (common I/O routine). The emulated device address distinguishes 2311/14 or 3330/40 SIO instructions from 3310/70 SIOs.

2. The SIO/TIO interpreter checks the compatibility feature subchannel. If it is available (CC=0), control is passed to the compatibility feature; otherwise, CC=2 (compatibility feature busy with another device), or CC=3 (feature not operational) is set.

3. The SIO/TIO interpreter checks the availability of the host device. If it is available (CC=0), control is passed to the compatibility feature; otherwise, CC=1 (with respective status indication), or CC=3 (not operational) is set.

4. The compatibility feature fetches the 2311/14 or 3330/40 CCW and checks it for formal validity:

   a. If an error is detected, CC=1 (error detected during initial selection) is set.

   b. If no error is detected, the feature uses the current seek address to check whether the addressed track is already in any compatibility feature buffer. If yes, it operates from the buffer and continues with step 4.f.

   c. If no, the feature assigns a buffer to the operation. For orientation purposes, the feature maintains a buffer-internal pointer which defines the starting point of an operation, and in case more than one buffer is used, a buffer-external pointer which ensures that the operation goes to the correct buffer.

   d. The compatibility feature transforms the emulated track address into a host block address and starts the host disk in order to read a complete emulated track into the assigned buffer.

   e. When the 2311/14 or 3330/40 track resides in the buffer, the feature performs an entry into its logical arms position table. The compatibility feature has thus positioned an imaginary 2311/14 or 3330/40 access mechanism on a track which does not rotate under a head *but is located in the buffer.*

The logical arms position table contains enough entries, so that the last used access position for each drive is always available. The buffer-internal pointer ensures that the starting point for each operation is defined.

f.   The compatibility feature applies the CCW command to the buffer content, provided the channel is enabled for I/O interruptions. When the channel is disabled, command execution begins either when a TEST I/O is issued or when the channel is enabled.
In case of a Read, for example, it moves data from the buffer to the user area in machine storage.
In case of a Write, it moves data from the user area to the buffer. These move operations are performed in blocks of 256 bytes so that the processor is periodically interruptible for jobs which require fast real-time response. After such a Write, the feature writes back the updated 2311/14 or 3330/40 track onto the appropriate 3310/70 blocks. The first block changed, the last block changed, and all blocks between the first and the last block changed are written onto the 3310/70. A host verify operation is automatically performed.

If there is more than one Write command in one CCW chain working on the same track, all write changes are accumulated and written back at the end of the chain.

g.   The compatibility feature checks for a chain command or chain data flag. If yes, it continues with step 4.b.

h.   The feature generates the ending status and sets up an I/O interrupt request.

Because 2311/14 or 3330/40 commands are not directly executed on the 3310/70, violation of programming rules cause responses which would not be expected from a real 2311/14 or 3330/40 in the same circumstances. Users who intend to write new 2311/14 or 3330/40 programs should refer to the section

"Emulated Commands" which explains all deviations that must be taken into consideration when writing programs on the physical IOCS level. All deviations which are of significance to programmers are called out by a "note."

Input/Output Instructions

The compatibility feature executes the following I/O instructions:

- START I/O
- TEST I/O
- HALT I/O
- CLEAR I/O
- HALT Device

Note: START I/O FAST RELEASE is executed as START I/O by the compatibility feature.

START I/O

The compatibility feature executes all START I/O instructions which address one of the emulated 2311/14 or 3330/40 devices via the emulated device address. When such a START I/O is received, the compatibility feature first checks whether the 3310/70 is occupied by a "host:" START I/O or not, or whether the compatibility feature is 'busy'. Depending on the condition found, one of the following condition codes is set:

Condition Code	Meaning
0	Compatibility feature proceeds with execution
1	Channel status word stored
2	Compatibility feature or 3310/70 'busy'
3	Compatibility feature not operational

Condition Code Zero:
Is set for a 2311/14 or 3330/40 START I/O whenever the 3310/70 is not 'busy' with a selector mode "host" START I/O, and the compatibility feature is available. Condition code zero thus indicates that the basic prerequisites for command execution are satisfied.

Condition Code 1:
Indicates that the CSW has been updated and must be examined.

Condition Code 2:
Is set when the 3310/70 is 'busy' with a selector mode "host" operation. Condition code 2 is also set when the compatibility feature is 'busy'.

Condition Code 3:
Is set in any of the following situations:

- A device address is called that normally belongs to the compatibility feature, but is not supported by the specific installation or IPL input (in the PROGRAM LOAD picture).

- When the host is not attached or is not powered.

TEST I/O

The compatibility feature executes a TEST I/O by addressing the 3310/70 (the host device) to obtain appropriate status and, if required, the pertinent sense information. The results of these activities are indicated in the condition code as follows:

Condition Code	Meaning
0	Compatibility feature (and 3310/70) available
1	CSW stored
2	Compatibility feature busy
3	Compatibility feature not operational

Note: When a host device is ready and a TIO is given to any emulated address that belongs to the range of addresses allocated for this host device, condition code 0 is set. This is done even when the emulated address cannot be used because the data module was not preformatted for this address.
A TEST I/O instruction which addresses an emulated device will in any case start a data transfer operation that has been pending due to the channel being disabled for interruptions.

HALT I/O is executed as follows when the compatibility feature is working:

* Command chaining is turned off and if the channel is bursting, the burst is stopped. (A burst is a data transfer between CF buffer and user data area. A host operation is never interfered with.)

* A full CSW is set up and a Primary Interrupt is enqueued.

Notes:

1. If a write operation to the host device is pending in the compatibility feature, this write is still executed when a HALT is issued. Only when the compatibility feature is executing the first Write in a user chain is the CCW count reset to its original value and is the buffer contents marked 'invalid'.

2. If, in BMPX mode, the processor is busy with a compatibility feature request and a host HIO, HDV, or CLRIO is given for the same host device, the processor informs the compatibility feature of the event with 'unsolicited status'. The compatibility feature then raises 'intervention required' and, if a host write was executed, 'channel control check'.

The resulting condition code has the following meaning:

Condition Code	Meaning
0	Compatibility feature is interruption pending.
1	Compatibility feature is available or busy. If busy, a HALT is executed.
2	Is never given.
3	Compatibility feature is not operational.

CLEAR I/O

The compatibility feature executes a HALT if it is working with the addressed device and a CLEAR I/O is issued.

The following applies only if channel is working in block-multiplex mode, if it is working in selector mode, the CLRIO is executed as a TIO.

The resulting condition code has the following meaning:

Condition Code	Meaning
0	Compatibility feature is available or interruption pending or working with a device other than the addressed one.
1	Compatibility feature is working with addressed device or interruption pending with addressed device. In the first case a HALT is executed. In the latter case the compatibility feature is made available.
2	Is never given.
3	Compatibility feature not operational.

HALT Device

The compatibility feature executes a HALT if it is working with the addressed device and a HALT DEVICE is issued. The resulting condition code has the following meaning:

Condition Code	Meaning
0	Compatibility feature is interruption pending or busy with a device other than the addressed one.
1	Compatibility feature is available or compatibility feature working with the addressed device. In the latter case, a HALT is executed.
2	Not used.
3	Compatibility feature is not operational.

Error Recovery

When the processor returns an error indication to the compatibility feature, it normally has done several retries and no further retries are necessary. When the processor returns an unexpected error to the compatibility feature (for example 'file protection', 'program check', 'protection check' etc), 'channel control check' is returned to the user.

Errors in Write Operations and Write Verification

When the compatibility feature has written a 3310/70 block and an error has occurred, the whole emulated track is invalid (not only the emulated record as in the case of native 2311, 2314, 3330 or 3340).It is therefore recommended to 'verify' after each write operation.

The compatibility feature assumes a 'verify' when a Read command with the skip bit on occurs in the same chain in which the writing is done. In this case, the compatibility feature executes a channel program which specifies a write/verify operation when the emulated track is written back onto the 3310/70.

When several writes occur in one 2311 (or 2314, 3330, 3340) chain, the compatibility feature executes only one "host" write to the 3310/70 when it has finished the user chain or when a head switching of the emulated track is necessary. When an error occurs during that host write, the CSW points to the first write CCW of the user chain and contains 'channel control check'.

Alternate Track Support

If, under normal use of the emulated CKD disk, an FBM block becomes defective, any data on the defective block is lost. In this case, the user will attempt to assign an alternate track, using the appropriate utility program of his operating system. If this attempt is not successful due to permanent disk error or due to the nonsupport of alternate track assignment for a 3330, the defective block of the host disk must be assigned to an alternate block on the host disk. The relative block address of the defective block on the host disk can be found from EREP printout (DOS/VSE and VM) or from the DUMPCECYL printout (OS/VS1, DOS/VS or DOS). For alternate block assignment in DOS/VSE, the online system utility may be used. Other operating systems should use the surface analysis option of the program 5747-SA1.

Error Logging

Hardware and microcode errors that affect the operation of the compatibility feature can generally be classified as follows:

1. Errors logged on the CE cylinder of the host device.

2. Errors logged on the integrated system/service diskette (emulator-specific data).

In most cases, only one type of information is stored. There may be cases, however, which cause both types of information, host 3310/70 data plus compatibility feature specific data, to be stored (e.g. in case of error after host write).

Error Data Logged on CE Cylinder

The emulated sense bytes presented by the compatibility feature after a 'unit check' on host 3310/70 do not reflect in any way the real events on 3310/70. For this reason, the original sense data from the host 3310/70 sense information must be logged.

Error and counter information logging for the host device is performed by the compatibility feature. Note that the information that is logged includes, of course, only those errors which are normally logged by the operating system for the host device; it does not include, for example, operator errors such as 'intervention required'.

The following conditions require logging:

- Usage, error and overrun counter overflow ('unit check' and 'environmental data present')
- Errors that require logging ('unit check' and for example, 'equipment check')
- End-of-day condition (Wait, STOP, Power Off at the console).

Logging of Error and Counter Information

Whenever an SIO in FBM ends with 'unit check', the compatibility feature issues a sense and logs the host error or counter information.

If the check condition cannot be recovered, the user gets a 'unit check' and sense bytes of the emulated 2311/14 or 3330/40 too, which may be recorded on the recorder file by the operating system. However, this information does not reflect in any way the real events on 3310/70.

When normal power-off is initiated at the processor (power-off key pressed at the console), the compatibility feature gets control to log all outstanding counter information before power down is executed, (Wait, STOP, Power Off).

Dump CE-Cylinder Program (DMPCECYL)

For editing of logged records from the CE cylinder of the 3310/70, handling of the DMPCECYL program and error messages produced by DMPCECYL, use the description which is delivered together with the utility program "IBM 2311/2314/3330/3340 Emulation on Fixed Block Disks," Program Number 5747-SA1.

