DSD 5217
DSD 7217
Multibus Disk Controller

Programming Addendum for
217 Tape Functions

DSD Part Number:
040069-01, Rev 3

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Preface

This document is an addendum to Chapter 4 (Programming) of the DSD 5215 and DSD 7215 manuals. This addendum documents the new tape functions in the expanded function set of the DSD 5217 and the DSD 7217. These new tape functions are referred to as 217 tape functions, because they emulate the tape function set of the Intel iSBX 217. This addendum must be used with a 5215 or a 7215 manual.

Except for the presence of the 217 tape functions, the 5217 is identical to the 5215, and the 7217 to the 7215. This addendum is limited to the programming information needed to implement the 217 tape functions. Consult the 5215 or 7215 manual for:

- General Information
- Specifications
- Installation
- Programming Information for other Functions
- Controller Architecture
- User Level Maintenance
- Appendices

For the 5217 and 7217, section 4.4.1 of this addendum (Controller Invocation Block) replaces section 4.6.7 of the 5215 and 7215 manuals, regardless of whether the 217 tape functions are implemented.

The material in this manual is subject to change without notice. The manufacturer assumes no responsibility for any errors which may appear.

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4. Programming

4.1. Introduction

The DSD 5217 and the DSD 7217 are an enhanced versions of previous Multibus controllers. In these units, the function set has been expanded to include an emulation of the tape function set of the Intel iSBX 217. These additional functions (referred to as 217 tape functions) supplement the existing function set. The DSD tape functions remain unaffected, and can be used with tape drive 0.

4.2. Features

The new features in the expanded function set are:

- Support of an additional three streaming tape drives, for a total of four.
- Support of file oriented data transfers, between host memory and tape.
    - Backup of selected records and files (onto blank tape), in addition to the existing function for mirror-image backup of a disk.
    - Restoration of selected records and files to the disk, in addition to the existing function for mirror-image restoration of a disk.
- Erase and rewind of tape cartridges can be done as a utility function.

4.3. New Functions

The new functions transfer data between host memory and tape. Records or files on disk must be transferred to host memory before being written to tape. Restoration of data to disk requires a similar procedure.

There are two types of 217 tape functions: short term and long term (see Table 4-1). Short term functions generate one interrupt when they are complete. No other DSD functions are possible during a short term function.

Long term functions generate an interrupt when they begin, and return control of the bus to the host. A second interrupt is generated when they finish. During a long term function, other functions (non-tape) may be issued.

Table 4-1. 217 Tape Functions

Function	Hex	L or S	Sect.	Fig.	Page
Initialize	(00H)	Short	4.5.1	4-3	4-8
Tape Initialization	(10H)	Short	4.5.2	4-4	4-10
Tape Reset	(1CH)	Short	4.5.3	4-5	4-11
Read Tape Status	(1EH)	Short	4.6.1	4-6	4-13
Transfer Status	(01H)	Short	4.6.2	4-7	4-14
Read Data	(04H)	Short	4.7.1	4-8	4-18
Write Data	(06H)	Short	4.7.2	4-9	4-21
Read/Write Terminate	(1FH)	Short	4.7.3	4-10	4-23
Forward One Record	(1AH)	Short	4.7.4	4-11	4-24
Forward One File	(12H)	Long	4.7.5	4-12	4-26
Write File Mark	(14H)	Short	4.7.6	4-13	4-27
Retension Tape	(1DH)	Long	4.8.1	4-14	4-28
Rewind Tape	(11H)	Long	4.8.2	4-15	4-29
Erase Tape	(17H)	Long	4.8.3	4-16	4-30

To use the 217 tape functions, a function sequence must be executed after power-up. The initialize function (00H) tells the DSD controller that tape drives are present. Not present is the default for all drives. Tape initialize (10H) and then tape reset (1CH) is required for each drive present. These functions are detailed in section 4.5, Power-Up Function Sequence.

A set of error status messages for the 217 tape functions is accessed through the read tape status (1EH) and transfer status (01H) functions. These functions are detailed in section 4.6, Tape Status Functions.

The 217 tape functions allow specific files and records to be read and written with the read (04H) and write (06H) data functions. There are functions to move the tape forward

one record (1AH) or one file (12H), and to write a file mark (14H). There is also a read/write terminate function (1FH). These functions are detailed in section 4.7, Read/Write/Terminate Functions.

The retension (1DH), rewind (11H), and erase (17H) functions are detailed in section 4.8, Utility Functions.

4.4. Control Blocks

The 217 tape functions use an additional control block (Tape Parameter Buffer) with the IOPB, as well as the five used previously.

- Wake-Up Block (WUB)
- Channel Control Block (CCB)
- Controller Invocation Block (CIB)
- Input/Output Parameter Block (IOPB)
- Data Buffer: used with the IOPB
- Tape Parameter Buffer (TPB): used with the IOPB

4.4.1. Controller Invocation Block (CIB)

For the 5217 and the 7217, this section replaces section 4.6.7 and Figure 4-6 of the 5215 and 7215 manuals.

The DSD controller uses the CIB to post status to the host. Figure 4-1 shows the layout of the CIB in host memory, and Table 4-2 shows the function of each byte.

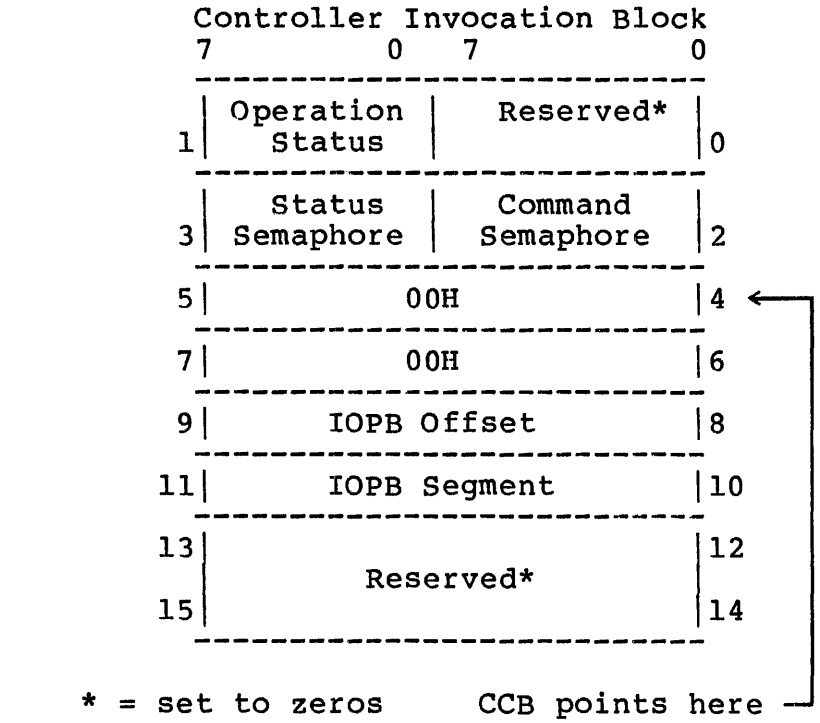

Figure 4-1. Controller Invocation Block

Table 4-2. Controller Invocation Block

Byte #	Definition
0	Reserved: set to zeros.
1	Operation Status: This byte contains the most recent data transferred by a transfer status function. The status is encoded bit-by-bit as shown. Bit numbers: 7 6 5-4 3 2 1 0 S H U 0 0 0 0 = Winchester drive (reserved), or DSD u a n tape function (function codes 81H m r i or 82H). m d t 0 0 0 1 = Winchester drive: immediate m d t function complete. a 0 0 1 0 = Winchester drive: seek complete. r E I 0 0 1 1 = Winchester drive: reserved. y r D 0 1 0 0 = Media change detected: Winchester r drive, or tape drive during a DSD E o tape function. r r 0 1 0 1 = Winchester drive: reserved. r 0 1 1 0 = Winchester drive: reserved. o 0 1 1 1 = Winchester drive: reserved. r 1 0 0 0 = Floppy drive: reserved. 1 0 0 1 = Floppy or tape drive: immediate function complete. 1 0 1 0 = Floppy drive: seek complete. 1 0 1 1 = Floppy drive: reserved. 1 1 0 0 = Floppy drive: media change detected. 1 1 0 1 = Floppy drive: reserved. 1 1 1 0 = Tape drive: media change detected. 1 1 1 1 = Tape drive: long term function completed.
2	Command Semaphore: The controller does not use this byte. It is provided as a multiprocessor interlock.
3	Status Semaphore: The controller posts status only when this block is 00H. After posting new status, the controller sets this byte to FFH. After the host reads status, it should reset this byte to 00H.
4-7	Set to zeros.
8-11	Segmented IOPB address.
12-15	Reserved: set to zeros.

4.4.2. Input/Output Parameter Block (IOPB)

There is an IOPB figure in each function section of this addendum. The shaded fields in each IOPB figure are the ones necessary for that function. The fields shaded include:

- Device:
  When the hex code 04H is placed in this field, it indicates that a 217 tape function is being issued.

- Function:
  The hex code placed in this field selects the next function.

- Unit:
  The value placed in this field selects the tape drive. The value may range between 0 and 3.

- Modifier:
  Bit 6 of this field (previously reserved) is used with the transfer status function. This bit selects the data to be returned by the transfer status function. The choices are:

  - A short term function, or the first interrupt of long term function, or

  - the second interrupt of a long term function.

