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# 3480 Installation Guide and Reference for MVS, VM and VSE

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# Preface

The 3480 is not a difficult piece of hardware to install, but it does require more planning than some new products. This is due, in part, to the fact that tape technology has not changed for a very long time. There may not be much expertise within your data processing shop on the subject of tape conversions.

It is our intent to discuss the things that the reader will need to know to complete a 3480 conversion. A lot of the discussion will provide background material for the 3480. Given this information, the reader should feel comfortable about developing a conversion plan and executing it successfully.

Much of the information in the first edition of this manual was learned from the 3480 A22/B22 Early Support Program (ESP) accounts who had to work through this planning process without benefit of the type of information presented here.

This Bulletin can be read front-to-back or used as a reference. Some material is previously published, sometimes in another form, while other material is available for the first time. We assume that the reader has some general knowledge of tape processing concepts.

In addition to the material in the original Bulletin, this version contains information on the 3480 model A11/B11 subsystem, the Automatic Cartridge Loader (ACL), and the increased storage for the A22 buffer. We also revised the VM Support section in Chapter 4 so that it is more informative and useful, and added the VSE Software support section.

# Acknowledgements

Many thanks to Bob Siederer for his time and effort publishing the original version of this manual. We added the additional text on VM support, Automatic Cartridge Loaders, VSE support, and increased A22 memory to the original version, along with other minor technical and editorial changes.

Thanks also to Dan Janda and Richard Irving from the Dallas Systems Center for their comments on the VSE-3480 support section. We are also thankful for the technical support provided by the Dallas Systems Center for the VSE accounts in the Model 11 Early Support Program.

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# Chapter 1. IBM 3480 Magnetic Tape Subsystem Overview

This chapter will present an overview of the IBM 3480 Magnetic Tape Subsystem hardware. Throughout the rest of the manual, we will use the term "3480" instead of the long, official title. Most of the time our use of 3480 will refer to both 3480 Models 11 and 22. If it doesn't, we will note this and explain any differences.

Throughout this Bulletin we generally use MVS examples for access method names and commands. Where it is important, we will distinguish between MVS and VM or VSE commands. In general, all three operating systems have similar facilities with different names.

## The 3480 Subsystem

There are two Models available for the 3480 Subsystem: the Model 11 and the Model 22. The control unit is called the 3480 Model A11 or A22, and the drive unit is called the 3480 Model B11 or B22. Unlike many other IBM device types that connect to control units of a different device number, both pieces of this one are called 3480s.

A 3480 subsystem consists of, at minimum, one A unit and one B unit. In its largest form, a subsystem has 2 A units and 8 B units, but more on that later.

The 3480 is intended as the replacement product for the 3420. The 3480 B22 transfers at data rates of up to 3 Mb/sec between the drive and the A22 buffer. The maximum data transfer rate between the A11 buffer and the B11 drive is 1.5 Mb/sec. Data transfer between a host and either 3480 control unit can be up to 3.0 Mb/sec. Compare this to the 3420 Model 8 (3420-8) which can transfer at up to 1.25 Mb/sec.

3480s can attach to a variety of processors. The list consists of

The IBM 3090 Processor Complex
The 3092 Processor Controller of the 3090E Processor Complex
The IBM 3081, 3083, and 3084 Processor Complexes
The IBM 4381, 4361, and 4341 Processors
The IBM 9370 Processor Complex with the System/370 Block Multiplexer Channel Feature
The IBM 3031, 3032, 3033 Processors and the 3042-2 Attached Processor

The 3480 can also attach to a variety of channel types and speeds. Both Data Streaming and DC Interlock protocols are supported.

When attached to Data Streaming-capable channels, the 3480 will operate at channel speeds, either 2.0 Mb/sec or 3.0 Mb/sec, at a distance of up to 400 feet from the processor. The 3480 can also be attached to DCI channels at distances of up to 400 feet, but with a performance penalty depending on the channel length. Figure 1 shows examples of the relationship between distance and data rates for the 3480. Regardless of cable length, the maximum data transfer rate on a DCI channel is 1.5 Mbytes/second.

| Cable Length | Data Rate |
|---|---|
| 0-80 feet | 1.5 |
| 120 feet | 1.25 |
| 400 feet | .660 |

**Figure 1. DCI channel lengths and data rates (Mb/sec).**

Channels of any supported type and speed can be mixed on a 3480 subsystem. No special features are required to support the different speed channels or their protocols. The speed at which the 3480 will communicate with a specific channel is determined by a switch setting on the control unit channel interface.

## The A11/A22 Control Unit

The 3480 Models 11 and 22 Control Units perform the functions that any control unit normally does. It is an intelligent, buffered control unit and is microcode driven. The microprocessors control the channel interfaces, the buffer and the drive interfaces. When data is buffered, the control unit performs internal error recovery.

One channel adapter is a standard feature for both control unit models. Up to three additional channel adapters may be installed, bringing the total to four. Each of these channel adapters can attach to any of the channel types described above, and they may do so in any order and combination on one control unit.

The A11 Control Unit has a 512 Kbyte buffer; the A22 Control Unit comes with a 1.0 Mbyte buffer. The original A22 Control Unit came with the 512 Kbyte buffer, but these units have been upgraded to 1.0 Mbytes with a field-installed Engineering Change (EC). For more information on the 3480 buffer, see Chapter 3, "3480 Buffer Processing" on page 27.

The A22 has the "Dual Control Unit Communications Capability" (DCUCC) built in. When activated by the installation of the "Dual Control Unit Communications Coupler" feature, it allows an A22 to communicate with another A22, giving each control unit access to two strings of drives.

On the Model A11, the DCUCC Feature is optional. It is installed by the Dual Control Unit Communications Feature (Feature Code 3201) on each control unit, and allows an A11 to communicate with another A11, giving each one access to two strings of drives. Each A11 or A22 in a connected pair will have access to the other control unit's buffers and channel adapters.

The coupler feature is a set of cables that runs under the floor between the control units. One coupler is needed for each pair of Model A11 or Model A22 Control Units to activate the capability.

*Note:* **Only 3480s of the same model can be connected for dual control unit communications - A11 with A11, and A22 with A22. You cannot connect an A11 with an A22.**

With the coupler installed, the subsystem is called a "2 by x" subsystem, where "x" is the number of tape transports attached to the two controllers. When the coupler is not installed, the subsystem is called a "1 by x."

Installation of the coupler also activates some microcode called the "Channel Sensitive Load Balancing Algorithm" which we will discuss further in "Selecting the Proper Channel Selection Algorithm" on page 49.

When the coupler is installed, the maximum subsystem configuration would be a 2 by 16 with 8 channels attached. Each of the 8 channels would have access to any of the 16 drives.

## The B11/B22 Drive Unit

Both B11 and B22 Models of the 3480 contain two 3480 tape transports. The B22 attaches to the right-hand side of the A22, as seen from the front of the devices. The same is true for the B11 and A11. Four B22s can be serially attached to an A22 to form a string of eight drives. Four B11s can be serially attached to an A11 to form a string of eight drives. **You cannot intermix B11s and B22s on the same string, and you must attach B11s to A11s and attach B22s to A22s.** All cabling within the string is between the frames. There are no cables under the floor that go between the drives. Power for the string is provided by the A11/A22, and each drive may be powered off independently.

The 3480 Drive also contains a microprocessor. It controls the motion of the tape electronically. There are no vacuum columns, pinch rollers, or capstans involved with the tape motion.

The microprocessor also controls an operator's display, which is located on top of the drive. The display can be rotated horizontally through 165 degrees so that operators can set it to the angle they find most useful. The vertical angle is fixed.

The display has room for 8 characters of information. The character matrix is made of red LEDs (light-emitting diodes.)

The 3480 B22 tape drive transfers data to and from the buffer in the control unit at 3 Mb/sec at all times. The 3480 B11 tape drive transfers data to and from the buffer in the control unit at 1.5 Mb/sec at all times. This speed is independent of the speed of the channel that is communicating with the control unit. The drive always communicates with the buffer, and the buffer with the channel, thereby allowing speed differences. The one exception to this data transfer speed of 3.0 or 1.5 Mbytes occurs when data blocks are greater than 100 Kbytes, and we will discuss this exception in "Tape Synchronous Mode" on page 6.

## The 3480 Data Cartridge

The media for the 3480 is significantly different from previous magnetic tape media. The tape is physically in an enclosed cartridge. The tape coating is chromium dioxide ($CrO_2$) instead of the traditional ferric oxide.

The cartridge is roughly 4" by 5" by 1" in size. It can hold about 20% more data (at 24K blocksize) than a 10 1/2", 2400 foot reel of traditional media recorded at 6250 BPI density. The end of the tape is attached to a device called a "leader block" which latches into the cartridge. When the cartridge is placed into the drive, the leader block is grasped by an arm in the drive and inserted automatically onto the take-up reel. The tape itself is not touched by the threading mechanism. When the cartridge is unloaded, the arm follows the threading path backwards as the tape is wound into the cartridge and snaps the block into place in the cartridge, thereby closing it. A clutch mechanism is built into each cartridge to keep the tape securely in the container when it is not in a drive. The drive automatically releases this clutch when the cartridge is loaded.

The reader might ask why IBM changed from ferric oxide to chromium dioxide for the 3480. To understand the answer, we must discuss some characteristics of magnetic tape. Every piece of tape has a certain amount of noise inherent in its design. This noise is the level of the electronic signal that exists on the tape before anything has been recorded on it. If you have ever listened closely to a brand new audio tape, you probably heard a slight hissing noise. That hiss is always there, no matter what you do. It is a characteristic of the tape. Different coating materials have different characteristic noise levels. Chromium's noise is much lower in strength than iron.

As we record data at greater densities, it gets more difficult to distinguish between the data and the inherent noise. To go to densities greater than 6250 BPI and obtain the reliability we desired, we needed to change coatings to get a quieter one, and chromium was chosen. Given the noise level inherent in chromium dioxide, we can increase the density five to six times over the density of the 3480, which is about 38,000 bytes per inch, before we begin to run into the same noise problem.

There are no reflector spots on 3480 tape. These spots were used on 3420 tapes to indicate load point and end-of-volume (EOV) to the drive. The 3480 still has to know about load point and EOV. Imagine the feed and take-up reels in the 3480. On one, there is one sense mark, on the other, a large number of sense marks equally spaced around its circumference. There is a tachometer on each of the reels. As the tape moves from the feed reel to the take-up reel, the speed of the two reels relative to each other changes. The two tachometers count the marks and report that information to the microprocessor. The data represents the number of sense marks on the one reel that pass a sensor in the time it takes the other reel to make one revolution. The ratio of the two tachometer values yields a number. This number is used to calculate a "sector". There is a specific sector value that is defined as the beginning-of-tape (BOT) value and one defined as the EOV value.

In other words, when the tachometer ratio has a specific value, the tape is considered to be at BOT. Different values signal logical end-of-tape (EOT) and phys-

ical EOT. Just like 3420s, you can write past the logical EOT value. The drive will not allow the tape to be moved past the physical EOT value.

As you can imagine, this design is very sensitive to the length of the tape. Changing the length by as much as one or two wraps on the cartridge could make a difference. Therefore, you shouldn't cut a few feet from a 3480 cartridge because you can potentially make the cartridge unusable.

The main reason for cutting tape from 3420 reels is that the first few feet might have worn out. The wear was caused by handling, both by the operators and by the equipment. The 3480 tape is handled in a much more gentle fashion, so we don't expect the tape to wear out as it did before.

Another major difference between the 3480 cartridge and the 3420 reel is in the file protection mechanism. 3420 reels come with the disposable plastic ring that, when removed, prevents the tape from being written on. The 3480 uses a thumb wheel that is built into one edge of the cartridge. When the flat part of the wheel is showing (it has a white dot engraved on it), the cartridge is write-protected. Turning the wheel 180 degrees allows a curved surface to be exposed, and the cartridge may be written on.

## Subsystem Modes of Operation

The 3480 subsystem will always be operating in one of four modes. They are:

- Buffered Read
- Buffered Write
- Tape Write Immediate
- Tape Synchronous Mode

Let's look at each one.

### Buffered Read

This is the default mode for read operations. When the first I/O is done to a drive, control unit buffers are assigned to it and they are "primed" with data from the tape. From that time on, all read requests are satisfied with data in the buffer. The drive continues to feed data into the buffer as space becomes available.

Buffered read mode can mask the tape motion time from the host application. Initial error recovery is performed by the control unit.

### Buffered Write

This is the default mode for write operations. When a WRITE is done to the drive, the data is placed in the buffer and Device End (DE) and Channel End (CE) are returned to the host. Asynchronously, the data in the buffer is moved to the tape. The control unit will attempt to keep space available in the buffer for future write commands.

Buffered write mode can mask the tape motion time from the host application. Initial error recovery is performed by the control unit.

## Tape Write Immediate

Tape Write Immediate (TWI) must be explicitly requested by the application on a dataset basis. When writes are performed, the data is first placed in the buffer. When the block is in the buffer, CE is presented to the channel, which frees it for other use. The data is then moved to the tape. When the data has been verified, i.e. read-back checked, as correct on the tape, DE is presented to the host.

**TWI is the only mode in which tape logging data can be reliably expected to be useable after a power outage.**

TWI may also be invoked by the operating system or the hardware in certain circumstances. For instance, MVS will cause a file to go into TWI-mode during Dynamic Device Reconfiguration processing. The drive forces TWI after logical EOT is sensed.

TWI does **not** mask device motion time from the host application. TWI is discussed further in "Tape-Write-Immediate" on page 22. Host software may also cause synchronization with the buffer by using the MVS SYNCDEV macro which is discussed in "SYNCDEV Macro" on page 60. Initial error recovery is performed by the control unit.

## Tape Synchronous Mode

Tape synchronous mode can be used for both READ and WRITE commands. It is entered automatically by the control unit when the channel command chain transfers more data than can fit in the buffer. This means that tape synchronous mode will be used on the 3480 Model 11 subsystem if the data block exceeds 100 Kbytes. For 3480 Model 22 subsystem with the 1.0 Mbyte buffer, tape-synchronous mode will be used if the data block exceeds 200 Kbytes.

In a control unit with a 1.0 Mbyte buffer, the maximum storage available is two 128 Kbyte segments or 256 Kbytes; the A11 can allocate a maximum of 128 Kbytes. Standard MVS access methods allow blocksizes up to 32 Kbytes (32,760) in length. By using data chaining to tie multiple READ or WRITE channel commands together, an application can read or write blocks larger than 100 Kbytes on an A11 or 200 Kbytes on the A22 with the 1.0 Mbyte buffer, and thus invoke tape synchronous mode.[1] Tape synchronous mode normally will not be invoked on VSE systems because the standard blocksize doesn't exceed 32,767 bytes.

The 3480 must be attached to a channel that can support the drive's data rate of 3 Mb/sec for it to operate in tape synchronous mode. Attempts to use channels slower than 3 Mb/sec will generally result in overruns. The buffer is essentially passed through in tape synchronous mode and the application transfers data to or

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[1] Tapes with long blocks on them are sometimes called "gap-less" tape.

from the drive directly through the buffer. The control unit does not perform error recovery in tape synchronous mode.

# Subsystem Configuration Examples

Figure 2 shows the simplest, or minimum, 3480 configuration. One A11 or A22 control unit, with the one, standard, channel adapter and one B11 or B22 drive unit are shown. The drive unit is shown a distance from the control unit, with a cable attaching the two together. In actuality, the A11-B11 and A22-B22 are physically bolted together, and the cabling is under the covers.

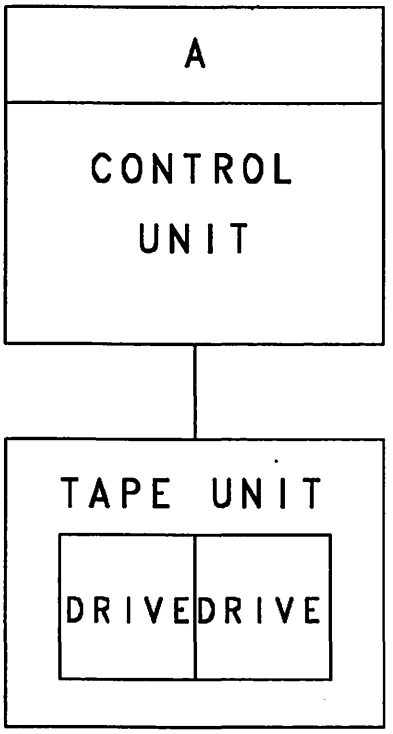


**Figure 2. 3480 one by two configuration.**

Figure 3 shows the most complex configuration. Two A11s or A22s are shown, each with 4 channel adapters. Each control unit has a full string attached to it. The Dual Control Unit Communications Coupler has been installed. Again, the diagram shows the logical connections between the controllers, and between the controllers and the drive strings. In actuality, the coupler connection is made under the floor and the connections between drives are under the covers. The strings are physically bolted to the control units.

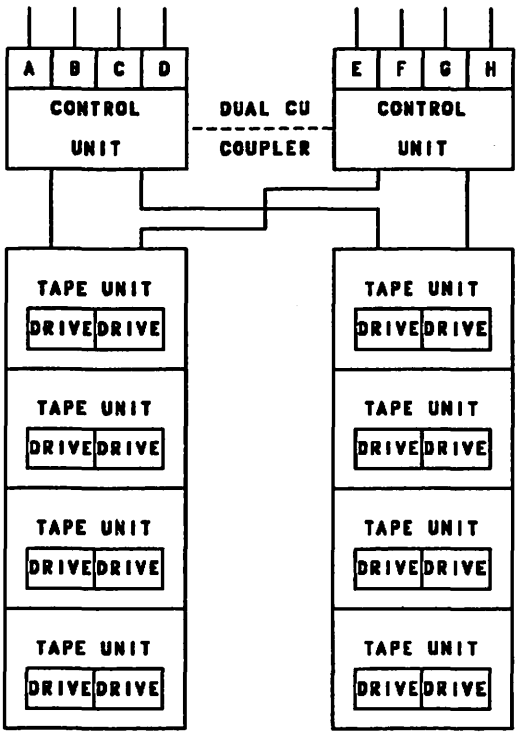


**Figure 3. 3480 two by sixteen configuration.**

# 3480 to 3420 Comparison

Figures 4 and 5 show a comparison between the 3480 Models 11 and 22 and the 3420 Models 6 and 8. A number of points need to be made about these comparisons.

The 3480 B22 moves its tape at 79 inches per second (IPS), while the 3420 moves tape at 200 IPS. This slower 3480 B22 tape speed is one of the factors in the 3480s increased reliability. The increased number of data tracks (18 versus 9) and the increased density to approximately 38,000 bytes per inch (compared to 6250 bytes per inch) allow the 3480 B22 to reach an instantaneous data rate of 3 Mb/sec, compared to the 3420-8s nominal rate of 1.25 Mb/sec.

| | 3480-B22 | 3420-8 |
|---|---|---|
| Tape Speed (inches/second) | 79 | 200 |
| Instantaneous Data Rate (Mb/sec) | 3.0 | 1.25 |
| Data Tracks | 18 | 9 |
| Density (Bytes/inch, approx.) | 38K | 6250 |
| Nominal IBG (inches) | .08 | .3 |
| Maximum rewind time (seconds) | 48 | 45 |
| Drives per controller | 8 | 8 |
| Channels per controller | 4 | 2 |
| Tape capacity (Mb, 24K blocksize) | 200 | 165 |

**Figure 4. 3480 Model B22 to 3420-8 Comparison**

Comparing the Model B11 to the 3420-6, the significant items here are tape speed and drive Data Rate. As with the Model 22, the Model 11's slower tape speed across the head contributes to the drive's reliability. The Model 11 data rate is just under twice the rated speed of the 3420-6.

| | 3480-B11 | 3420-6 |
|---|---|---|
| Tape Speed (inches/second) | 39 | 125 |
| Instantaneous Data Rate (Kb/sec) | 1500 | 780 |
| Data Tracks | 18 | 9 |
| Density (Bytes/inch, approx.) | 38K | 6250 |
| Nominal IBG (inches) | .08 | .3 |
| Maximum rewind time (seconds) | 48 | 60 |
| Drives per controller | 8 | 8 |
| Channels per controller | 4 | 2 |
| Tape capacity (Mb, 24K blocksize) | 200 | 165 |

**Figure 5. 3480 Model B11 to 3420-6 Comparison**

We need to be careful when discussing the 3480's density so that we don't fall into a trap. For years, we have used the acronym "BPI" to describe density. BPI has been used interchangeably to mean "bytes per inch" and "bits per inch." Until the 3480 came along, either of these was correct.

Figure 6 shows a piece of 3420 tape.

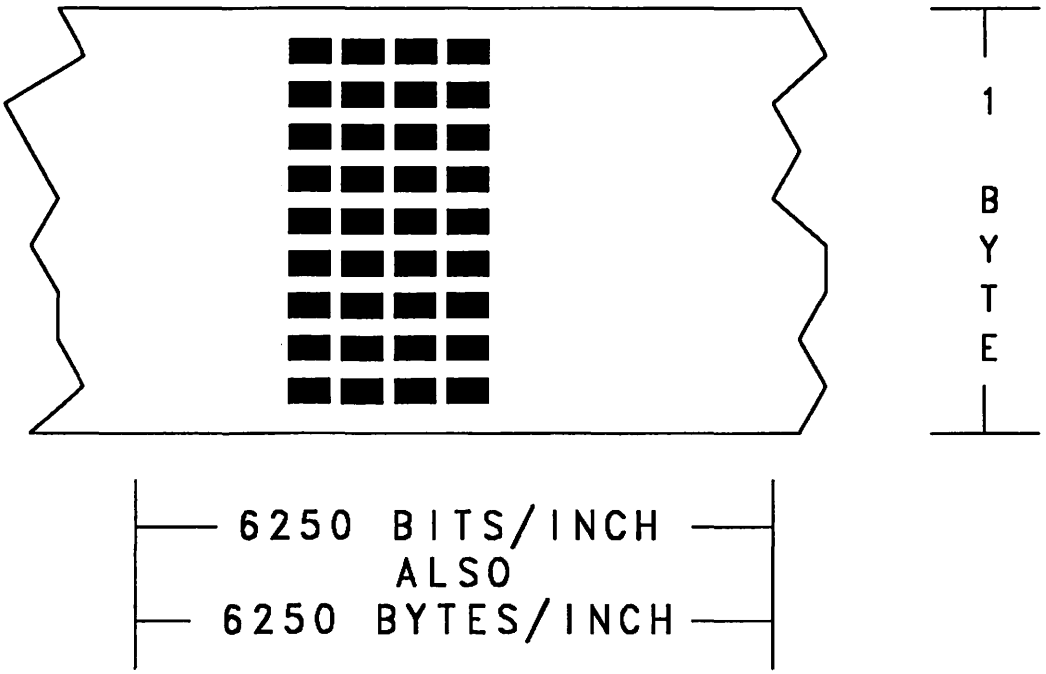


**Figure 6. Bit layout on 9-track tape.**

The bits are represented by the small rectangles on the tape. A byte is represented by 9 of the bits, and the 9 bits are stacked one on top of another. If we look at a horizontal row of bits, and counted the number in an inch, we would get 6,250 bits. If we took the byte count in that same inch, we would also get 6,250.

Now look at Figure 7. It shows a piece of 3480 tape.

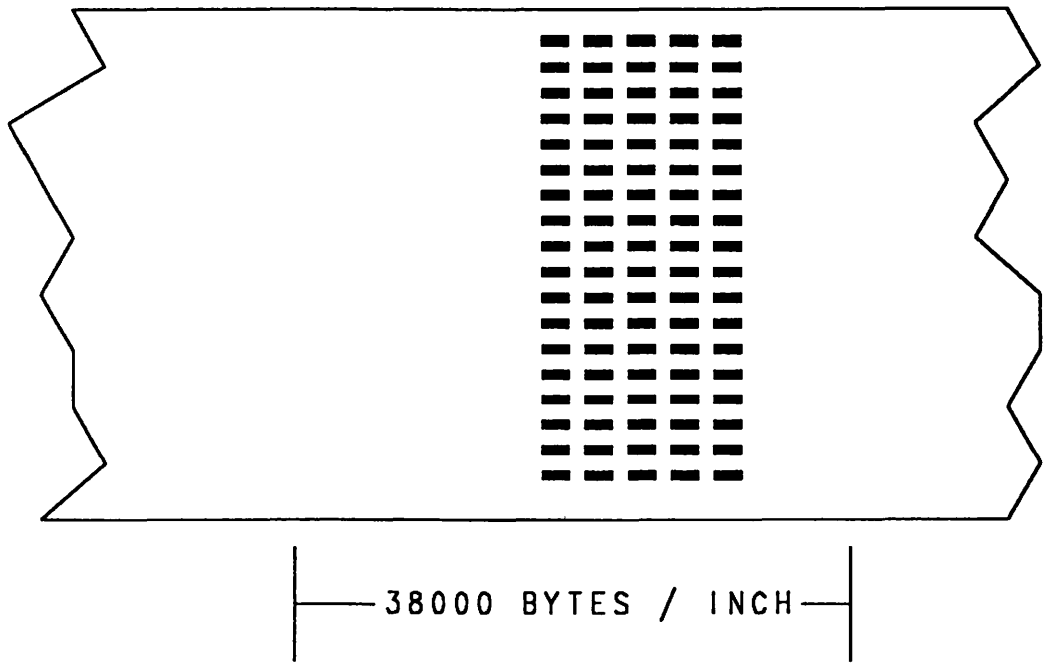


**Figure 7. Conceptual bit layout on 18-track tape.**

Although the bit layout looks familiar, the byte layout for the 3480 is very different from anything we have seen before. You could visualize a byte as being stacked vertically on 9 of the tracks in a column, but in actuality, the bytes are not recorded that way.

A byte of data is recorded horizontally along a track. Four of the 18 tracks are used for parity checking. This means that multiple bytes of data are recorded in parallel. In addition, the bytes are broken into groups, and pad and check characters are placed between each group. The new Adaptive Cross Parity (AXP) checking method uses two diagonal redundancy checks, a vertical redundancy check, and a cyclic redundancy check to provide improved data integrity.