Compatibility Feature Status Indications

This section describes the unit status and channel status that is set into the channel status word (CSW) at the termination or completion of a Disk Compatibility Feature command.

The following unit status indications are given by the compatibility feature:

CSW Bits	Meaning if '1'
32	Attention (not used)
33	Status Modifier
34	Control Unit End
35	Busy
36	Channel End
37	Device End
38	Unit Check
39	Unit Exception

Attention: Is not used by the compatibility feature. However, during execution of host Read or Write commands, this bit may be set. See also section 'Logging of error in mixed mode' in Chapter 1.

Status Modifier: Is set for any Search command that succeeds in finding the search criteria (equal, high, or high or equal). The setting of the status modifier causes automatic skipping of the next sequential command and execution of the command thereafter (CCW address plus 16) when command chaining is specified.

Control Unit End: Is set when the control unit becomes available after it has signaled 'control unit busy'.

Busy: Is set in conjunction with 'status modifier' to indicate 'control unit busy'. The control unit busy response is given when the addressed device resides on a host device which is the subject of an in-line test or not ready. Control unit busy is also given whenever the compatibility feature collects sense information from the host device and is addressed during that time. Control unit end is then presented when the sense information is available.

Channel End, Device End: Both status bits are presented together for any of the Disk Compatibility Feature commands. This is because the indirect method of command execution does not allow for any separation between channel and device (which do not physically exist). The presentation of 'channel end' and 'device end' indicates that the compatibility feature is free to accept the next instruction or command.

> Note: When an operation is terminated without processing any CCW (for example the first CCW at a chain has an invalid Op.-code), no 'channel end' and 'device end' are presented, however, 'unit check' is set. In this case, only the channel and unit status are presented (short store).

When a check occurs in the middle of a chain and no data transfer has been initiated for the CCW in error, a full CSW but without channel and device end is stored.

Note: 'Device end' is presented alone when the emulated "drive" is transferred from the not-ready to the ready state. Because the operator can make ready nothing but an actual 3310 drive, all emulated volumes that can possibly reside on that host device are made ready at once which means that eight successive 'device ends' are issued for 2311 devices, or three successive 'device ends' are given for 2314 devices. The number of device ends given is always the theoretical maximum, independent of the number of actually initialized volumes.

Unit Check: Is presented for errors or unusual conditions detected during command execution. Unit check indicates that a subsequent Sense command will retrieve the actual condition. (See "Sense Information" for details.)

Unit Exception: Is set when 'end-of-file' is detected during any of the following operations:

- Read record zero
- Read data
- Read key/data
- Read count/key/data
- Search key/data
- Write key/data
- Write data

The 'end-of-file' condition results from the fact that the count area involved had a data length of zero (which marks the end of a logical file).

Channel Status

The following channel status indications are used/not used by the Disk Compatibility Feature:

CSW Bits	Meaning if '1'
40	Program-Controlled Interruption
41	Incorrect Length
42	Program Check
43	Protection Check
44	Channel Data Check - not used
45	Channel Control Check
46	Not used
47	Not used

Program Controlled Interrupt: Is set at the end of a chain in which any CCW had the PCI flag set. This means that the compatibility feature never breaks a chain due to PCI. Actually, PCI is not emulated.

Incorrect Length: Is indicated when the length count in the CCW does not agree with the number of bytes actually transferred, provided the 'suppress length' indication (SLI) flag is not set. If the SLI flag is on, 'incorrect length' is not indicated; in this case the residual count will show how many bytes were not transferred.

> **Note:** When data chaining is specified (CD flag on), the situation that channel end is recognized at the time the count is exhausted can occur because the compatibility feature does not prefetch the new CCW. If the channel end signal coincides with count zero, an interruption condition with incorrect length indication is generated (even when the SLI flag is on).

Program Check: Is indicated for the following errors as defined in principles of operation manuals.

- Invalid command code
- Invalid CAW format
- CCW is not on double-word boundary
- CCW address points out of storage
- CCW format is invalid (bits 38, 39 are not zero, or count is zero)
- Any page addressed is out of storage
- Invalid sequence (TIC refers to TIC; the chain starts with TIC)
- Invalid IDA-word
- IDA is specified in VSE mode

The presentation of 'program check' only indicates that the command (for which 'program check' is indicated) was not executed. When the compatibility feature presents 'channel end' and 'device end' together with 'program check', the failing command was partially executed before the error condition was detected. The same is true for 'protection check'.

Protection Check: Is indicated in the following cases:

- The compatibility feature attempts to place data into, or fetch data from, a protected storage area.

- The page addressed is disconnected.

Channel Data Check: Not used. Any errors that occur during data transfer from the buffer to the user area are indicated by 'channel control check' or 'machine check'.

Channel Control Check: Is set when the host drive has a 'channel control check' or an error that causes the compatibility feature to lose control, such as missing 'channel end' or 'device end' status, lack of response from host drive, etc. It is also set when a write operation to the host device results in 'unit check'.

Together with 'channel control check' (CCC), the following limited channel logout (location 176-179) is stored:

```
Byte  0       Byte 1      Byte 2      Byte 3
-------------------------------------------

     04          00          OF          00
```

In case of CCC, the disk compatibility feature stores a log record on the integrated system diskette.

System Reset

RESET CLEAR and RESET NORMAL are handled by the compatibility feature in the same way:

- Buffer contents are invalidated.

- All exceptional conditions are set to zero.

- Internal areas are set to their initial (IPL status) values.

Performance Considerations

In general, more data is transferred using DASD Compatibility for CKD device emulation compared to operation of the same devices when attached to a S/370 or 4300 processor channel.

Accordingly, use of this feature introduces additional channel demands and additional processor demands due to the microcode execution of the emulator. This can have a significant effect on system performance particularly in environments with high I/O loads using emulated DASD exclusively.

Note: Because emulated device addresses may physically be mapped on one host data module, seek separation will not improve the performance. The same is true for split cylinders.

Chapter 2. 2311/14 on 3310

Mapping of 2311/14 Volumes on 3310

This section describes how 2311/14 volumes are recorded (mapped) on a 3310. The block organization of the 3310 is not changed in any way. Each 2311/14 track occupies several blocks on the 3310.

Mapping of 2311 Volumes

- Each 2311 track (including home address, count, key and data areas, but excluding gaps) becomes eight 512-byte blocks on 3310.

- 203 cylinders of the 2311 (at 10 tracks per cylinder) build one volume.

- Up to seven full 2311 volumes may be mapped on one 3310 spindle.

- If seven full 2311 volumes are mapped on one 3310, space is left on the 3310 which may be used by the customer to initialize an (8th) emulated 2311 partial volume. For an 8th emulated 2311 partial volume, a space of 150 cylinders remains available. The size of the emulated partial volume is specified, in emulated cylinders, when the pack is formatted with the Format Emulator Extent program.

Mapping of 2314 Volumes

- Each 2314 track (including home address, count, key and data areas, but excluding gaps) becomes fifteen 512-byte blocks on 3310.

- 203 cylinders of the 2314 (at 20 tracks per cylinder) build one volume.

- Up to two 2314 volumes may be mapped on one 3310 spindle.

- If two 2314 volumes are mapped on one 3310, space is left on the 3310 which may be used to initialize a (third) emulated 2314 partial volume. For a third emulated 2314 partial volume, a space of 10 cylinders remains available.

The size of the emulated partial volume is specified, in emulated cylinders, when the pack is formatted with the Format Emulator Extent program.

Mapping Scheme

The following formulas and tables show the mapping of 2311/14 emulated devices on a host 3310 device.

Alternate tracks (cylinder numbers 200..202) are mapped in front of the prime cylinders in order to allow for "mini packs" (see Figure 2-1 on page 2-3).

Emulated Devices

	2311	2314
NOBTRK (No. of Blocks per Emulated Track)	8	15
No. of Emulated Alternate Cylinders	3	3
No. of Tracks per Emulated Cylinder (Heads)	10	20
NOBCYL (No. of Blocks per Cylinder)	80	300
No. of Prime Cylinders per Emulated Pack	200	200
NOEB (No. of Blocks per Emulated Device)	16240	60900
No. of Emulated Packs per Host Device	8	3
PBN (Physical Block Number)		
for Emulated Pack Start, Pack No. 1	126015	126015
◄(NONB−1) − 1 * NOEB► No. 2	109775	65115
◄(NONB−1) − 2 * NOEB► No. 3	93535	4215
No. 4	77295	
No. 5	61055	
No. 6	44815	
No. 7	28575	
No. 8	12335	
Remainder if used as emulated space (no. of prime cylinders)	150	10
Space for host VTOC (512–byte blocks)	96	316

```
Emulated              PBN = 0
Addresses
                 ┌─────────────────────────────────┐
                 │ Remaining space may be used for ─│
                 │ part. volume (+ alternate cyl.)  │  PBN = 4215
        Cyl 199  ├─────────────────────────────────┤
                 │                                  │
           A     │                                  │
           │     │          Device XX1              │
           │     │                                  │
        Cyl 0    │                                  │
                 ├─────────────────────────────────┤
        Cyl 202  │        Alternate Cylinders       │
        Cyl 200  │                              ┌───┤
                 ├──────────────────────────────┘   │  PBN = 65115
        Cyl 199  ├──────────────────────────────────┤
           A     │                                  │
           │     │                                  │
           │     │          Device XX0              │
           │     │                                  │
        Cyl 0    │                                  │
                 ├─────────────────────────────────┤
        Cyl 202  │        Alternate Cylinders       │
        Cyl 200  │                              ┌───┤
                 └──────────────────────────────┘   │  PBN = 126015
                       A                    A
                       │                    │
                     Head 9              Head 0
```
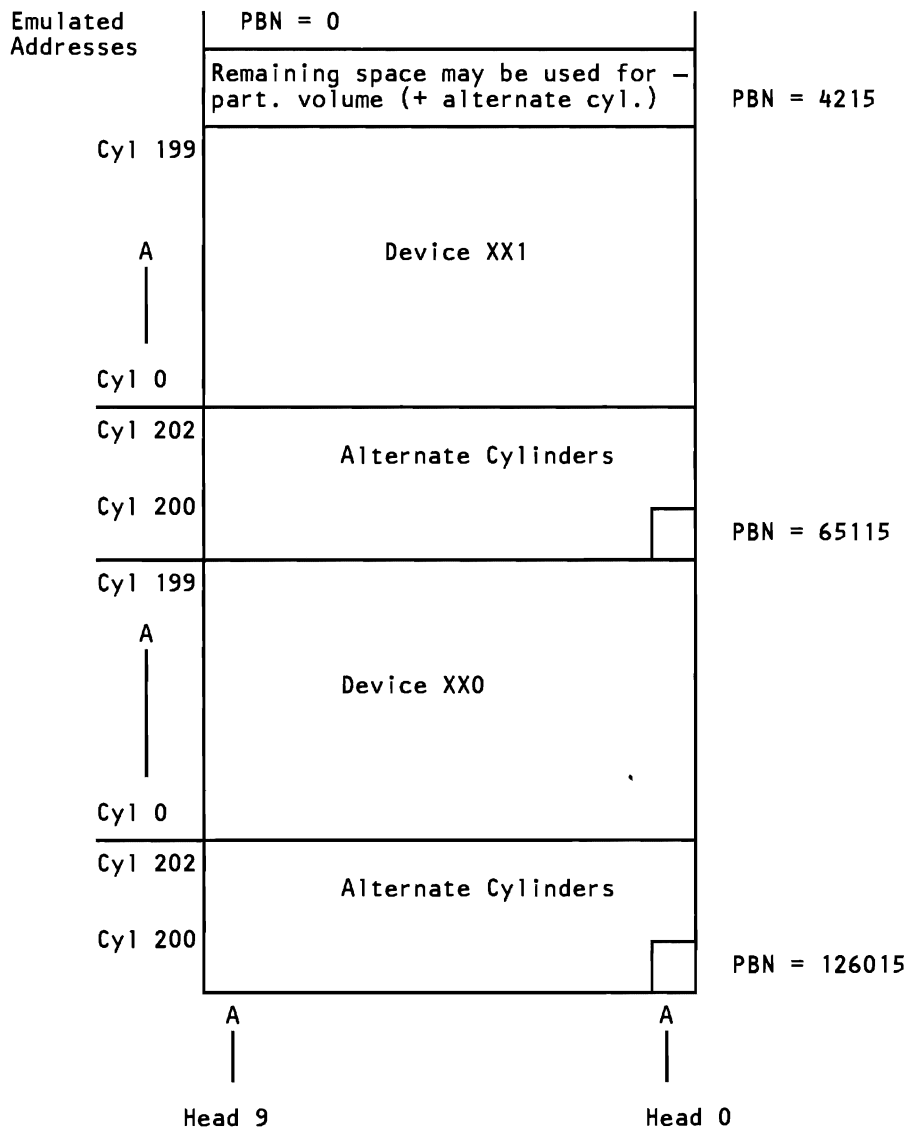
Figure 2-1. 2314 Mapping on 3310