- Data Buffer Address:
  These fields are used with the Initialize function (00H) to point to a one-byte long tape parameter buffer. It is also used (as before) to point to addresses in host memory.

- Requested Transfer Count:
  Used the same as for floppies and Winchesters.

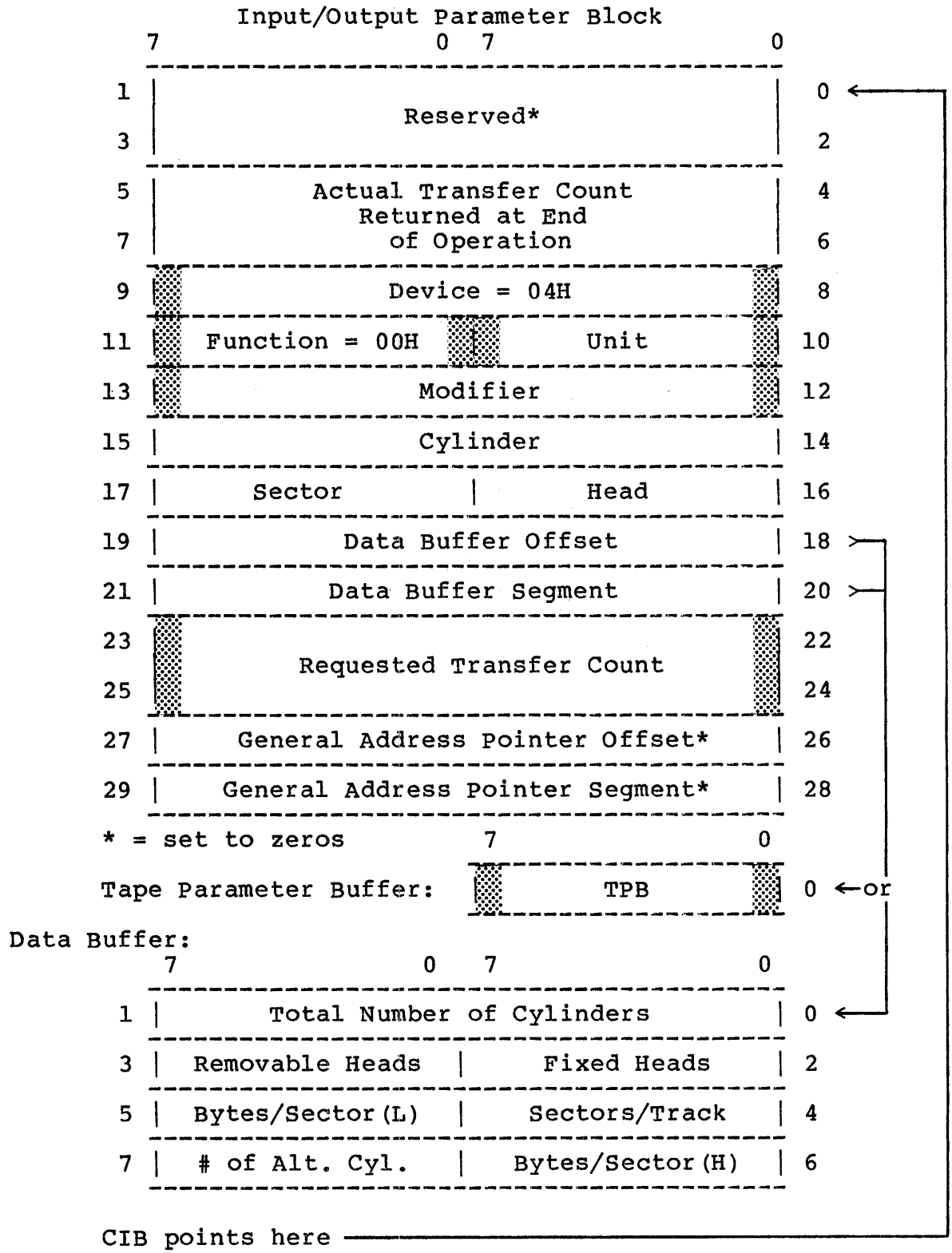

Figure 4-2. Input/Output Parameter Block

4.5. Power-Up Sequence

There are three functions that must be invoked in a power-up sequence:

Initialize (00H)
Tape Initialization (10H)
Tape Reset (1CH)

4.5.1. Initialize (00H)

Initialize (see Figure 4-3) is a short term function that informs the DSD controller that tape drives are present. Not present is the default for all drives. This function must be followed by the tape initialization (10H) function.

The information transferred to the controller by this function is stored in an extension to the IOPB called the tape parameter buffer. The data buffer offset and segment stored in the IOPB are used to address the TPB.

Only bit 0 is used in the TPB. Bits 1 through 7 are not looked at by the controller. Present (bit 0 = 1) must be indicated in the TPB for each drive installed. Not present (bit 0 = 0) is the default for all drives.

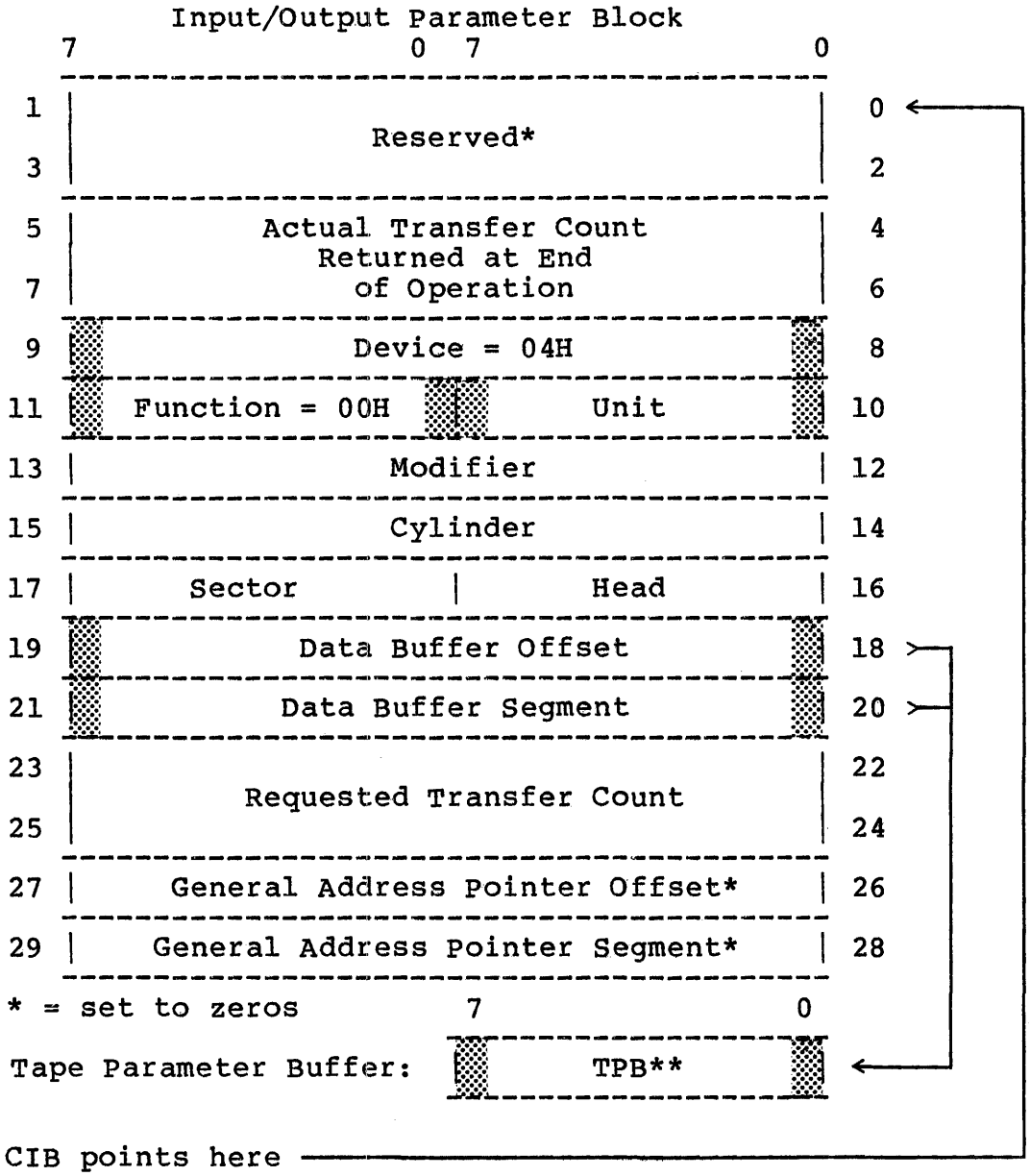

Figure 4-3. Initialize (00H)

4.5.2. Tape Initialization (10H)

Tape initialization (see Figure 4-4) is a short term function that allows the tape drive controller to set up its internal parameters.