Because of the uniqueness of the recording method, we do not describe the density in bits per inch. Instead, the density is given as approximately 38,000 bytes per inch.[2]

On a 3420, the inter-block gap (IBG) is used as a "coasting" area. After the 3420 reads a block of data, it decelerates and stops. It then accelerates to the proper

[2] The actual density is 1,491 characters per millimeter.

speed and reads the next block. The tape that passed under the head during these stop and start actions was the IBG, and was roughly 0.3 inches long.

The 3480 also stops and starts, but it can't do it in its IBG size of .08 inches. Instead, the 3480 performs an action called a "back-hitch". We graphically compare the tape motion of the 3420 and the 3480 in Chapter 3, "3480 Buffer Processing." The time taken to do this extra motion may be masked from the application by the control unit buffer. As we will see, the tape's motion is controlled by the 3480 independently from the activity going on between the host and the buffer. The host application communicates with the buffer, not with the drive directly.

Many installations have "3 by" or "4 by" 3803/3420 configurations today because they need access to a specific tape drive by more than 4 channels. These extra control units contain an additional 2 channels each. The 3480 control unit can accept 4 channels, so a "4 by" 3420/3803 configuration can be replaced with a "2 by" 3480 configuration if 4 channel access, not 4 data paths, is required. The internal data pathing in an 8 channel 3420 configuration is quite different from the pathing in an 8 channel 3480 configuration.

Figure 8 shows a 4 X 16 configuration for 3420s.

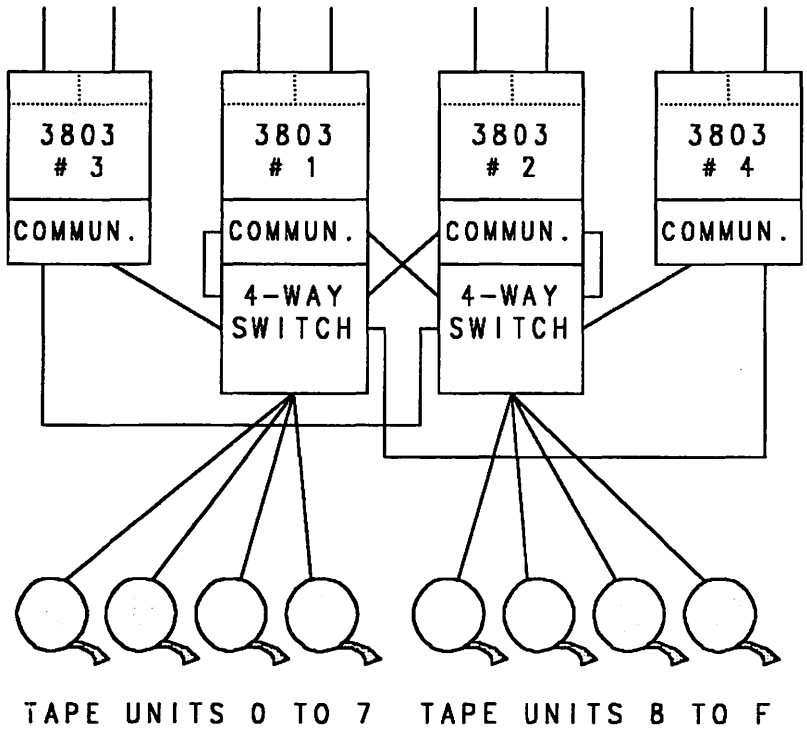


**Figure 8. 4 X 16 3420 Configuration**

Notice that 3803 numbers 1 and 2 have switches and numbers 3 and 4 do not. Each of the 4 3803s has a communicator that is connected to the switches. The drives are radially attached to the switches. Each communicator can be actively communicating with one of the 3420 drives, giving a maximum of four concurrent data transfers from any four of the drives.

Figure 9 shows a 2 X 16 configuration for the 3480.

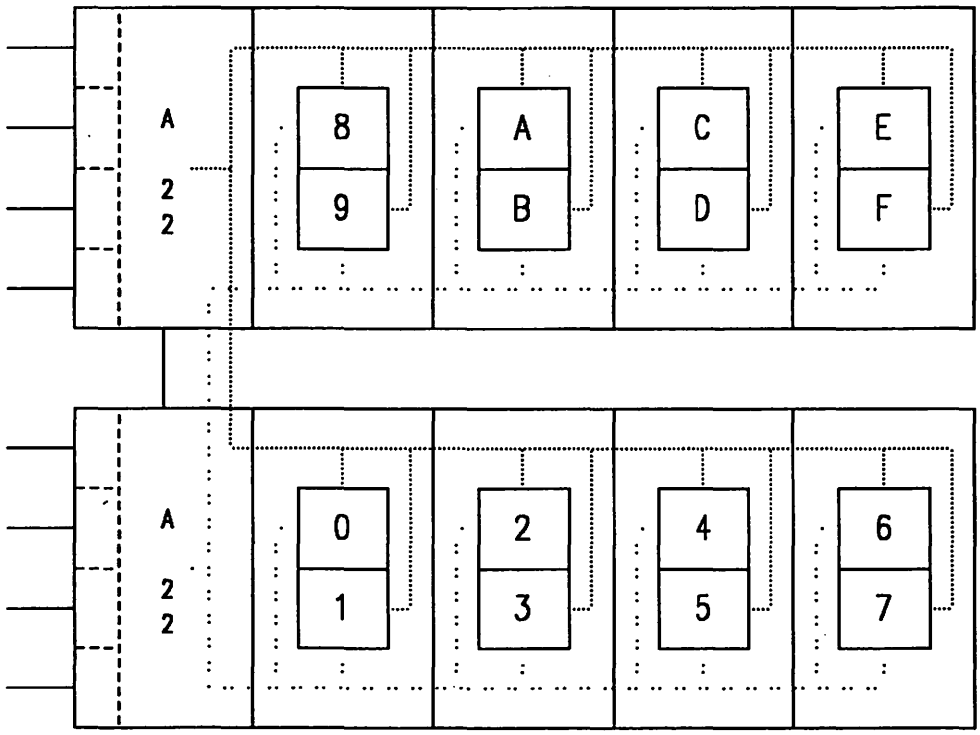


**Figure 9. 2 X 16 3480 Configuration**

The 3480 drives are serially attached to the control unit. There are two paths from each control unit, one to each string. One 3480 control unit can be actively communicating with any one drive while the other control unit can communicate with any other drive. In addition, each control unit can communicate with one channel adapter. This gives us a total of four concurrent I/O operations occurring on a 2 control unit subsystem.

From this comparison, you can see that fewer active transfers are possible at any time for the 3480. The 3480s speed and intelligence generally make up for the reduced number of paths.

The tape capacity given in Figure 4 on page 10 shows a nominal capacity for both 3420 reels and 3480 cartridges. The actual capacity depends on the quality of the tape when it was written, i.e. how many erase gaps there are on it, and its actual length. The larger the blocksize, the bigger the improvement you should

expect. Our ESP accounts found that, generally, for every 5 reels they had before, they had 4 cartridges now.

# 3480 Automatic Cartridge Loader (ACL) Feature

## ACL Feature Description

The automatic cartridge loader is a hardware feature that is attached to the front of a 3480 drive. The ACL can run in one of three operating modes - MANUAL, AUTO, and SYSTEM. Assuming the correct software is installed, any of these modes can be used.

- MANUAL - This mode does not load or unload cartridges; MANUAL mode works the same as a 3480 without an ACL.

- AUTO - In this mode, the ACL loads the next cartridge in the input stack as soon as the cartridge in the 3480 is rewound, unloaded, and indexed to the output stack. The next cartridge is moved into the drive, the drive readies the cartridge, and the volume is available for the next host request.

- SYSTEM - This mode combines the best features from both AUTO and MANUAL modes. In SYSTEM mode, available only on Full-Function MVS systems, the ACL responds to host scratch requests by loading the next cartridge; for specific mount requests, the operator loads the cartridge. SYSTEM mode works as follows:

  - If the host requests a scratch cartridge on the 3480, and the ACL is set in SYSTEM mode, the ACL will automatically load the next cartridge in the input stack. When processing is complete, the cartridge will be unloaded and returned to the feed position. This is the slot right in front of the load door of the 3480. If the next request is for a scratch cartridge, the ACL will index the used cartridge into the output stack and load the next cartridge in the input stack.

  - If the host requests a specific volume on the drive, the ACL will not load a cartridge; the operator will retrieve the requested cartridge from the library, remove any used cartridge from the feed position, place the specific volume in the feed position, and press the start button. When processing is complete, the cartridge will be returned to the feed position for the operator to remove, or it will be indexed to the output stack if the next request is for a scratch cartridge.

Be sure to review the ACL operating procedures in the *3480 Magnetic Tape Subsystem Operator's Guide, GG32-0066*, and also see Chapter 7, "3480 Automatic Cartridge Loader" on page 101 for more information.

# Chapter 2. IBM 3480 Functions and Capabilities

This chapter will discuss the commands that programs issue to tape drives and how the 3480 responds to them. We will look at the existing 3420 commands and the new capabilities of the 3480.

## 3420 Commands on the 3480

There are a large number of channel commands that have existed for years that are executed by 3420s. Every one of these channel commands is also supported by the 3480, and yields the same results, with some exceptions noted below. This means that programs that function on 3420s should function on 3480s without change, at least from the channel command point of view.

However, there are certain sequences of channel commands that will not yield the same result. These sequences were not supported on 3420s either, but they functioned without causing errors, and some users have come to rely on them. These sequences usually cause the 3420 to write a record and then attempt to re-write another record in the same place, usually with an intervening backspace. Sometimes, these program sequences were used to change the label data on an existing tape, a process called "clipping[3]". In other cases, test programs wrote, backspaced, and wrote over and over to test a drive for creeping.

Both of these types of actions are called "update-in-place." For the 3480, update-in-place can be defined as any sequence of commands that cause data to be written over other existing data, where the new data is expected to fit in the same space and to be read later without causing an error. Update-in-place was not supported on 3420s (although some people did it anyway), and it is not supported on 3480s. It will not work on 3480s. It won't work primarily because of the BLOCK-IDs that are used by 3480s, and described in "Block Search Capability" on page 21.

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[3] The word clip, when used in this sense, is really an acronym for Change Label In Place. It has been used for so long that it has become an accepted data processing word.

### MODESET Commands

For the 3420, there are three channel commands called MODESET. One of them is issued at the beginning of a channel program. It is used to tell the 3803 control unit at what density the program wants to write the tape. The operation codes for these commands are

X'CB' for 800 BPI,
X'C3' for 1600 BPI, and
X'D3' for 6250 BPI.

There is only one density for the 3480, and it is not the same as any of the 3420 densities. The 3480 hardware will ignore the 3420 MODESET commands for 800 BPI and 6250 BPI. The 1600 BPI MODESET, X'C3', will cause the drive to write its data in tape-write-immediate mode. We will talk more about that in "Tape-Write-Immediate" on page 22. We will also discuss why these commands might be issued for 3480s when we discuss the different modes of MVS software support in "3420 Code-Compatibility" on page 53.

The 3420 MODESET commands are unlike most other System/370 channel commands in that there is no data associated with them. The function to be performed, namely setting the density, is determined strictly by the operation code value. The 3480 has a new MODESET command, and it has data bytes associated with it.

The operation code for the 3480 MODESET is X'DB' and there is one data byte associated with the command. It is used to set the drive to tape-write-immediate mode and for other things. If you are interested in reading more about the 3480 MODESET, see *IBM 3480 Magnetic Tape Subsystem Reference, GA32-0042.*

## New 3480 Functions

The 3480 has some new capabilities and functions. The new functions include

The Operator Display
The ASSIGN Facility
The Block Search commands
Tape-Write-Immediate mode

There are also some old functions that are implemented differently. These implementations improve the 3480s system resource utilization when compared with the 3420.

Implementation of support for the new 3480 capabilities varies with the operating system. We will discuss the details in Chapter 4, "3480 Software Support."

## The 3480 Operator Display

Every 3480 B unit has a pair of displays pods located on the top, one for each 3480 tape drive. Each display has space for 8 characters of data. Messages that appear on the display come from two sources: the host, and the hardware.

### Host-Initiated Messages

Host-initiated messages are issued by either the operating system or a user program. A new macro, MSGDISP, is provided in the MVS software to issue messages. The rest of this discussion will only apply to MVS.

Host-initiated messages usually correspond to console messages indicating that tapes are to be mounted or dismounted. Messages are also issued by allocation at label verification time and for certain utilities, such as IEHINITT.

The messages can contain up to 16 bytes of text. The data can alternate on the display in two groups of 8 bytes. Options can be selected to display half of the 16 bytes in certain circumstances, or to delete or display part of the message as the operator performs certain actions. For example, the operating system has finished reading a volume and wants it demounted and another one mounted on the same drive. The message display will show alternating dismount and mount requests. When the operator removes the old cartridge, the dismount message will no longer be shown, and the mount message will remain on the display.

User programs may issue the MSGDISP and its full range of functions are available to them. MSGDISP is described in *IBM 3480 Magnetic Tape Subsystem User's Reference, GC35-0099.* Most forms of the MSGDISP macro are APF-authorized.

By writing the proper channel commands, programs on MVS systems such as stand-alone dump, or programs on VM and VSE systems can also issue messages to the drive display pod.

### Hardware-Initiated Messages

There are also two groups of hardware-initiated messages, Status Messages and Error Messages.

*Status Messages:* The 3480 hardware will always show something on the display, unless the power is turned off or the display is broken. The hardware will always display its current status, unless there is a software message overlaying the hardware message. These status messages tell the operator that the drive is READY, NT RDY (not ready), or that certain channel commands are executing. These include the rewind command (REWINDNG), the unload command (UNLOADNG), and the locate command (LOCATING), which is discussed in "Block Search Capability" on page 21.

If there is nothing else to display, the drive will show an asterisk (*). There are some other messages that can appear on the display. We will discuss some of these as we come to them. For more information, you should look in the *IBM 3480 Magnetic Tape Subsystem Operator's Guide, GA32-0066.*

*Error Messages:* When the drive hardware detects an error, it will show a Check message on the display. This message will take the form CHK XY. "X" and "Y" are hexadecimal digits that describe the error. The recovery actions for check conditions are described in the *Operator's Guide.*

Check messages will not go away by themselves. The operator must take some action to clear them, and the drive won't be usable until this is done. Most check messages can be easily cleared by the operator, but some will require CE assistance.

### The Attention Bars

There are two yellow bars to the left of the operator's display. These bars are the attention indicators. They blink when there is some operator action required, such as mounting a tape.

## ASSIGN Facility

To understand the ASSIGN facility, you need to understand what it replaces. On a 3803 control unit there are up to four rows of toggle switches. There is one switch for each drive for each channel adapter installed on the 3803. These switches control the physical interface between the drive and the channel, and determine whether or not that device can be online to that channel. Since there can be four channels associated with each 3803 pair, and 8 drives can be physically attached to each 3803, you could have 64 switches on each 3803.

On the other hand, two 3480 A11s or two A22s can have 8 channel adapters and sixteen drives attached. The number of possible switches then would be 128. These switches, like the ones on the 3803, obviously require some manual interaction to be set, and anything that requires manual interaction is prone to error.

For these reasons, the 3480 designers decided to implement the hardware interface switching differently, and to put it under software control. The result is the ASSIGN Facility. When a drive is assigned to a particular host, the control unit prevents access to that drive from other hosts unless it is specifically allowed. The control unit determines which channel paths are valid for that device and host and won't allow any accesses to the drive from any other paths unless you specifically allow them.

The ASSIGN command is issued when a 3480 is VARY'ed online, either at IPL time or by a VARY command by a Full-Function MVS system or in a VM/SP Rel 4 system where the 3480s are defined to DMKRIO. There is no special ASSIGN operator command for 3480s; the channel command is issued by the operating system VARY command processor.[4] When the 3480 is VARY'ed offline, the UNASSIGN command is issued, reversing the process.

For drives that are brought online at IPL time (the OFFLINE parameter in the SYSGEN was set to NO), JES will cause the ASSIGN command to be issued when it (the JES) is initialized. For drives that are OFFLINE at IPL time, a

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[4] Current versions of JES3 require only the JES3 VARY command, and no MVS commands to vary the 3480s online and offline.

VARY must be issued before they can be used, and the ASSIGN is issued as part of that VARY.

The software implementation of ASSIGN, including situations where no ASSIGNs are issued, is discussed in Chapter 4, "3480 Software Support." When no ASSIGNs are issued, the subsystem will look just like all the switches, if there were any, are enabled. This also looks just like your system does today if you run with all your 3803 toggle switches enabled.

Have you ever been in a situation where some of your 3803 switches were enabled to more than one system and you IPL'ed one of those systems or VARY'ed some of the 3420s online while the other system was using them? If so, you know that the tapes in question promptly rewound, although they were being used by another application. This probably caused great consternation and gnashing of teeth.

The ASSIGN facility can help prevent this from happening. If a drive is online to one system, and the other system tries to access it, like it might at IPL or VARY time, the other system's request will fail. The error returned will show that the drives are assigned elsewhere or ASE as the MVS error message shows.

Please note that this is **not** tape sharing in a JES2 environment. This does not allow multiple JES2 hosts to share a tape pool and allocate from it dynamically without interfering with the other host. If you need that kind of function, you need JES3 or some other software that will control it.

Operator actions with respect to the ASSIGN command are discussed in "VARY Procedures for Maintenance" on page 91.

## Block Search Capability

For a long time, users wanted a way to search a tape file for a particular block without having to read every block on the tape. With the 3480, they now have a way.

Every piece of information that is written to a 3480 tape has a BLOCK-ID associated with it. This information includes data blocks, label records, etc. The ID is written onto the tape automatically by the control unit and drive when your data is written to the tape. IDs are assigned but not written for some things, such as tape marks. You can't change the ID value from the host software, and its value is not given to the software unless the software asks for it. You do not need to leave room for the ID in your buffers or record descriptions. In other words, the addition of the BLOCK-ID to the data is transparent to the user.

The BLOCK-ID has two parts to it. One is a relative block count value. It is unique for each block on the tape. The second part is the sector value that we discussed in "The 3480 Data Cartridge" on page 4. More than one block can have the same sector value, but each block will still have a unique, relative block count value.

MVS software can ask for the BLOCK-ID values for a particular block by issuing a NOTE macro when the block is written. It can then store the values for later use.

When the software wishes to use a BLOCK-ID value to find a specific block, it issues a POINT macro. POINT causes the tape to be moved, in either direction, until the desired block is found. The channel command that is issued for the block search process is a LOCATE command. While this command is executing, the 3480's display will have the word LOCATING showing on the pod. We will look at how this movement is done in "Improved 3480 Functions" on page 24. The tape will usually be positioned so that the next read instruction will get the desired block. For more information on this process and how to use it, see the *IBM 3480 Magnetic Tape Subsystem User's Reference* manual.

MVS software uses this facility in a few places. Checkpoint/Restart will store BLOCK-ID values when a checkpoint record is taken and will use them to speed up a restart. Dynamic Device Reconfiguration (DDR/SWAP) will use it in repositioning the tape during SWAP processing. Lastly, Data Facility Hierarchical Storage Manager (DFHSM) uses the BLOCK-ID to position the 3480 tape when it uses single-file-format for dataset migrate and recall. See "DFHSM" on page 58 for more information.

## Tape-Write-Immediate

The normal mode of operation for the 3480 is buffered write mode. Writes are done to the buffer, and the control unit returns channel end (CE) and device end (DE) right away. The data is now in the buffer and will be transferred to the tape at some later time. The control unit has assumed responsibility for getting the data on the tape.

If an unrecoverable error occurs when the control unit does finally write the data to the tape, the status is posted for the host at the next I/O request for that drive. This is called a deferred unit check. It will be returned as status for an I/O request for a block other than the one getting the error.

There are software philosophies that assume log data is safely on tape before databases are updated. Journaling on Information Management System/Virtual Systems (IMS/VS), Customer Information Control System/Virtual Systems (CICS/VS), and DL/I-DOS/VS follows this philosophy. IMS updates the data bases after it thinks the data is on the log tape. For the 3480 in buffered write mode, the log data may just be in the buffer. Should you now experience a problem that requires using the IMS log tape for recovery, the databases and the log may be out of synchronization.

When tape-write-immediate (TWI) mode is used on 3480s, the CE status is returned when the data is in the buffer, but the DE status is not returned to the application until the data is actually on the tape. The buffer is still used, but the timing of host notification is different. TWI guarantees that the data is on the tape, but it does so with a significant price in performance.

**This is the only mode in which data integrity can be guaranteed on a record basis across a system or device outage.**

In tape-write-immediate mode, the application will now see the tape motion time that the buffer was designed to mask off. We determined that the maximum number of blocks of data that 3480 drives in TWI mode could process is about

10 per second. This was measured on a dedicated A22 system with a 512 Kbytes buffer; the number of blocks processed per second could drop to 5, with other activity in the control unit. If we assume a large blocksize of 32 Kbytes, the maximum theoretical data rate is 320 Kb/sec for the 3480 model A22, and 160 Kb/sec for the 3480 model A11. The Washington Systems Center has documented their TWI measurements in *3480 Performance Considerations, GG22-9335*. You should refer to that publication for more details on actual TWI performance.

In MVS, tape-write-immediate mode is invoked through a Data Control Block (DCB) parameter. If OPTCD=W is specified, the dataset will be written in TWI mode.

Earlier, we discussed MODESET channel commands and said that a 3420 MODESET for 1600 BPI would also invoke tape-write-immediate mode. If your operating system is running the 3480 in Code-Compatibility mode, this channel command is placed at the front of each channel program. If you are running in Full-Function mode, the new 3480 MODESET channel command is used. We will discuss these two modes of operation and the MODESET commands in Chapter 4, "3480 Software Support."

In VSE systems, tape-write-immediate mode is requested by using the // ASSGN statement as shown in "VSE/SP System Installation" on page 69.

**CICS and IMS Log Alternatives**

There are a few alternatives that can be used for CICS and IMS log tapes. The first is available in release 1.3 of IMS/VS. It is disk logging, which places the IMS log on DASD. The DASD log is then archived to 3480s in normal buffered mode, avoiding the performance degradation of TWI.

The second involves duplicate logging. By placing a second, duplicate log on a different 3480 subsystem (separate 2 by X) which is attached to a different channel path, you greatly reduce the exposure of losing log data if a 3480 subsystem or a channel set or group goes down. If the entire host or computer room goes down, you still risk being out of synchronization, but the overall risk is much less.

The third alternative is perhaps the most obvious. The installation may choose to leave its CICS and IMS logs on 3420 tapes, but this does not bring the 3480 benefits to either CICS or IMS.

Each installation must weigh the value of using the 3480 for logging, with its greater reliability and capacity, versus the exposure in the event of a system outage. You may find that the potential exposure is acceptable given the fact that you will probably be able to recover faster, and that the reliability of the logged data is substantially enhanced.

# Improved 3480 Functions

There are a few 3420 commands and processes that are improved on the 3480. This section will discuss each one in detail.

## Drive Cleaning

Cleaning 3420 drives is a tedious chore at best. At worst, it is something that is not done, or is done incorrectly, and contributes to data reliability problems. It is a labor-intensive task that is prone to error.

Cleaning a 3480 drive is a delight. Instead of using swabs and lint-free cloths, and cleaning fluid, the operator inserts the special cleaning cartridge into the drive, and the drive automatically goes through a cleaning cycle and finishes in about a minute.

The 3480 cleaning cartridge is different from the data cartridge in three ways. It contains a length of a special fabric that is used to clean the drive tape path. The cleaning cartridge is lighter in weight than the data cartridge because there is much less of the fabric than tape, and the fabric is lighter. The exterior of the cartridge is also different. There is a notch cut out of the bottom which is sensed by the drive. It indicates that the cartridge is a cleaning cartridge and causes the cleaning cycle to start automatically once it is loaded.

There is no notification given to the host, or to the control unit, and no system resources are used to perform the cleaning cycle. The entire operation is done under the drive's microcode control, disconnected from the control unit. The cleaning cycle can be performed while the drive is offline, not ready, or even while a mount is outstanding for the drive from the host. The cleaning cartridge can also be intermixed with data cartridges in the input stack of the Automatic Cartridge Loader (ACL).

## Temporary Error Recovery

When a 3420 drive had a problem writing a tape, error recovery procedures were invoked in the host. The host would attempt to rewrite the data several times, and would move the tape back and forth over a cleaning block attempting to scrape off whatever foreign matter might be causing the problem. This process took CPU, channel, and control unit resources.

In buffered mode, the 3480 attempts error recovery without the host's involvement. In fact, since writes are done asynchronously to the tape, the host can execute multiple write commands, just like normal, while a recovery action is taking place. The 3480 control unit will attempt the recovery and will notify the host if it fails. If the error can't be corrected by the control unit, it is, by definition, a permanent error. In this case, MVS hosts in Full-Function mode can invoke Dynamic Device Reconfiguration (DDR), if the type of error and the bit setting in the sense bytes indicate this action.

A count of temporary errors is kept in the 3480 subsystem and is reported to the operating system at volume unload time, along with other statistics. Detailed

sense data about temporary errors is not sent to the host unless it has been requested by the CE, who has to turn Forced Error Logging on in the control unit by using the maintenance device (MD). Forced Error Logging might be used to help diagnose some error conditions within the 3480 subsystem.

Since the 3480 traps and records errors differently than the 3420, you will not be able to make direct comparisons between error rates on the two devices. For a detailed discussion of this comparison, see "Comparing Reliability Data from 3420s and 3480s" on page 94.

## Forward Space and Back Space Command Processing

On 3420s, these two commands lock up the control unit and effectively manage to shut down the subsystem for other work until the next tape mark is reached. This can have a serious affect on system throughput.

On 3480s, when these commands are executed, the channel is disconnected from the control unit. This frees the channel and the control unit channel adapter for other users. Data can be transferred between host and buffer, and other drives may perform work through the other control unit of the subsystem if connected.

## Data Security Erase

The Data Security Erase (DSE) channel command causes data on 3420 reels to be erased. The data is erased from the point in the tape where the command is issued to the ***logical*** end of the volume. The channel and control unit are busy while the command executes.

The DSE command is implemented differently on the 3480. It processes from the same point in the tape to the ***physical*** end of the volume. Now, a random bit pattern is written, the channel is disconnected, and the control unit remains connected to the drive until the DSE operation is complete. Data can be transferred between host and buffer, and other drives may perform work through the other control unit of the subsystem if connected. Once the new random bit pattern is written, the old bit patterns can't be detected.