Association of Emulated and Host Device Addresses

Identification of Emulated Volumes on Host Devices

In order to identify each 2311 or 2314 volume on a 3310, each group of 3310 blocks that holds an emulated volume is logically associated with an emulated device address. The logical association is done by the compatibility feature, which needs these emulated ("dummy") addresses to find the correct 3310 drive, cylinder, and block number when the old program addresses a (former) 2311 or 2314 volume.

Range of Host 3310 Addresses Available

The range of standard host addresses available is as follows:

```
X00   through   X73
 ││ └─────────┐ ││ └────── Device number
 │└───────────┘ │└──────── String number
 └──────────────┴───────── Channel number
```
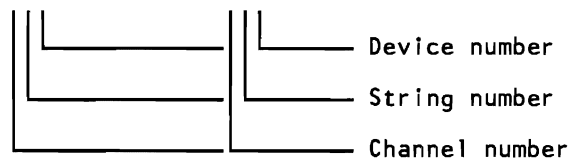
Channel Number: For DASDs attached to the processor, the channel assignment may range from 1 to 6. Note, however, that this address may be changed by the service representative at any time.

String Number: May range from 0 through 7

Device Number: May range from 0 through 3 (four spindles per string are supported).

First Host Address Specified at IPL Time →	Last Host Addresses							
	2x0	2x1	2x2	2x3	2(x+1)0	2(x+1)1	2(x+1)2	2(x+1)3
	Corresponding Emulated 2311 Addresses							
2x0	290–297	298–29F	2A0–2A7	2A8–2A5	2B0–2B7	2B8–2BF	2C0–2C7	2C8–2CF
2x1	–	290–297	298–29F	2A0–2A7	2A8–2AF	2B0–2B7	2B8–2BF	2C0–2C7
2x2	–	–	290–297	298–29F	2A0–2A7	2A8–2AF	2B0–2B7	2B8–2BF
2x3	–	–	–	290–297	298–29F	2A0–2A7	2A8–2AF	2B0–2B7

String boundary ⟶

First Host Address Specified at IPL Time →	Last Host Addresses							
	2x0	2x1	2x2	2x3	2(x+1)0	2(x+1)1	2(x+1)2	2(x+1)3
	Corresponding Emulated 2314 Addresses							
2x0	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	2C0–2C2	2C8–2CA
2x1	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	2C0–2C2
2x2	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA
2x3	–	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2

Figure 2-2. Association of Host Device Addresses with Emulated Device Addresses

- The first column of host device addresses shows the four user options. At IPL time, the user may specify one of these four addresses as the "first host" address.

- The host channel address '2' is an example; it may be changed by the service representative at any time.

- 'x' is the string number; it may range from 0 through 7.

- The last of a range of eight (2311) or three (2314) emulated addresses is for a partial volume.

The compatibility feature supports a maximum of 64 emulated 2311 volumes or a maximum of 24 emulated 2314 volumes on up to eight 3310 host devices which may be located in no more than two (successive) strings. One string comprises four 3310 devices and can thus accommodate either twelve emulated 2314, or 32 emulated 2311 volumes.

The user has the choice to start his emulated space on any of the four host devices of the (first) string he wants to use for 2311/14 emulation (see Figure 2-2 on page 2-5):

- If the user starts his emulated space on the host device with the address X'2x0' (which may be '240', '250', or '260'), he has the full range of two host strings (X'2x0' through X'2(x+1)3') for the emulated address range X'290' through X'2CF' at his disposal.

At IPL time, the user only has to specify (in the PROGRAM LOAD picture) the address of the first/last host device that holds the first emulated volume; in this case, X'2x0'. By entering this address he defines where the emulated space "starts" and this determines the emulated address range. If during subsequent processing, the user refers to any of the emulated addresses X'290' through X'2CF', the compatibility feature automatically accesses the corresponding host device (the emulated volumes must, of course, have been mapped accordingly).

- If the user starts his emulated space on the host device with the address X'2x1', he has the host address range from X'2x1' to X'2(x+1)3' for the emulated address range X'290' through X'2C7' at his disposal. Any reference to the emulated addresses X'2C8' through X'2CF' would result in CC3, because no more than two strings of host devices are supported.

- If the user starts his emulated space on the host device with the address X'2x2' or X'2x3', the host space available for emulation purposes is reduced accordingly, and references to the emulated addresses X'2C0' to X'2CF' or X'2B8' to X'2CF', respectively, result in CC3.

Emulated 2311/2314 Commands

This section assumes that the reader is familiar with /360 and /370 principles of operation and has, in addition, knowledge of the 2841. The following text contains details about minor deviations caused by the emulation. The command, status, and sense byte descriptions apply to both compatibility features except where marked with "2314 only." The deviations are of interest for anyone who writes 2311/14 programs on the physical IOCS level or who is involved with maintenance of old programs.

Refer to the following publications for detailed command descriptions:

IBM System/360 Component Description, 2841 and Associated DASD, GA26-5988
IBM System/360 Component Description, 2314 DASD and 2844 Auxiliary Storage Control, GA26-3599

```
Command Code              Command Name
Hex    CCW Bits
-------------------------------------------------------------------
05     00000101           Write Data
0D     00001101           Write Key/Data
1D     00011101           Write Count/Key/Data
19     00011001           Write Home Address
15     00010101           Write Record Zero
01     00000001           Write Special Count/Key/Data
11     00010001           Erase

-1     X0110001           Search ID Equal
-9     X0101001           Search Key Equal
-9     X0111001           Search Home Address Equal
-1     X1010001           Search ID High
-9     X1001001           Search Key High
-1     X1110001           Search ID High or Equal
-9     X1101001           Search Key High or Equal
-D     X0101101           Search Key and Data Equal
-D     X1001101           Search Key and Data High
-D     X1101101           Search Key and Data High or Equal

-6     X0000110           Read Data
-E     X0001110           Read Key/Data
-E     X0011110           Read Count/Key/Data
-A     X0011010           Read Home Address
-6     X0010110           Read Record Zero
-2     X0010010           Read Count
02     00000010           Read IPL (initial program load)

07     00000111           Seek *)
0B     00001011           Seek Cylinder *)
1B     00011011           Seek Head *)
13     00010011           Recalibrate *)
0F     00001111           Space Count *)
1F     00011111           Set File Mask *)
17     00010111           Restore
03     00000011           No Operation
04     00000100           Sense

-5     X0100101           Continue Scan Equal
-5     X1000101           Continue Scan High
```

Legend: X is the multi-track bit. When X is 0, the operation is confined to a single track, when X is 1, the operation can be extended over one cylinder.

*) Cannot be used for data chaining.

Command Deviations

Read Initial Program Load (IPL)

The Read IPL command can be issued stand-alone or in a chain, but must not be preceded by a Set File Mask or a Space Count command (which automatically sets the file mask) in the same chain.

Write Home Address

The Write Home Address command must be preceded by the correct Set File Mask command; otherwise, the Write Home Address command is rejected with 'command reject' because of 'invalid sequence'.

Write Record Zero

The key and data that follows the count field is written into the compatibility feature buffer under control of key and data length. No cyclic check bytes are attached. After the record zero is assembled in the buffer, the appropriate block is written onto the 3310 volume concerned.

Write Count/Key/Data

If a Write command is chained after a 'space count', the sense information is 'file protect' instead of 'invalid sequence'.

Search Commands

When a Search command is followed by a TIC pointing back to the search, performance is increased. In this case, searching is done directly from the buffer without any CCW-fetching, till either the search is successful or finished with 'no record found' or 'end-of-cylinder'.

Search Key

Record zero (the track descriptor record) does not participate in the key search if the Search Key command is not chained from a preceding search ID command. If chained from a Search ID, the search key includes record zero.

Continue Scan Commands

The Continue Scan commands cannot be used to detect erased portions of an overflow record because the compatibility feature does not maintain address markers. A search over an erased record passes on to the next one and a multiple track search can continue to the end of the cylinder without giving the "address marker missing" and "no record found" indications.

Space Count

When the key and data length given with the Space Count command do not agree with the actual values, the results of a following Read command are unpredictable. A 'chain data' flag in a Space Count command finishes the chain.

Restore

This command is executed as a no operation.