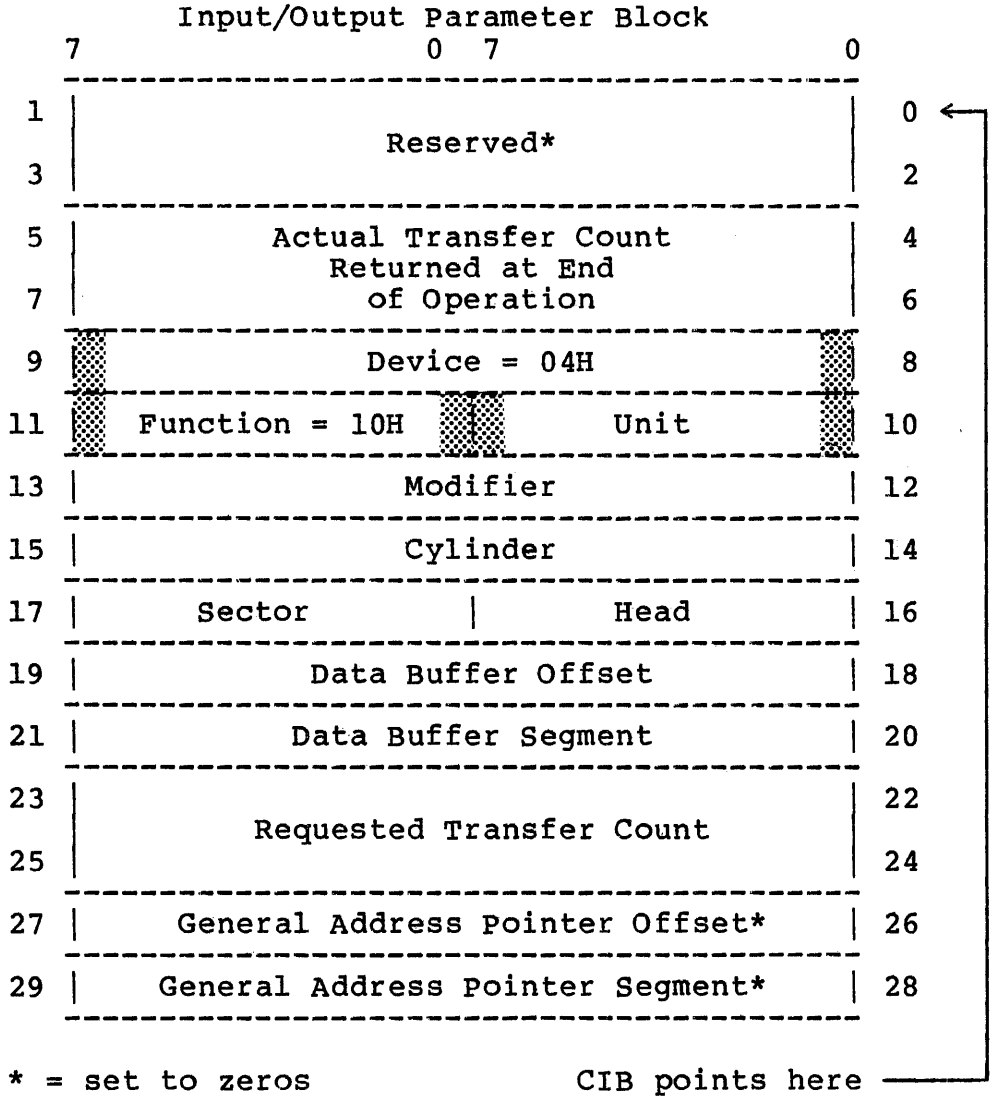

Figure 4-4. Tape Initialization (10H)

This function must be invoked immediately after the 00H initialization function, and must be followed by the 1CH tape reset function. If the tape drive controller cannot complete a tape initialization function, bit 4 of byte 0 in the error status buffer is set.

4.5.3. Tape Reset (1CH)

Tape reset (see Figure 4-5) is a short term function that invokes a tape drive controller reset procedure. This function must be invoked after the tape initialization (10H) function in the function sequence following power-up.

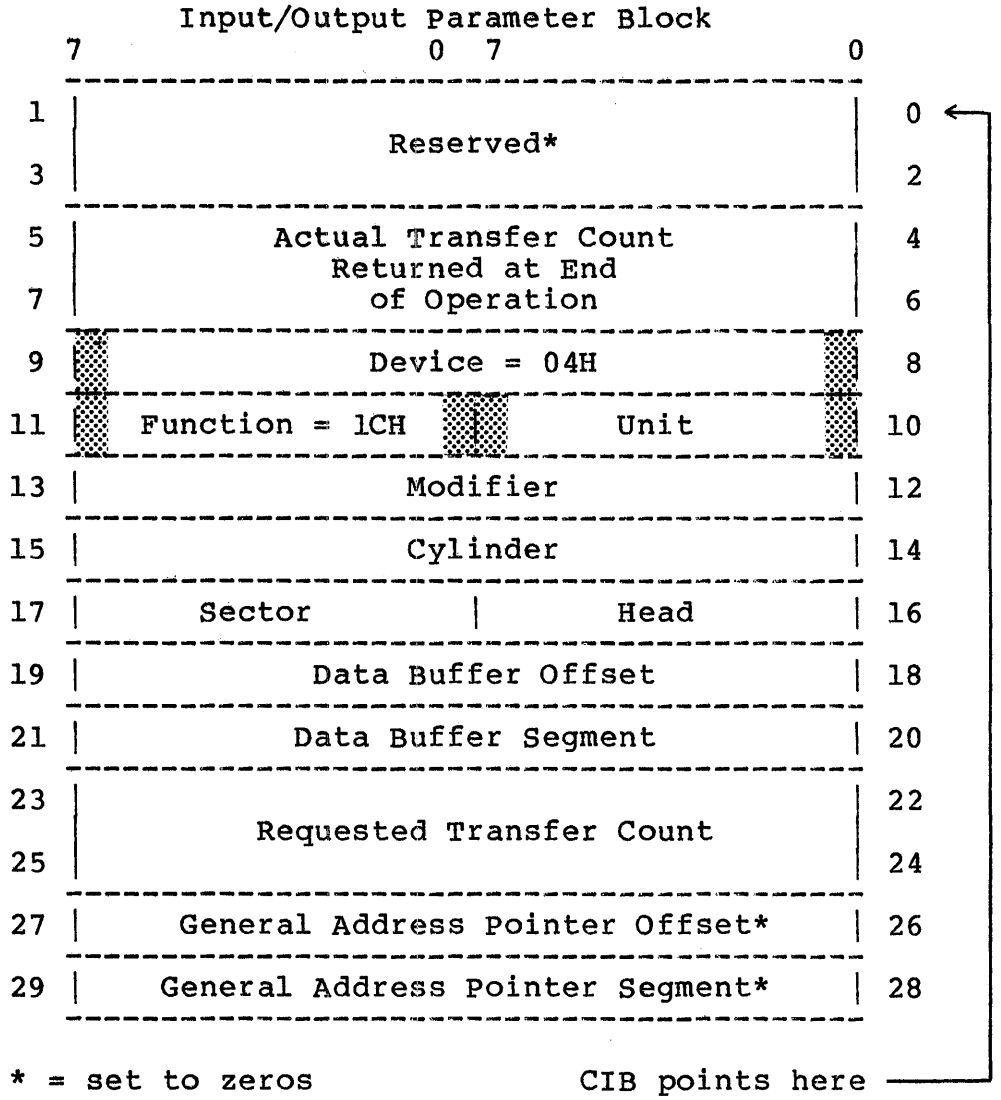

Figure 4-5. Tape Reset (1CH)

4.6. Tape Status Functions

There are two functions used to obtain tape status:

Read Tape Status (1EH)
Transfer Status (01H)

Please note that these functions are normally invoked sequentially. Read tape status (1EH) transfers data to the 6217. Transfer status (01H) is required to move the data into host memory.

4.6.1. Read Tape Status (1EH)

Read tape status (see Figure 4-6) is a short term function that puts current tape status into the status buffer of the DSD controller. This function should be followed by a transfer status function (01H).