DSE must be issued by EXCP-level programming. There are no system interfaces to this facility.

Because the 3480 implementation of DSE erases to the ***physical*** end of the volume, additional write commands will receive a unit check indicating end-of-tape (EOT). The user needs to reposition the tape before a write command can be executed properly.

For example, after issuing the DSE command, if the user issues a CLOSE for the tape file, CLOSE will attempt to write a tape mark. But because the tape is at physical end-of-tape, this write command will receive a unit check. Your code should be prepared to accept this condition, or you should reposition the tape before attempting the write command. Repositioning can be done with a LOCATE command, described in the next section.

## Block Search

As we described in "Block Search Capability" on page 21, the 3480 has a new search capability. Much of the LOCATE channel command executes disconnected from the system. The first part of the execution is done disconnected from the channel and the control unit. The sector value is used to fast-forward (or backward) the tape until it is positioned at the requested sector. For both control unit models, this part is done at double the B22 speed, or 159 inches per second.[5]

When the sector is found, the drive will connect to the control unit and the blocks (and IDs) will be read until the one you are looking for is found, or until you leave the sector. The *Reference* manual describes what happens if the block isn't found. When the command is finished, the channel is reconnected and status is sent to the software.

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[5] Sharp readers will notice that the normal speed for the 3480 B22 is 79 inches per second. Doubling this should give 158, not 159 inches per second. Actually, we have lied a little. The actual, normal speed is 2 meters/second and the double speed is 4 meters/second. The difference in speeds is caused by rounding error.

# Chapter 3. 3480 Buffer Processing

The 3480 control unit manages the flow of data between the drive and the host. This management is enhanced by the presence of the buffer. This chapter will describe some of the functions performed by the parts of the control unit in managing this data flow. The explanations may seem to get somewhat involved at times. The important thing to understand while reading this chapter is the intelligence built into the 3480, especially when compared to other tape devices, including other buffered tape subsystems.

## Control Unit Components

There are three functional parts in each 3480 A11 or A22 control unit. They are shown in Figure 10 on page 28. In addition, two drives are shown in Figure 10. In this section, we will discuss each part and its function.

### Channel Interface

The 3480 control unit contains a channel interface component. It is microprocessor driven and controls the I/O activity between the buffer and the channel adapters. One channel adapter is standard on each A11 or A22. Up to 3 additional adapters may be ordered, for a total of 4 per control unit. In the following diagrams, the channel interfaces are shown as 4 rectangles, each one representing one possible channel attachment.

### The Buffer

The 3480 buffer is shown in the center of the diagrams. The buffer size for the A22 is 1.0 Mbytes; the buffer size for the A11 is 512 Kbytes. The buffers in both control units are divided into segments of either 128 Kbytes for the A22 or 64 Kbytes for the A11. Zero, one or two segments are allocated to drives as needed. The 8 segments are shown as boxes within the buffer.

### The Drive Interface

The drive interface is shown at the bottom of the control unit diagram. It is also microprocessor driven, and controls the switching of data from the buffer to any of the 16 possible drives in the subsystem.

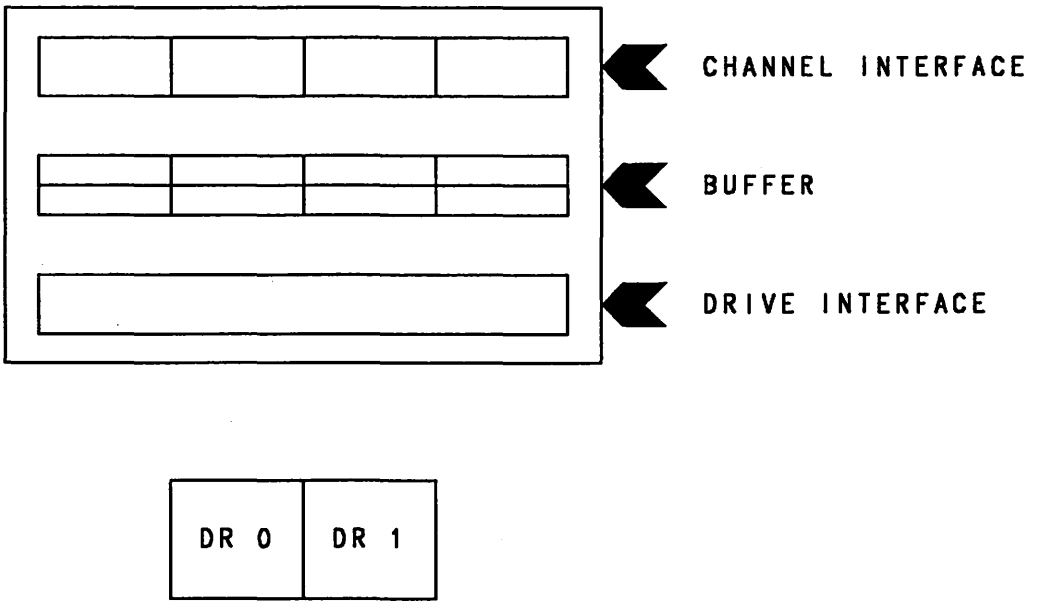


Figure 10. 3480 Control Unit Components

# Tape Motion

The 3420 and the 3480 move their respective tape in radically different ways. We need to discuss both ways to understand the 3480 buffer's function.

The examples that follow describe READ scenarios. Write operations will work in a similar fashion. We will discuss the differences in "WRITE Differences" on page 50.

## 3420 Tape Movement

On a 3420, the data is recorded on the tape with an inter-block gap (IBG) of 0.3 inches between each block. This space is used by the drive for deceleration and acceleration as it moves the tape. In Figure 11 on page 29, we show a piece of tape with the data blocks and IBGs. Below the tape is a graphical representation of the movement of the tape relative to the head and the speed of the tape. The vertical dashed line represents the head's location. The diagrams in this example are not to scale.

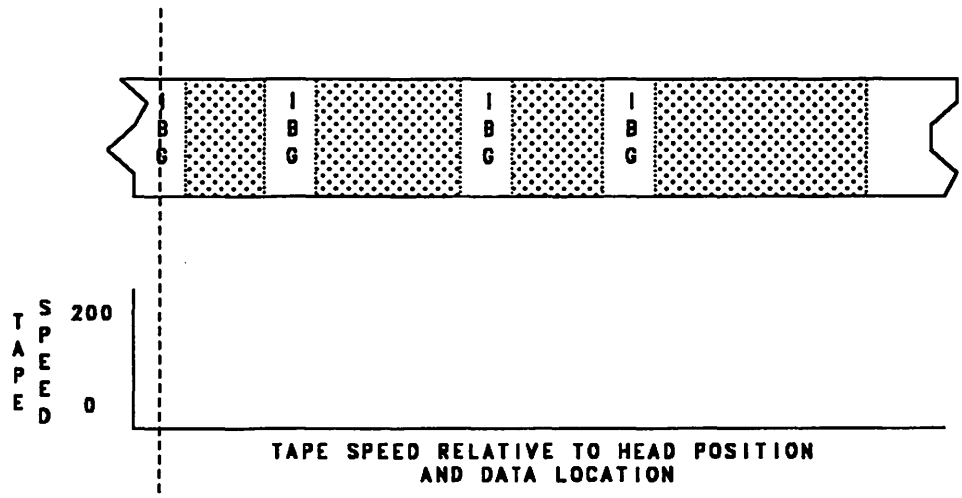


**Figure 11. 3420 tape positioning example, part 1**

As we begin this example, the tape is positioned so that the head is in the first IBG.

Now, a read is issued for the drive.

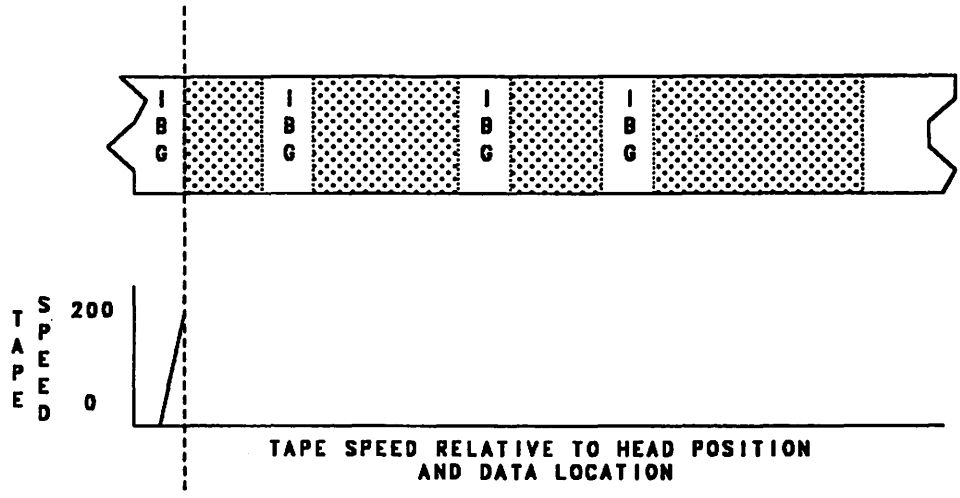


**Figure 12. 3420 tape positioning example, part 2**

The control unit signals the drive to start and the tape accelerates. The tape achieves read speed of 200 inches per second as the beginning of the data passes the head. Figure 12 shows the tape in this position.

The tape continues moving at 200 IPS until the entire block has passed over the head.

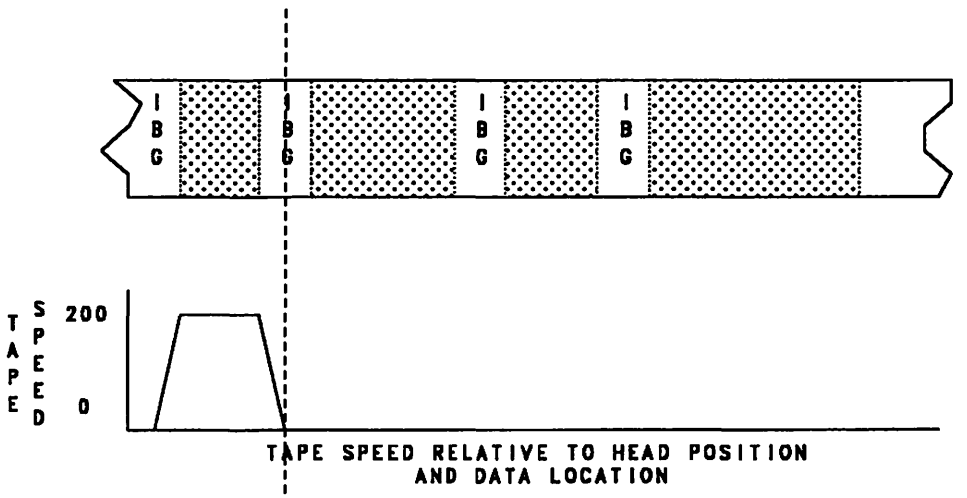


**Figure 13. 3420 tape positioning example, part 3**

The drive is then signaled to stop and it decelerates the tape and stops within the IBG as shown in Figure 13.

When the next read is issued, the same sequence will be performed. Figure 14 on page 32 shows the tape speed changes relative to the data for a series of tape movements. Note that the 3420 has to stop the tape between each block.

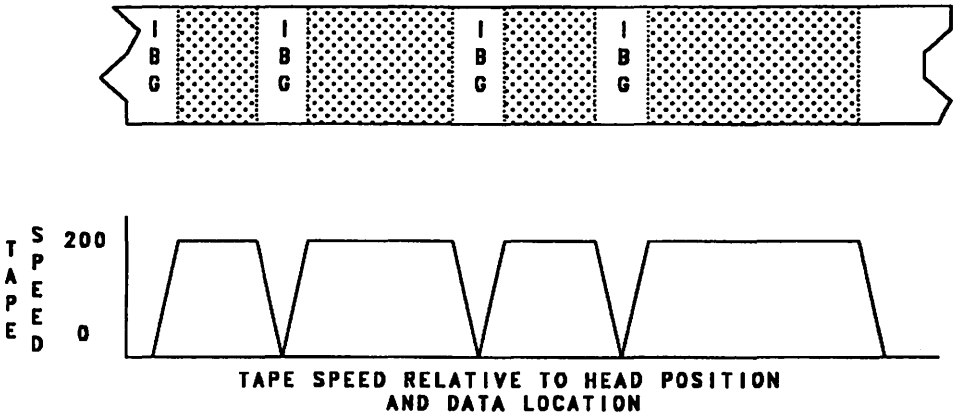


**Figure 14. 3420 tape positioning example, part 4**

## 3480 Tape Movement

The 3480s tape motion characteristics are quite different. The IBG on the 3480 is much smaller than the 3420s (about 0.08 inches). The IBG is too small to use as an acceleration or deceleration space. Because of this, the 3480 performs an action called a "back-hitch" every time the tape is stopped. Because the 3480s tape speed is slower (39 or 79 IPS versus 200 IPS), and because a back-hitch is involved, it takes the 3480 longer to get ready to move the tape again once it has stopped. The buffer in the control unit can mask the time associated with both the slower tape speed and the back-hitch so that the impact on the application is minimal.

Let's look at the 3480's motion. Like the 3420 example, this series of diagrams will not be to scale. To keep the example simple, we will show just the 3480 B22's speed and direction on the graph below the tape. When the line on the graph is above the X axis, the tape is moving forward. When it is below the X axis, the tape is moving backwards.

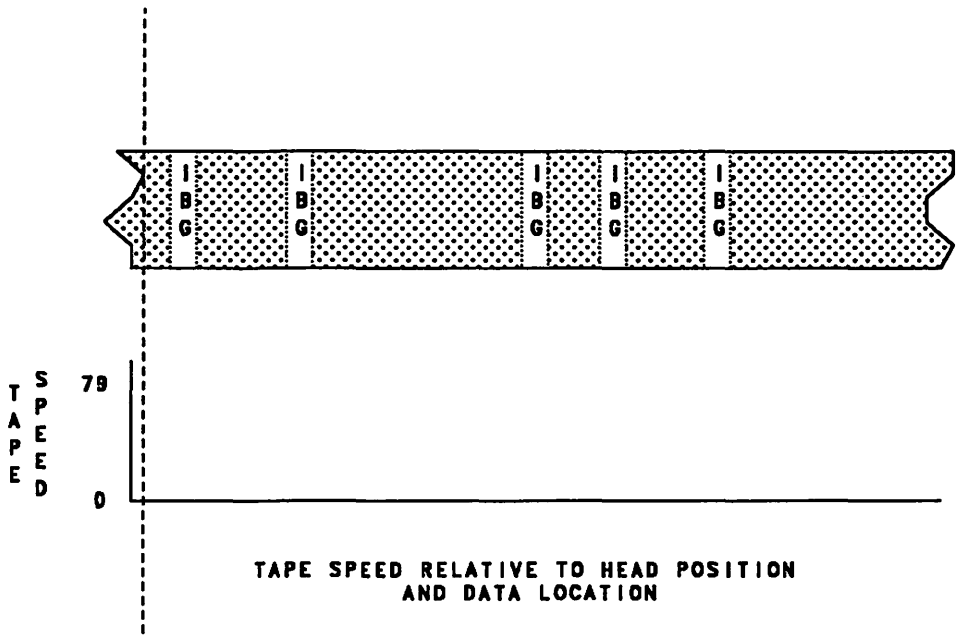


**Figure 15. 3480 tape positioning example, part 1**

Figure 15 shows a piece of 3480 tape with data blocks and IBGs. The head is positioned in the portion of the first block that you can see in the diagram, not in the IBG. As we go through the example, the reason for the head's position in the data record will become clear. Data from the 3480 is moved into the buffer (for reads) when the control unit decides it is needed. The data moves independently from read channel commands coming from the host. We will discuss this in detail in "Buffer Management" on page 39.

The control unit decides that it is ready to put some data in the buffer and issues a command to the tape drive to start.

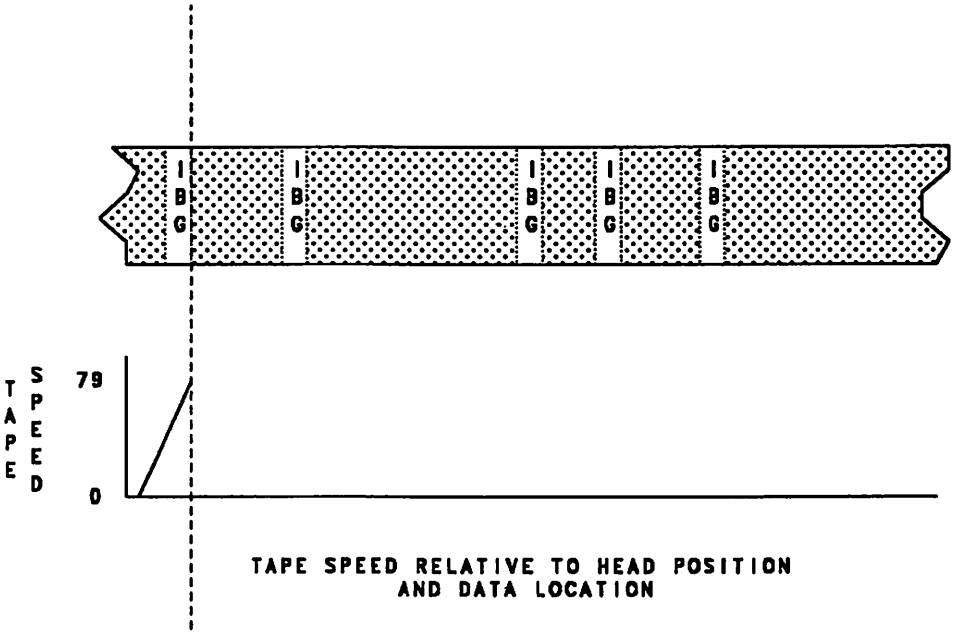


**Figure 16. 3480 tape positioning example, part 2**

The tape accelerates up to speed by the time the first data bytes are over the head as shown in Figure 16. The tape continues to move and the data block is transferred to the buffer. While this is going on, the control unit determines if more than one block should be transferred. For our example, it decides that one block is enough. As the end of the data block passes, the control unit tells the drive to stop, and the tape is stopped with the head in the next block. Figure 17 on page 35 shows the tape in this position.

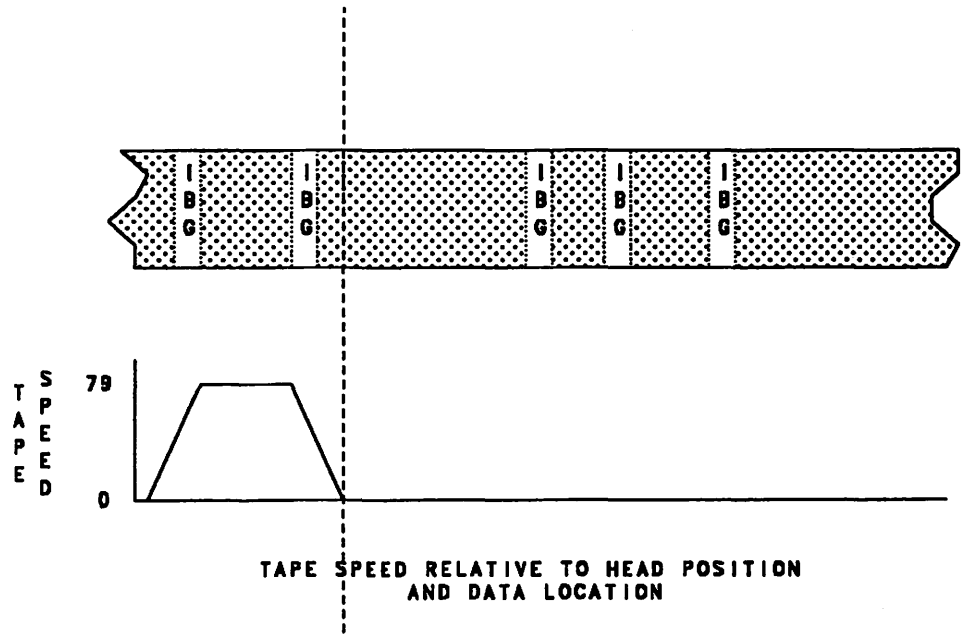


Figure 17. 3480 tape positioning example, part 3

Before it can read the tape again, the drive must reposition the tape into the previous block. This is required so the tape will be moving at the correct speed when the next data block is read.

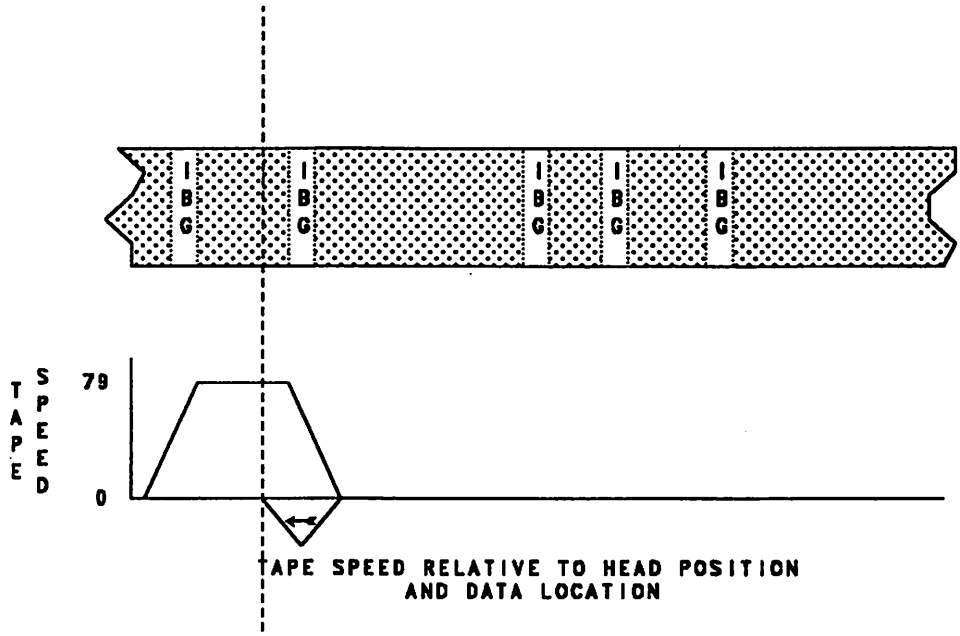


**Figure 18. 3480 tape positioning example, part 4**

The backwards movement is the back-hitch. Figure 18 shows the tape after a back-hitch. Note that the graph shows the tape has backed up and that the head position is now in the previous block.

After some time, the control unit requests more data and the cycle is repeated. Figure 19 on page 37 shows the tape as the end of the next block is approaching.

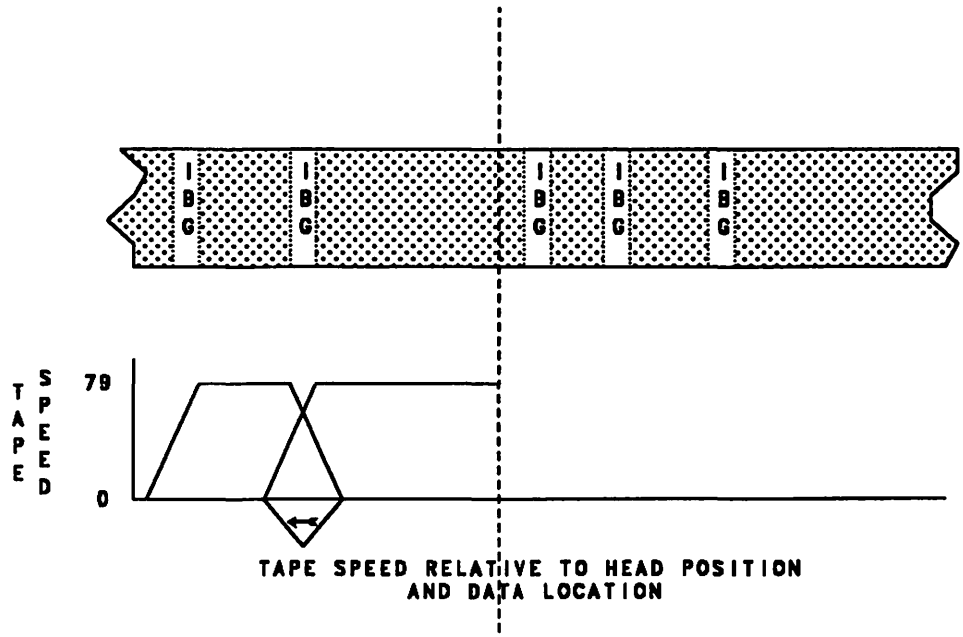


**Figure 19. 3480 tape positioning example, part 5**

This time, the control unit decides that it wants more than this one block to be transferred. Without stopping the tape, the drive continues past the IBG and transfers the second block. Again, the control unit determines that another block is desired, and the drive again passes the IBG and transfers a third block. This time the control unit decides that it has enough data and tells the drive to stop. Once stopped, the drive performs the back-hitch again, leaving the tape in the position shown in Figure 20 on page 38.