2311/14 Compatibility Feature Sense Information

The compatibility feature generates six sense bytes and keeps these ready for transfer to storage if a Sense command is issued. Because the compatibility feature obtains sense information automatically when the need arises, a 2311/14 Sense command must be issued following a 'unit check'. If a Sense command is not issued following 'unit check', the pertinent information may no longer be available at some later time because of the compatibility feature's own activity that may (or may not) have occurred in the meantime. The following sense bytes are provided:

Sense Byte 0

Bit Number	Meaning if '1'
0	Command Reject
1	Intervention Required
2	Not used
3	Equipment Check
4	Data Check
5	Overrun
6	Track Condition Check
7	Seek Check

Command Reject: Is set in any of the following situations:

- A command is given which is not part of the 2311/14 repertoire.
- An invalid command sequence is given.
- Commands are chained incorrectly.
- A Seek command has an invalid seek address or a length count of less than six bytes.
- A command violates the write portion of the file mask, or an invalid file mask is set.

For details, see "Invalid Sequence."

Intervention Required:
Is set in any of the following situations:

- A 2311/14 command is issued to an existing device (correct device address) while that device is not ready or in CE mode (actually the 3310 is not ready, i.e., is stopped, or is not up to speed)

- A 2311/14 device is correctly addressed and the host drive is ready, but the host was not formatted as a 2311/14 (i.e. is actually a host). Note, however, that 'intervention required' is only presented if the data is actually to be used. It is not presented, for example, if only a seek is given.

  Note: The compatibility feature checks the ready/not ready status of the host device at initial selection time but does not check whether this host was formatted as a 231X. When the host device is not ready a Start I/O

gets condition code 1 and unit check. A subsequent Start I/O with sense operation ends with condition code 1 and control unit busy. After receipt of control unit end the Start I/O with sense operation must be repeated and 'intervention required 'is available in the sense bytes. When the host is ready, a Test I/O gets condition code 0 even if the host is not formatted as 2311 or 2314. A start I/O issued to an unformatted (but ready) host will get condition code 0 with 'intervention required' indicated to the accessing CCW.

Equipment Check: Is set in any of the following situations:

- The 3310 presents 'equipment check' during execution of a command chain started by the compatibility feature, which was not a write operation (a hardware check in the 3310 is responsible).

- The user command currently executed is a Write command, but the read operation started by the compatibility feature prior to the user write had resulted in a 'data check'.

- A malfunction occurs during arm positioning which results in 'equipment check (seek error)' on the host device.

Data Check: Is set when the 3310 is involved in a compatibility feature operation and the 3310 indicates 'data check' to the compatibility feature.

Data check is not presented (although the operation on 3310 ended with 'data check') when the block affected (i.e. the "bad" block) is not involved in the emulated operation, e.g. no data has to be transferred from the "bad" block.

Overrun: Is set in any of the following situations:

- When the host 3310 presents 'overrun' with the 'permanent' bit on, and the operation was not a write.

- When a 'chain data' flag is detected in a control command with a short CCW count.

Track Condition Check: Indicates defective track (bit 6 of the flag byte is 1) to a Search command other than search HA, a Read command other than read HA or read RO, or any Write command.
It also indicates that a switch to a defective track was attempted as a result of executing a multiple-track command or a command on a segment of an overflow record (bit 1 of the flag byte is 1). In the case of overflow, overflow-incomplete is also set.
Also indicates that an attempt was made to switch from an alternate track (bit 7 of the flag byte) or a defective track (bit 6 of the flag byte) by means of overflow or by a multiple-track command.

Seek Check: Is set when the Seek command has a length count of less than six bytes, or the seek address is invalid (i.e. points to a location outside the physical disk storage); in addition, 'command reject' is set.

Sense Byte 1

Bit Number	Meaning if '1'
0	Not used (0)
1	Track Overrun
2	End-of-Cylinder
3	Invalid Sequence
4	No Record Found
5	File Protected
6	Not used (0)
7	Overflow Incomplete

Track Overrun: Is set when a formatting write or erase operation attempts to write more bytes than the remaining space can accommodate. Note that 'track overrun' does not necessarily occur at the same instant where it might have occurred on the 2311/14 formerly used. This is because the compatibility feature does not emulate gaps, hence, has a somewhat larger track capacity.

End-of-Cylinder: Indicates that the CCW command chain has not been completed, and cylinder end has been detected during multiple-track operation.

> **Note:** End-of-cylinder is also indicated for multiple-track searches when all records of a track have been erased. On a real 2311/14, the indications 'no record found' and 'missing address marker' were given when an erased record was encountered. Since the compatibility feature does not maintain address markers, a missing address marker is not detected and the search can therefore continue to the end of the cylinder (which is then indicated).

Invalid Sequence: Is set when the program attempts to issue a command that would lead to undefined situations in conjunction with the preceding command. Command reject is set together with 'invalid sequence' and the command in question is not executed. The following are invalid sequences to the 2311/14 compatibility feature:

- A multi-track search is not preceded by a Seek command in the same chain.

- A Set File Mask command appears for the second time in the same chain.

- A Write Record Zero command is not preceded by a successful Search Home Address Equal or Write Home Address.

- A Write Count/Key/Data command is not chained from a preceding Write Record Zero, or another Write Count/Key/Data command. However, a Read Data or Read Key/Data command may be inserted between the Search and the Write command without causing 'invalid sequence'.

- A Write Data command is not preceded by a successful Search Identifier Equal or Search Key Equal command.

- A Write Key/Data command is not preceded by a successful Search Identifier Equal command; the Search may be a truncated command.

No Record Found: Is set only for single-track operations which (repeated on the same track) have encountered the index marker for the second time, without completing an intervening command to read or write or search the data area, read home address or read R0, or a control command.

File Protected: Is set when a command violates the specifications given by a Set File Mask command. If the violating command is a Write command 'command reject' is also set.

> Note: If the violating command is a Write command and, in addition to violating the file mask, other requirements are violated (for example, chaining requirements), normally 'file protect' and 'command reject' are presented (not 'invalid sequence'). When a Write command is the first in a chain, 'command reject' and 'invalid sequence' are presented.

Overflow Incomplete: Is used with the record overflow operation. The following situations cause the compatibility feature to set 'overflow incomplete' for overflow commands:

- Overflow over cylinder boundary
- Overflow to file-protected boundary (dictated by the file mask)
- Overflow to a defective track
- Overflow from an alternate track

When 'overflow incomplete' is signaled, sense byte 5 contains information about the command in progress when the condition did arise, as follows:

Hex Value	Meaning
06	Read command was in progress
05	Write command was in progress
25	Search Key/Data Equal was in progress, and comparison is equal to this point
45	Search Key/Data High was in progress and comparison is equal to this point
65	Search Key/Data High or Equal was in progress and comparison is equal to this point
55	Search Key/Data was in progress and comparison is low, or a Search Key/Data Equal was in progress and comparison is high
75	Search Key/Data High or High-Equal was in progress and comparison is high

Sense Byte 2

Sense byte 2 defines which type of device is emulated on which host device, as follows:

```
Bit Number      Assignment
---------------------------------------------

0               0
1               0
2               0
3               0
4               0
5               0
6               1 = 2311 or 2314 on 3310
7               0
```

Sense Byte 3

```
Bit Number  2311 Meaning if '1'      2314 Meaning if '1'
-----------------------------------------------------------

0*          Ready                    Not used
1*          On-line                  On-line
2           Not used                 Not used
3           Not used                 Not used
4*          On-line                  Not used
5           End of Cylinder          End of Cylinder
6           Not used                 Not used
7           Not used                 Not used
```

• These bits are already forced on for compatibility reasons during emulation and do not reflect the actual status of the 3310 drive.

Ready: Is set whenever the 3310 host disk drive is ready (2311 only).

On Line: Is always set when 'ready' is set. The compatibility feature does not distinguish between 'ready' and 'on-line'.

End-of-Cylinder: Same as for sense byte 1.

Sense Byte 4

Is not used.

Sense Byte 5

Sense byte 5 indicates the type of command in progress when 'overflow incomplete' occurs (bit 7 in sense byte 1). If 'overflow incomplete' did not occur, sense byte 5 is zero.

Chapter 3. 2311/14 on 3370

Mapping of 2311/14 Volumes on 3370

This section describes the mapping of 2311/14 volumes on 3370. The block organization of the 3370 is not changed in any way. Each 2311/14 track is spread over several blocks onto 3370.

> **Note:** Instead of the term "spindle" which was used to clarify on removable disks the number of volumes that could be mounted, we will say "3370 volume" or "host device." This nomenclature is necessary because there are two volumes with two separately addressable access mechanisms on a "3370 spindle," hence, two devices, and each device may be the host of emulated volumes.

Mapping of 2311 Volumes

- Each 2311 track (including home address, count, key and data areas, but excluding gaps) becomes eight 512-byte blocks on 3370.

- 203 cylinders of the 2311 (at 10 tracks per cylinder) build one volume.

- Up to thirty-four full 2311 volumes may be mapped on one 3370 volume.

- If thirty-four full 2311 volumes are mapped on one 3370 volume, space is left on the 3370 which may be used to initialize a (35th) emulated 2311 partial volume.

Mapping of 2314 Volumes

- Each 2314 track (including home address, count, key and data areas, but excluding gaps) becomes fifteen 512-byte blocks on 3370.

- 203 cylinders of the 2314 (at 20 tracks per cylinder) build one volume.

- Up to nine full 2314 volumes may be mapped on one 3370 volume.

- If nine full 2314 volumes are mapped on one 3370 volume, space remains available on the 3370 which may be used by the user to initialize an emulated partial volume of 29 cylinders.

Mapping Scheme

The following formulas and tables show the mapping of 2311/14 emulated devices on a host 3370 device.

The file mapping algorithm is chosen in such a way that Home Address, Record Zero, and the maximum capacity of the Data Records (without any gaps, however) of the emulated disk are mapped onto as many 512-byte data blocks of the host disk as are needed. Alternate tracks (cylinder numbers 200..202) are mapped in front of the prime cylinders in order to allow for partial volumes (see Figure 3-1 on page 3-4).

Restriction

The additional 208 cylinders of the 3370 models A2, B2 cannot be used for emulation.

- 3370 models A1, B1 have 754 cylinders.
- 3370 models A2, B2 have 962 cylinders.