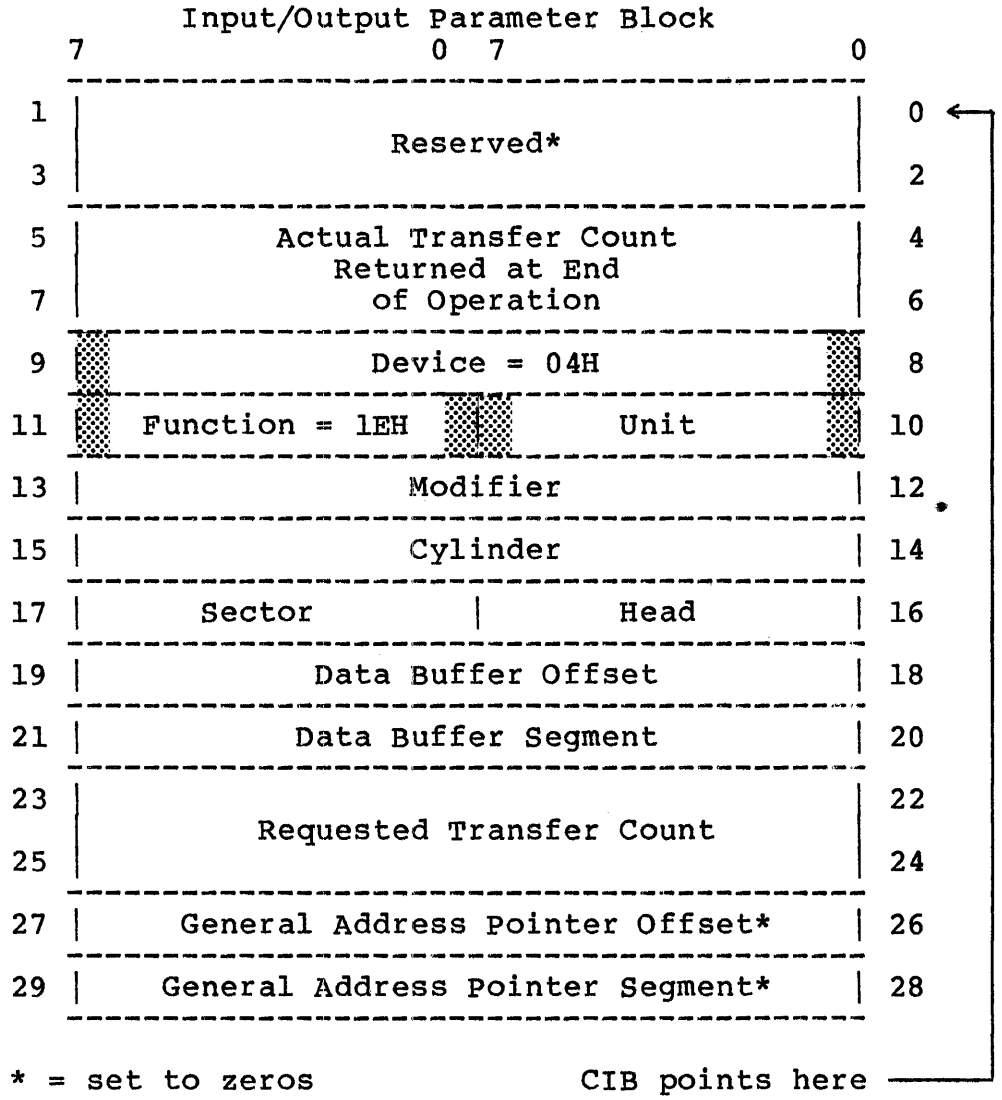

Figure 4-6. Read Tape Status (1EH)

4.6.2. Transfer Status (01H)

Transfer status (see Figure 4-7) is a short term function used to read the error status buffer from the controller's internal memory. The read tape status (1EH) function must first be used to place information describing function status or error information in the internal buffer.

The IOPB data buffer offset and segment specify the address in host memory where the data from the internal error status buffer are to be placed.

The 12 byte error status buffer (see Table 4-3) may contain three types of data as selected by the IOPB modifier field. The buffer may contain data about the function or error status of:

- The last short term function (modifier bit 6 = 0), or
- the last long term function at the time of the first interrupt (modifier bit 6 = 0), or
- current status of the last long term function (modifier bit 6 = 1).

Because the error status buffer is cleared by the controller at the beginning of all other functions, desired information must be read before each new function is invoked.

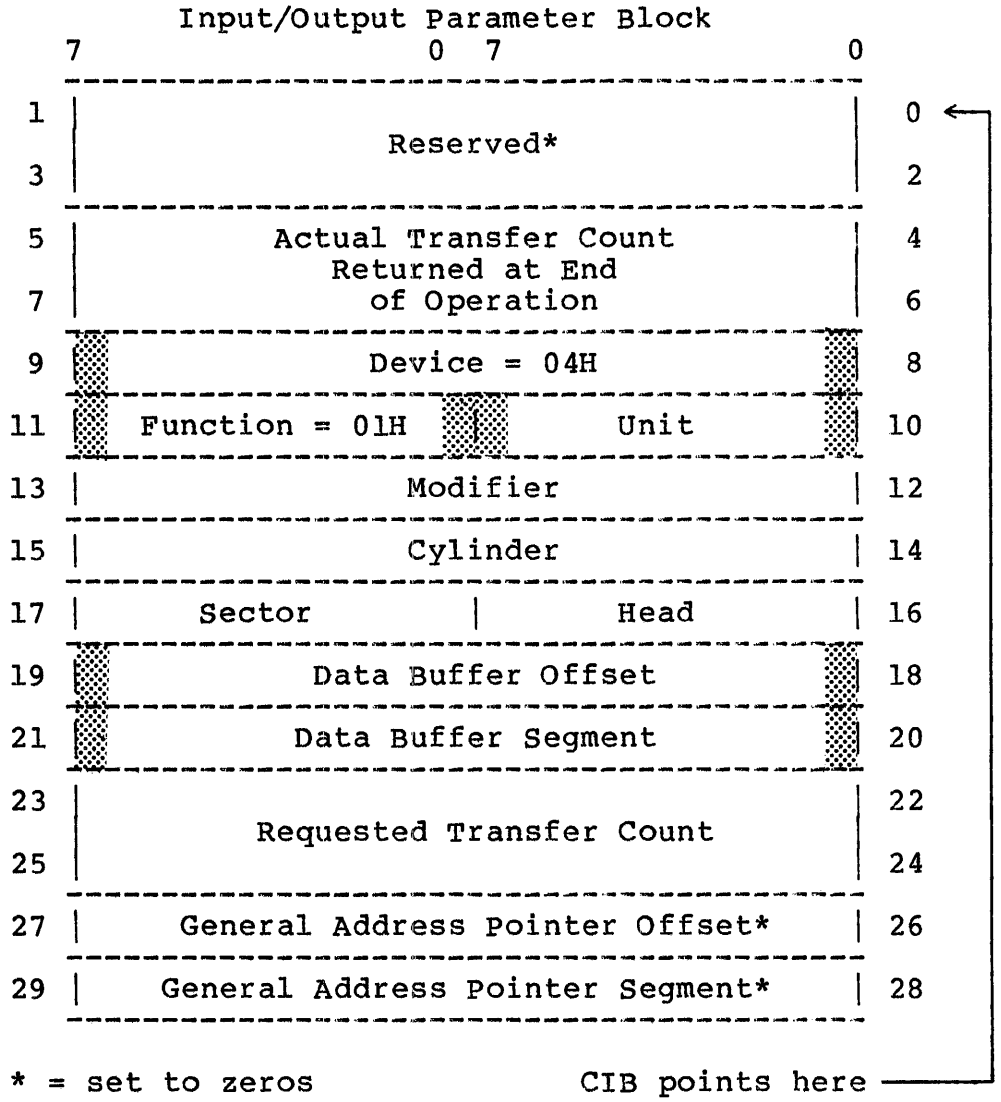

Figure 4-7. Transfer Status (01H)

Table 4-3. Error Status Buffer Definitions

Byte #	Definition	
0	Hard Error Byte	
	Bit: 7	End of tape (EOT).
	6	Illegal format or device code, unit not present, or wrong unit.
	5	Long term function in progress when another function was issued.
	4	Failed tape initialization function.
	3	Not used.
	2	Tape drive function rejected by tape drive controller.
	1	217 tape function rejected by 6217.
	0	DSD tape function rejected by 6217.
1	Hard Error Byte	
	Bit: 7	Tape cartridge write protected.
	6	Selected unit not ready.
	5	Invalid address.
	4	No tape cartridge in selected drive.
	3	Invalid function as defined by byte 0, bit 0, 1, or 2.
	2	Timeout occurred on tape function.
	1	Diagnostic fault.
	0	Length error: o No transfers requested, or o requested transfer count not divisible by 512, or o read or write function terminated as specified by other bytes.

(Continued)

Table 4-3. Error Status Buffer Definitions (continued)

Byte #	Definition
2	Soft Error Byte Bit: 7 — Not used. 6 — Buffer over/underrun: no data lost, but tape drive controller had to stop tape, rewind slightly, and bring tape up to speed before continuing. 5 — Broken tape or other drive fault. 4 — Not used. 3 — Unrecoverable data detected on tape. 2 — Not used. 1 — Recoverable data error: function completed through the use of retries. 0 — Not used.
3	Beginning of tape (BOT), FFH = true.
4	Not used.
5	File mark detected (FMD), FFH = true.
6, 7	Not used.
8	No data detected, FFH = true.
9, 10	Not used.
11	Number of retries. Byte value: 1 — Less than 8. 8 — Between 8 and 16: indicates probable media wear. 16 — Unrecoverable data: indicates media probably worn out.

4.7. Read/Write/Terminate Functions

There are six functions grouped in this section:

Read Data (04H)
Write Data (06H)
Read/Write Terminate (1FH)
Move Forward One Record (12H)
Move Forward One File (12H)
Write File Mark (14H)

4.7.1. Read Data (04H)

Read data (see Figure 4-8) is a short term function that transfers data from the tape drive to a host memory buffer. The IOPB unit field specifies the drive to be accessed.