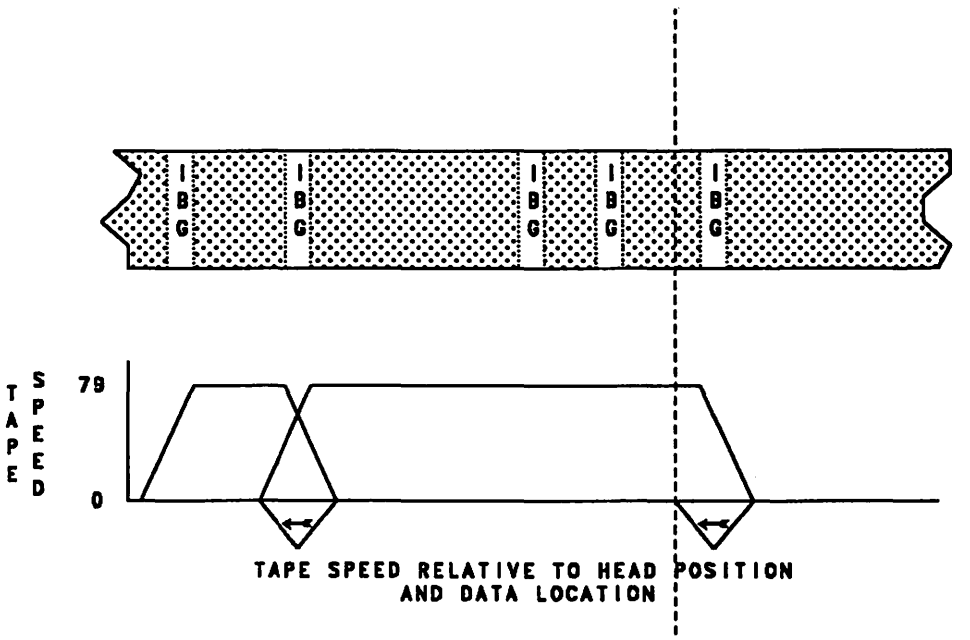


**Figure 20. 3480 tape positioning example, part 6**

The process of transferring more than one block without stopping the tape is called "streaming." Streaming allows a drive to be very efficient in its data transfer. Whether or not a drive will stream is determined by the control unit. The decision is made based on the amount of data that needs to be transferred and the overall activity level of the subsystem. The control unit will not allow one drive to stream at the expense of other drives in the subsystem that have work to do. It will stop one drive so that another may transfer some data.

In performance measurements at the Washington Systems Center, we have seen consistent streaming in unconstrained environments. When we transferred blocks to or from the 3480, we saw the one drive stream from one end of the tape to the other, provided the blocksizes were larger than 8K. To understand how this can happen, we need to look at the control mechanism for the buffer.

# Buffer Management

The buffers in the 3480 are located in and are managed by the control unit. In a Dual Control Unit configuration, each control unit has access to the other's buffers.

## Buffer Assignment

Control unit buffer segments are assigned according to rules. Each drive will have 0, 1, or 2 buffer segments assigned to it at any time. If the drive is not "active," there will be no segments assigned. If it is active, it will have one or two, depending on how active the subsystem is. When two segments are assigned to a drive, they will always be contiguous. For the A22, these segments are treated as one, large 256K buffer, not two 128K segments. For the A11, these segments are treated as one, large 128K buffer, not as two 64K segments.

If the control unit reassigns buffers, which it will do from time to time, it will never "add" one buffer segment to another to make a larger buffer, even if the two segments would be contiguous. It will always free or deallocate a segment, and then reallocate a contiguous pair of segments.

In the examples of control unit functioning that follow, the same general diagram format will be used. The drives will be shown below the control unit. To save space, we will only show 2 drives, or one B unit. Buffer management is the same for both models of the control unit. The drives are shown separated from the control unit by some space. This is done so that we can illustrate internal connections and paths. In your installation, the drives will be physically attached to the control unit, and the paths will be internally cabled.

Because there are no active drives, no buffer segments are assigned to any drives, and the subsystem is inactive. A job is started in the host. The host is attached to this subsystem through the first channel interface, interface "A". A job is started and it allocates drive 0 and the operating system issues a mount command. The drive becomes "active" when the first I/O is done to it. This is normally at OPEN time. For our example, the application has just OPEN'ed the file for input and a READ command has been issued as part of OPEN.

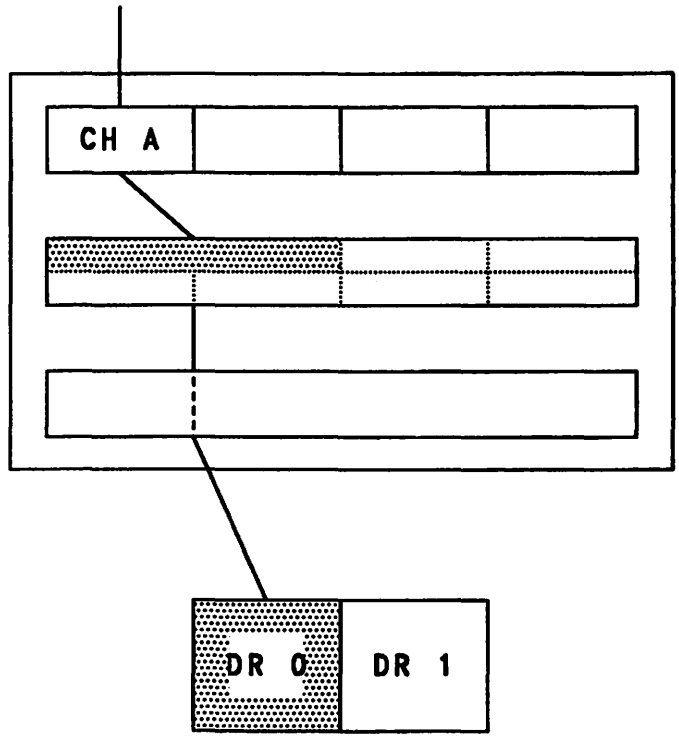


**Figure 21. Buffer assignment example, part 1**

Figure 21 shows the subsystem after the read and buffer assignment has taken place. To get to this point, the following things had to happen:

- The READ command was issued.

  The control unit determined that the command was for drive 0, and that there was no buffer assignment for that drive.

- The control unit suspended the channel program, leaving the channel free to do other work.

- The control unit determined that two buffers would be allocated and assigned them to drive 0.

- The control unit issued a start command to drive 0.

In the diagram, the dotted area in the buffer shows the segments that have been allocated to drive 0. The drive has the same shading so that you can equate the buffer with the drive.

Once the drive has reached read speed, the first block is transferred from the tape to the buffer.

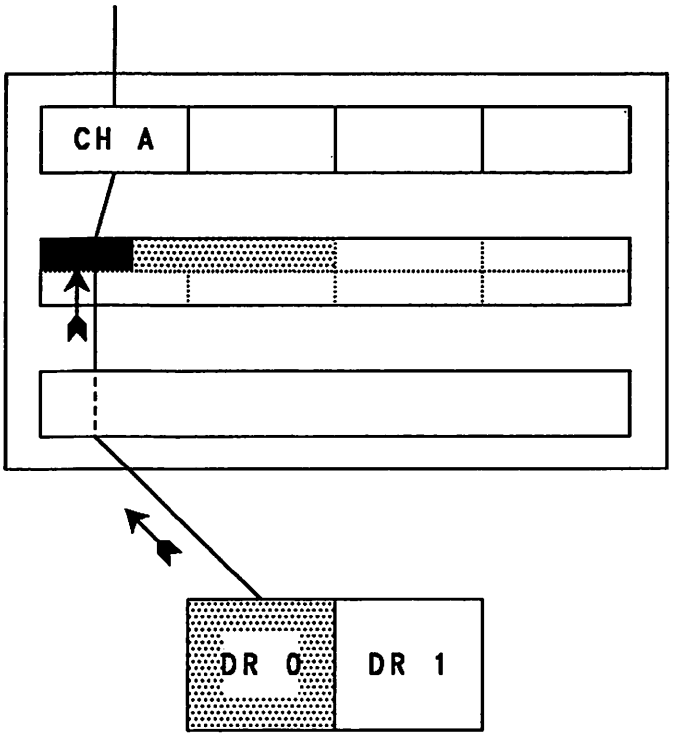


**Figure 22. Buffer assignment example, part 2**

Figure 22 shows the first block in the buffer (solid shading). The drive will continue to stream and transfer additional blocks into the buffer.

The control unit realizes that one block of data is now available for channel transfer. It causes a Channel Command Retry to occur, and the channel is reconnected to the control unit. Figure 23 on page 42 shows the first block being transferred up the channel (diagonal stripes) while the second block is being fed into the control unit by the drive.

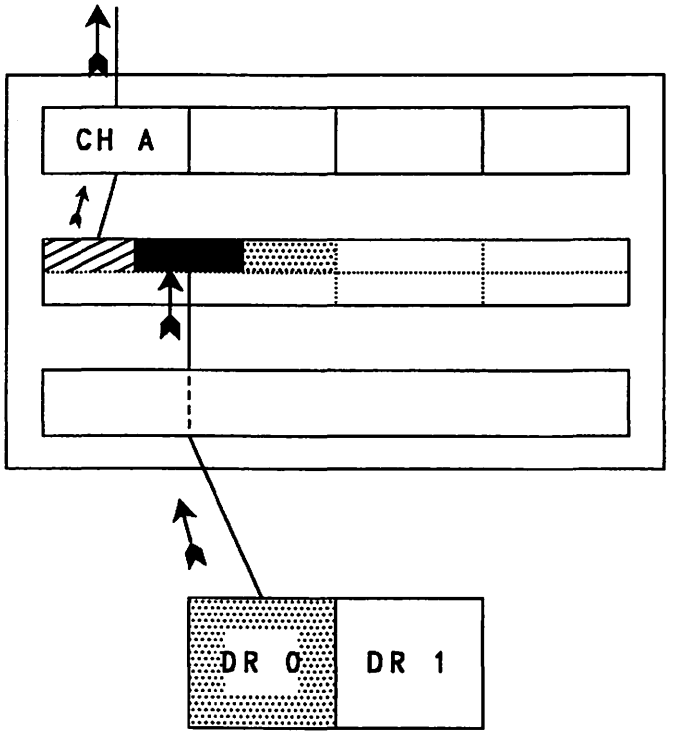


**Figure 23. Buffer assignment example, part 3**

When all of the first block has gone up the channel, the control unit signals device end/channel end and the channel program is complete. The host can now process the data. Meanwhile, the drive is still moving data into the buffer.

The host has processed the data it received and issues another read command. This time, the read is answered immediately. The second block in the buffer is transferred.

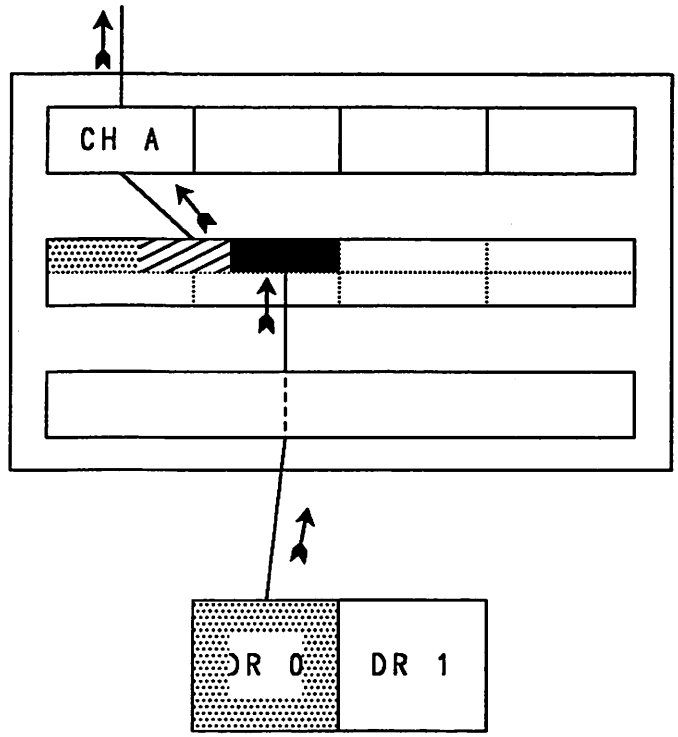


**Figure 24. Buffer assignment example, part 4**

Figure 24 shows the second channel transfer. It shows the third block being placed in the buffer by the drive, and it shows the area that was held by the first block as free again. The control unit must now decide whether to continue to transfer data from the drive, or to stop the drive. If the space is available at the beginning of the buffer, it will "wrap-around" to the front and continue transferring. This is shown in Figure 25 on page 44.

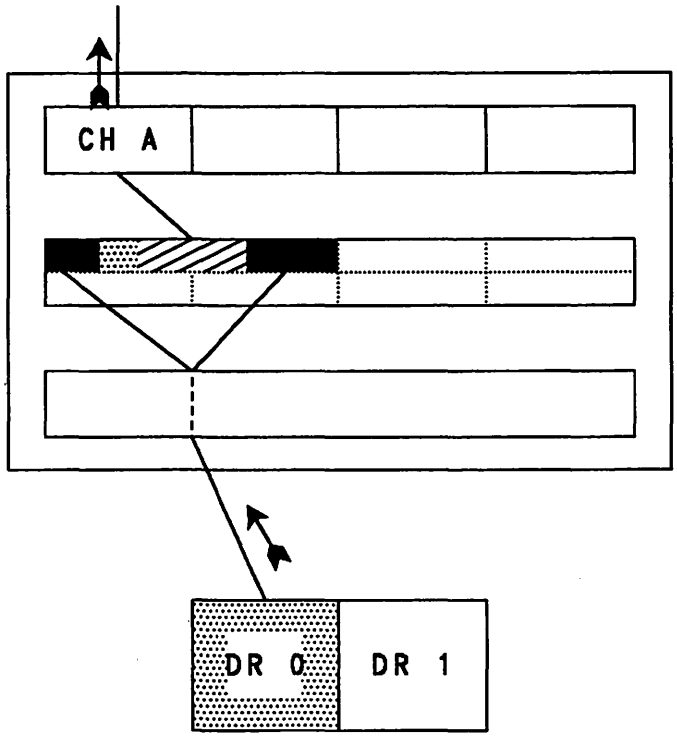


**Figure 25. Buffer assignment example, part 5**

In order to stream all the way through a cartridge, the host must be able to read the data fast enough to keep ahead of the tape drive's filling of the buffer. If it can, the host in effect "chases" the drive around and around the buffer, never catching it. The drive doesn't stop until it reaches the end of the file, and the host application never has to wait for the drive after the buffers are primed.

This example has shown us a few things. We have seen the drive in streaming mode. We have seen the concept of the wrap-around buffer in action. We have also seen that the buffer can hold more than one block. Although we didn't point it out, the file we used had variable length blocks. The diagrams reflected this.

When deciding whether or not there is space in the buffer to hold the next block, the control unit looks at the largest block it has seen for this volume on this drive since the drive became active. If this largest block will fit in the available space, it is eligible for transfer. If it is not, the drive will be told to stop, and won't be started again until there is sufficient space in the buffer to hold the largest block.

You might wonder, "What if the block turns out to be bigger than the previous largest block, and it doesn't fit in the available space?" The control unit will realize this, will ignore the part of the block that was transferred, and will reposition the tape so that the next control unit read will read the block again. The control unit knows where to position the tape because it is keeping track of the

BLOCK-IDs. We can now see that the BLOCK-IDs are used by the subsystem to keep track of the tape's position. The fact that we can have access to a specific BLOCK-ID and can store and manipulate them and cause searches to happen is a by-product.

We mentioned before that one drive can't monopolize a subsystem. There are counters and thresholds in the microcode that prevent one drive from continually streaming and transferring data when other work is waiting. If a set number of data blocks transferred from one drive exceeds this threshold, work for the drive will be suspended and another drive will be given use of the drive interface.

For example, let's assume that there are two drives active. As the control unit nears the end of a block being transferred to the buffer from drive 0, it determines that there is work for another drive and it will stop drive 0 after the current transfer. The start command for the other drive is issued over a separate internal path that is used just for motion commands like start, stop, and back-hitch activity. The start command is issued so that the other drive will get up to speed and to the beginning of the data just as drive 0 reaches the end of its current block. The control unit then switches transferring of data to the other drive and issues the stop command to drive 0 over the special path.

## Internal Path Management

The next few examples will use a "2 by X" subsystem. We will look at how the two control units interact and communicate with each other.

Each control unit has a number, either 0 or 1. In a "1 by" subsystem, the control unit is always number 0. The drives attached to it will always have addresses 0-7. In a "2 by" subsystem, control unit 1 will have drive address 8-F attached to it. In the examples, control unit 0 is always on the left.

In a "2 by X" subsystem, each control unit has access to all 16 possible drives in the subsystem. Each channel adapter can access the buffers for all 16 drives attached to the two control units. A given drive's buffers will always be in one control unit or the other; it cannot have buffer assignments in both controllers. This means that a channel must have access to both buffers. Figure 26 on page 46 shows a "2 by" subsystem. It is attached to a host through two channels, "A" and "B". The channels are in different control units.

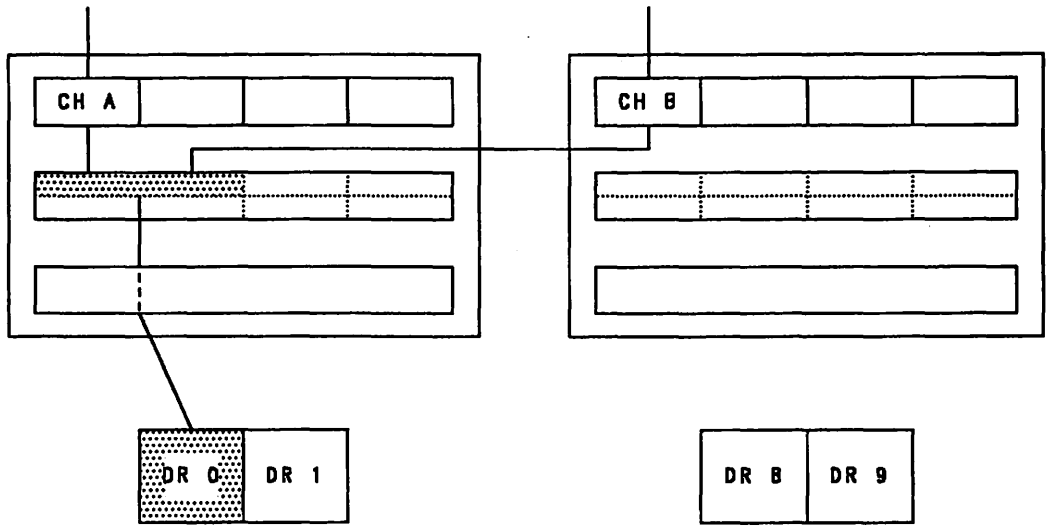


**Figure 26. Dual Control Unit example, part 1**

The allocated drive is once again drive 0. The first I/O has been done, and the buffers have been allocated in control unit 0. Usually, the buffers are allocated in the control unit containing the channel adapter that had the first I/O request. There are some factors that can influence this initial allocation, such as the possibility that all the buffers in control unit 0 are assigned to other drives.

Note that channel B has access to the buffer in control unit 0. This is provided by the Dual CU Communications Coupler we discussed in Chapter 1, "IBM 3480 Magnetic Tape Subsystem Overview." When an I/O request in one control unit communicates with the buffer assigned in the other control unit, the data transfer is said to be done in "remote" mode. The channel adapter is "remote" from the buffer. When the buffer and the active channel adapter are in the same control unit, the transfers are said to be done in "local" mode.

There is some overhead associated with remote communication, and it can have an effect on effective data rate. It is most noticeable in under-utilized subsystems. You can't determine which control unit a drive's buffers will be in, but you can have some influence over which path most of your I/O will go on. Your objective should be to have most of the I/O occur on one path. There is an algorithm in the control unit microcode that will attempt to move or reassign buffers between control units if most of the I/O for a given drive is coming from a given channel adapter. This buffer reassignment temporarily suspends data transfer while the new buffer is allocated in the other control unit. This algorithm is

called "Channel-Sensitive Load Balancing" and it tries to keep I/O to a drive local. We will tell you how to exert your influence in "Selecting the Proper Channel Selection Algorithm" on page 49.

Let's complicate things somewhat by starting another job. This job allocates drive 1. It is using the same channels as our old job on drive 0.

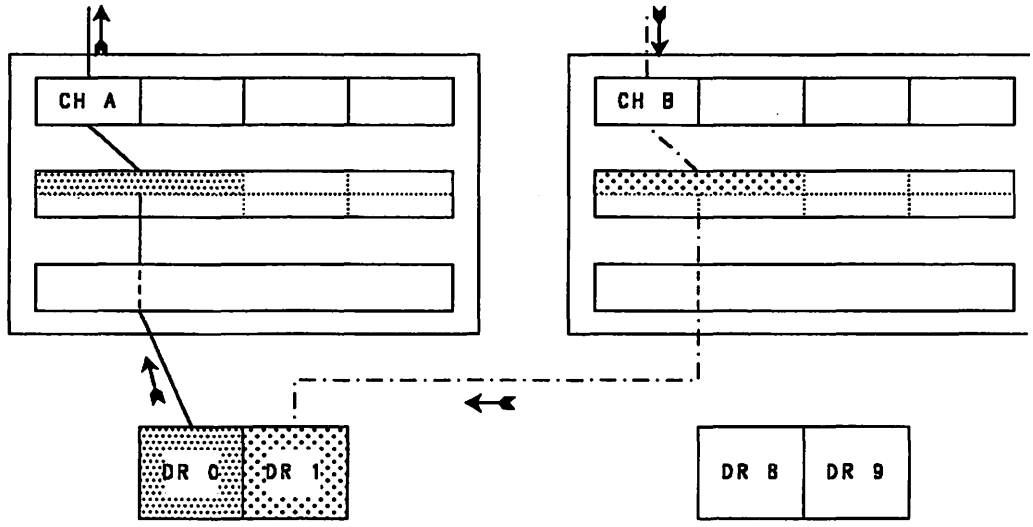


**Figure 27. Dual Control Unit example, part 2**

Figure 27 shows that the buffer for drive one was assigned from control unit 1. This probably happened because channel A was busy when the first I/O was tried to drive 1, and the alternate path (B) was not busy. Therefore, the first I/O to drive 1 came over channel B.

Each control unit has a separate path to each string of drives. This means that two drives on the same string can be transferring data to and from their buffer simultaneously. Figure 27 shows both drive 0 and drive 1 are transferring at the same time. If the buffer for drive 1 was in control unit 0, only one of the two drives (0 or 1) would be able to transfer at a time because there is only one path from the string to control unit 0.

Since drive-to-buffer transfers happen asynchronously from channel-to-buffer transfers, it is also possible for two channels to be transferring data into and out of buffers in separate control units. Look again at Figure 27 and you will see that both channels are also active.

Channel A is local to drive 0, and channel B is local to drive 1. If you specified the proper channel scheduling algorithm (see "Selecting the Proper Channel Selection Algorithm" on page 49), most of the I/O to both drives will stay local, and no attempt will be made to move the buffers.

Now, let's change this example and complicate it a bit more. Figure 28 looks like the previous example, except that channel B is in control unit 0.

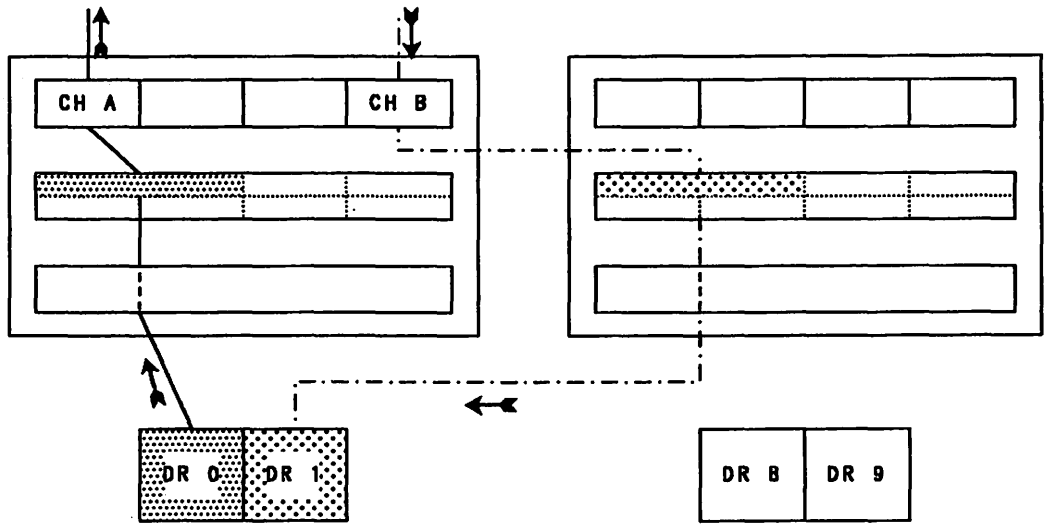


**Figure 28. Dual Control Unit example, part 3**

The buffers have been assigned in the same places, and the same two drives are allocated. Channel B is remote to drive 1 because the buffer is in control unit 1. Even though channel A may be busy, and both channels are connected to the same control unit, channel B can transfer data simultaneously with channel A because they are not transferring to the same buffer. What this really means is that the "channel busy" indicator to the host is really "buffer busy." The microprocessor that controls the channel adapter is able to allow two transfers through two channels that are attached to the same control unit as long as the buffers are in different control units. Another way of looking at this is to say that the number of active transfers over channels is one per buffer in the subsystem.

For a further example, look at Figure 29 on page 49. It shows the buffers for drives 0 and 1 in control unit 0.

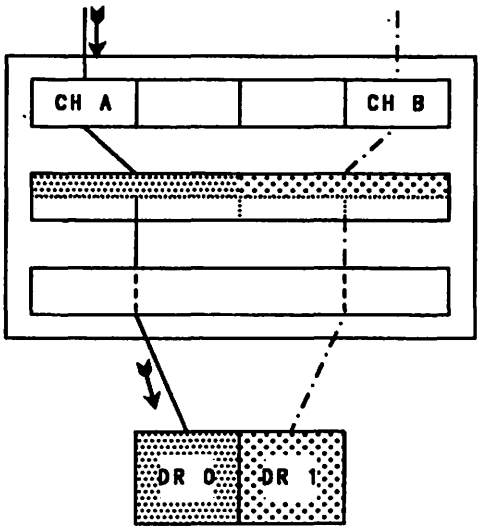


**Figure 29. Dual Control Unit example, part 4**

In this situation, either drive 0 or 1 can be transferring, and either channel A or B can be transferring. Channel B can't transfer while A is transferring because both are transferring to the same buffer.

## Selecting the Proper Channel Selection Algorithm

We have discussed the Channel Sensitive Load Balancing algorithm active in two control unit 3480 subsystems. It was designed to work well when most of the I/O for a drive comes from one path. In MVS systems, you can influence this by selecting the proper channel selection algorithm. In VSE systems with an alternate channel, you don't have this choice; VSE attempts to balance the number of successful Start I/Os across its paths to tape.

In MVS/370, this is defined in the IECIOSxx member of SYS1.PARMLIB for each channel. The algorithm assumes that you have specified "last channel used." The MVS documentation says that I/O channel queuing nullifies LCU for 3033 and 308X processors. Specification of LCU actually acts like sequential and reverse-sequential. The 3480 design allows for this. We recommend specifying LCU all the time because it is less confusing that trying to remember which way to specify for which machine.