Emulated Devices

	3370 Mod. A1, B1		3370 Mod. A2, B2	
	2311	2314	2311	2314
NOBTRK (No. of Blocks per Emulated Track)	8	15	8	15
No. of Emulated Alternate Cylinders	3	3	3	3
No. of Tracks per Emulated Cylinder (Heads)	10	20	10	20
NOBCYL (No. of Blocks per Cylinder)	80	300	80	300
No. of Prime Cylinders per Emulated Pack	200	200	200	200
NOEB (No. of Blocks per Emulated Device)	16240	60900	16240	60900
No. of Emulated Packs per Host Device	35	10	35	10
PBN (Physical Block Number)				
for Emulated Pack Start, Pack No. 1	557999	557999	712751	712751
◄(NONB−1) − 1 * NOEB► No. 2	541759	497099	696511	651851
◄(NONB−1) − 2 * NOEB► No. 3	525519	436199	680271	590951
No. 4	509279	375299	664031	530051
No. 5	493039	314399	647791	469151
No. 6	476799	253499	631551	408251
No. 7	460559	192599	613311	347351
No. 8	444319	131699	599071	286451
No. 9	428079	70799	582831	225551
No. 10	411839	9899	566591	164651
No. 11	395599		550351	
No. 12	379359		534111	
No. 13	363119		517871	
No. 14	346879		501631	
No. 15	330639		485391	
No. 16	314399		469151	
No. 17	298159		432911	
No. 18	281919		436671	
No. 19	265679		420431	
No. 20	249439		404191	
No. 21	233199		387951	
No. 22	216959		371711	
No. 23	200719		355471	
No. 24	184479		339231	
No. 25	168239		322991	
No. 26	151999		306751	
No. 27	135759		290511	
No. 28	119519		274271	
No. 29	103279		238031	
No. 30	87039		241791	
No. 31	70799		225551	
No. 32	54559		209311	
No. 33	38319		193071	
No. 34	22079		176831	
No. 35	5839		160591	
	5840	9900	160592	164652
Remainder if used as emulated space (no. of prime cylinders)	69	29	—	—
Space for host VTOC (512−byte blocks)	80	300	Not Limited	Not Limited

```
Emulated        | PBN = 0
Addresses       |
                |Remaining space may be used  ┌─            3370
                |for partial volumes.         │   PBN =    9899 /A1, B1
                |                             ─┘         164652 /A2, B2
     Cyl 199    ├─────────────────────────────┐
                │                              │
                │         Device 298           │
                │                              │
       │        │                              │
       │        │       Prime Data Area        │
       │        │                              │
                │                              │
     Cyl 0      │                              │
     Cyl 202    ├──────────────────────────────┤
                │         Device 298           │
                │       Alternate Tracks       │
     Cyl 200    │                              │
                ├──────────────────────────────┤
                │              .               │
                │              .               │
                │              .               │
                │              .             ┌─            3370
                │              .            ─┘   PBN = 497099 /A1, B1
     Cyl 199    ├───────────────────────────┐          651851 /A1, B2
       │        │                            │
       │        │         Device 290         │
                │       Prime Data Area      │
     Cyl 0      │                            │
     Cyl 202    ├────────────────────────────┤
                │         Device 290         │
                │       Alternate Tracks     │
     Cyl 200    │                          ┌─            3370
                │                         ─┘   PBN = 557999 /A1, B1
                │                                     712751 /A2, B2
                └──────┬──────────────────┬──

              Head 19                  Head 0
```
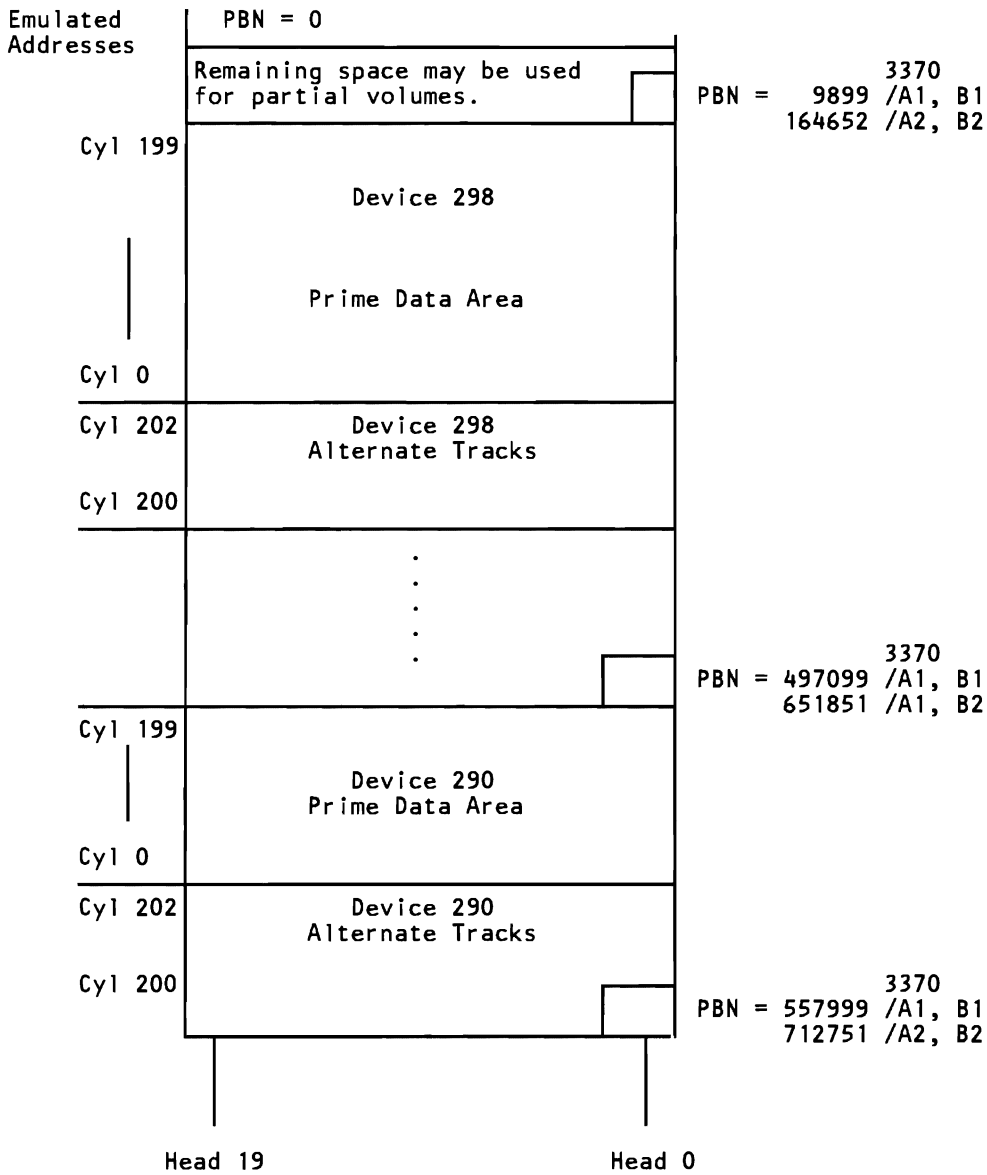
Figure 3-1. 2314 Mapping on 3370

Association of Emulated and Host Device Addresses

Identification of Emulated Volumes on Host Devices

In order to identify each 2311 or 2314 volume on a 3370, each group of 3370 blocks that holds an emulated volume is logically associated with an emulated device address. The logical association is done by the compatibility feature, which needs these emulated ("dummy") addresses to find the correct 3370 drive, cylinder, and block number when the old program addresses a (former) 2311 or 2314 volume. The user need only specify, at IPL time, first and last host address of the devices(s) that holds the first emulated volume.

Range of Host 3370 Addresses Available

The range of standard host addresses available is as follows:

```
X'220' through X'237'
```

```
          ┌──────────── Device number
          ├──────────── String number
          └──────────── Channel number
```
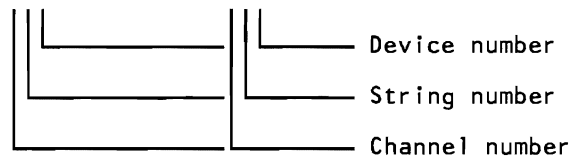
Channel Number: For DASDs attached to the processor, the standard channel assignment is '2'. Note, however, that this address may be changed by the service representative at system installation time.
String Number: May be 2 or 3.
Device Number: May range from 0 through 7 (eight spindles per string are supported).

First Host Address Specified at IPL ↓	Last Host Addresses specified at IPL time.								
	2x0	2x1	2x2	2x3	2x4	2x5	2x6	2x7	2(x+1)0
	Corresponding Emulated 2311 Addresses								
2x0	290–2B2	2B8–2DA	–	–	–	–	–	–	–
2x1	–	290–2B2	2B8–2DA	–	–	–	–	–	–
2x2	–	–	290–2B2	2B8–2DA	–	–	–	–	–
2x3	–	–	–	290–2B2	2B8–2DA	–	–	–	–
2x4	–	–	–	–	290–2B2	2B8–2DA	–	–	–
2x5	–	–	–	–	–	290–2B2	2B8–2DA	–	–
2x6	–	–	–	–	–	–	290–2B2	2B2–2DA	–
2x7	–	–	–	–	–	–	–	290–2B2	2B8–2DA

string boundary —

First Host Address Specified at IPL Time ↓	Last Host Addresses specified at IPL time.								
	2x0	2x1	2x2	2x3	2x4	2x5	2x6	2x7	2(x+1)0
	Corresponding Emulated 2314 Addresses								
2x0	290–299	2A0–2A9	2B0–2B9	2C0–2C9	2D0–2D9	2E0–2E9	2F0–2F9	–	–
2x1	–	290–299	2A0–2A9	2B0–2B9	2C0–2C9	2D0–2D9	2E0–2E9	2F0–2F9	–
2x2	–	–	290–299	2A0–2A9	2B0–2B9	2C0–2C9	2D0–2D9	2E0–2E9	2F0–2F9
2x3	–	–	–	290–299	2A0–2A9	2B0–2B9	2C0–2C9	2D0–2D9	2E0–2E9
2x4	–	–	–	–	290–299	2A0–2A9	2B0–2B9	2C0–2C9	2D0–2D9
2x5	–	–	–	–	–	290–299	2A0–2A9	2B0–2B9	2C0–2C9
2x6	–	–	–	–	–	–	290–299	2A0–2A9	2B0–2B9
2x7	–	–	–	–	–	–	–	290–299	2A0–2A9

Emulated Device Addresses

Figure 3-2. Association of Host Device Addresses with

- The first column of host device addresses shows the eight user options. At IPL time, the user may specify one of these eight addresses.

- The host channel address '2' is an example; it may be changed by the service representative at any time.

- 'x' is the string number; it may be any number from 0 to 7.

- The last of a range of emulated addresses may be used for partial volume.

The compatibility feature supports a maximum of 70 emulated devices in no more than two (successive) strings of 3370 host devices. One string comprises eight 3370 devices and can accommodate either 70 emulated 2314 or 70 emulated 2311 volumes. Actually all host devices may bear emulated files.

The user has the choice to start his emulated space on any of the eight host devices in any string he wants to use for 2311/14 emulation and will then, depending on his choice, be able to address either the maximum number of emulated devices or not. For 2314 emulation, the following considerations apply (see Figure 3-2 on page 3-6):

- If the user starts his emulated space on the host device with the address X'2x0', he has the full range of two host strings (X'2x0' through X'2(x+1)7') for the emulated address range X'290' through X'2F9' at his disposal.