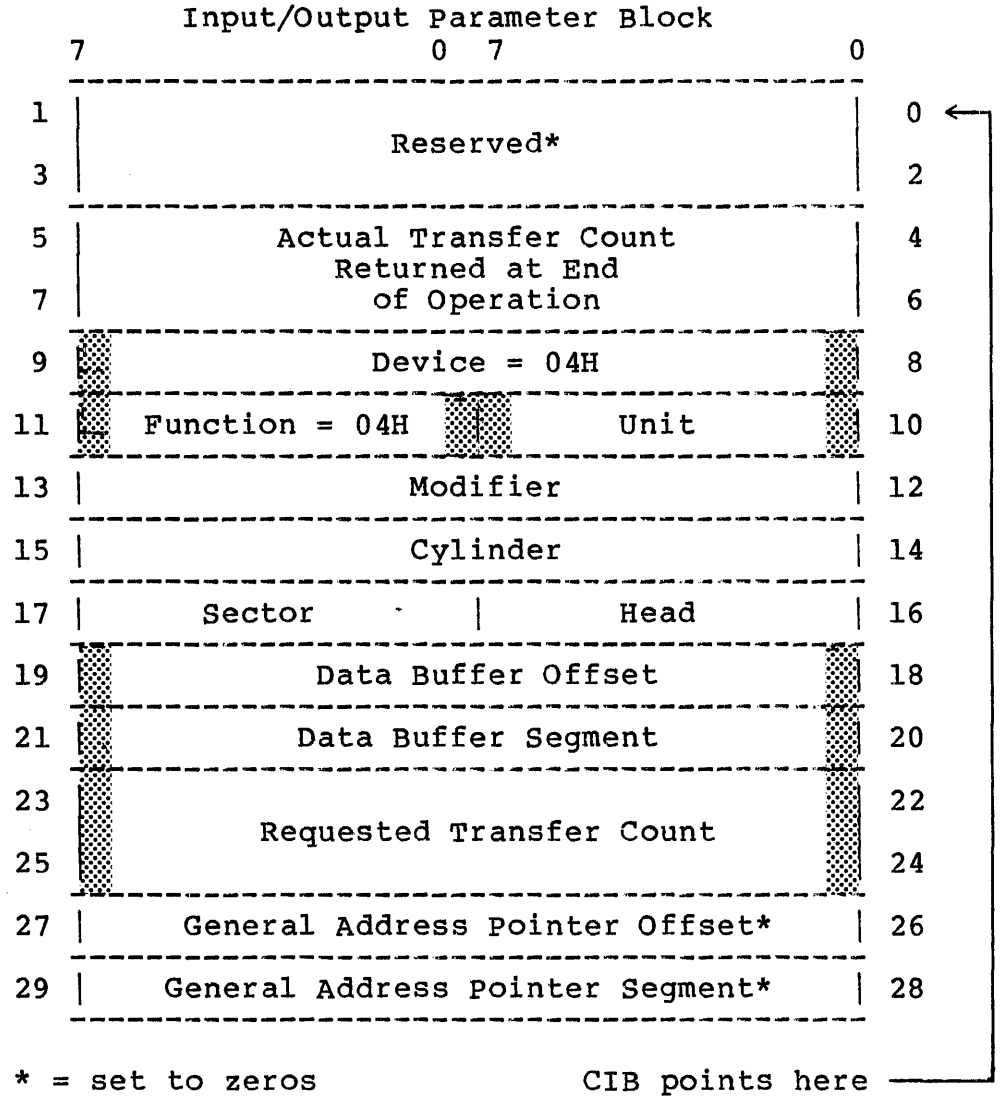

Figure 4-8. Read Data (04H)

The IOPB data buffer offset and segment specify the address of the buffer in host memory. Bytes are transferred consecutively from the on-board buffer to the sequentially accessed host memory.

The controller clears the actual transfer count field in the IOPB at the beginning of this function. The requested transfer count is placed in the IOPB for the controller to read. It must be divisible by 512.

If the data transfer rate falls below 200 Kb/sec during the read data function, the streaming mode cannot be maintained. In such a case, a buffer over/underrun error is posted to indicate that the tape drive controller had to stop and reposition the tape, and then continue the read data function. This is not an indication of bad data.

This function continues until one of three conditions is met:

- The actual transfer count equals the requested transfer count, or
- a file mark is encountered on the tape, or
- a Read/Write terminate function is encountered.

If the buffer area in host memory is too small to accommodate an entire file, it may be necessary to use a series of read data functions with small transfer counts. If the actual transfer count equals the requested transfer count before a file mark is encountered, a transfer status function would reveal a buffer over/underrun error.

If the actual transfer count equals the requested transfer count shortly before a file mark is encountered, a transfer status function does not return file mark status, because this value is not written until the next read data function is issued.

When the read data function continues until it is terminated by a file mark on the tape, the controller writes 89H in the operation status byte of the controller invocation block. 89H in the operation status byte indicates a tape drive summary error, and termination of the function.

If a transfer status function reveals the file mark byte and the length error bit set, this should be interpreted as a successful termination. This is a legal termination procedure, although it does use what are otherwise error messages to indicate a successful completion.

A read data function still in progress can be terminated by a read/write terminate function. A Read/Write terminate

function is legal only before the read data function terminates for other reasons.

When a read data function is terminated by a read/write function, it causes the drive to stop reading data and rewind to the BOT. In the error status buffer, this function posts a buffer over/underrun error, and sets the BOT byte. The over/underrun error does not indicate bad data.

If the tape drive controller detects bad data, it makes a maximum of 16 attempts to read the data. This action is transparent to the DSD controller and the host.

If the data is successfully read, byte 11 of the error status buffer indicates that retries were necessary, with an approximation of how many. A byte value of 1 indicates that less than seven retries were necessary. A byte value of 8 indicates that between 8 and 16 retries were necessary.

If the data cannot be read in 16 automatic attempts, an unrecoverable data error is posted. The value 16 is posted to byte 11.

A read data function issued on a blank tape will terminate after a few inches of tape have been accessed. These errors post:

- Length
- Recoverable data
- Unrecoverable data
- No data detected

4.7.2. Write Data (06H)

The write data function (see Figure 4-9) is a short term function that transfers data from a host memory buffer to a tape drive. The IOPB unit field specifies the drive to be accessed.

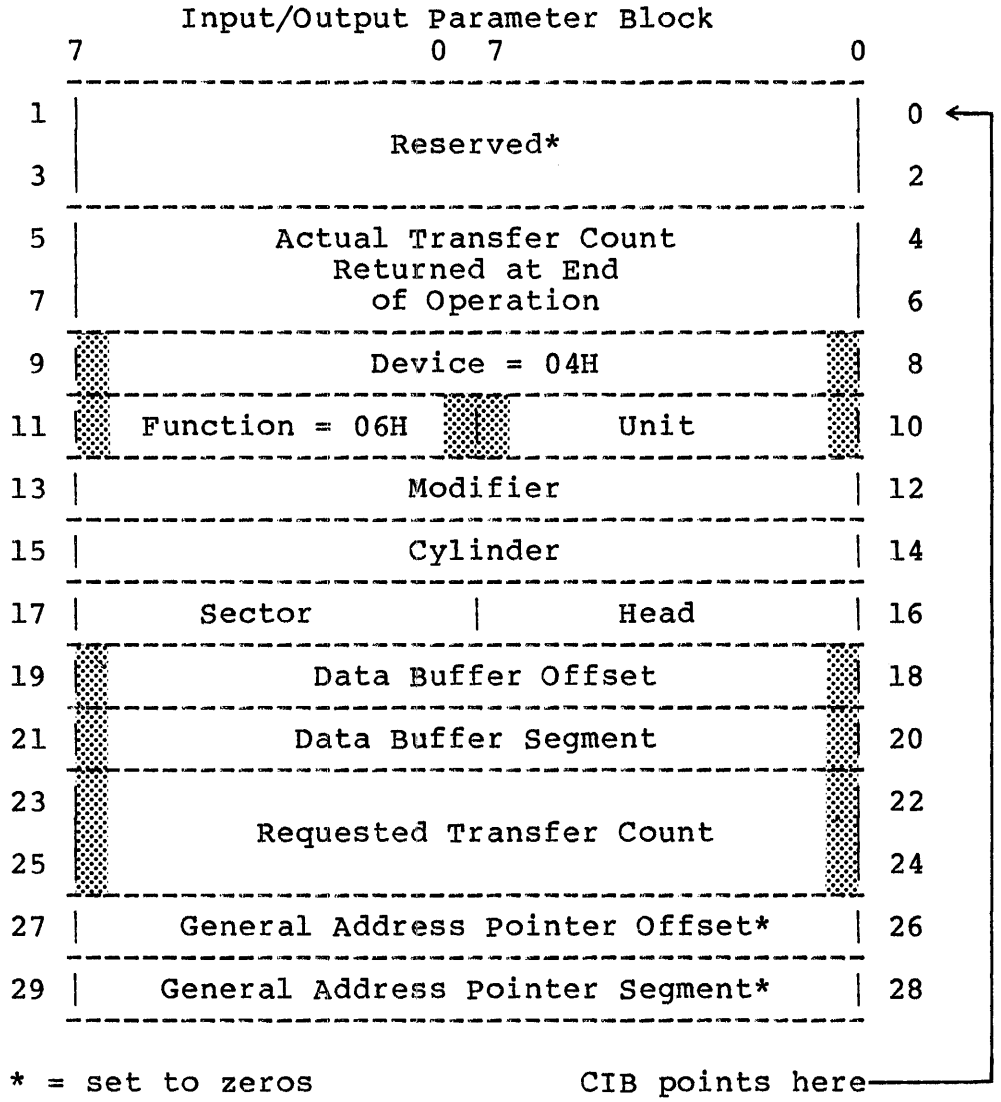

Figure 4-9. Write Data (06H)

The IOPB data buffer offset and segment specify the address of a buffer in host memory. The host memory is sequentially accessed. Bytes are transferred consecutively into the on-board buffer and then written to the tape.

The controller clears the actual transfer count field in the IOPB at the beginning of this function. The requested transfer count is placed in the IOPB for the controller to read. It must be divisible by 512.

This function continues until the actual transfer count equals the requested transfer count, or a read/write terminate function is encountered.

If the buffer area in host memory is too small to accommodate an entire file, it may be necessary to use a series of write data functions with small transfer counts, until the entire file has been transferred. The series of write data functions must be terminated by an Archive read/write terminate function. A read/write terminate function is legal only before the write data function terminates for other reasons.