For MVS/XA installations, the definition is different. You will specify a set of valid paths for each device in your system. For the 3480 addresses, you should specify one of the paths as a "preferred path." This tells MVS/XA to prefer that path over the other for that address.

If the system always allocates from the lowest available tape address, and the preferred paths are set by string, then all drives in a subsystem with addresses 0-7 would prefer one path, and would also get allocated more frequently than the drives 8-F. The system's path activity would not balance out very well.

The algorithm MVS uses to select a drive for allocation is determined by the installation through the SELTAPE parameter in the IEAOPTxx PARMLIB member. The options have not changed with the introduction of the 3480. The algorithms may work differently, however. If more than one tape device type (3420s and 3480s for example) are in the system, and NEXT is selected (or defaulted to), the system will allocate beginning at the lowest address and continuing upward through all addresses ***as long as all allocation requests are for the same device type***. For example, 3420s are defined at addresses 550 through 55F and 3480s are defined at addresses 850 through 85F. Allocation requests 4 of each type of device and 550-553 and 850-853 are allocated. When the job is done, the devices are unallocated. The next allocation request will select either 550 or 850, not 554 or 854 as you might expect.

Specifying NEXT and allocating mixed tape device types will cause lower numbered devices to be utilized more heavily than higher numbered devices. Most installations specify NEXT to get the opposite result, namely even utilization across their entire tape pool. We recommend that you specify RANDOM if you want even utilization.

## WRITE Differences

Most of our discussion so far has been about read commands. There are some minor processing differences for write commands.

### WRITE at the Channel Interface

The host writes data into the 3480 control unit buffer. After each buffered WRITE command is executed, the control unit sends an immediate CE/DE to the host, before the data is transferred to the tape. The control unit has now assumed responsibility for getting the data safely on the tape. The host program can continue with its processing.

Should an error occur when the data is transferred to the tape, a unit check condition will be posted to the host. This unit check will be returned for an I/O command other than the one that originally wrote the block to the 3480, and the host now has to perform some error recovery actions which are described in "Error Recovery Code" on page 61.

If a block is being written from the host, and the block turns out to be larger than the amount of buffer space available, the control unit will suspend the channel program, and cause it to be retried later when more buffer space is available. If the block is larger than 100K on the A11, or 200K on the A22 with the 1.0 Mbyte buffer, Tape Synchronous Mode will be entered.

### WRITE at the Drive Interface

Writes to the drive are similar to reads. The process is virtually identical, except that the data is going the other direction. Streaming can (and will) occur if data is supplied from the host quickly enough. If the data is not sent quickly, existing buffered data will be written and streaming will not occur. There is a slight increase in subsystem overhead involved in writing data, so the effective data rates for writes are slightly lower than those for reads.

### Data Synchronization

In Buffered Write Mode, which is the default, the data written by the host program and the data on the tape can be out of synchronization. This is because the data can be in the buffer and not on the tape while the program has assumed the data is written correctly. There are some cases where the hardware forces the drive's buffer and the drive to synchronize with the software command.

The commands that can cause synchronization are:

- Rewind (REW)
- Rewind and Unload (RUN)
- Write Tape Mark (WTM)
- Locate Block
- Erase Gap
- Any space command such as Forward Space Block
- Any read command followed by a write command (direction change)

An example may help explain why these commands cause synchronization. Let's follow a sequence of actions:

1. A program is writing.

2. CE/DE is received after each write, and the data is in the buffer awaiting transfer to tape.

3. The program CLOSEs the file, causing a tape mark to be written.

4. The WTM command is received in the control unit. Instead of responding with CE/DE right away, the 3480 just sends CE, which frees the channel for other work.

5. All data blocks in the buffer are written to tape, followed by the tape mark.

6. The tape mark is successfully written, the channel is reconnected and DE status is returned.

If the 3480 returned CE/DE initially for the WTM, and one of the last blocks or the tape mark itself had an error, it is possible that the program that wrote the block or WTM could have terminated, unaware of the error. By holding DE until the tape mark is really on the tape, the drive guarantees that the program will stay around to handle any error conditions.

A synchronize as part of a tape direction change ensures that data in the buffer is written to the tape before the direction of the tape changes. If a read was to be issued after a write, with an intervening back space, the read could have executed before the last block had been written to the tape. The results would be unpredictable because of timing.

Host programming can request synchronization at any time by issuing a SYNCDEV macro. The SYNCDEV macro is described in "SYNCDEV Macro" on page 60.

# Chapter 4. 3480 Software Support

This chapter will look at the software requirements to support the 3480. We will discuss MVS, other IBM products that support 3480s, VM, and VSE/SP.

## MVS Software Support

MVS software provides two modes of 3480 support. One is called 3420 Code-Compatibility, or Code-Compatibility (CC) for short. The other is Full-Function (FF) support. First, we will look at the differences between the two modes, then the levels of MVS and related products that are needed for each mode. We will also look in some detail at changes that were made to MVS to support the 3480.

**There are no hardware differences in the 3480 for CC or FF mode. There are no features or microcode changes necessary. The difference in function exists strictly in the software.**

### 3420 Code-Compatibility

3420 Code-Compatibility (CC) mode means that all channel programs that executed on 3420 drives will execute on 3480 drives. Minimal changes were made to MVS to support the 3480 in CC mode. In CC mode, the 3480 looks like a 3420 Model 9 to the operating system. Of course, a 3420-9 doesn't exist. The operating system knows that a 3420-9 has different device requirements than other 3420 models, so it will not try to mix the two for allocation requests. It also knows that different error recovery procedures need to be used for the 3420-9. A unique catalog entry and a unique UCB DEVTYP field value are used.

There were no changes to OPEN/CLOSE/EOV, or to other parts of MVS for CC support. The intent was to modify as little code as possible while making the 3480 usable. To do this, some new 3480 functions are not supported. They are

- Use of the Display - No macros are provided to write to the 3480 display. (Hardware-generated messages are always shown.)
- Block Search - The high speed search facility is not supported. Block-IDs are written on the tape, however, as that is a hardware function.
- ASSIGN and UNASSIGN - These commands are not supported and are not issued.

- Automatic Cartridge Loaders in SYSTEM mode

Tape-Write-Immediate mode is supported. The data is written to the 3480 in TWI mode with a 3420 MODE SET command in the channel program. This MODE SET, for 1600 BPI, causes the 3480 to go into TWI mode. We discussed TWI in "Tape-Write-Immediate" on page 22. The 3420 MODE SET is used because no code was added to MVS for new 3480 channel commands. The 3480 MODE SET command has a data bit that indicates TWI, but this is not a valid channel command for a 3420, and MVS thinks the 3480 is a 3420 model.

*Note:* If you have a program with a hard-coded DCB density value of 3 for a file that will be written on 3480s in CC mode, **it will be written in TWI mode.** It will not be possible for this to happen accidentally through JCL as we will see in "MVS JCL Differences" on page 57

One MVS function not supported in CC mode is Dynamic Device Reconfiguration, or DDR (SWAP). The implementation of DDR requires use of NOTE, POINT, and LOCATE commands, and some other related commands that are not available in CC mode. This means that the operator will not have an opportunity to swap a cartridge to another drive if a permanent error is encountered.

There are two cases where drives running in CC mode will give operating system data that looks like Full-Function data. SMF records will have a Full-Function device type value in them. This will make it easier to process records from multiple or mixed-mode systems and recognize that they are 3480 records. The same is true for LOGREC records. The device type field in these records also contains the Full-Function value. Catalog processing recognizes the unique value that is in a catalog for a drive operating under FF mode and treats it as if it were the same as CC mode.

## Full-Function

The Full-Function (FF) mode of 3480 support is its native support. It includes all features of CC mode, plus support for all the new 3480 facilities and DDR. The 3480 has a unique catalog value and a unique UCB DEVTYP value. Catalog processing recognizes the unique value that is in a catalog for a drive operating under CC mode and treats it as if it were the same as FF mode.

## Selecting Support Modes

There are two things to do to select Full-Function or Code-Compatibility support. The first is to decide which one you want; the second is to code this selection correctly in the SYSGEN IODEVICE macro that specifies 3480s.

Code-Compatibility mode was designed to allow the 3480 to be used by the operating system with the least possible change to existing code. This should allow users with large investments in code that is dependent on OPEN/CLOSE/EOV, or allocation, or various control block values, to get the benefits of the 3480 without having to change much code. Full-Function support modifies these and other areas of MVS, as we will see in "MVS Software Changes" on page 59.

In the 3480 Early Support Program (ESP), we selected a mixture of environments that would allow us to look at the impact that both CC and FF support would have on existing IBM and non-IBM software. We found that the impact was very minor. Except for JES3 users, we found that Full-Function mode could be implemented without difficulty. JES3 FF support requires JES3 release 1.3.4 or higher.

Given this experience, we have found little reason for you to consider Code-Compatibility mode, except if you are a JES3 installation using Main Device Scheduling, or plan to run the 3480 under VM. We recommend that you install your 3480s using Full-Function mode.

Once you have made the CC or FF decision, you tell the operating system which mode you want in your SYSGEN. The IODEVICE macro specification for the 3480 makes this determination.

If you code **3420C**, you will generate Code-Compatibility mode support. If you code **3480**, you will generate Full-Function mode support.

*Note:* You can't be ambivalent about this. The two modes are **mutually exclusive** in one SYSGEN. You must specify either one or the other, but not both.

You can have some hosts running in Code-Compatibility and some running in Full-Function in the same data center, connected to the same 3480s. You must be aware of potential tape sharing problems between these complexes, because the CC system doesn't know about the ASSIGN rules, and won't play by them. Other than that, they may share catalogs and drives without difficulty. This will prove useful to the JES3 user, and others, who start in CC mode and migrate to FF mode later. This user will be able to change one complex at a time.

## MVS Software Requirements

Software support for the 3480 is in three parts. There is support in the base release of MVS (MVS/SP), in the data management software (DFP), and in the job entry subsystems (JES2 and JES3).

### MVS/SP Base Requirements

For **Code-Compatibility** mode support, you need one of the following:

For MVS/370

- MVS/SP JES2 (5740-XYS) at release 1.3.0 or higher
- MVS/SP JES3 (5740-XYN) at release 1.3.0 or higher

For MVS/XA

- MVS/SP JES2 (5740-XC6) at release 2.1.2 or higher
- MVS/SP JES3 (5665-291) at release 2.1.2 or higher

For **Full-Function** mode support, you need one of the following:

For MVS/370

- MVS/SP JES2 (5740-XYS) at release 1.3.3 or higher
- MVS/SP JES3 (5740-XYN) at release 1.3.4 or higher

For MVS/XA

- MVS/SP JES2 (5740-XC6) at release 2.1.2 or higher
- MVS/SP JES3 (5665-291) at release 2.1.2 or higher

**Data Facility Product (DFP) Requirements**

One of the DFP products **MUST** be installed for 3480 support. You cannot SYSGEN the 3480 without DFP. Even if you are in CC mode, there are changes to MVS, and they are only provided by the appropriate DFP.

For **Code-Compatibility** mode support, you need one of the following:

For MVS/370

- MVS/370 DFP (5665-295) at release 1.1 or higher.

For MVS/XA

- MVS/XA DFP (5665-284) at release 1.2 or higher
- MVS/XA DFP (5665-XA2) Version 2.1

For **Full-Function** mode support, you need one of the following:

For MVS/370

- MVS/370 DFP (5665-295) at release 1.0 or higher.

For MVS/XA

- MVS/XA DFP (5665-284) at release 1.2 or higher
- MVS/XA DFP (5665-XA2) Version 2.1

**JES2 Requirements**

The JES2 releases given below are for MVS/370. The equivalent MVS/XA levels may be used in MVS/XA.

All levels of JES2 support either Code-Compatibility mode or Full-Function mode.

For MVS/370, SU25, 1.3.0, 1.3.3, 1.3,4, 1.3.6

For MVS/XA, 1.3.0, 1.3.3, 1.3.4, 1.3.6

If you will be running in Full-Function mode, and your JES2 level is earlier than 1.3.3, you need to know what you will be missing. Starting with release 1.3.3, JES2 will perform a new function at initialization time. It will call a routine that will search for online 3480s. When it finds one, it will cause an ASSIGN command to be issued. This will cause drives that are SYSGEN'ed

OFFLINE = NO to be assigned to the system. Without this, they would remain unassigned until something caused a VARY command to be issued for them. Since they were IPL'ed online, it is quite unlikely that a VARY will be issued, hence the JES2 change.

If you are running an older version of JES2, you should SYSGEN your 3480s to be IPL'ed OFFLINE = YES. Since a VARY must be issued before they can be used, and the VARY will issue the ASSIGN command, the drives will be properly assigned before use.

### JES3 Requirements

The JES3 releases given below are for MVS/370, except 2.1.5. The equivalent MVS/XA levels may be used in MVS/XA.

For **Code-Compatibility** mode, you need one of the following:

For MVS/370, SU26, 1.3.0, 1,3,1, 1.3.4

For MVS/XA, 1.3.0, 1.3.1, 1.3.4, 2.1.5

For **Full-Function** mode, you need one of the following:

For MVS/370, 1.3.4

For MVS/XA, 1.3.4, 2.1.5

JES3 was modified substantially to support the 3480.

If you do not use the Main Device Scheduling facility of JES3 to control allocation of your tape drives, you can run in Full-Function mode at a release earlier than 1.3.4.

Changes were made to JES3 starting in release 1.3.4 that are similar to those described above for JES2. At initialization time, JES3 calls the same routine and causes ASSIGNs to be issued for any online 3480s in the system.

## MVS JCL Differences

There are two JCL parameters that you should be concerned with when converting your operations to the 3480.

### UNIT Parameter

The UNIT parameter has two new values for the 3480. In Code-Compatibility mode, the value is 3400-9; in Full-Function mode, the value is 3480. For ease of conversion, both values are generated for both Full-Function and Code-Compatibility modes and either may be used. Of course, you can define your own unit names with the UNITNAME macro in your SYSGEN.

### DCB DEN Parameter

The acceptable DCB DEN parameter values depend on your mode of software support. If you are in CC mode, the only valid DEN value is DEN = 4. In CC mode, the 3480 looks like a single density, 6250 BPI 3420, with a model designation of 9. DEN = 4 is the only valid density value for a single density, 6250 device. Any other value will cause a JCL error. Look again at the note on page 54 for more information on this parameter value in CC mode.

In FF mode, all values for the DEN parameter are ignored; any values remaining in JCL will run without error. See "Programs to Review" on page 95 for a caution on hard-coded DCB DEN values.

## MVS Related Products

Several MVS Programs have specific level requirements for the 3480. They are discussed in this section.

### DFSORT

The DFSORT Program Product (5740-SM1) supports the 3480 for input and output files **only** beginning with release 6. Intermediate work datasets (SORTWKnn) on 3480s are supported beginning with release 7.

### DFHSM

The Data Facility Hierarchical Storage Manager (DFHSM) Program Product (5664-329) supports the 3480 for space management functions of automatic dataset migration and recall beginning with Version 2, Release 1. In Version 2 Release 2, DFHSM supports a single-file format for migration and backup to 3480s. DFHSM exploits the 3480 high speed search (or block locate) to access user datasets in this single-file format. DFHSM also supports the Automatic Cartridge Loader for the 3480.

Use of the 3480 with the prior Hierarchical Storage Manager (HSM) product (5740-XRB) is not supported.

### DFDSS

Data Facility Data Set Services (5740-UT3), IBM's dump/restore offering, supports the 3480 in all releases.

### EREP

The EREP support for the 3480 is provided in EREP Version 3.1, feature 1. Substantial changes were made to EREP to produce new reports and provide information formerly available in the CE tool, TSS. For information on how error information is reported, see "Comparing Reliability Data from 3420s and 3480s" on page 94.

### Stand-Alone Dump

The MVS stand-alone dump programs support the 3480 as follows:

- For MVS/370, support is provided for releases 1.3.0 and higher via PTF. This is minimal support. The 3480 may be used as an IPL target, and as a dump-to device. No special 3480 capabilities are exploited.

  Beginning in release 1.3.5, full support for the 3480 is provided. Messages will be issued to the display and ASSIGN and UNASSIGN commands will be issued by the stand-alone dump program.

- For MVS/XA, full stand-alone support is provided in the base release 2.1.2. The support is similar to that provided in MVS/370 1.3.5.

Operational implications for the Full-Function version of stand-alone dump are discussed in "Stand-Alone Dump Considerations" on page 88.

### ICKDSF

The ICKDSF utility may be IPL'ed from the 3480 beginning with release 6.

## MVS Software Changes

Several areas of MVS were changed to support the 3480. We will discuss some of these, and the implications, in this section.

### IEBGENER

The IEBGENER utility has been part of OS since the beginning. It uses BSAM for all I/O except copying of RECFM=VBS files when the blocksize is being changed. There was virtually no overlap between input and output operations, and I/O was done one block at a time with no host buffering. Our ESP experiences showed that IEBGENER did not achieve the performance improvements with the 3480 that we had expected.

As a result, IEBGENER has been changed to manage its I/O better. With the changes, IEBGENER performs as you might expect with the 3480. The APARs that change IEBGENER allow the user to specify the number of buffers using the BUFNO or NCP DCB parameters. The default number of buffers is 5.

### IEHINITT

For every volume IEHINITT attempts to label, message IEC701D is issued to the operator. It states that the volume to be labeled "vvvvvv" is to be mounted on a device address. For the 3480, the volume serial to be labeled and the characters "*IEC701" will alternate on the display. The operator must still respond to the console message before the volume will be initialized.

### MSGDISP Macro Support

The MSGDISP macro is new for the 3480. It is described in the *User's Reference* manual. There are various forms of the MSGDISP macro that cause certain types of messages, such as mount or dismount, to be displayed. The "RDY" form can be used by any problem program. All others forms require APF authorization.

If you use the RDY form, the text of the message sent to the display is also displayed on the operator's console as part of message IEC271I.

One of the parameters on the MSGDISP macro is WAIT. You can specify YES or NO. These specify whether control is to return to the program after the message I/O is complete, or immediately. Generally, you should specify WAIT = NO, as you don't want your entire program to hang up if the message cannot be displayed for some reason. This is especially true if you also issue a console message with the same, or similar, information.

### BLOCK-ID Use Support

The BSAM NOTE and POINT macros were modified to support the high speed search capability of the 3480. The TYPE operand was added. The default value for TYPE is REL, which causes both macros to work as they did before. The TYPE value of ABS is used for high speed search on the 3480.

NOTE and POINT had a restriction when used with BSAM datasets -- the restriction required that you specified in the DCB for the dataset that NOTE and POINT were to be used. This restriction was removed when the 3480 code was added to the macros. The documentation has not been changed to indicate that you no longer need to specify the presence of either NOTE or POINT macros in the DCB.

When using POINT with TYPE = ABS for high speed search, you should know that the DCB block count field will not be updated to reflect the new position of the tape.

### SYNCDEV Macro

Another new macro has been provided for 3480 block buffering support. The macro is SYNCDEV, and it causes the contents of the buffer to be written to the tape before ending status is returned to the application. This means that you can cause the contents of the buffer to be dumped to tape when you request it. Checkpoint/Restart uses SYNCDEV (in Full-Function mode only) so it knows what data is actually on tape when a checkpoint is taken.

SYNCDEV can be used effectively only if BSAM, EXCP, or single buffer QSAM are being used. If multiple host buffers are used with QSAM, and 5 is the default, no attempt is made to purge the QSAM buffers to the control unit by SYNCDEV. The blocks currently in the control unit will be moved to tape before status is returned.

SYNCDEV can also be used for an inquiry. It will return the number of blocks in the buffer waiting to be written to tape without causing synchronization.

### Error Recovery Code

The 3480s error handling philosophy is very different from the 3420s. The 3480 does all temporary error recovery for buffered-mode operations. The host is not involved. Since the 3480 is buffered, extra error recovery actions need to be taken to recover data that is in the buffer and not yet on the tape when a permanent error occurs.

The error recovery routines are called Error Recovery Procedures (ERPs). For the 3480, the ERP's functions are to

- retry errors
- issue error and intervention messages
- write records to LOGREC
- invoke DDR.

The ERP is entered for channel errors, unit checks, and after ERP retries. The 3480 control unit passes a large amount of information back to the system when an error occurs. Included is a recovery action code. This code tells the software what recovery action should be taken. The codes are documented in the *IBM 3480 Magnetic Tape Subsystem Reference, GA32-0042.* Based on this code, and values in the channel status word (CSW), the ERP makes a decision on what recovery should be tried.

Message processing occurs in an ERP exit. For "intervention required" messages, the operator action is added to the message text. The action might read "READY THE DRIVE". A MSGDISP macro is also issued to display "*NT RDY" at the 3480.

For errors where DDR is invoked, some additional processing must be done (over 3420 DDR processing.) If the file is being written, there is probably some data in the buffer. DDR issues a NOTE macro to determine how many blocks are in the buffer. It issues a GETMAIN for some storage (up to 256K), and issues READ BUFFER channel commands to read the buffered data back into the host. It then processes the swap and issues a LOCATE command to high-speed search to the proper block. The blocks in the GETMAIN'ed area are written in tape-write-immediate mode and the swap and DDR processing are completed.

The TWI MODE SET command is added to the channel program in a SIO exit.

An End-Of-Sense exit is used when SENSE commands are issued. SENSE commands are used to retrieve data from the control unit counters. The data returned is not error data, just statistical data, and this exit recognizes this fact and causes the statistics to be written to LOGREC.

At demount time, or at other times that SMF records are written (when a Z EOD command is issued), SVC 91 is called to write an MDR record to LOGREC and to write an SMF type 21 (volume error statistics) record.

### EREP Record Changes

Data is written to LOGREC for 3420s in OBR (Outboard Recorder) records. These records are still written for 3480s, but some of the data is different. The 24 byte header is the same as for 3420s except for:

- The device type value, which is the 3480 Full-Function value of X'78008080'.
- The sense byte count, which is 32 instead of 24.
- The SDR counters, which don't exist.

In the device dependent section, there are 32 bytes of sense data. The 3420 records contain volume error statistics. For the 3480, these fields are zeros, and the corresponding information is provided in Miscellaneous Data Recorder (MDR) records.

MDR records are not produced for 3420s. For the 3480, the standard 24 byte header has a device-id value of X'41'. The device dependent section contains the volume serial number, the blocksize, and 32 sense bytes of format 21 sense data. This contains the volume error and megabytes-transferred information.

MDR records will not be produced for 3480s that were opened but never read, or where fewer than 4K bytes are processed. For example, no records will be produced when a tape is labeled because fewer than 4K bytes of data are written in the labeling process.

For information on comparing error statistics between 3420s and 3480s, see "Comparing Reliability Data from 3420s and 3480s" on page 94.

### SMF Record Changes

The SMF Type 21 record provides volume error statistics for tape volumes. For the 3480, the device type will be the Full-Function value of X'78008080' and the density field will always show X'00'. The temporary read error field will contain the sum of the read forward and read backward errors. All other fields have the same meaning as for 3420s. The record length is unchanged.

### Open/Close Processing for Fast Positioning

Changes were made to Open and Close to support a fast positioning option. At OPEN, you can provide a BLOCK-ID value in the JFCB for the file you wish to open. The tape will be positioned to that BLOCK-ID value by OPEN. The value must be for a HDR1 label or tape mark, or the job will ABEND.

When the file is closed, the value of the BLOCK-ID for the next tape mark or label record will be provided. This can be stored for later use. See the *User's Reference* manual for more information.

### Close-time Block Count Checking

Changes were also made to OPEN and CLOSE to take advantage of the BLOCK-IDs on 3480 tapes. During OPEN processing, a NOTE macro is issued and the BLOCK-ID value is stored. At CLOSE time, another NOTE is issued. The two BLOCK-ID values are subtracted and compared with the DCB Block Count value. If the values are different, the job ABENDs. This change will allow the user to know that blocks are missing from the tape at create time instead of when the tape is read. This change is available as APARs.

### Allocation Changes

Several changes have been made to MVS allocation to make migration to 3480s easier.

The first one allows 3420s and 3480s to be concatenated. The operating system previously treated the devices as unlike device types. Without these changes, you would have to set the unlike device type bit for the dataset and do a substantial amount of processing on your own. The concatenated files may be in any order (3480 first, or 3420 first) and may switch back and forth between device types. Normal restrictions for concatenation apply.

Changes were made to two areas of Generation Data Group processing. You can now mix device types within the GDG, and can use the GDG(ALL) method of retrieving the members of the dataset. Allocation will allocate the requested number of units of the type for the first generation (as specified in the UNIT parameter.) Subsequent generations will be mounted on the same device, until the device type changes. When this happens, the requested number of the new device type will be allocated, and the processing will continue. This should greatly improve your ability to migrate without having to copy the generations in a GDG that are on 3420s.

The other GDG change is an extension of the first. In the example below, two DD statements are concatenated. Both DDs define GDGs, and both use the GDG(ALL) retrieval method. The second one has a unit affinity request to the first. Without the allocation change, the second statement would not affinity properly to the drives allocated to the first DD statement if the GDGs contained mixed device types.

```
//GDG1    DD    DSN=GDG1,DISP=OLD
//        DD    DSN=GDG2,UNIT=AFF=GDG1
```

With these changes, the second DD statement's unit affinity request will be honored and processed correctly.

These changes are available as APARs.

# VM Support

VM Support of the 3480s is a subset of the MVS Full-Function support of the 3480s and a superset of MVS 3420 Code-Compatibility support.

## VM/SP Support of the 3480

VM/SP Release 4 includes native VM support for the 3480. In this release:

- the 3480 can be defined in DMKRIO as a 3480
- the 3480 can be used by CP/CMS
- Guest Machines can use the 3480 in Code-Compatibility mode
- DASD Dump/Restore (DDR) Utility support is available
- error recovery for CP and Diagnose 20 I/O is available
- CP ASSIGN and UNASSIGN support is available
- existing 3420 channel programs execute properly
- tape-write-immediate mode is available for CP/CMS

CP does not provide any level of virtual ASSIGN or UNASSIGN support for guest machines. If a guest issues any of the ASSIGN or UNASSIGN related CCWs, CP will force a Command Reject of the CCW.