  At IPL time, the user only has to specify (in the PROGRAM LOAD picture) the first and last host address of the device that holds the first emulated volume; in this case, X'2x0'. If during subsequent processing, the user refers to any of the emulated addresses X'290' through X'2F9', the compatibility feature automatically accesses the corresponding host device (the emulated volumes must, of course, have been mapped accordingly).

- If the user starts his emulated space on the host device with the address X'2x1', he has the host address range from X'2x1' to X'2(x+1)7' for the emulated address range X'290' through X'2F9' at his disposal.

  At IPL time, the user has to specify the host address X'2x1' in the PROGRAM LOAD picture.

- If the user starts his emulated space on the host device with the address X'2x2' or X'2x7', the host space available for emulation purposes is reduced accordingly, and references to the emulated addresses X'2F0' to X'2F9' or X'2E0' to X'2F9', respectively, result in CC3.

For 2311 emulation the user has the full range of 290 through 2DA, independent of the first address of the host device he specifies at IPL time.

Emulated 2311/2314 Commands

The command deviations are the same as described in the equivalent section for 2311/14 data sets on 3310.

Refer to the following publications for detailed command descriptions:

IBM System/360 Component Description, 2841 and Associated DASD, GA26-5988
IBM System/360 Component Description, 2314 DASD and 2844 Auxiliary Storage Control, GA26-3599

Error Handling

The procedure is the same as described in Chapter 1, section 'Error Recovery'.

Sense Byte 0

Sense byte 0 bit 1 (intervention required) is also set if the 3370 Read Only switch is set to 'Read Only' position.

Sense Byte 2

Sense byte 2 defines the emulated device and the host device as follows:

```
Bits          Assignment
--------------------------------------------------------
0             0
1             1=2311 or 2314 on 3370 (if bit 6 on)
2             0
3             0
4             0
5             0
6             1=2311 or 2314 on 3370 (if bit 1 on)
7             0
```

Sense Byte 3

```
Bit Number  2311 Meaning if '1'      2314 Meaning if '1'
-----------------------------------------------------------
0*          Ready                    Not used
1*          On-line                  On-line
2           Not used                 Not used
3           Not used                 Not used
4*          On-line                  Not used
5           End of Cylinder          End of Cylinder
6           Not used                 Not used
7           Not used                 Not used
```

* These bits are already forced on for compatibility reasons during emulation and do not reflect the actual status of the 3370 drive.

Ready: Is set whenever the 3370 host disk drive is ready (2311 only).

On-Line: Is always set when 'ready' is set. The compatibility feature does not distinguish between 'ready' and 'on-line'.

End-of-Cylinder: Same as for sense byte 1.

Chapter 4. 3330/40 on 3370

With this compatibility feature, the customer may run his 3330/40 files under DOS or DOS/VS without any changes to his source or object code. However, the customer must keep in mind that the Rotational Position Sensing (RPS) feature is not supported by the compatibility feature.

The service representative is recommended to run a diagnostic test against the host device. Diagnostic programs for the compatibility feature are meaningless and not supported by the compatibility feature. Diagnostic commands to the 3330/40 device will result in unit check with 'command reject'. Error/usage statistics will be maintained for the host device either by the Operating System (DOS release 35 and later releases) or by the compatibility feature on the CE cylinder of the host device.

Mapping of 3330/40 Volumes on 3370

This section describes the mapping of 3330/40 volumes on 3370. The block organization of the 3370 is not changed in any way. Instead, each 3330/40 track is spread over several blocks onto 3370.

> **Note:** In subsequent chapters, the term "3370-volume" or "host device" is used instead of "spindle" because the 3370 bears two volumes with two separately addressable access mechanisms on one spindle.

Mapping of 3330 Volumes

- Each 3330 track (including home address, count, key and data areas, but excluding gaps) becomes twenty-six 512-byte blocks on 3370.

- 411 cylinders of the 3330 (at 19 tracks per cylinder) build one volume.

- Up to two full 3330 volumes may be mapped on one 3370 volume.

- If two full 3330 volumes are mapped on one 3370 volume, space is left on the 3370 to initialize an emulated partial volume.

Mapping of 3340 Volumes

- Each 3340 track (including home address, count, key and data areas, but excluding gaps) becomes seventeen 512-byte blocks on 3370.

- 698 cylinders of the 3340 (at 12 tracks per cylinder) build one volume.

- Up to three full 3340 volumes may be mapped on one 3370 spindle.

- The user may use the remaining 130824 blocks to initialize an emulated partial volume. (See the table below for the space left available). The size of the partial volume is specified, in emulated cylinders, when the pack is formatted.

- The 3340 CE-cylinders are not emulated. A seek to CE cylinders results in command reject.

Mapping Scheme

The following formulas and tables show the mapping of 3330/40 emulated devices on a host 3370 device.

The file mapping algorithm is chosen in such a way that Home Address, Record Zero, and the maximum capacity of the Data Records (without any gaps, however) of the emulated disk are mapped onto as many 512-byte data blocks of the host disk as are needed. Alternate tracks are mapped in front of the prime cylinders in order to allow for partial volumes (see Figure 4-1 on page 4-3).

Emulated Devices

	3370 A1, B1		3370 A2, B2	
	3330	3340	3330	3340
NOBTRK (No. of Blocks per Emulated Track)	26	17	26	17
No. of Emulated Alternate Cylinders	7	2	7	2
No. of Tracks per Emulated Cylinder (Heads)	19	12	19	12
NOBCYL (No. of Blocks per Cylinder)	494	204	494	204
No. of Prime Cylinders per Emulated Pack	404	696	404	696
NOEB (No. of Blocks per Emulated Device)	203034	142392	203034	142392
No. of Emulated Packs per Host Device	3	4	3	4
PBN (Physical Block Number)				
for Emulated Pack Start, Pack No. 1	557999	557999	712751	712751
◄(NONB−1) − 1 * NOEB► No. 2	354965	415607	509717	570362
◄(NONB−1) − 2 * NOEB► No. 3	151931	273215	306683	427970
No. 4		130823		
Remainder if used as FBM space (512−byte blocks)	151932	130824	306684	285579
Remainder if used as emulated space (no. of prime cylinders)	300	638	——	——
Space for host VTOC (512−byte blocks)	274	264	Not Limited	Not Limited

Restriction

The additional 208 cylinders of the 3370 models A2, B2 cannot be used for emu-
lation.

- 3370 models A1, B1 have 754 cylinders.
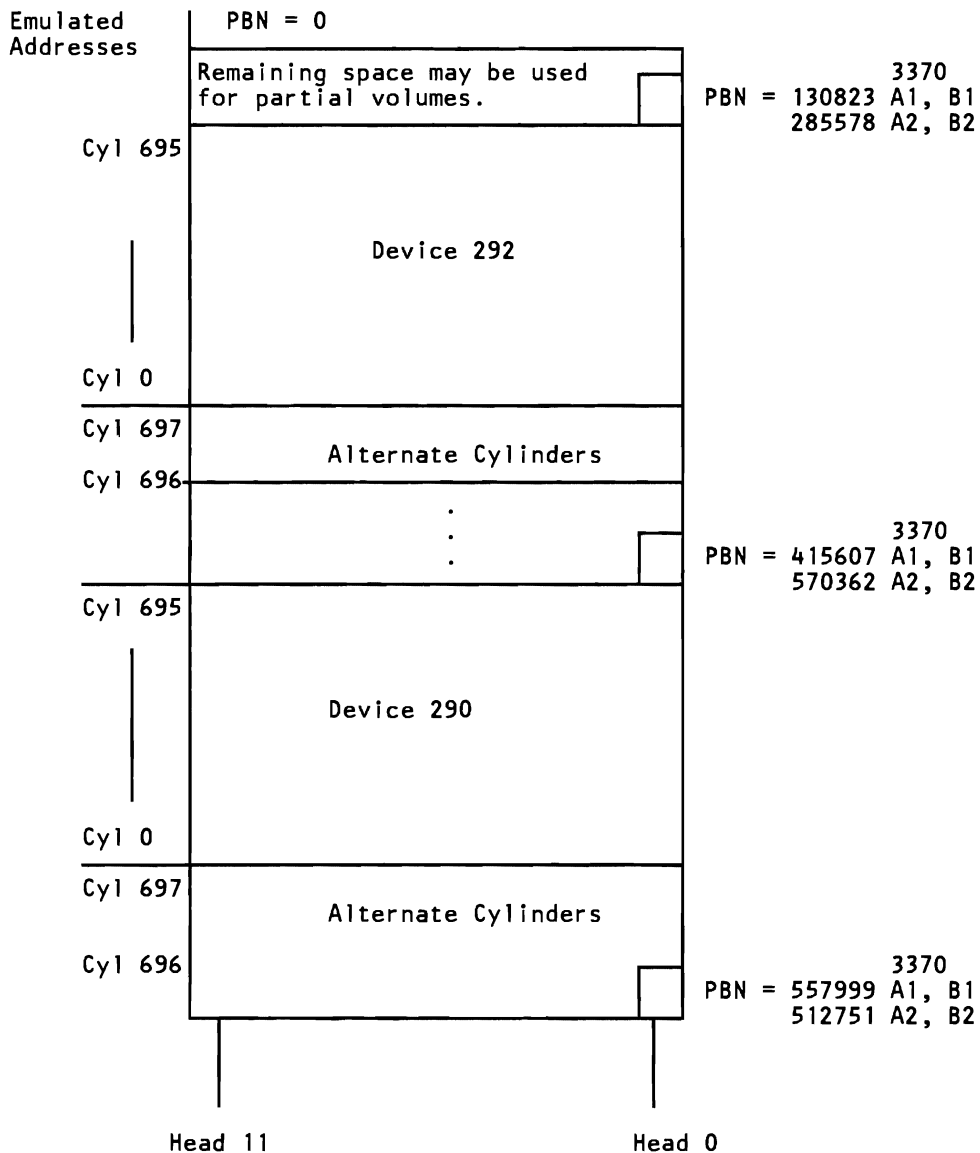- 3370 models A2, B2 have 962 cylinders.

```
Emulated            PBN = 0
Addresses       ┌─────────────────────────────┬──┐
                │Remaining space may be used  │  │                    3370
                │for partial volumes.         └┐ │  PBN = 130823 A1, B1
    Cyl 695     ├──────────────────────────────┤ │        285578 A2, B2
                │                              │ │
                │                              │ │
                │          Device 292          │ │
                │                              │ │
                │                              │ │
    Cyl 0       ├──────────────────────────────┤
    Cyl 697     │      Alternate Cylinders     │
    Cyl 696─────┼──────────────────────────────┤
                │              .              └┐ │                    3370
                │              .               │ │  PBN = 415607 A1, B1
                │              .               │ │        570362 A2, B2
    Cyl 695     ├──────────────────────────────┤ │
                │                              │ │
                │                              │ │
                │          Device 290          │ │
                │                              │ │
                │                              │ │
    Cyl 0       ├──────────────────────────────┤
    Cyl 697     │      Alternate Cylinders     │
                │                              │ │
    Cyl 696     │                             └┐ │                    3370
                │                              │ │  PBN = 557999 A1, B1
                │                              │ │        512751 A2, B2
                │              │               │
              Head 11                        Head 0
```

Figure 4-1. 3340 Mapping on 3370

Association of Emulated and Host Device Addresses

Identification of Emulated Volumes on Host Devices

In order to identify each 3330 or 3340 volume on a 3370, each group of 3370 blocks that holds an emulated volume is logically associated with an emulated device address. The logical association is done by the compatibility feature, which needs these emulated ("dummy") addresses to find the correct 3370 drive, cylinder, and block number when the old program addresses a (former) 3330 or 3340 volume. The user need only specify, at IPL time, the first and last host address of the device that holds the first emulated volume.