When a write data function is terminated by a read/write function, it causes the drive to stop writing data, write a file mark, and then rewind to BOT. In the error status buffer, this function posts a buffer over/underrun error, and sets the BOT byte. The over/underrun error does not indicate bad data.

If the tape drive controller detects bad data, it makes a maximum of 16 attempts to write the data. This action is transparent to the DSD controller and the host.

If the data is successfully written, byte 11 of the error status buffer indicates that retries were necessary, with an approximation of how many. A byte value of 1 indicates that less than seven retries were necessary. A byte value of 8 indicates that between 8 and 16 retries were necessary.

If the data cannot be written in the 16 automatic attempts, an unrecoverable data error is posted. The value 16 is posted to byte 11.

If the data transfer rate falls below 200 Kb/sec during the write function, the streaming mode cannot be maintained. In such a case, a buffer over/underrun error is posted to indicate that the tape drive controller had to stop and rewind the tape, and bring it up to speed before continuing the write data function.

4.7.3. Read/Write Terminate (1FH)

The read/write terminate (see Figure 4-10) function terminates a read or write function in progress. This function is legal only before a read or write function terminates for other reasons.

This function causes the drive to stop reading data and rewind to BOT. If the function being terminated by the read/write termination was write data (06H), a filemark is automatically written before the tape rewinds.

In the error status buffer, this function posts a buffer over/underrun error and sets the BOT byte. The over/underrun error does not indicate bad data.

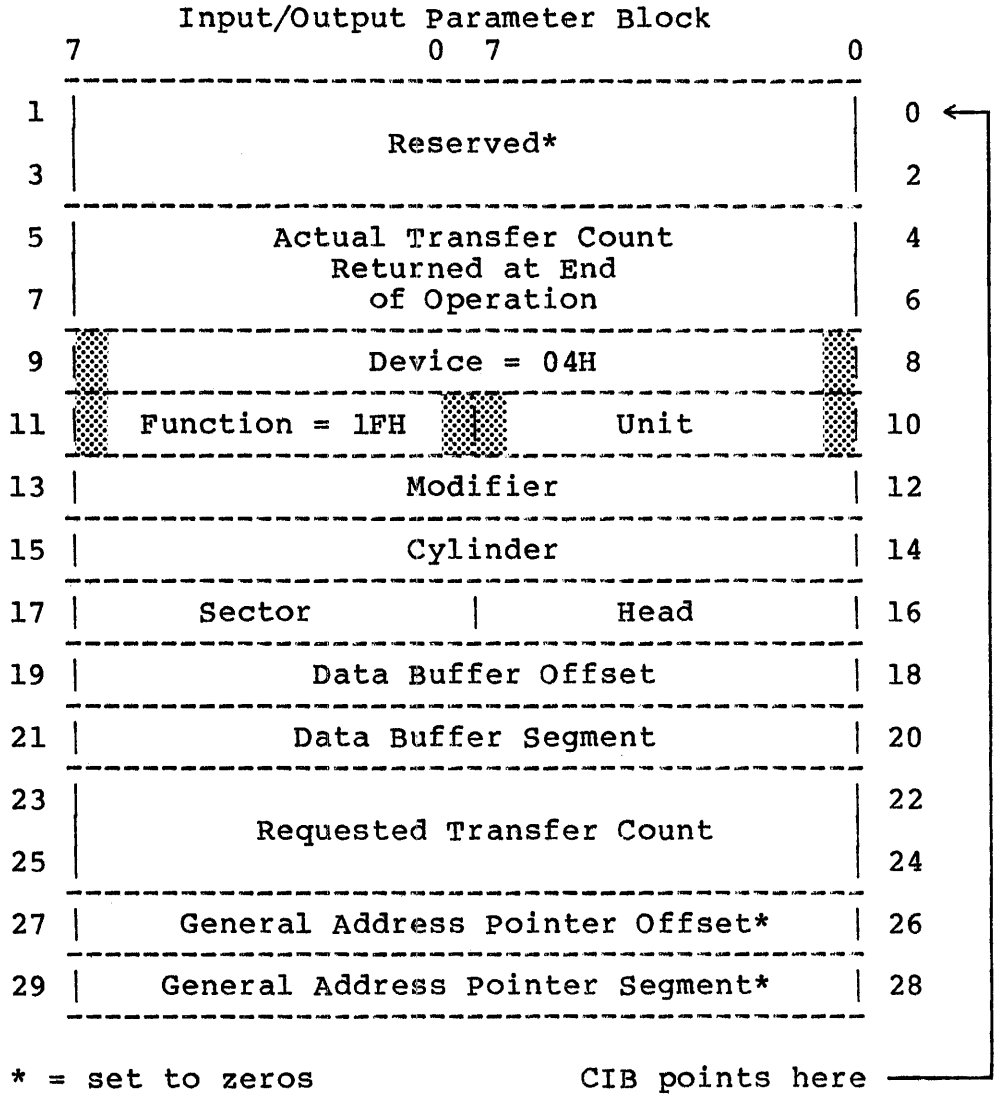

Figure 4-10. Read/Write Terminate (1FH)

4.7.4. Move Forward One Record (1AH)

Move forward one record (see Figure 4-11) is a short term function that moves the tape forward seeking an interblock gap.

The function terminates when one of four conditions is met:

- An interblock gap is encountered, or
- a file mark is detected (FMD bit set in error status buffer), or
- the end of tape is encountered (EOT bit set in error status buffer), or
- the function times out on a blank tape (time-out bit set).

Time out occurs after the time needed for 32 data blocks to pass has elapsed.

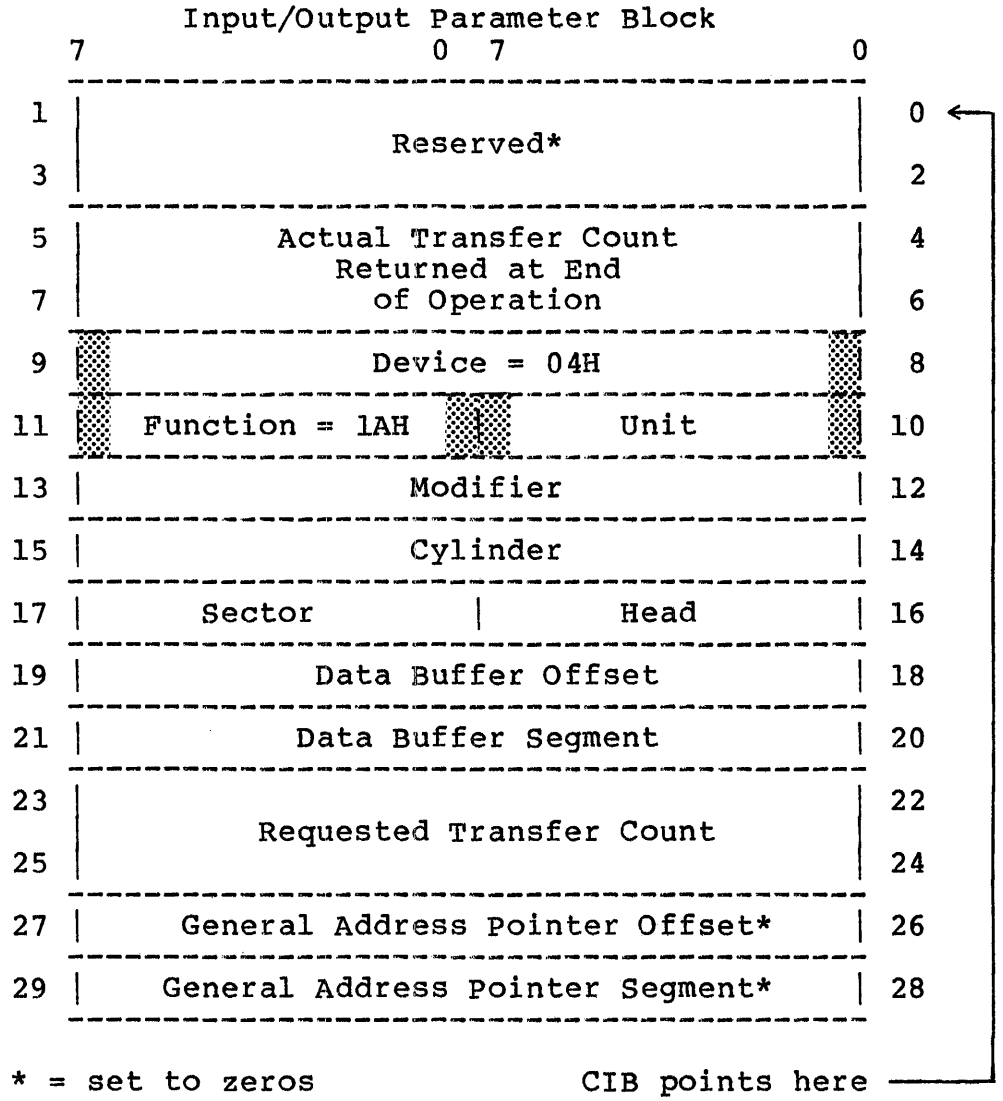

Figure 4-11. Move Forward One Record (1AH)

4.7.5. Move Forward One File (12H)

Move forward one file (see Figure 4-12) is a long term function that causes the tape to advance until a file mark is encountered, or the end of media is reached. When a file mark has been found, the FMD bit is set in the error status buffer.