A VM/SP R4 DMKRIO-defined 3480 that is ONLINE to CP will be ASSIGNed to CP and cannot be used in Full-Function mode by either a guest running under VM/SP Release 4, by another VM/SP Release 4 system, or by an MVS system that has this 3480 generated in Full-Function mode. MVS guests using DMKRIO-defined 3480s must have them SYSGENed in MVS as Code-Compatibility devices when running under VM/SP Release 4. However, the subsystem can be shared by an MVS Full-Function system and a VM/SP R4 DMKRIO-defined system. Multi-system sharing of a 3480 drive is not allowed because VM/SP Release 4 does not issue multi-system ASSIGNs.

When the 3480 is ATTACHed or DEDICATEd to a guest machine, that guest may:

- Issue commands to the display (VM/SP itself does not use the display)
- Issue high-speed search commands (VM/SP does not use high-speed search)
- Not issue Set Path Group ID related commands (SPGID, ASSIGN, UNASSIGN, etc.) This means that MVS guests must run in Code-Compatibility mode if VM is to know about and control the 3480s.

VM/SP Release 4 will issue the SPGID CCW to the control unit and establish the paths to the drives at IPL time and at VARY ONLINE. The Path Group ID (PGID) is made up of the CPU serial number, model number, and the IPL time-of-day Clock. Any SPGID CCW issued where the PGID does not match the one stored in the channel adapter will be command-rejected.

VM/SP Release 4 will ASSIGN all unassigned drives in the subsystem to itself. Guests can then use the drive(s) that have been ATTACHed or DEDICATEd to them by CP.

## Operation as an "Unsupported Device"

An MVS guest can access 3480s in Full-Function mode when the guest is running under VM/SP, VM/XA Migration Aid, or VM/XA SF systems that have the 3480s defined as "unsupported" device types to the VM system.

When defined to VM as an "unsupported device" in either DMKRIO or HCPRIO, the 3480 subsystem can be used by an MVS guest in either Code-Compatibility or Full-Function mode. When 3480s are defined to VM as unsupported devices they cannot be used by CP/CMS.

Prior to a 3480 drive in Full-Function mode being ASSIGNed to an operating system, the SET PATH GROUP ID (SPGID) command is executed over all channel paths from the operating system CPU to that drive. Only one Path Group ID can be associated with a channel adapter. Path Group IDs are unique to each IPL'ed operating system.

The PGID in the 3480 channel adapter is reset ONLY by

- a System Reset
- a 3480 control unit power-on sequence
- a channel interface disable-enable sequence
- the use of the IBM Customer Engineering Maintenance Device (MD)

Until the channel adapter is reset, all subsequent PGID-related I/Os over that channel adapter MUST have the same PGID as the one that established the PGID.

Guests running under VM/XA Migration Aid or MV/XA SF have no control over which channel adapter will be used to establish the PGID in the channel adapter. Therefore, two guests cannot simultaneously access the same 3480 subsystem as Full-Function devices. Different SPGIDs would be issued over the same channel adapters without a reset of the PGID associated with the channel adapters. In addition, even if the first guest UNASSIGNs all the drives, a second guest could not ASSIGN them until the 3480 channel adapter is reset by one of the methods mentioned above.

Because the devices are defined as "unsupported", VM will treat them as it would any "unsupported" device and use the CLASS= parameter to decide how to translate the CCWs issued by the guest to this device. If the guest is accessing the devices in MVS Code-Compatibility, then the CCWs issued are similar to those issued to a 3420 tape drive. If the guest is accessing the devices in MVS Full-Function mode, then the PGID and ASSIGN related CCWs are also issued to the 3480 subsystem. VM/SP and VM/XA do not treat the PGID and ASSIGN related CCWS in the same manner; you should consult the latest documentation to decide what to code for the CLASS= parameter. As of this writing, VM/SP systems should use CLASS=URO while VM/XA systems can use CLASS=TAPE, PRT, or CTCA.

## MVS Guests in Full-Function Mode

- Operating the 3480 under any VM/SP product in Full-Function mode either 1) when defined in DMKRIO as an "unsupported" device, or 2) when dedicated to a Preferred MVS Guest requires that the following operational considerations be observed:

  - Only one guest can access the 3480 subsystem on a given channel path.
  - The guest may issue PGID, ASSIGN, and UNASSIGN CCWs.
  - When the guest has completed use of the subsystem, the 3480 operator must **manually** generate a reset for the channel path by disabling and enabling the channel adapter at the 3480 A22.
  - The guest MVS operator should issue a #CP RESET command for each drive **before** the drive is returned to VM and before issuing a #CP DETACH command for the drive.

  If the above sequence is followed, the drive may then be attached to another guest machine.

- Operating the 3480 under any VM/XA product in Full-Function mode when defined in DMKRIO as an "unsupported" device requires that the following operational considerations be observed:

  - Any MVS/SP guest must have only one physical path to a given drive.
  - Multiple MVS/XA guests can access a subsystem concurrently over the same channel(s) if MVS/XA has the dynamic pathing PTFs installed This assumes all drives have been grouped by the first guest.
  - The guest may issue PGID, ASSIGN, and UNASSIGN CCWs.
  - The guest MVS operator should issue a #CP RESET command for each drive **before** the drive is returned to VM and before issuing a #CP DETACH command for the drive.

If the above sequence is followed, the drive may then be ATTACHed to another guest machine.

## MVS Guests in Code-Compatibility Mode

For VM/SP release 4, MVS guests may use 3480s as described in "VM/SP Support of the 3480" on page 64. For earlier releases of VM/SP, and for users of the other VM products, the following operational procedure must be followed if the MVS guest is running in CC mode:

- The VM console operator must ensure that each drive is ATTACHed and online to only one host/guest at a time. Since there are no PGID or ASSIGN commands in CC mode, this checking must be done manually.

- The guest MVS operator should issue a #CP RESET command for each drive **before** the drive is relinquished to VM and before issuing a #CP DETACH command for the drive.

If the above sequence is followed, the drive may be ATTACHed to another guest machine. The manual channel reset is not necessary if the guest is in CC mode

because no path group or drive assignment information has been passed to the control unit.

## Operation by a Preferred Guest

You may want to run a Preferred MVS guest that accesses the 3480s in FF mode while running under VM/SP 4. To do this, the MVS guest must run under the High Performance Option (HPO) as a preferred guest, and the 3480 channel must be a preferred channel. Since VM doesn't know about this channel, and doesn't intercept any I/O to it, Full-Function commands can be issued.

## VSE Guests

These considerations are the same as the MVS Code-Compatibility Guests because VSE support does not include PGID or ASSIGN CCWs.

### VSE Guest on VM/SP Release That Supports 3480s

A 3480 drive cannot be accessed by CP and CMS and VSE/SP concurrently, only one operating system can access a drive at one time.

If you plan to have VM use some of the drives in the subsystem at the same time as VSE is using other drives in the subsystem, then you need to have VSE/SP Version 2.1.3 or later as the guest running under VM/SP Release 4 or later.

When 3480s are accessed by a guest under VM/SP Release 4 or later and they are defined in DMKRIO as 3480s, then the EREP information is logged to VM's CPEREP file - this includes VSE guests using the 3480s.

Make sure that you specify the full 16 address range in your VM and, if appropriate, in your IOCP.

### VSE Guest on VM/SP Release That Does Not Support 3480s

This section is applicable only if your VSE/SP system is a guest running under a VM which either does not support the 3480s as a valid device type, or the 3480s are defined to VM as an "unsupported device" type.

VM releases prior to Release 4, VM/XA Migration Aid, and VM/XA SF Release 1 do not recognize 3480 as a valid device type, i.e. 3480s are "unsupported devices" in these VM systems. Additionally, VM/SP Release 4 or later systems could define the 3480s as "unsupported devices" by not coding DEVTYPE=3480 in DMKRIO. When the 3480s are defined to VM as an unsupported device they cannot be used by CP or CMS.

Even when defined to VM as an "unsupported device", the 3480 subsystem can be used by a VSE/SP Release 2.1.3 or later guest. In this situation, EREP recording for the 3480s is logged to the VSE EREP file.

VM intercepts and translates CCWs issued by guest operating systems. When the device is an "unsupported device" type to VM, then VM uses the CLASS= parameter to decide how to translate the CCWs issued by the guest to this device

type. We have found that though VSE does not issue the SPGID, ASSIGN or UNASSIGN CCWs, it does, at times, issue the MODE SET CCW (DB) and VM/SP does not transfer the one byte that the 3480 expects to receive. Therefore, the VM DMKRIO definition should specify the "unsupported device" with CLASS=URO which will result in the one byte being transferred to the 3480 control unit.

If the drives are not ATTACHed to the VSE system when the VSE system is IPLed and the VSE system is a guest under a VM system where the 3480s are defined as unsupported devices, then you should use the EML parameter on the ADD card. The EML parameter will cause VSE not to change the device type to FF after VSE does a SENSEID CCW; instead it instructs VSE that this is a 3480 and to treat it as a 3480. Sample coding follows:

```
ADD CUU,3480,EML
```

# VSE/SP 3480 Support

VSE/SP support of the 3480s is provided in VSE/SP Version 2.1.3 and later. This level of VSE provides the same type of support as in MVS 3420 Code-Compatibility support in that it includes 3420-related CCWs, but does **not** provide:

- use of the display pod for VSE messages or display of the VOLSER
- support for high-speed locate
- support for SPGID related CCWs: no ASSIGN and UNASSIGN support

*Note:* **The verb ASSIGN is not the VSE/SP ASSGN function, but rather the 3480 ASSIGN and UNASSIGN function to connect a drive logically to channel path(s).**

The number of sense bytes for IBM 3480 Magnetic Tape Subsystem devices is 32 instead of the 24 sense bytes for 3420 tape devices. This support is the major portion of the changes added to VSE/SP for the 3480s. Planning considerations for 3480s in VSE environments can be the same as those in an MVS Code-Compatibility (CC) environment. Of course, there are differences between MVS and VSE planning and installing, and we will point these out when appropriate.

## VSE and 3480 Rewind-Unload

During the recent 3480 Model 11 ESP, the VSE utilities that were used by the ESP accounts supported the 3480s. However, some of these VSE utilities do not rewind and unload the cartridge at completion. This caused some operator-induced errors at the VSE ESP accounts. VSE operators are use to unloading tapes manually at the completion of the utilities. Doing this on the 3480s can cause a deferred unit check that causes an error on the next I/O to that drive. See "Use of the 3480 REWIND Switch" on page 93 for a more complete description of the 3480 deferred unit check.

We recommend that instead of pressing the REWIND and UNLOAD switches on the 3480 operator panel, the operator should issue a console command to unload the cartridge. The ESP customers used the MTC command to accomplish the desired results. The problem is that the operator may not be able to issue the command within the job which did not unload the cartridge. The operator may have to release a job containing the VSE Job Control PAUSE command before issuing the MTC command.

The best recommendation is to perform the above functions (release a PAUSE job and at the prompt, issue an MTC RUN command to the drive) if when a job is run, the cartridge is not unloaded. Then, modify the original job by inserting a "// MTC RUN,SYSxxx" command in the job so the problem will not happen again.

The operator should be instructed never to use the REWIND or UNLOAD switches on the 3480 operator panel unless specifically directed to by the error recovery procedures in the *Operator's Manual.*

## Using DITTO under VSE

One VSE ESP customer had problems when using DITTO to copy his production 3480 output tape for disaster recovery procedures while in the conversion phase (in case they needed to go to their backup location which did not have 3480s). The production tapes had standard labels, and when DITTO was used to copy the 3480 cartridge, it resulted in multiple reel output to contain the same file. Unfortunately, at the end of the second output reel, they encountered data checks because the second reel did not have a label. They used IDCAMS REPRO to copy the contents of the production cartridge successfully to multiple reels with standard labels.

## VSE/SP System Installation

In VSE/SP systems, installation of 3480s is accomplished by the use of ADD statements and // ASSGN statements. At system IPL time, VSE/SP will recognize the devices and they will be ready for use by your application programs. Examples of coding for these are:

```
ADD CUU,3480
// ASSGN SYSxxx,CUU
```

There are variations of these if the VSE system is a guest under VM. See "VSE Guests" on page 67 for more information.

VSE customers should know that much of the documentation currently available deals with MVS Full-Function use of 3480s. This includes the Operator Training video, which was highly recommended by the A11/B11 VSE/SP Early Support Program (ESP) customers. This video shows many MVS Full-Function messages on the operator display pod that are not displayed in a VSE environment, such as MOUNT, KEEP, and VOLSER.

Hardware-initiated messages such as:

- READY
- NT RDY
- REWINDNG
- UNLOADNG
- LOCATING
- CLEAN
- *

and the hardware error messages (CHK xy) are shown in the tape for Full-Function and Code-Compatibility systems, as well as for VSE/SP.

VSE/SP 3480 users can elect to have the 3480 subsystem write in tape-write-immediate (TWI) mode. We do not recommend that customers do this because of the performance degradation. See "Tape Write Immediate" on page 6 for more information on the TWI mode of writing.

The write default mode setting for 3480s in VSE/SP systems is specified on the ADD statement. bThe ASSGN statement is where the default mode is overridden. Therefore, to use tape-write-immediate mode, use

```
ADD CUU,3480,mm
// ASSGN SYSxxx,CUU,mm
```

where mm is either 00 (normal buffered mode) or 20 (tape write immediate mode).

You should contact all vendors of any OEM software packages to ensure that you have versions of those packages which will work with 3480s.

No matter how many drives are physically installed, all 16 Unshared UCWs must be defined for each 3480 control unit. However, only those drives physically present need to be included in your VSE IPL ADD statements.

An equivalent SYNCDEV function is available in VSE systems by specifying SYN on the CONTRL macro.

The *VSE/SP Hardware and System Support Extensions*, SC33-6184, manual contains useful information for successful planning and installation of 3480s in a VSE environment.

The *VSE/SP Hardware and System Support Extensions* manual, SC33-6184, p. 24, states that the use of generic assignments for TAPE does not select an available 3480. You may, therefore, either change your tape assignments to include an actual 3480 address (cuu) or change your generic assignments to specify 3480 so that a 3480 drive will be selected.

## Automatic Cartridge Loader (ACL) with VSE

There is a feature available for 3480 drives which automatically loads cartridges into the 3480 drives. This feature is called the Automatic Cartridge Loader (ACL) and is discussed in more detail in "3480 Automatic Cartridge Loader (ACL) Feature" on page 15. There is no explicit support for the ACL in VSE/SP systems, but ACLs can be installed on 3480s controlled by VSE systems that support 3480s.

If you install ACLs on the 3480s in a VSE environment, you must set the ACL mode to either AUTO or MANUAL. SYSTEM mode is not available in VSE because there is no software support for ACLs in VSE systems. Manual mode doesn't buy you much more than the normal 3480. AUTO mode will continue to load cartridges when you finish with the last one.

## Sharing a 3480 Subsystem - VSE Considerations

### Overview

Because VSE does not issue ASSIGN and UNASSIGN CCWs, the 3480 subsystem cannot dedicate a 3480 to a VSE host. If the 3480 subsystem is being shared by two operating systems either in two different CPUs or in the same CPU, it is the operator's responsibility to ensure that a drive being used by VSE is not simultaneously accessed by the other operating system.

### 3480 Shared Between Full-Function (FF) MVS and VSE

A Full-Function MVS system can issue the ASSIGN CCW and get exclusive use of a 3480 drive. The ASSIGN CCW prevents the VSE system from accessing the same drive simultaneously.

Conversely, an MVS FF system in another CPU can steal a drive from a VSE system that is using the drive because VSE does not issue the ASSIGN CCWs. If the operating system in the other CPU is either VSE or MVS CC, then that system could think that it owns the drive and use it. In this case the results are unpredictable and definitely not pleasant.

### 3480 Shared Between Multiple VM Guests

VM systems control guest access by the use of the CP ATTACH command which prohibits two guests from accessing the same drive simultaneously.

Two VSE guests running under a single VM system can share a string of 3480s. The operational considerations will be the same as if the 3480s were 3420s. The CP operator does the "allocation" of the drives to the guests with either the ATTACH or DEDICATE command.

## 3480 Performance in a VSE Environment

Data transfer rates as quoted in announcement letters are instantaneous data rates. That is, the speed at which a byte is transferred from the CPU to the tape when both are ready for the transfer. The maximum effective data rate of a tape is a function of the size of the block of data to be read or written, the size of the Inter-Block Gap (IBG), the recording density of the tape, and the speed at which tape passes the read/write head of the tape drive.

In order to determine what performance improvements, if any, a faster tape will provide, it is necessary to understand what part of a job's elapsed time is reduced by a faster tape.

If we picture a job as using three resources: CPU, other I/O, and tape I/O, we can understand what part of the job's elapsed time will be reduced with faster tapes. Because faster tape drives do not increase the CPU speed or the speed of the other I/O devices, we would expect performance improvements with the faster tapes only when the CPU is waiting exclusively for the tapes with no other work to do. This time is called non-overlapped tape I/O time. The amount of non-overlapped tape I/O time defines and sets an upper limit to the **maximum** amount of elapsed-time improvement for a job due to a faster tape drive.

If a job could be found that was 100% non-overlapped tape I/O and this job could be run on 3420-6, 3420-8, and 3480-22, we could calculate, using an instantaneous data rate, that such a job would run 58.3% faster on the 3480-22 than on the 3420-8 and 74.2% faster on the 3480-22 than on the 3420-6. If a job had no non-overlapped tape I/O, then we would expect no improvement with a faster tape. In actuality, no jobs have 100% non-overlapped tape I/O - there is always some CPU time used - and some jobs have little non-overlapped tape I/O.

Therefore, you would expect to have an overall throughput improvement commensurate with the following formula. Multiply the percent faster the new drive is times the percent non-overlapped tape I/O that you have in the shop minus some percent for contention between tape jobs for the tape resource. It would not be realistic to expect a 74.2% improvement in your non-overlapped tape I/O for all your jobs when replacing 3420-6s with 3480-22s because of contention by the jobs on the tape subsystem.

Another consideration is channel contention when the drives being used are on the same channel. When the input and output devices are on separate channels the effective data rate for the job would approach the instantaneous data rate of the slower device assuming the job had 100% non-overlapped tape I/O.

A factor affecting the 3480 effective data rate is the drive back-hitch. Although the 3480 is a buffered device, it is still a streaming device and its performance is affected if data is not presented to it in time to avoid back-hitching.

We published a technical bulletin, *IBM 3480 Tape Subsystem: Performance Considerations*, GG22-9335, which should be reviewed by 3480 customers. While this data was measured on MVS systems, the concepts apply to all systems.

The IBM Mid-Range Performance Evaluation Center recently completed a performance study of VSE/SP, VM/SP, 3420s, and 3480 tape subsystems. The

results of this study will be available in *Tape Subsystem Performance Measurements in VSE/SP and VM/SP Environments*, G360-1025.

# Chapter 5. 3480 A22/B22 Early Support Program Experiences

An extensive Early Support Program was conducted for the 3480 Model 22 subsystem. This chapter will discuss the general objectives and results of the program. Even though this chapter discusses the 3480 A/B Model 22 ESP, most of the information applies to Model 11s also.

## Purpose of the ESP

When IBM undertakes an ESP, we have a specific set of objectives in mind. The 3480 ESP was no exception. We wanted to accomplish the following:

- Determine the 3480's installability in production environments in customer installations. No matter how much testing IBM does, we can't stress a product like a customer does. Every environment and combination of connections and applications is different and an ESP is often the best way to evaluate complex combinations.
- Determine the supporting software's installability.
- Evaluate different migration techniques. Left to their own devices, the ESP participants approached the migration from many different angles and developed different methods of implementing the 3480.
- Operate in different industry environments. We attempted to select sites from a range of industry groupings to determine the 3480's applicability to different industries.
- Gather actual performance data. Each ESP participant was asked to prepare a series of "typical" tape jobs for benchmarks in the old hardware environment and with the 3480s.
- Use non-IBM software. There are many products on the market that deal with tape in one form or another.
- Evaluate supporting furniture. The 3480 ESP was the first ESP to include furniture. As a result, several changes were made to IBM's Cartridge System Library products that support the 3480 media.
- Develop skills transfer materials. The things we learned in the ESP are passed on in manuals such as this one.
- Confirm our product objectives for drive cleaning and reliability.

The environments we wanted to test were combinations of several different factors:

- We included both MVS/370 and MVS/XA. In some cases, both were in the same installation and shared the 3480s.
- We wanted both JES2 and JES3 sites.
- We selected some sites to install in Code-Compatibility (CC) mode and some in Full-Function mode (FF). During the ESP, some of the CC customers converted to FF.
- We had a variety of processors, including 3033, 3081, 3083, 3084 (both partitioned and single image), 4341, and 4381 processors. In some sites, the 3480 subsystem was connected to a single processor; in others, it was attached to multiple processors.
- Since the 3480 can process data from multiple-speed channels, we wanted 3480s attached to various channel combinations during the ESP.
- Some customer operations describe themselves as traditional batch shops. Others are mostly on-line processing. We wanted both types of installations, as well as some data servicers and combinations.
- We wanted a variety of IBM and non-IBM software packages.

Armed with this set of objectives, we set out to select our sites, plan for the 3480 installations, install, and monitor the process.

## ESP Results

In general terms, the ESP experiences exceeded our objectives. We found the 3480 easier to install than we had expected. The 3480's performance was, generally, as expected. We learned that care should be used in setting performance expectations for jobs, and we have documented this in *3480 Performance Considerations, GG22-9335.*

We processed well over the equivalent of 400,000 full cartridges of data during the ESP (that is over 80 million megabytes of data) and significantly exceeded our reliability objective of one permanent error per 1 trillion bytes read.

## Installation Planning

Each of the ESP customers had to build an installation plan. It included a hardware quantity plan and schedule, an application conversion method and schedule, test plans, etc. We have developed a general plan from the ESP plans. It has four main parts:

- Plan Development Phase

- Pre-Installation Phase
- Installation Phase
- Conversion Phase

We will look at each phase and discuss what is in them.

Besides this section, you should use *IBM 3480 Magnetic Tape Subsystem Planning and Migration Guide, GC35-0098* for help in developing your migration plan.

## Plan Development Phase

This phase comes first, and during it you will gather information and develop the plan for the rest of the installation. Our ESP experiences show us that this phase should take roughly two or three weeks to complete. This will depend, of course, on the size and complexity of your shop and other things that are happening at the time this plan is being developed.

To build a plan, you need to gather information about the operation of your shop and tape's place in it. Our ESP accounts found this information in a variety of places and through many methods. Your tape library, and any associated controlling software, contains much of the raw information. Use of some general purpose statistical processing software can greatly assist you in understanding the characteristics of your library.

You need to gather information about the size and volatility of your library. How much of it "turns over" in a fixed period of time? You will probably find that the majority of your tape datasets exist for 45 to 60 days, and that the rest have much longer retention periods. How quickly you library turns over will help you decide what percentage of your production library can be converted and in what time period.

In addition to looking in your tape library software, you can analyze SMF data about tape, including dataset CLOSE records and tape error statistics records. You can also examine job JCL and documentation.

You may have difficulty finding all of your job decks. If your users control their own JCL, they may have it stored in places that you don't have control over or access to. This will make it difficult for you to be sure that you have seen everything you want to see while developing your plan.

Once you have gathered the information, you need to determine which migration approach to use. We have seen several.

- Migrate by application.

  This was one of the most popular in the ESP. It is most useful when the jobs associated with a particular application have files that do not extend into other systems. In other words, the application is somewhat self-contained. It allows you to convert that application to 3480s without impacting other applications.

- Migrate by application group.

  This is similar to migration by application, but is broader in scope. When there are a group of related applications separate from other applications or application groups, you can convert them one group at a time. This is a bigger bite to take, but works just as well.

- Migration by file.

  When applications intersect quite a bit, or when a given application or application group is too large to convert comfortably at one time, you may want to consider converting a file at a time. You need to know where that file is created and where it is used. This is useful where you have large files that you wish to convert early because their conversion payback is desirable.

- Migration by User Group.

  When operations does not control job submission, it may be desirable to convert one user group at a time. Each group has responsibility for their own job decks and files and for submission of their work. This method requires that you work with each group to give them the 3480-related information that they will need to know to convert.

- Migration "All at Once".

  While this sounds difficult, and made us quite nervous when we heard that one of the ESP accounts wanted to try it, it is really the easiest way to migrate. All that is needed are enough drives and media to support all of your production work, and standards that require that users catalog all output tapes. They must specify UNIT parameters when the tapes are created, using the catalog for all other references. You implement the 3480 by changing the esoteric UNIT name to point from 3420s to 3480s, thereby creating all new tape files on the 3480. This change is done through an EDT SYSGEN.

You don't need to limit yourselves to any one of these methods. You can use a combination of any of them, and we have seen all of these approaches work. If you feel comfortable with the method(s) you have chosen, and think you have enough data about your operation to build a plan, then you are probably ready to start the pre-installation phase.

## Pre-Installation Phase

This part of the conversion includes the things you need to do before you can begin installing hardware or software. During the ESP, we found that this phase lasted roughly six weeks.

- Conversion Selection

  You will need to select the applications or files you will convert first, second, etc. You need to consider the following items when you make this selection:

- What is the potential benefit? Many ESP sites picked the applications or files with the largest potential benefit as early candidates for conversion. You should consider the need for reliability improvements or for increased speed in making this determination. Applications that fit a processing window tightly make good candidates, especially if the 3480 can help reduce the scheduled run time, either through reducing the execution time, or by reducing need to schedule time for reruns caused by tape-related errors. You should be conservative in your planning.

  If you are looking for reduced run times, you must be sure that your expectations are valid. Many jobs appear tape bound, but our ESP experience shows us that there are very few truly tape bound jobs. For a discussion of the things to look for and for a methodology for determining the potential improvement for your job, see *3480 Performance Considerations, GG22-9335*. Remember that the improvement methodology in this bulletin applies to the Model 22 3480s. Because of the slower data transfer speed between buffer and drive, performance improvements for the Model 11 Subsystem may be somewhat less than those of the Model 22 Subsystem.

- How sensitive is the application? Although you should not expect anything to go wrong, you should plan for it. Your most visible applications are probably not good candidates for early conversion. Until you are comfortable with the 3480 and with your conversion progress and the validity of your plan, you should stay away from very sensitive applications.