Range of Host 3370 Addresses Available

The range of standard host addresses is:

```
X'220' through X'237'
      |_____    |L_____ Device number
      |_____    |L_____ String number
      |_____    L_____ Channel number
```
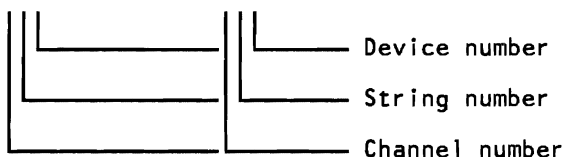
Channel Number: For DASDs attached to 4361, the standard channel assignment is '2'. Note, however, that this address may be changed by the service representative at system installation time.

String Number: May range from 0 through 7 but should be confined to two consecutive numbers if emulation extends over more than one string of host devices.

Device Number: May range from 0 through 7 (eight spindles per string are supported).

First Host Address Specified at IPL Time ↓	Last Host Addresses specified at IPL time.									
	2x0	2x1	2x2	2x3	2x4	2x5	2x6	2x7	2(x+1)0	...2(x+1)
	Corresponding Emulated 3330 Addresses									
2x0	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	2C0–2C2	2C8–2CA	2D0–2D2	...2FA
2x1	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	2C0–2C2	2C8–2CA	
2x2	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	2C0–2C2	
2x3	–	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	2B8–2BA	
2x4	–	–	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	2B0–2B2	
2x5	–	–	–	–	–	290–292	298–29A	2A0–2A2	2A8–2AA	
2x6	–	–	–	–	–	–	290–292	298–29A	2A0–2A2	
2x7	–	–	–	–	–	–	–	290–292	298–29A	...

String boundary —

First Host Address Specified at IPL Time ↓	Last Host Addresses specified at IPL time.									
	2x0	2x1	2x2	2x3	2x4	2x5	2x6	2x7	2(x+1)0	
	Corresponding Emulated 3340 Addresses									
2x0	290–293	298–29B	2A0–2A3	2A8–2AB	2B0–2B3	2B8–2BB	2C0–2C3	2C8–2CB	2D0–2D3	...2FB
2x1	–	290–293	298–29B	2A0–2A3	2A8–2AB	2B0–2B3	2B8–2BB	2C0–2C3	2C8–2CB	
2x2	–	–	290–293	298–29B	2A0–2A3	2A8–2AB	2B0–2B3	2B8–2BB	2C0–2C3	
2x3	–	–	–	290–293	298–29B	2A0–2A3	2A8–2AB	2B0–2B3	2B8–2BB	
2x4	–	–	–	–	290–293	298–29B	2A0–2A3	2A8–2AB	2B0–2B3	
2x5	–	–	–	–	–	290–293	298–29B	2A0–2A3	2A8–2AB	
2x6	–	–	–	–	–	–	290–293	298–29B	2A0–2A3	
2x7	–	–	–	–	–	–	–	290–293	298–29B	

Figure 4-2. Association of Host Device Addresses with Emulated Device Addresses

- The first column of host device addresses shows the eight user options. At IPL time, the user may specify one of these eight addresses.

- The host channel address '2' is standard for the processor; it may be changed by the service representative at system installation time.

- 'x' is the string number; it may range from 0 through 7.

- The last of a range of emulated addresses is used for a partial volumn.

The compatibility feature supports a maximum of 42 emulated 3330 volumes or a maximum of 56 emulated 3340 volumes, which must reside on host devices located in no more than two (successive) strings. One string comprises up to eight 3370 host devices. Actually, all host devices may bear emulated volumes, but no more than 42 or 56 devices can be addressed at a time.

The user has the choice to start his emulated space on any of the eight host devices of the (first) string he wants to use for 3330/40 emulation and can then, depending on his choice, make use of either the maximum number of volumes, or not (see Figure 4-2 on page 4-5):

- If the user starts his emulated space on the host device with the address X'2x0', he has the full range of one host string (X'2x0' through X'2x7' for the emulated address range X'290' through X'2CA' (for 3330) or X'2CB' (for 3340) at his disposal.

At IPL time, the user only has to specify (in the PROGRAM LOAD picture) the first and last host address of the device that holds the first emulated volume; in this case, X'2x0'. If during subsequent processing, the user refers to any of the emulated addresses X'290' through X'2FA' (for 3330) or X'2FB' (for 3340), the compatibility feature automatically accesses the corresponding host device (the emulated volumes must, of course, have been mapped accordingly).

- If the user starts his emulated space on the host device with the address X'2x1', he has the host address range from X'2x1' to X'2(x+1)0' for the emulated address range X'290' through X'2CA' (for 3330) or X'2CB' (for 3340) at his disposal.

    At IPL time, the user has to specify the first and last host address of the device X'2x1' '2xx'.

- If the user starts his emulated space on the host device with the address X'233' through X'237', the host space available for emulation purposes is reduced, and references to emulated addresses outside the range specified in Figure 4-2 on page 4-5 result in CC3.

Emulated 3330/3340 Commands

This section assumes that the reader is familiar with /360 and /370 principles of operation manuals and has, in addition, knowledge of the 3830 and associated DASD components. The following text contains details about minor deviations caused by the emulation. The command, status, and sense byte descriptions apply to both compatibility features except where marked with "3330 only" or with "3340 only." The deviations are of interest for anyone who writes 3330/40 programs on the physical IOCS level or who is involved with maintenance of old programs. The commands emulated are described on the pages that follow. Refer to the following publication for detailed command descriptions:

Reference Manual for IBM 3830 Storage Control Model 2, GA26-1617

```
Command Code                Command Name
Hex    CCW Bits
---------------------------------------------------------------------------
05     00000101             Write Data
0D     00001101             Write Key/Data
1D     00011101             Write Count/Key/Data
19     00011001             Write Home Address
15     00010101             Write Record Zero
01     00000001             Write Special Count/Key/Data
11     00010001             Erase

X1     X0110001             Search ID Equal
X9     X0101001             Search Key Equal
X9     X0111001             Search Home Address Equal
X1     X1010001             Search ID High
X9     X1001001             Search Key High
X1     X1110001             Search ID High or Equal
X9     X1101001             Search Key High or Equal

X6     X0000110             Read Data
XE     X0001110             Read Key/Data
XE     X0011110             Read Count/Key/Data
5E     X1011110             Read Multiple Count/Key/Data **)
XA     X0011010             Read Home Address
X6     X0010110             Read Count
02     00000010             Read IPL (initial program load)
22     00100010             Read Sector **)

07     00000111             Seek *)
0B     00001011             Seek Cylinder *)
1B     00011011             Seek Head *)
13     00010011             Recalibrate *)
0F     00001111             Space Count *)
1F     00011111             Set File Mask *)
03     00000011             No Operation
23     00100011             Set Sector **)
27     00010111             Restore
53     01010011             Diagnostic Load **)
73     01110011             Diagnostic Write **)
04     00000100             Sense
E4     11100100             Sense I/O
A4     10100100             Read and Reset Buffered Log
94     10010100             Device Release **)
B4     10110100             Device Reserve **)
44     01000100             Read Diagnostic Status 1 **)
```

Legend: X is the multi-track bit. When X is 0, the operation is confined to a single track, when X is 1, the operation can be extended over one cylinder.

*)   These commands cannot be used for data chaining.
**)   These commands are not supported by the emulator.

Command Deviations

Read Multiple Count/Key/Data

Not emulated. Unit check with 'command reject' is generated.

Read Initial Program Load (IPL)

The Read IPL command can be issued stand-alone or in a chain, but must not be preceded by a Set File Mask or a Space Count command (which automatically sets the file mask) in the same chain.

Read Sector

No rotational position sensing (RPS) is emulated. The Read Sector command returns a byte of all zeros to the system.

Write Home Address

1. The Write Home Address command must be preceded by the correct Set File Mask command; otherwise, the Write Home Address command is rejected with 'command reject' because of 'invalid sequence'.

2. The skip displacement for a 3340 track is transferred, but not used by the compatibility feature. For all following records, no skip displacement is generated. This means, skipping of defect records is not emulated by the compatibility feature.

3. For 3330, any attempt to flag a track defective results in command-rejection of the Write Home Address command. This is because the compatibility feature does not emulate the automatic alternate and defective track handling of the 3830-2 control unit. (See "Alternate Track Support" in Chapter 1 for details).

Write Count/Key/Data

If a Write command is chained after a 'space count', the sense message in byte 7 is 'file protect' instead of 'invalid sequence'.

Write Special Count/Key/Data

This command writes a complete record and sets bit 1 of the flag byte to mark the overflow record as such.

Search Commands

When a Search command is followed by a TIC pointing back to the Search, performance is increased. In this case, searching is done directly from the buffer without any CCW-fetching, till either the Search is successful or finished with 'no record found' or 'end-of-cylinder'.

Search Key

Record zero (the track descriptor record) does not participate in the key search if the Search Key command is not chained from a preceding search ID command. If chained from a Search ID, the Search Key includes record zero.

Sense I/O

The Sense I/O command allows programs to find out which device is emulated and on which host. The command delivers seven sense bytes, as follows:

Byte:	0	1	2	3	4	5	6
Contents:	FF	43	61	XX	33	40	22
or							
Contents:	FF	43	61	XX	33	30	12

Note XX stands for model type 00/01/02/11.

Byte 0 is always FF to distinguish sense I/O data from regular sense data. Bytes 1 to 3 define the control unit. Bytes 4 and 5 define the emulated devices. Byte 6 defines the device model in the left digit and the host device in the right digit, as follows:

```
Byte 6
12 = 3330 emulated
22 = 3340 emulated
```

Read and Reset Buffered Log

Twenty-four sense bytes of Format 6 are returned, but all error and usage counters are set to zero. For error/usage counter logging, refer to section 'Dump CE-Cylinder Program' in Chapter 4.