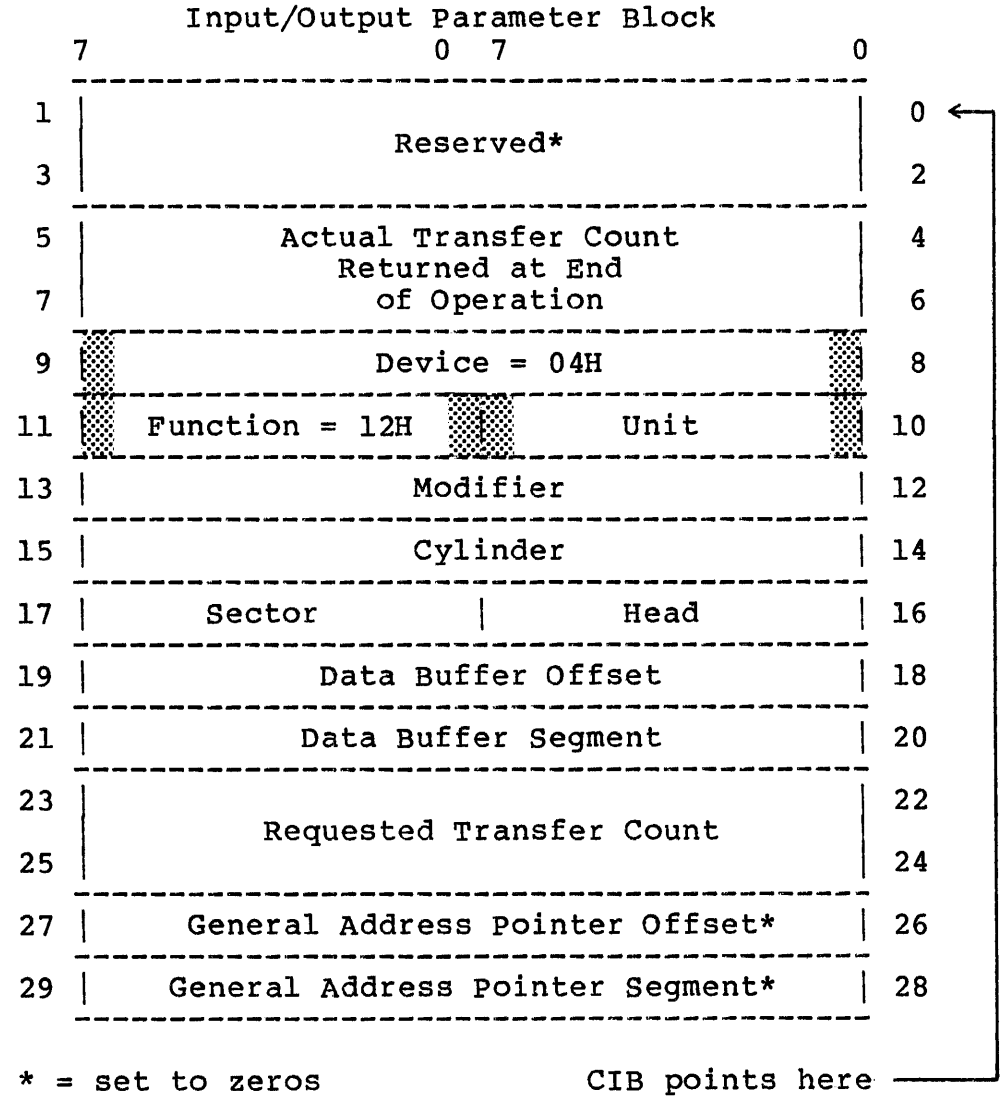

Figure 4-12. Move Forward One File (12H)

4.7.6. Write File Mark (14H)

Write file mark (see Figure 4-13) is a short term function that writes a file mark on the tape. The IOPB function field value for this function is 14H. The value in the unit field can range from 0 to 3.

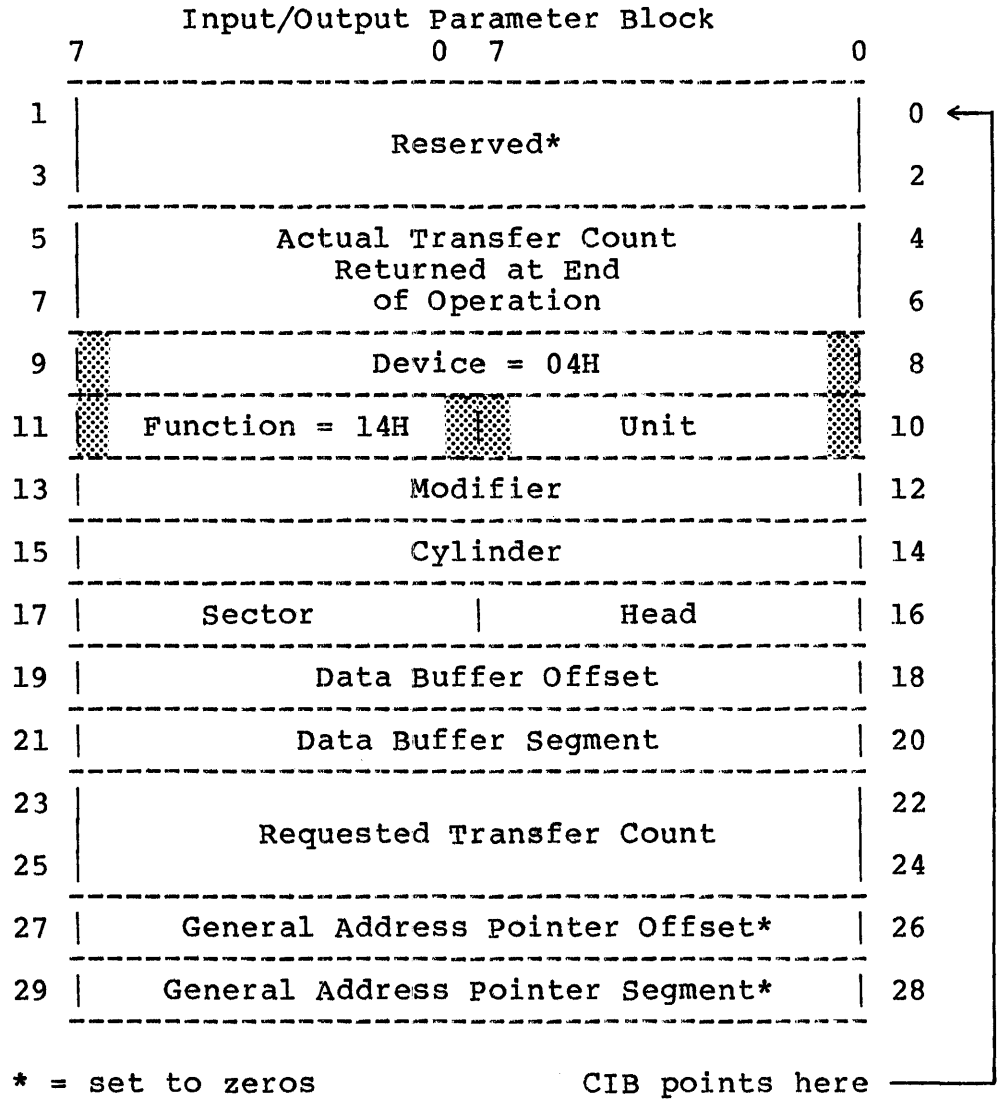

Figure 4-13. Write File Mark (14H)

4.8. Utility Functions

Retension, rewind, and erase tape are offered as utility functions.

4.8.1. Retension Tape (1DH)

Retension tape (see Figure 4-14) is a long term function that causes the tape to fast forward to EOT and then rewind to BOT. This function attempts to improve the condition of the tape in the cartridge.