- How many volumes does the candidate use? You need to know how many cycles of the dataset are kept and for how long. Will you have enough tapes on hand to make it through all of the cycles? If not, you can postpone the conversion of this application or file, or get more tapes. You will probably want to convert as much of your library as quickly as possible.

- How much control do you have over the application? Until you are comfortable with the drive and your plans, you should plan to convert easily controlled jobs. These usually include DASD backups, as operations usually schedules and controls these runs. They use many volumes, and usually take quite a bit of time. Converting these first will give you a good opportunity to get used to the 3480. The sensitivity of the application is rather low. Once you are comfortable, you can begin to convert things that you have less control over.

- Physical Planning

  When the 3480s are installed, you will have the opportunity to rearrange your tape library. Many of our ESP sites combined their libraries and drives to reduce the travel time for the operators and mount time. Be sure to check your local fire regulations to see if having the drives and the cartridges in the same room is acceptable. The space savings in both the library and the drive area can be substantial.

- Cartridge labels.

There are two label areas on the cartridge that you will need to concern yourselves with. The spine of the cartridge has an indentation for a volume serial label. The size is 10 mm by 80 mm. The cartridges are stored vertically in a rack, so your label should be readable when the cartridge is in that position.

The area on top of the cartridge is used for a contents label. Its size is 75 mm by 80 mm. If you use "moon" labels today, you will probably need to change to a different sized label since most moon labels are too large.

You should also use caution when selecting your labels to be sure that you pick ones that will stick. IBM has a recommended set of adhesives for permanent labels. Your labels should either be on paper stock that uses one of these adhesives, or an equivalent adhesive. Contact you IBM supplies representative for more information.

## Installation Phase

This part of the project can overlap somewhat with the pre-install phase. It is divided into two major parts; software and hardware. For more information on things to consider, see Chapter 6, "Installation Information."

### Software

The duration of this part of the installation will depend on your current software release and maintenance levels as well as the number of non-IBM products you will have to update.

- Level Determination. You must determine the proper software release levels for VSE/SP, VM, MVS/SP, DFP, JES2 or JES3. See "MVS Software Requirements" on page 55. for more information on the required levels. You must then install the appropriate software releases.

- Maintenance Determination. Several PTFs were developed as the result of our ESP experiences. Some of them correct problems and some of them provide new or changed function for the 3480. In general, the more current you are, the better off you will be.

- Stabilization. Once you have installed the proper releases and necessary maintenance, you should test and stabilize your software. Our ESP experiences found that the software was rather stable, but that the installation tasks, especially for DFP, were not trivial.

- CC or FF? With the software installed, you are ready to perform your SYSGEN and select Code-Compatibility mode or Full-Function mode. Remember that they are mutually exclusive in the same SYSGEN and that there are no hardware differences.

  You may share drives between CC and FF systems, but you must take operational precautions similar to those you take today without ASSIGN and UNASSIGN protection.

- JCL conversion

You may be able to change some of your JCL early. If you plan to make the 3480s accessible to users through a new esoteric unit name, or the 3480 generic, you can change your JCL procedures early to make the UNIT value symbolic. It can default to the old 3420 value now and can be easily changed to the new 3480 value by changing one symbolic instead of multiple DD statements per procedure. Although the amount of change is the same, it is easier to do it before the drives come in, when you may have more time, than it is when you are looking at a production schedule deadline.

- Program examination. You will need to look at several types of programs for possible modification. They will be discussed in "Programs to Review" on page 95.

**Hardware**

The second part of the installation phase deals with actual installation of the hardware. You should consider the following while planning this part of the installation.

- Hardware EC requirements. There are some prerequisite Engineering Changes (ECs) required for certain CPU-3480 combinations. These requirements should be researched and the necessary ECs installed.

- Actual installation. The actual installation of the 3480 is relatively simple and takes roughly four hours per 2 by 16 subsystem. This includes some system test time using OLTEP.

- Functional Testing. Once the hardware has been installed and turned over to you by the customer engineer, you will probably want to determine that the 3480 is working as it should. You should plan a few test jobs that will functionally test the subsystem. This will probably start with some cartridge initializations, and may include tests of VARY commands, verification of performance and overall throughput, and some other general things you might want to see.

- Operator Training. Before you go much further, we recommend you train the 3480 operators. Before the hands-on training that happens during the functional testing of the 3480, the operators should watch the 3480 Operator Training videotape. This videotape demonstrates how to load, unload, and operate the 3480s. The Operator Training Videotape is available in VHS 3/4" as SV38-0284, and for VHS 1/2" as SV38-0283.

  The *3480 Magnetic Tape Subsystem Operator's Guide*, GA32-0066, is a thorough description of the operator's tasks. **It should be read by every operator that will use the 3480, and a current copy should be available near the drives.**

- Cartridge initialization. Once the operators are trained, they should begin initializing cartridges. Plan on initializing 3 to 4 cartridges per minute.

- Cleaning procedures. Specific new cleaning procedures and schedules will need to be developed. The 3480 is much easier to clean, and needs to be cleaned less often than the 3420. We suggest you begin by cleaning each

drive once a week, and clean any drive when the CLEAN message appears on the display pod.

## Conversion Phase

Once you have tested the drives and are comfortable with their stability, you are ready to begin converting. This phase should be rather orderly and should follow the conversion plan that you developed. You should go as fast as your "comfort level" permits, being sure that you have enough drives and tape cartridges on hand to allow the conversion to proceed.

As you might expect, the ESP experience shows that the duration of this phase will depend on how many applications and files you convert and how many you do at a time.

# Chapter 6. Installation Information

Since we began working with the 3480 at the Washington Systems Center, we have accumulated quite a bit of information that we feel will be useful in installation planning. This chapter will discuss some of this information. We have grouped it under several headings:

- Operational
- Configuration
- Hardware
- Software
- Performance

## Operational Considerations

Tape operators have been using the same type of equipment for many years, and they are used to it. In most locations, tape operations have become rather routine. Now that the 3480 has arrived, the tape operator needs to learn some new and different operational procedures. Proper operator training is one of the most critical steps in a successful 3480 installation.

### Operator Training

All of the installation's operators should be trained on the 3480 early in the install process. This training should include care and handling of the cartridge, proper operation of the drive, and recovery procedures.

While most of this information is available in the *IBM 3480 Tape Subsystem: Operator's Guide*, GA32-0066, some areas need special emphasis.

Our experience has shown that installations that have trained their operators to run the 3480 in a "hands-off" mode have had the fewest problem. This means that the operators are trained to leave the switches on the 3480 alone. They mount tapes when requested and let the system unload the tapes when it is done with them.

The *IBM 3480 Tape Subsystem: Operator's Guide*, GA32-0066, contains details on recovering from error situations or problems. The recovery procedures should be followed carefully. The 3480 is a microcoded device, unlike its predecessor, and has some intelligence. If the operators take a guess instead of following the proper procedure, they may turn a recoverable situation into an ABEND for the job.

## Drive Assignment Considerations

In multi-CPU machine rooms, tapes are often shared between two or more independent processors. Unlike DASD, "sharing" of tapes does not normally mean concurrent use of a single drive by more than one job. Instead, it means that there are multiple data paths from different processors to the same string of tape units, so that different tape drives within that string may be used by different processors at the same time.

At any given time, a single tape drive may normally be used by only one job (processor). At the end of a job or shift, the operator may discontinue the use of this drive for this processor and allow its use by another processor. One of the problems with this operational method is the prevention of inadvertent concurrent access to a drive from more than one processor. There are several ways to solve this problem:

- Device Management by JES3

  For all processors running in a JES3 complex, JES3 is always aware of the tape drive's usage and will not allow more than one job to use a drive at any time.

- Manual Switches

  Operators could use the hardware switches that were available on pre-3480 devices to enable or disable the hardware paths at the drive level. The operator could physically restrict access to a certain device from a specific processor.

- VARY command

  The operator VARY command may also be used to control device usage. It works at the operating system interface level. Every tape drive must be offline to all but one processor to prevent concurrent access.

All but the JES3 approach are subject to human error. Such errors can cause data loss, job ABEND, or both.

The 3480's ASSIGN Facility was designed to help with this problem. The control unit microcode interacts with the connected processors to coordinate 3480 use in multi-CPU environments. The ASSIGN Facility consists of a set of channel commands that perform the following tasks:

- SET PATH GROUP ID

  Identifies all channels that make up a "path group" from a specific processor leading to a specific 3480 drive. This function is usually performed during system initialization and at VARY ONLINE processing time.

- ASSIGN

Allow access to a 3480 from that processor's path group. After the first processor has ASSIGN'ed a 3480, no other processor can access it. A device that is available to only one processor is said to be "single system assigned".

If more than one processor needs access to a device concurrently, a subsequent concurrent assignment can be established by a different processor by using a common access password and the CONTROL ACCESS command.

- CONTROL ACCESS

  Establishes an access password for a currently assigned device. The password is established by the first processor to assign the device and is repeated by all processors who subsequently need concurrent assignment. A device that is available to more than one processor through use of this command is said to be "multi-system assigned". A JES3 complex with JES3-managed 3480s uses this type of assignment.

- UNASSIGN

  Releases the assignment of a 3480 to allow assignment to a different processor. Optionally, UNASSIGN can disband the entire path group.

The MVS implementation of the ASSIGN facility is synchronized with the ONLINE and OFFLINE status of the device. In Full-Function mode, after the system is initialized, a device is assigned as long as it is online, and is unassigned as long as it is offline. The ASSIGN facility is not available in Code-Compatibility mode; all 3480s are logically available to all systems. The third control method (the VARY command) described above must be used.

**Path Group Initialization**

All MVS processing for path group initialization and path group maintenance is identical for all devices that support path groups, namely 3380s and 3480s. The device's ability to honor path groups is determined by the setting of a bit in the UCB for the device.

During MVS initialization, all 3480 devices that are SYSGEN'ed to come up online are checked by issuing a NOP command across all paths to the devices. If at least one path responds successfully, the device is marked ONLINE.

Next, Master Scheduler Initialization will issue a SET PATH GROUP ID command on every one of the device's paths to establish the path group. The 11 byte Path Group ID, created by MVS, is made up of the CPU serial number, model number, and a time stamp.

If a device is offline, either because no paths were available, or because it was SYSGEN'ed OFFLINE, the path group will not be initialized at this time.

Path Group initialization will also be performed when a VARY ONLINE command is issued.

### Initial Assignment for JES2

Any tape device whose allocation is not managed by some software (such as JES3), should normally be online (and assigned) to only one processor at a time.

At JES2 initialization time, a call will be made to a special MVS service routine (IEFAUINT). This routine will issue ASSIGN commands for all online 3480s. If the assignment fails for a particular 3480, the 3480 will be marked OFFLINE. If the assignment is successful, the RESERVED bit will be turned on in the UCB for the device. This service is only performed by certain levels of JES2. See "JES2 Requirements" on page 56 for more information.

### Initial Assignment for JES3

Any tape device that will be managed by JES3 should normally be online (and assigned) to all processors within the JES3 complex. It must not be online to any processors outside of the JES3 complex.

When JES3 is initialized, the Main Device Scheduling component of JES3 will invoke IEFAUINT for every online, JES3-managed 3480 to establish multi-system assignment. In addition, IEFAUINT is invoked again to assign all online, non-JES3 managed 3480s to the processor in the same fashion as they are assigned in JES2.

The 11 byte CONTROL ACCESS password for the multi-system assignment of the JES3 managed 3480s is created by the JES3 global processor when a cold start is performed. It is saved on SPOOL and is retrieved at every JES3 non-cold start and stored in the MVS nucleus. This password will be different from the one MVS uses for multi-system assignment of non-JES3 managed 3480's.

### VARY Processing

The MVS VARY command will cause path group initialization and assignment to occur.

If the 3480 is currently online (and, therefore, assigned) to a different processor, the VARY ONLINE command will fail. The message will show that the drive is assigned to another system. To get the device online on this system, the operator must first take it offline to the other system. The VARY OFFLINE will UNASSIGN the device to the other processor. It will then be available for ASSIGN'ment to this processor. VARY OFFLINE will also disband the path group definition for the paths over which its UNASSIGN is issued.

If a device is brought online during Allocation Recovery,[6] the same steps are followed as for normal, single system assignment. A multi-system assignment cannot be done in response to allocation recovery messages.

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[6] Allocation Recovery is the process entered when a device allocation is requested by some system task and no device of the proper type is online, but an offline UCB exists for the proper type. The operator is presented with a list of appropriate addresses and asked to select one for allocation. When the operator selects the address, the device is brought online in much the same way as if a VARY ONLINE command had been issued.

***JES3-managed 3480 VARY processing:*** JES3-managed 3480s are multi-system assigned automatically within the JES3 complex. JES3 will control the 3480 the same way it controls other tape devices. The ASSIGN facility is used to prevent inadvertent access from a processor that is outside the JES3 complex.

Beginning with JES3 1.3.4, MVS and JES3 VARY commands are synchronized. Previously, operators had to issue both MVS and JES3 VARYs to bring a JES3-managed device online. With 1.3.4, the JES3 *VARY command will perform both functions. The JES3 *VARY command will invoke MVS VARY processing. An ASSIGN command will **NOT** be issued by MVS in this case. JES3 will invoke ASSIGN processing itself and will cause a multi-system assign.

This means that, starting with JES3 release 1.3.4, operators should not issue the MVS VARY command for 3480s.

***JES2 and JES3 non-managed 3480 VARY processing:*** Sometimes, tape drives in this environment need to be shared between processors. Multi-system assignment may also be established in this situation by the operator. The 3480 must be in one of the following states:

- already online (and single-system assigned) to this processor
- already multi-system assigned to any processor
- offline to all processors

The 3480 is brought online by issuing the VARY ONLINE,SHR command. It must be issued from all processors that wish to be concurrently online to the 3480. The VARY processor will use the CONTROL ACCESS command with a system-supplied common password to assign the 3480 to these processors. The password was assembled into the system nucleus at SYSGEN time, and is different from the password used by JES3 for its managed devices.

Once the VARYs have been done, all processors that are assigned to the drive may access it. A processor that did not issue the VARY command with SHR cannot access the drive.

If the operator wishes to remove the drive from multi-system assign status and return to single-system assign status, the drive must be varied offline to all processors first.

**Displaying a Drive's Status**

The MVS Display Unit (D U) command will display the assign status of a 3480. The characters "-R" will indicate single-system assign and "-M" indicates multi-system assign. These characters are in the "STATUS" field of the display.

Display Units will also indicate if the ACL feature is installed on the 3480.

- If the 3480 does ***not*** have the ACL feature installed, the IEE450I message response to the DISPLAY UNITS command will have **3480**

- If the 3480 does have the ACL feature installed, the IEE450I message response to the DISPLAY UNITS command will have **348S**

Another method to display drive status is available only in XA systems. This is the DEVSERV, or device services, operator command. This command performs I/O to the device as opposed to the D U command that gets device status from the UCB. Besides the usual device and path information, DEVSERV will display whether the 3480 has the ACL feature installed or not. If the ACL is installed on the 3480, the response to the DEVSERV is **3480S**; if not, the displayed response is just **3480** as before.

### Manipulating Path Groups

The VARY PATH command is used to cause the path definitions for a device to be changed. VARY PATH can take a path offline or online without causing an ASSIGN to be issued.

VARY PATH,ONLINE will cause the path to be added to the group. Likewise, VARY PATH,OFFLINE will cause a path to be removed from the group.

VARY CH and VARY CPU commands in MVS/370 and CONFIG commands in MVS/XA will cause similar path processing to occur.

### Stand-Alone Dump Considerations

When the stand-alone dump program, AMDSADMP, is IPL'ed, it causes a system reset signal to be sent across all paths to the 3480. The system reset will cause all assignments to this processor (and only those to this processor) to be dropped. AMDSADMP can then use any unassigned device.

Some levels of AMDSADMP will issue ASSIGN commands themselves. We describe the level requirements in "Stand-Alone Dump" on page 59.

## Drive Cleaning Procedures

The cleaning philosophy for the 3480 is radically different from that for a 3420. While cleaning is still very important, it needs to be done less often, and is easier.

Operators must understand what triggers the cleaning process for the 3480. IBM recommends that the 3480 drives be cleaned once per week. This recommendation is based on an assumed average usage. If your drives are used more than the assumed amount, you will need to clean them more often. To help you with this determination, the 3480 counts the number of feet of tape that it processes. When this count reaches the equivalent of about 50 full cartridges, the drive will show the "CLEAN" message on the display. The operator should then clean the drive when it is convenient.

The CLEAN message can be overlayed by other hardware and system messages. Regular work, such as mounts, can continue while a CLEAN message is outstanding. The cleaning process itself does not generate any interrupts to the control unit or the host, so it can be done while a mount is outstanding for a drive. Cleaning can even be done between reels of a multi-volume file. See also "ACL and 3480 Drive Cleaning" on page 106 for more information on the CLEAN message.

We do not recommend that the operators rely solely on the CLEAN message to determine when to clean the drives. The drive's counter can be reset by powering the drive off, by pushing the drive reset button (selective reset), or by running diagnostics against the drive with the Maintenance Device. Cleaning should be scheduled for a specific time each week, with additional cleaning performed when the CLEAN message appears.

One cleaning cartridge is shipped with each 3480 control unit. There is a slot on the inside of the control unit door for storing the cleaning cartridge. We suggest that the cartridge in a specific control unit be used to clean that controller's string of drives. If you know how often the drives are cleaned, and use one cartridge per string, you can calculate the approximate life of the cartridge.

The cleaning cartridge is designed to be used about 500 times. Let's assume that you clean the drives once per week, as recommended. If you use one cartridge for a string, you will perform 8 cleanings with that cartridge per week. The cartridge should be good for 62.5 weeks, or a little over a year. By planning to replace each cartridge once every year, cumbersome procedures for tracking cleaning cartridge uses can be avoided. When the year is up, simply replace the cartridge with a new one.

## Cartridge Initialization

New cartridges from IBM are totally blank. There is no recorded data on them at all. Before they can be used, they must be initialized. If standard IBM labels are used, the IEHINITT utility, or some similar function, can be used to label the tape. If standard labels are not used, a tape mark must be placed at the beginning of the tape.

The only way to produce the initial tape mark is to cause the tape to be opened for output with label processing specified as LABEL=(1,BLP) in the JCL. The following sample JCL could be used:

```
//INIT EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT1   DD DUMMY
//SYSUT2   DD UNIT=3480,LABEL=(1,BLP)
//SYSIN    DD DUMMY
```

Cartridge initialization is not a fast process. Our experience shows that you should plan to initialize at a rate of around 3 to 4 cartridges per minute, using IEHINITT.

## Cartridge Handling

The operators will have to develop new techniques for carrying 3480 cartridges around the machine room. They should be cautioned not to try to stack and carry too many cartridges at a time.

## Channel Switching

In most installations, the 3480 will be attached to processors directly on channels. In some special cases, a 2914/3814 switch will be used to switch 3480 interfaces between processors. Operators must be careful when switching between channels of different speeds.

There are thumbwheel switches for each channel interface in the control units. These switches are set to specific values that show the channel address and the speed at which the control unit should communicate with the channel. Figure 30 shows a 3480 attached to a 3814 switch. The 3480 can be switched between a 4341's 2 Mb/sec channel and a 3081's 3 Mb/sec channel.

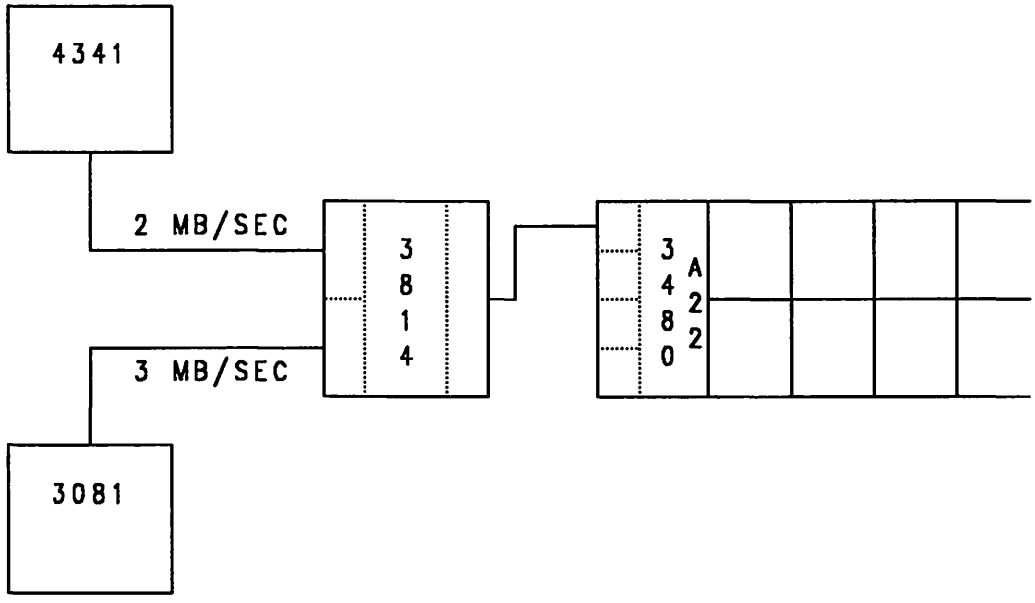


**Figure 30. 3814/3480 Switching Configuration Example**

Assume that the 3480's interface is normally switched to the 4341. If we switch it to the 3081, and do not change the interface thumbwheel settings, the 3480 will continue to run **at 2 Mb/sec** on the 3081, despite the fact that the 3081's channels can run at 3 Mb/sec. The operator must change the thumbwheel setting to change the 3480's communications speed.

If we assume the reverse, that is that the 3480 is normally switched to the 3081, the problem is worse. The thumbwheel setting will indicate 3 Mb/sec channels. When we switch the 3480 to the 4341, the control unit will attempt to communicate at 3 Mb/sec, and overruns will occur.

The procedure for changing the thumbwheels is simple.

1. VARY all drives accessed through this channel OFFLINE.
2. Physically disable the channel interfaces by switching them to DISABLE.
3. Change the thumbwheel setting. The code for the setting is printed on the control unit panel.
4. Physically ENABLE the channel interface.
5. VARY the drives back online.

## Restarting 3480 Jobs from Checkpoints

If the host operating system is running in Code-Compatibility mode, and checkpoint restart is in use, specific restart procedures must be set up to insure data integrity during a restart. The synchronize function, which is included in Full-Function support, is not available to Code-Compatibility users. Synchronize is described in "Data Synchronization" on page 51. If a checkpoint is taken, and the system fails, it is possible for data to remain in the 3480 controller and not get to the tape. The checkpoint process would assume that the data was on the tape.

The operators should cause the restart to occur at the next-to-last checkpoint to make more sure that all data is recovered when restarting in Code-Compatibility mode. The data at the next-to-last checkpoint is valid because of the time differential between checkpoints.

Users of Full-Function software can use the latest checkpoint because the Full-Function changes to checkpoint/restart processing include synchronize support.

Some early 3480 users have found that, because of increases in data reliability, they are able to lengthen the time between checkpoints.

## VARY Procedures for Maintenance

Care must be used when turning drives or control units over to the CE for maintenance. Depending on the situation, the following procedures should be used:

- Service to a drive or drives

  The drives to be serviced must be varied offline to all processors before service begins.

- Service to a control unit

  In a dual control unit subsystem, all paths into the control unit to be serviced must be offline. Use a VARY PATH command to accomplish this. When the control unit is returned to the operator, the appropriate path should be VARY'ed online again.

An IML of the control unit may be necessary depending on the repair procedure performed. In general, if the Maintenance Device was used, an IML should be done.

- Service to all control units in the subsystem.

  All drives attached to the control unit(s) must be varied offline before the CE starts repair. An IML of each control unit may be necessary when the repair is complete.

If the operator doesn't follow these procedures, an ASSIGN array mismatch is possible. If the drives stay online to a processor, that processor will assume that the ASSIGN information in the controller is valid. The repair action may have caused the ASSIGN information to be purged. If the drives were varied offline before the action, the ASSIGN information would have been removed from the control unit and the processor would not think that the drives were assigned any longer.

### Other VARY Procedures

There are circumstances similar to those discussed above that will also require the drives to be VARY'ed offline.

- If the operator has to disable a channel adapter, all drives that can be accessed through that path must have the path varied offline first.
- If the operator has to switch a 2914/3814 interface with the 3480, the drives must be varied offline first.
- An error condition on the control unit (CHECK 1) will cause the control unit to go offline. Before it is returned to service, the paths through it should be varied offline. Jobs may still be running that were using the failing control unit. Their I/O has been switched to the other control unit, assuming that the host has a path online to the other control unit. Once the control unit is physically online, the paths may be varied online again.

## Configuration Considerations

### Channel Attachment

The 3480 can be attached on channels up to 400 feet long. For every control unit attached to the channel, you must subtract 15 feet from the 400 foot maximum.

If the channel is a data streaming channel, and a 2914 is also attached to the channel, you must reduce the length by more than 15 feet. The length reduction is dependent on the number of system interfaces in the 2914. For more information, see *IBM 3031, 3032, 3033 Processor Complex Channel Configuration Guide-*

*lines, GG22-9020.* The information also applies to data streaming channels found on non-303X processors.

When a 3814 Switching Unit is on the same channel as the 3480s, the length of the channel will be affected by the 3814. You need to reduce the length of the channel by some number of feet, depending on the 3814 configuration on the channel. Be sure to refer to *IBM 3814 Switching Management System Product Description, GA22-7075* to determine how to calculate this value.

### One Control Unit or Two?

If you are thinking of installing 8 drives or fewer, you could install just one control unit. However, there are reasons why you should consider two control units, even when they are not needed for configuration reasons.

The first is availability. Having a second control unit provides you with backup if one control unit is down or is involved in certain maintenance activities. Either control unit can access the drives, and either control unit's buffers can be used.

The second reason is performance. With two control units, there will be two paths to the drives. Two drives will be able to transfer data simultaneously. There will also be more buffers available. The chances of having two buffer segments instead of one will increase. The actual performance improvement will depend on the amount of I/O done in remote mode and cannot be predicted accurately.