Device Release

Not emulated. Unit check with 'command reject' is presented.

Device Reserve

Not emulated. Unit check with 'command reject' is presented.

Read Diagnostic Status 1

Not emulated. Unit check with 'command reject' is presented.

Seek Commands

'A chain data' flag in a Seek command finished the chain.

No Operation

Because the No Operation command resets the 'no record found' indicator, the command must be used with great care. The programmer must avoid an endless loop such as the one shown below:

```
No-Op.
Search ID
TIC *-16
```

An unsuccessful Search (no record found) would cause a branch back to the no-Op. which resets the 'no record found' indication, etc. A loop of this type would tie up not only the compatibility feature but the entire processor. Also, there is no indication of such a loop (which consists of valid operations).

Space Count

When the key and data length given with the Space Count command do not agree with the actual values, the results of a following Read command are unpredictable.

3330/40 Compatibility Feature Sense Information

The compatibility feature generates 24 bytes and keeps these in the buffer ready for transfer to storage if a Sense command is issued. These 24 sense bytes may have the following format: Formats 0, 1, 4, 6. Formats 2, 3, and 5 will not be generated. After setting 'unit check' in the status byte, the compatibility feature establishes a "contingent connection." The connection lasts until either a command (other than TIO or NOP) is issued to the device for which the 'unit check'

was generated, or a reset occurs. During contingent connection, the (emulated) storage control appears busy to all device addresses other than the address for which the contingent connection was established.

Sense Byte 0

Bit Number	Meaning if '1'
0	Command Reject
1	Intervention Required
2	Not used
3	Equipment Check
4	Data Check
5	Overrun
6	Not used - set to 0 (for 3330)
	Track Condition Check (for 3340)
7	Not used - set to 0

Command Reject: Is set in any of the following situations:

- An invalid 3330/40 command is given.

- An invalid command sequence is given.

- Commands are chained incorrectly.

- A Seek command has an invalid seek address or a length count of less than six bytes.

- A command violates the write portion of the file mask, or an invalid file mask is set.

- An attempt was made to flag a 3330 track defective using the Write Home Address command (applies to 3330 only).

- A Write command is given when the read-only switch is on.

For details, see sense byte 7, bits 4-7.

Intervention Required: Is set in any of the following situations:

- A 3330/40 command is issued to an existing device (correct device address) while that device is not ready or in CE mode (actually the 3370 is not ready, i.e., is stopped, or is not up to speed).

- A 3330/40 device is correctly addressed and the host drive is ready, but the host was not formatted as a 3330/40 (i.e. is actually a host). Note, however, that 'intervention required' is only presented if the data is actually to be used. It is not presented, for example, if only a Seek is given.

  Note: The compatibility feature checks the ready/not ready state of the host during initial selection but does not check whether the host has been formatted as a 3330 or 3340. When the host device is not ready a Start I/O gets condition code 1 and unit check. A subsequent Start I/O with sense operation ends with condition code 1 and control unit busy. After receipt of control unit end the Start I/O with sense operation must be repeated and 'intervention required' is available in the sense bytes.

A Test I/O issued to a ready host gets condition code 0 even if the host is not formatted. If a Start I/O is issued to a ready but unformatted host, condition code 0 is returned for the Start I/O and the accessing CCW gets intervention required.

Equipment Check: Is set in any of the following situations:

*   The 3370 presents 'equipment check' during execution of a command chain started by the compatibility feature, which was not a write operation (a hardware check in the 3370, such as gap counter check, SERDES check, etc. is responsible).

*   The user command currently executed is a Write command, but the read operation started by the compatibility feature prior to the user write had resulted in a 'data check'.

*   Any malfunction occurs during arm positioning, resulting in 'equipment check (seek error)' on the host device.

Data Check: Is set when the 3370 is involved in a compatibility feature operation and the 3370 indicates 'uncorrectable data check' to the compatibility feature.

Data check is not presented (although the operation on 3370 ended with 'data check') when the block affected (i.e. the "bad" block) is not involved in the emulated operation, e.g. no data has to be transferred from the "bad" block.

Data check is always set together with sense byte 1, bit 0 ('permanent error').

Overrun: Is set in any of the following situations:

*   When the host 3370 presents 'overrun' with the 'permanent' bit on, and the operation was not a write.

*   When a 'chain data' flag is detected in a control command with a short CCW count.

Track Condition Check: Indicates defective track (bit 6 of the flag byte is 1) to a Search command other than search HA, a Read command other than Read HA or Read RO, or any Write command.
It also indicates that a switch to a defective track was attempted as a result of executing a multiple-track command or a command on a segment of an overflow record (bit 1 of the flag byte is 1).In the case of overflow, overflow-incomplete is also set.

Also indicates that an attempt was made to switch from an alternate track (bit 7 of the flag byte) by means of overflow or by a multiple-track command.

Bit Number	Meaning if '1'
0	Permanent Error
1	Invalid Track Format
2	End-of-Cylinder
3	Not used - set to 0
4	No Record Found
5	File Protected
6	Write Inhibited
7	Operation Incomplete

Permanent Error: Is set together with sense byte 0, bit 4, to indicate a permanent data check. (For 3330 operations only.)

Invalid Track Format: Is set when a formatting write or erase operation attempts to write more bytes than the remaining space can accommodate. Note that 'Invalid Track Format' does not necessarily occur at the same instant where it might have occurred on the 3330/40 formerly used. This is because the compatibility feature does not emulate gaps, hence, has a somewhat larger track capacity.

End-of-Cylinder: Indicates that the CCW command chain has not been completed, and cylinder end has been detected during multiple-track operation.

No Record Found: Is set only for single-track operations which (repeated on the same track) have encountered the index marker for the second time, without completing an intervening command to read or write or search the data area, Read Home Address or Read R0, or a control command.

File Protected: Is set when a seek or a multi-track or overflow command violates the specifications given by a Set File Mask command. If the violating command is a Write command, 'command reject' is also set.

Operation Incomplete: Is used with the record overflow operation. The following situations cause the compatibility feature to set 'operation incomplete' for overflow commands:

- Overflow over cylinder boundary
- Overflow to file-protected boundary (dictated by the file mask)
- Overflow to a defective track
- Overflow from an alternate track

When 'overflow incomplete' is signaled, sense byte 3 contains information about the command in progress when the condition did arise, as follows:

Hex Value	Meaning:
06	Read command was in progress
05	Write command was in progress

Write Inhibited: Is set if a Write command is received when the read-only switch is on.

Sense Byte 2

Sense byte 2 shows which type of device is emulated and on which host device. Sense byte 2 also contains an emulated "vironmental data present" indication to give the proper response to a read and reset buffered log command that may be issued to the emulated device.

Bit Number	Meaning if '1'
0	0
1	0
2	1=3330 or 3340 on 3370 (if bit 4 on)
3	1=Environmental data present
4	1=3330 or 3340 on 3370 (if bit 2 on)
5	0
6	1=3340 size is 70 MB
7	0

Environmental Data Presentation: Is set in response to a Read and Reset Buffered Log command of the customer, together with format 6 sense bytes. However, no counter information is transferred to the user area, because counter and error logging is done either via host command (in "mixed" mode) or by the compatibility feature on the CE cylinder ("compatibility only" mode). Unit check with format 6 sense bytes are never generated.

Sense Byte 3

Sense byte 3 indicates the type of command in progress when 'overflow incomplete' occurs (bit 7 in sense byte 1). If 'overflow incomplete' did not occur, sense byte 3 is zero.

Sense Byte 4

Sense byte 4 contains the device address of the host device.

Sense Byte 5

Bits 0 through 7 identify the low-order cylinder address of the most recent seek argument of the compatibility feature.

Sense Byte 6

Bit Number	3330 Meaning if '1'	3340 Meaning if '1'
0	Not used - set to 0	Not used - set to 0
1	High-order bit of cyl addr	1-2: High-order bit of cyl addr of last seek
2	Not used - set to 0	
3	Bit 3-7:	Not used - set to 0
4	Head address of	4-7: Head address of
5	last seek.	last seek.
6		
7		

```
Bit Number   Meaning if '1'
-----------------------------------------------------------------------
0..3         Specify the format of the sense bytes
             8 through 23 as follows:
             0000 = Format 0   Programming or system check
             0001 = Format 1   Equipment check
             0100 = Format 4   Data check not correctable
             0110 = Format 6   Usage/error counters

4..7         Give a message for each of the above
             formats.
```

The message table that accompanies each format specifies the function of the message bits for that format (see Figure 4-3 and Figure 4-4).

```
Sense Byte 7 - Bits 4 through 7:
-----------------------------------------------------------------------
0000         No message
0001         Invalid command
0010         Invalid sequence
0011         CCW count less than required
0100         Data value not as required
0101         Not used
0110         Not used
0111         Not used
1000         Not used
1001         Not used
1011         Not used
1100         Data overrun    (3340 only)  - not used (3330)
1101         Defective track (3340 only)  - not used (3330)
1110         Alternate track (3340 only)  - not used (3330)
1111         Not used
```

Figure 4-3. Message Table - Format 0

```
Messages, determined by format and message code (byte 7):

Sense Byte 7  Format 1        Format 4        Format 6
Bits 4-7
-----------------------------------------------------------------------
0000          No Message (0) No Message (0) No Message (0)
0001          Not used       Not used       Not used
0010          Not used       Not used       Not used
0011          Not used       Not used       Not used
0100          Not used       Not used       Not used
0101          Not used       Not used       Not used
0110          Not used       Not used       Not used
0111          Not used       Not used       Not used
1000          Not used       Not used       Not used
1001          Not used       Not used       Not used
1010          Not used       Not used       Not used
1011          Not used       Not used       Not used
1100          Not used       Not used       Not used
1101          Not used       Not used       Not used
1110          Not used       Not used       Not used
1111          Not used       Not used       Not used
```

Figure 4-4. Message Table - Formats 1, 4, and 6

Sense Bytes 8-21

> *Formats 0, 1, 4, 6::* Not used - set to 0

Sense Bytes 22 and 23 (Fault Symptom Code)

> *Formats 0, 1, 4, 6*: Not used - set to 0
>
> **Note:** All hardware-dependent information (such as skip displacements, error counters, CE cylinders, etc) is, of course, not emulated. Errors can occur only on the host device, and the appropriated data is collected from the host device when required.

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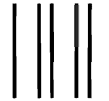Number of latest Newsletter associated with this publication: _____

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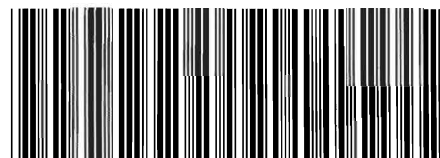
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