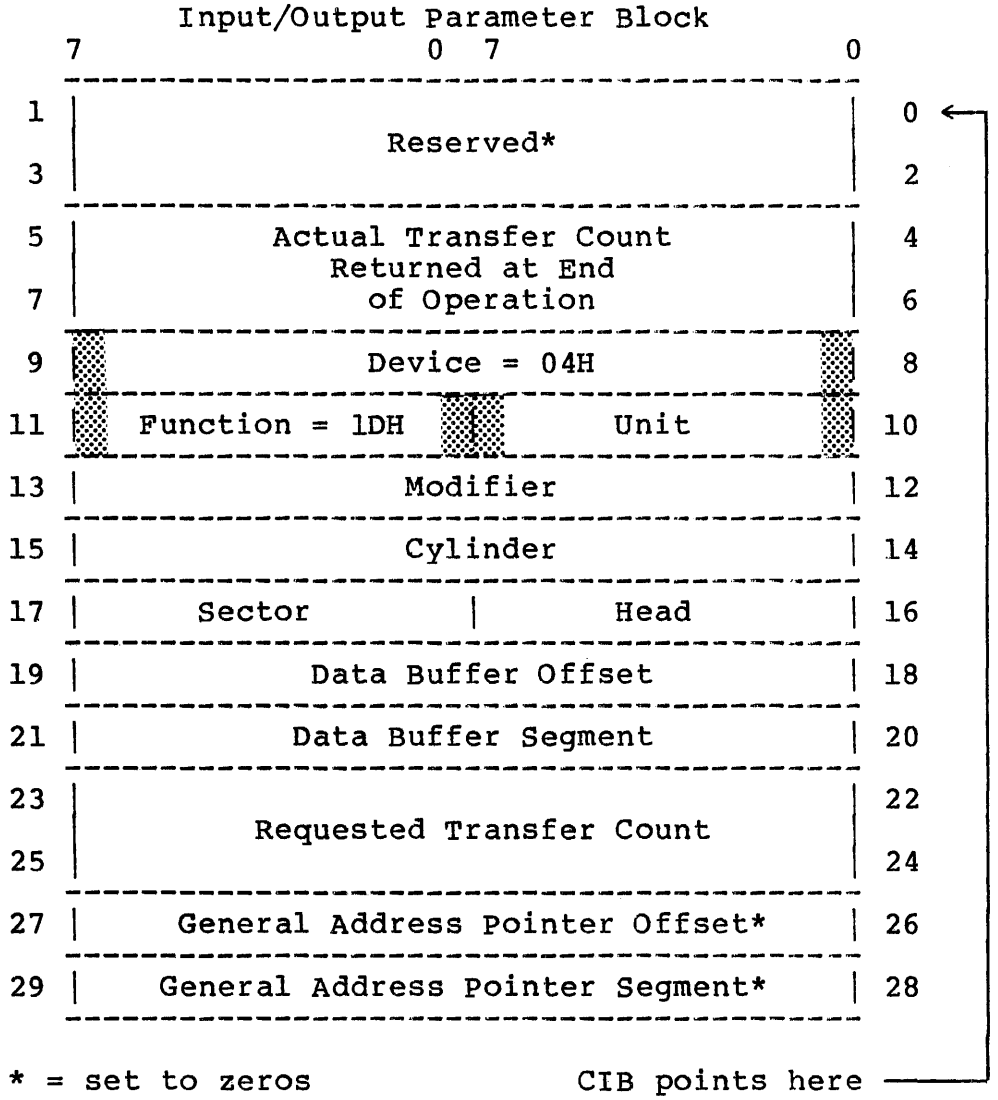

Figure 4-14. Retension Tape (1DH)

4.8.2. Rewind Tape (11H)

Rewind tape (see Figure 4-15) is a long term function used to place the tape in a known position. This is done by rewinding the tape to BOT position and setting the BOT bit in the status buffer.

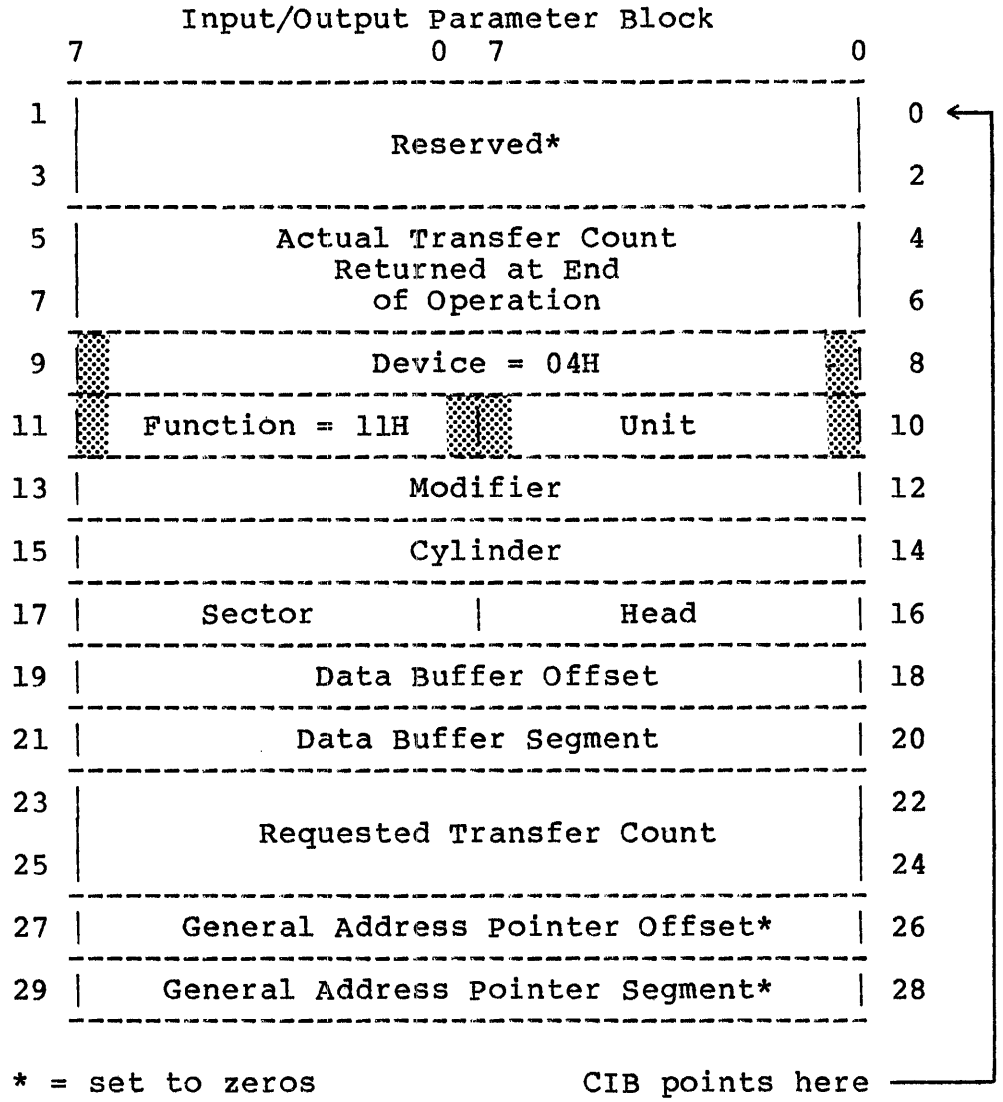

Figure 4-15. Rewind Tape (11H)

4.8.3. Erase Tape (17H)

Erase tape (see Figure 4-16) is a long term function that moves the tape to BOT, erases until EOT is reached, and then rewinds the tape to BOT again.

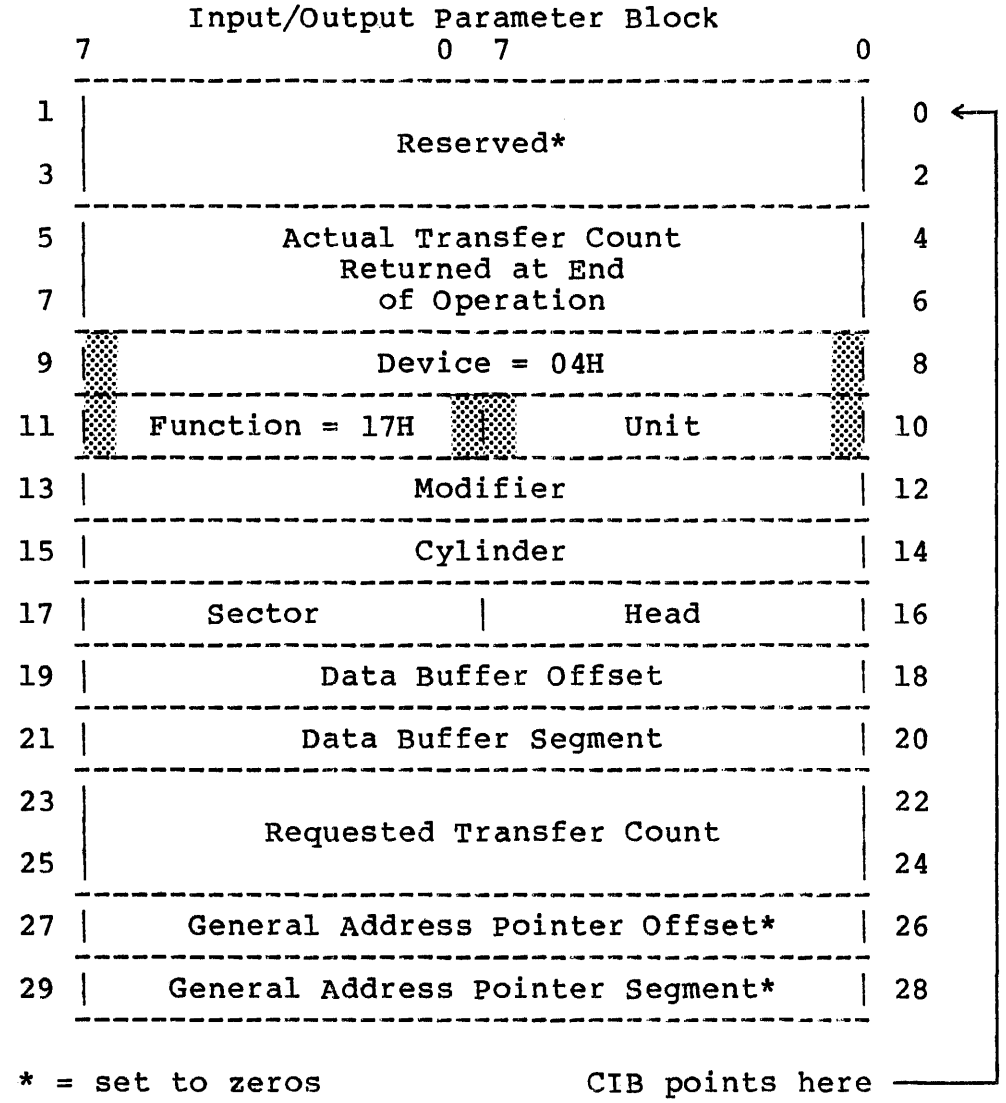

Figure 4-16. Erase Tape (17H)