## Hardware Considerations

### Microcode Updates

You should expect occasional microcode updates for the 3480. Follow your normal change control procedures to install the new microcode releases.

### Use of the 3480 REWIND Switch

There are times when operators use the REWIND switch on the 3480 to force the drive to rewind a cartridge. Using this switch may cause subsequent I/O to this drive to fail, and jobs to ABEND.

If the REWIND switch is pressed while the tape is not at load point or beginning-of-tape (BOT), a unit check condition is posted by the drive to the control unit. When the next I/O arrives for that drive, the unit check will be sent to the processor. The I/O request may have been from the same job or another job. This deferred unit check, as it's called, is sent because the drive wants the host to know that the tape is no longer in the position the host thought it was.

If the tape is at BOT when the REWIND switch is pressed, the unit check is not posted. The subsystem assumes that the operator really wanted to remove the

cartridge, probably because the wrong one was put into the drive and hasn't been used yet.

The one exception to this processing is after a host system goes down and the tapes are not at BOT. If tapes not at BOT are rewound prior to IPL, the deferred unit check will be posted, and the reset to the control unit at IPL will clear the unit check.

This means that recovering the 3480s after a host failure can be done in one of two ways:

1. In an MVS system with Automatic Volume Recognition (AVR), the operator can leave the tapes and drives alone, and not rewind or unload them. If the drives are online at host IPL, the tapes will be rewound to BOT by the operating system. The host will attempt to read the labels on the tapes and will show them as mounted PRIVATE on their drives. They will stay that way until the operator issues an UNLOAD command, or until allocation gets a specific request for that volume.

   If the drives are offline at host IPL the tapes will stay where they are. The operator should VARY them online and issue an UNLOAD command.

2. The operator can rewind and unload all 3480 drives; the deferred unit check will be cleared by the reset from the host IPL. This procedure is recommended for 3480s with the ACL feature installed so operators will not lose track of which cartridges are scratch and which ones have valid data on them.

## Comparing Reliability Data from 3420s and 3480s

EREP will report on tape errors for both 3420s and 3480s. The information is presented on the 3480 Temporary Error Summary report which is part of the Systems Exception (SYSEXN) series of EREP reports. The 3480 report must be explicitly requested. 3480 errors are reported in megabytes per error. The 3480 control unit keeps count of megabytes of data passed, and provides this information to the operating system at volume unload time, or when the counters overflow.

3420 data is also presented in megabytes-per-error. The 3420 does not keep track of megabytes passed; instead EREP calculates an approximation as follows:

- LOGREC records are read and divided into two groups. The groups contain records that EREP has determined have valid Start I/O counts, and those that don't have valid counts.

- EREP processes the valid records first. The SIO count is multiplied by the blocksize for the file. This produces an approximate megabyte value for the file. Two factors make this an estimate:

  1. More than one block of data may be transferred for a given SIO command. EREP assumes one block per SIO.

2. The file may have variable length records. The blocksize used is the DCB blocksize, which is the largest possible block length.

- EREP divides the megabyte value by the error count to get megabytes per error. An error per SIO count is also kept.

- The calculations are repeated for each file. The error per SIO count is averaged for all files and kept for later use.

- When all the "valid" records are processed, EREP goes to the "invalid" records. It uses the average SIO count it has calculated in place of the invalid SIO count and calculates megabytes per error for these records also.

Care must be taken when comparing the 3480 records, which reflect accurate Mb/error statistics, and 3420s, which reflect estimates.

The Mb/permanent error calculation in the 3420 error summary report is made using permanent read and write errors only. The same calculation for the 3480 report includes read and write errors as well as data checks, equipment checks and other errors, excluding operator reset errors.

Certain operational and hardware errors may be logged as permanent errors when, in fact, they are not. For example, a programmer may accidentally read past the end of a file (the double tape mark). The drive will get an error when it tries to read a void area, and will post a permanent error to the host. The drive can't tell if it is accidentally reading a void, or if something is truly wrong. Errors that are in this category should be factored out when error statistics are analyzed.

# Software Considerations

## Programs to Review

There are some general types of programs that should be reviewed before the 3480 conversion. Some of them may need to be changed to operate properly on the 3480.

- Update-in-place. Although not supported on the 3420 either, some people have written code to update an existing tape in-place. This usually takes the form of re-writing, or "clipping" the label. This will not work on the 3480.

- JCL Inspectors. If a program scans JCL looking for specific UNIT values for 3420s, it will probably need to be changed to look for the new 3480 values.

- Accounting Routines. Many job accounting algorithms charge users for each tape mount. They may also charge for time allocated. You can get into a great philosophical argument over whether you should charge more or less for the 3480 than for the 3420. The outcome of all this will probably depend on whether the installation is promoting 3480 use, or holding back on them.

- Dynamic Allocation. Programs that dynamically allocate 3420s will need to be changed to use 3480s as the device token values are different.

- DEVTYPE macro. Programs that issue this macro to obtain device characteristics should expect new values for the 3480.

- EXCP Programming. Most EXCP programming issues a SENSE command eventually. The 3480s response to a SENSE command is 32 bytes of data, the 3420 responds with 24. If the command's length attribute is 24, and the SLI bit is not turned on, the channel program will ABEND. Be sure to change the data target address also so that 32 bytes of storage are available there, not just 24. If you don't, you will overlay the next 8 bytes following the SENSE command's target.

- LOGREC tape analyzers. Programs that are dependent on LOGREC record contents and format for obtaining tape error statistic information must be changed to obtain the 3480 information. It is in a different record and a different format..

- Stand-alone programs. Programs that are meant to IPL in stand-alone mode must be changed to IPL from the 3480. In MVS/370 mode, bit 0 of control register 0 must be turned on. This bit shows that the channels are in block multiplexer mode. In MVS/XA mode, no changes are necessary.

- Hard-coded density (DEN) values. In Code-Compatibility mode, hard-coded DCB=DEN values of 3 will cause the 3480 to write data in tape-write-immediate mode.

- User-written ERPs. Users of the EXCP access method can specify as an option that they will handle error conditions themselves instead of using the operating system routines. These routines need to be examined for the 3480 as additional actions need to be taken for data written to the 3480 buffer but not yet on the tape.

## SYSGEN and IOCP Addressing

When the SYSGEN and IOCP generations are done, all 16 possible addresses for a 3480 subsystem **must** be specified, even if some of the drives will not be present. The 3480 control unit can address all 16 addresses, and may generate error information or interrupts for non-existent devices in certain circumstances. MVS must have a UCB to associate with these interrupts.

The only actions necessary to obtain 3480 support in MVS are

1. Install the appropriate DFP software (if not already installed)
2. Perform an IOGEN with IODEVICE macros specifying 3480s in either CC mode (3400-9) or FF mode (3480).

### UCW specifications

All Unit Control Word (UCW) specifications for 3480 addresses **must** be set to UNSHARED. 3420 devices used shared UCWs; having UNSHARED UCWs for the 3480 will be a change for IOCP. Also, the proper channel protocol, either data streaming or DC Interlock, must be specified.

### 3420/3480 CPU Time Comparisons

We have found that job TCB times will increase slightly for most jobs when 3480 runs are compared with 3420 runs. This change can be attributed to QSAM's buffer handling. QSAM will build buffers of data in the processor. The IOS component schedules the available blocks to be written to the drive. While the current group of blocks is being written, QSAM is filling more buffers. When the current group of buffers is transferred, IOS will build another channel program for the data now in the buffers.

The 3480 can take the data from the channel faster (up to 3 Mb/sec) and therefore takes less time to transfer the same amount of data. Since less time elapses, QSAM doesn't load as many CPU buffers, and IOS has fewer buffers to schedule. Its CCW string will be shorter. More I/Os will be needed to process the same amount of data because the strings are shorter. This additional processing will consume some additional CPU time. To put it another way, the ratio of SIO instructions to EXCPs will decrease; this ratio will get closer to 1:1 than it was for 3420s.

## Performance Considerations

Our experience with the 3480 shows that it is a superior performer. We have discovered a few things that should be considered to get the most out of your drives.

### Performance Expectations

The 3480 is a faster tape drive than any we have had before. It should help your tape-bound jobs get finished sooner. The problem with this is that everyone has a different definition of tape bound. We have found that some tape bound jobs are not tape bound at all, but use many drives and appear to be doing I/O all the time.

We made an extensive study of this topic and have written about it in *3480 Performance Considerations, GG22-9335*. We strongly suggest reading it to help you determine what your performance objectives should be.

The IBM Mid-Range Performance Evaluation Center recently completed a performance study of VSE/SP, VM/SP, 3420s, and 3480 tape subsystems. The results of this study will be available in *Tape Subsystem Performance Measurements in VSE/SP and VM/SP Environments*, G360-1025.

## Label Processing

The channel command sequences used during OPEN processing cause several directional changes to occur that cause the buffer segment to be purged. As a result, the 3480 takes longer to process this particular string of channel commands than a 3420. Therefore, OPEN processing on the 3480 takes a proportionally longer part of the overall job time when compared to OPEN on a 3420.

Applications that process many very small files stacked on one volume on the 3480 may see their performance degrade as a result.

## Sharing Channels with Other Devices.

The ideal configuration will have the 3480s on their own channels. If a channel must be shared with some other devices, we recommend that you share with non-response-oriented DASD. From the channel's point of view, the 3480 looks more like a DASD device than a tape device. For a good rule of thumb, decide if you can afford to place more DASD on the channel. If you can, you will probably be able to place the 3480 there instead until some 3420 channels are freed.

The least attractive configuration has the 3480 sharing a channel with active 3420s. The two drives will tend to approach the same speed when both are in use, and that speed, unfortunately, will be that of the 3420.

## Block Size Recommendations

If your blocksizes are already relatively large, i.e. 12 Kbytes or above, increasing the blocksize will not increase tape performance very much. This is because the effective data rate curve for the 3480, which is shown in Figure 31 on page 99, flattens out at 12 Kbytes to 16 Kbytes.

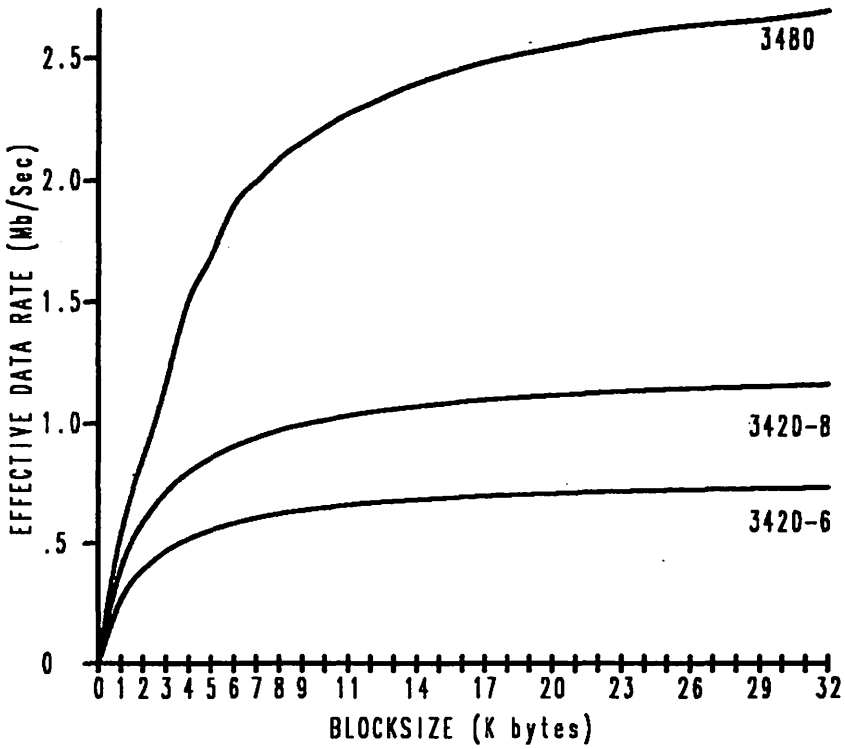


**Figure 31. 3480 Effective Data Rate for One Drive Reading**

If you have blocksizes larger than average, there is little benefit to be gained by increasing them now. If your blocksizes are small, you will gain significant performance benefit by increasing your blocksize.

In any case, the optimum blocksize for the 3480, as supported by standard access methods, is 32 Kbytes.

## Variable-Length Blocks

Different computer languages cause variable-length records to be handled in different ways. COBOL, for instance, will not determine if a record can fit in the block it is building if the record's potential length is greater than the amount of space left in the buffer. For example, A COBOL program specifies a block length of 1000 bytes and a potential record length of 600 bytes. Assume that the first record was 600 bytes long and 400 bytes remain in the block. Since the next record could be up to 600 bytes long, COBOL will close off the block and start another one.

PL/1, on the other hand, will attempt to fit the record into the block before starting on a new block. If, in our COBOL example, the second record was 300 bytes long, it would fit in the first block. PL/1 will put it there, COBOL will not.

The 3480 control unit's buffer processing is similar to that used in COBOL. The control unit uses the largest blocksize it has ever seen for the active file and won't attempt to fit another block into the buffer if the largest size it has seen won't fit. The actual size of the next block is unknown to the control unit, and doesn't matter. This can cause inefficient use of the control unit's buffer.

We recommend using the Spanned option for variable-length files - VS or VBS. Specifying spanned causes all blocks to be the same length. This allows more efficient use of the 3480's buffer, and also causes the languages to perform better in the host.

# Chapter 7. 3480 Automatic Cartridge Loader

This chapter will cover the Automatic Cartridge Loader (ACL) in more detail, including software support and installation considerations for MVS systems using JES2 and JES3.

## Automatic Cartridge Loader Operational Modes

As we described in "3480 Automatic Cartridge Loader (ACL) Feature" on page 15, the automatic cartridge loader is a hardware feature attached to the front of a 3480 drive. This feature loads cartridges from a stack and unloads cartridges from the drive automatically or under system control. The input stack holds five cartridges, plus one more in the feed position. The feed position is the slot right in front of the load door of the 3480. The output stack below the feed position holds six cartridges. For field installation of the feature, the front panel of the 3480 is replaced with the loader feature. The ACL extends into the aisle 7.5 inches beyond the 3480 front panel, and extends about 4 inches above the drive.

Cartridges placed in the input stack are indexed down to the feed position, and loaded into the 3480 by system or operator control, depending on the ACL mode. Once processed, cartridges are unloaded from the 3480 and moved to the ACL feed position. From there, the cartridge may either be indexed into the output stack, or remain in the feed position waiting for the operator to remove it.

On the front of the ACL there is an operator panel that has an amber light, a three-position rocker switch, and a start button. The amber light on the panel flashes when operator attention is required. This could be for a jammed cartridge or for a full output stack. The three-position rocker switch on the panel is used to set the ACL in one of three operating modes described below. The start button is used by the operator to indicate that a change in operating modes was made, or to move a cartridge from the feed position into the 3480 drive.

### ACL Operating Modes

The ACL can run in one of three operating modes - MANUAL, AUTO, and SYSTEM. Assuming the correct software is installed, any of these modes can be used. You can switch modes anytime using the switch on the ACL operator panel. The host operating system is *not* aware of the ACL operating mode.

- MANUAL - This mode does not load or unload cartridges; MANUAL mode works the same as a 3480 without an ACL. The operator places a cartridge in the feed position, presses the start button, and the cartridge is

loaded by the ACL into the drive. When processing is complete, the cartridge is unloaded by the drive and moved to the feed position where it is left for the operator to remove. There are no operational benefits in this mode. Occasionally you will use MANUAL mode for error recovery.

- AUTO - In this mode, the ACL loads the next cartridge in the input stack as soon as the cartridge in the 3480 is rewound, unloaded, and indexed to the output stack. The next cartridge is moved into the drive, the drive readies the cartridge, and the volume is available for the next host request. This loading and unloading is done automatically by the ACL with no commands from the host.

  AUTO mode can be used to load a multi-cartridge input file automatically, assuming you put the cartridges in the input stack on the allocated drive and in the right sequence. If you want to use AUTO for a multi-cartridge input file, you should provide physical protection for the cartridge using the file-protect button, RACF protection, or date protection so that you don't accidentally destroy the data.

- SYSTEM - This mode combines the best features from both AUTO and MANUAL modes. In Full-Function MVS systems, an ACL set in SYSTEM mode responds to host scratch requests by loading the next cartridge; for specific mount requests, the operator loads the cartridge.

  SYSTEM mode works as follows:

  - If the host requests a scratch cartridge on the 3480, and the ACL is set in SYSTEM mode, the ACL will automatically load the next cartridge in the input stack. When processing is complete, the cartridge will be unloaded and returned to the feed position. If the next request is for a scratch cartridge, the ACL will index the used cartridge into the output stack and load the next cartridge in the input stack.

  - If the host requests a specific volume on the drive, the ACL will not load a cartridge; the operator will retrieve the requested cartridge from the library, remove any used cartridge from the feed position, place the specific volume in the feed position, and press the start button. When processing is complete, the cartridge will be returned to the feed position for the operator to remove, or it will be indexed to the output stack if the next request is for a scratch cartridge.

*Note:* **SYSTEM mode is available only in Full-Function MVS systems.**

Be sure to review the ACL operating procedures in the *3480 Magnetic Tape Subsystem Operator's Guide, GG32-0066.*

As you might expect, the preferred mode of operation is SYSTEM mode. In addition to MVS Full-Function support, SYSTEM mode requires ACL software support to initiate ACL loads and to have "active" ACL drives preferred for scratch mount requests. Host control of initiating ACL scratch mounts, and suppressing cartridge loads for specific mounts in SYSTEM mode is done by setting a bit in the LOAD DISPLAY CCW. This is the CCW used by the Full-Function host to put messages on the 3480 display pod. The first byte of the

LOAD DISPLAY CCW contains the format control byte; the host turns on bit 7 of this byte to request a cartridge load by the ACL. For scratch mounts, the bit is turned on, causing the ACL to load the next cartridge. For specific mounts, the bit is not on, and no ACL action occurs.

Because the software support for SYSTEM mode is available only on Full-Function MVS systems, other operating systems such as VM, VSE, and MVS in Code-Compatibility mode cannot use SYSTEM mode. However, the ACL features can be installed on 3480s and used in MANUAL or AUTO mode by these systems.

## JES2 Installation Considerations

In JES2 MVS Full-Function environments, MVS allocation has been modified to recognize the ACL feature on 3480s, and to prefer these ACL drives for scratch and private tape mounts. MVS allocation will also attempt to use non-ACL 3480s to satisfy specific volume mounts.

This modification is implemented by changing allocation and by defining two bits in the 3480 UCB as follows:

- When on, bit four at offset X'2B' indicates that the ACL feature exists on the 3480. This is set at device VARY ONLINE and at system IPL if the 3480s were genned with OFFLINE=NO. The sense returned from the control unit indicates the ACL feature is present, and the bit in the UCB is set.

- When on, bit five at offset X'2B' indicates that the ACL is "active." This bit is set when the sense information from a host-initiated rewind-unload indicates that there is at least one cartridge in the input stack. This is the bit used by MVS allocation for scratch mount device preference.

When allocation searches for a 3480 tape drive for a scratch mount, it prefers "active" ACL drives over other 3480 drives. There are two categories of eligible devices - "active" 3480s and 3480s. Any 3480s with ACLs that are not marked as "active" fall into the second category. As you can see, the best way to get the benefits from an ACL drive is to have it marked "active" so it will be preferred for scratch mounts. If this selected 3480 ACL is also in SYSTEM mode, no operator action is required.

Because the rewind-unload sense data has the bit indicating more cartridges in the input stack, an ACL drive is **not** marked "active" and preferred by allocation until a cartridge has been unloaded by the system on that drive.

This means that 3480s with ACLs are **not** marked active after a

- System IPL

- VARY ONLINE of a 3480 with the ACL feature

- Rewind-unload occurs on a 3480 that has an empty ACL input stack.

However, once a 3480 with the ACL has been allocated and used, and the input stack has scratch cartridges in it, this drive will be marked "active" and be pre-

ferred for scratch mounts. You can see that it's important for the operators to keep the input stack full so the drives stay "active."

Marking a drive active after a VARY ONLINE or IPL can be done either by allowing normal allocation to select the drive or, if you can't wait for allocation to do it for you, by using this procedure:

1. Vary the 3480-ACL drive offline
2. Place at least one scratch cartridge in the ACL input stack
3. Put the ACL in the SYSTEM mode
4. Put another cartridge into the feed position of the ACL and press START
5. Vary the 3480-ACL drive online
6. Issue an MVS system UNLOAD command for that 3480 address

This procedure is documented in the *Guide to The IBM 3480 Automatic Cartridge Loader*, GG24-3094, published by The International Systems Center. This Technical Bulletin covers the 3480 ACL in great detail, including software support, planning, usage, and installation guidelines.

If 3480-ACL drives are at the beginning of the tape drive address range, and the tape selection algorithm (SELTAPE) is FIRST or LOWEST, these 3480-ACL drives will be selected early following an IPL or drive vary online. This early selection may not be for a scratch mount, but it will provide the cartridge rewind-unload needed to mark the ACL as "active."

If the 3480-ACL drives are positioned at the end of the tape drive address range, or if tape drives are selected using RANDOM, 3480-ACL drives may not be selected early. In this case, it might make sense to make these drives "active" after IPL or VARY ONLINE using the procedure described above. The ACLs could then be used to satisfy scratch requests sooner. **Putting a cartridge in the drive and unloading it using the UNLOAD button on the 3480 Operator's panel does not mark the drive "active." The unload command must come from the host operating system.**

## JES3 and ACL Device Selection

JES3 does not provide support to select "active" ACL drives scratch mounts as there is in JES2. JES3 processing selects a device and passes that address to MVS allocation. Therefore, the selection of an ACL drive for a scratch mount depends on the percent of 3480s that have ACLs installed. With 100% of the 3480s having ACLs installed, there would be no problem selecting a 3480 with an ACL for scratch mounts. But with fewer ACLs, and with no device preference, the chances of selecting the 3480 with ACLs are reduced.

### JES3 INIT Stream Changes for ACLs

To help device selection find the ACLs for scratch mount, a change can be made to JES3 INIT streams to bias device selection. The objective is to get JES3 to use 3480 devices with the ACL feature to satisfy scratch mount requests when possible. This means that if a device is needed to satisfy a scratch mount, and if both an ACL device and a non-ACL device are available, JES3 should favor the ACL device. This does not mean that the job should not be setup if only non-ACL devices are available.

These changes to the JES3 INIT stream assume that the installation does not have the ACL feature on all of the 3480 devices, and does not want to segregate the 3480 devices into two pools using additional esoteric names. These changes allow 3480 drives with ACL to be available to satisfy specific requests and 3480 drives without ACL to be available to satisfy non-specific volume requests. Lastly, we prefer that the installation not have to make any JCL changes to existing job streams that request scratch cartridges.

The example below illustrates how an installation might change their JES3 initialization stream to cause JES3 to prefer 3480 devices with the ACL feature for non-specific volume requests, and 3480 devices without the ACL feature for specific volume requests.

The assumptions for these INIT stream changes are that:

- All devices are JES3-managed.
- The esoteric name TAPE in the example includes all 3480 devices.
- All non-specific volume requests specify UNIT=TAPE on the DD statement.
- All existing tape datasets residing on cartridges are cataloged as 3480.
- Allocation requests for existing datasets use the catalog to obtain the unit information.

To influence JES3's device selection for a request, you should make the following changes to the JES3 initialization stream:

1. The DEVICE statements for the the 3480 devices should be modified. The XTYPE keyword value should be used to delineate the 3480 devices with the ACL feature (e.g. XTYPE=(STACK)) from those 3480 devices without the feature (e.g. XTYPE=(NOSTACK)).

2. The SETNAME statements should be updated and ordered in a such a manner as to provide device preference. The following could be used:

```
SETNAME,XTYPE=(STACK),NAME=(TAPE)
SETNAME,XTYPE=(NOSTACK),NAME=(TAPE,3480)
SETNAME,XTYPE=(STACK),NAME=(3480)
```

With the above definitions, JES3 will attempt to allocate non-specific volume requests using devices with XTYPE=STACK prior to trying to allocate the

requests from the devices with XTYPE=NOSTACK. Similarly, JES3 will attempt to satisfy specific volume requests using devices with XTYPE=NOSTACK prior to using devices with XTYPE=STACK.. However, each group can satisfy both non-specific and specific volume requests.

## ACL Field Test Experiences

The most frequently asked question by the Field Test accounts was "How many ACLs should I install?" Some accounts answered this by measuring the percent of scratch mounts going to 3480s, and installing roughly the same percent of ACLs on 3480 drives. This was a reasonable starting position for deciding how many ACL features to install. One account with 16 3480 drives installed ACLs on 100% of the 3480s. They never had to measure scratch mount allocation to ACLs, or prime the ACL-3480s to make them active.

The question of where to install ACLs was answered in a few different ways. Most customers placed them on drives far from the operator station; some kept them close to the scratch pool while others installed a few ACLs on each 3480 string.

The accounts in the Field Test did experience operational benefits from the ACLs. For example, in some cases, operators who normally worked in the tape area were reassigned to other locations because the ACLs were handling many of the mounts.

Field test accounts also found it beneficial to have the cartridge input stack full which kept the 3480s marked "active" for allocation preference. They were able to load four or five cartridges and unload used cartridges on each trip, but they made fewer trips to service the drives. Servicing the drives at this frequency also prevented the output stack from filling, thus interrupting the ACL operation.

## ACL and 3480 Drive Cleaning

Running ACLs in AUTO mode may prevent the drive CLEAN message from being displayed. This happens because the CLEAN message will be displayed when the drive is either rewinding a cartridge (REWINDNG), or when the 3480 is idle (*), i.e. no cartridge is in the drive. When the ACL is in AUTO mode, the drive is usually not in an idle state. A cartridge is in the drive and either the VOLSER or the READY message is displayed on the pod. The CLEAN message will be displayed during cartridge rewind, but the operator would have to pay close attention to see it. If you run the ACLs in AUTO mode, be sure to clean the drives regularly. You can even put the cleaning cartridge in the ACL input stack whenever you want to clean the drive.

Two new CHK codes were added to the *IBM 3480 Tape Subsystem: Operator's Guide*, GA32-0066, specifically for the ACL: CHK EC, and CHK 31. Refer to the Operator's Guide for the recommended recovery actions.

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