IBM System Storage Tape Drive 3592

SCSI Reference

Note:
Before using this information and the product it supports, be sure to read the general information under *Notices*.

Fourth Edition (25 May 2012)

This edition applies to the IBM TotalStorage Enterprise TS1140 Tape Drive, IBM TotalStorage Enterprise TS1130 Tape Drive, IBM System Storage TS1120 Tape Drive, IBM TotalStorage 3592 Tape System, and to all subsequent releases and modifications until otherwise indicated in new editions.

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Clause 0. Summary of Changes

The *IBM System Storage Tape Drive 3592 SCSI Reference* is the update to include support for the IBM TotalStorage Enterprise Tape Drive 3592 Model E06. The first edition of this book is the update to:

a) the *IBM System Storage TS1120 Tape Drive 3592 SCSI Reference; and*
b) the *TotalStorage Enterprise Tape System 3592 SCSI Reference.*

The title changed from *TotalStorage Enterprise Tape System 3592 SCSI Reference* to *IBM System Storage TS1120 Tape Drive 3592 SCSI Reference* for rebranding purposes and has now changed to *IBM System Storage Tape Drive 3592 SCSI Reference* since this document is not intended to be a marketing publication.

0.1 Revision History

0.1.1 The first edition (TotalStorage Enterprise Tape System 3592 SCSI Reference)

The first edition of the *TotalStorage Enterprise Tape System 3592 SCSI Reference*, released for the initial GA, provided basic SCSI command interface communication information for the IBM TotalStorage Enterprise Tape Drive 3592.

0.1.2 The second edition (TotalStorage Enterprise Tape System 3592 SCSI Reference)

The second edition of the *TotalStorage Enterprise Tape System 3592 SCSI Reference* was updated to include support for WORM and ECONOMY cartridges.

0.1.3 The third edition (IBM System Storage TS1120 Tape Drive 3592 SCSI Reference)

The third edition of the *TotalStorage Enterprise Tape System 3592 SCSI Reference* was updated to include support for the *IBM TotalStorage Enterprise Tape Drive 3592 Model E05* and was renamed to *IBM System Storage TS1120 Tape Drive 3592 SCSI Reference* and was called the first edition.

0.1.4 The fourth edition (IBM System Storage Tape Drive 3592 SCSI Reference)

The fourth modification is called *IBM System Storage Tape Drive 3592 SCSI Reference* and includes support for the *IBM TotalStorage Enterprise Tape Drive 3592 Model E06* also known as the *IBM TotalStorage Enterprise TS1130 Tape Drive.*

This is called the first edition of the IBM System Storage Tape Drive 3592 SCSI Reference.

0.1.5 The fifth edition (IBM System Storage Tape Drive 3592 SCSI Reference)

The fifth modification is called the second edition of the IBM System Storage Tape Drive 3592 SCSI Reference.

This edition contains the following Functional Change Requests (FCR):

FCR 3163r3 - IP Address Information Configuration;
FCR 3187 - SPIN & SPOUT (OOBE-KMIP-SSC-4);
FCR 3189 - Extended Write-Read Diagnostics;
FCR 3190r2 - SDTF MAM parameters (LTFS);
FCR 3193 - End of partition behavior control;
FCR 3197 - Update standard inquiry version field;
FCR 3205 - Drive Type in Inquiry C0h;

FCR 3208 - Logical block protection;

FCR 3209r2 - Jag4 Partitioning;

FCR 3213r1 - Jag4 SCSI Identifiers;

FCR 3215 - Jag Report Supported OpCodes;

FCR 3217 - Jaguar Programmable Early Warning;

FCR 3218 - J4 Volume statistics log page (17h);

FCR 3223 - Jag4 4 TB operating point;

This revision contains additions and corrections related to the following defects (fnnnn defects are Functional Change Requests (FCR)):

f3176r2	Encryption Configuration mode page 30h[20h]
f3178r3	Jag4 SkipSync Enhancements
f3178r4	SkipSync Policy limitation
f3179r3	Append-only mode (data-safe)
f3205r1	Drive type in inquiry C0h
f3208	FCR-3208: Logical block protection (E2E CRC)
f3208r1	Logical block protection - break out VERIFY
f3209r3	Jag4 Partitioning refinements
f3215r1	Jag Report Supported Operation Code
f3226	Add support for Verify command to Jaguar products (Jag2 - Jag4)
f3227	Make OIR bit saveable
f3228	Log Page 0Ch updated from standard
f3229	Deferred Check Condition (DCC) affinity
f3235	Manufacture assigned serial number VPD page (B1h)
f3236	Sequential-access Device Capabilities VPD page (B0h)
f3237	Read Block Limits MLOI
f3240	LP17 Remaining Native Capacity
31638	Minimum code level for LBP support needs listed
31562	Jag SCSI Ref: ASC/ASCQ EE31 missing from Annex B (Err Sns Info)
22192	BENCH: Documentation Missing Error Sns asc/ascq 05/4900

0.2 Do You Have Comments or Suggestions?

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Clause 1. Preface

1.1 Organization

The information in this book is presented as follows:

Clause 0. Summary of Changes, lists a summary of changes to this document including references to its predecessors which carried a different name.

Clause 1. Preface, describes the organization of this document and provides references to related documents.

Clause 2. Definitions, symbols, abbreviations, and conventions, describes words, terms, and conventions used in this book.

Clause 3. Introduction, describes the tape system.

Clause 4. Implementation Considerations, describes the SCSI implementation considerations.

Clause 5. SCSI Commands, describes the SCSI commands supported for the 3592 tape drive.

Clause 6. Parameters for SCSI Commands, describes the parameters transferred with SCSI commands

Annex A. Protocol Implementation Notes, describes the SCSI/Fibre Channel protocol implementation choices.

Annex B. Error Sense Information, provides all error sense information reported by the TotalStorage devices.

Annex C. Product Comparisons, summarizes product differences between various IBM tape drive offerings.

Annex D. Sample C program to generate Reed-Solomon CRC, provides sample code for the Reed-Solomon CRC used in logical block protection.

1.2 Related Information

1.2.1 IBM 3592 Publications

For additional information about the 3592 subsystem, refer to:

a) *IBM TotalStorage Tape System 3592 Operator Guide*, GA32-0465
b) *IBM TotalStorage Tape System 3592 Introduction and Planning Guide,*GA32-0464
c) *IBM TotalStorage Tape System 3592 Silo Compatible Frame Introduction, Planning, and User Guide*, GA32-0463
d) *IBM General Information Installation Manual-Physical Planning*, GC22-7072

1.2.2 IBM 3590 Publications

For additional information about the 3590 subsystem, refer to:

a) *IBM TotalStorage Tape System 3590 Hardware Reference*, GA32-0331
b) *IBM TotalStorage Tape System 3590 Operator Guide*, GA32-0330
c) *IBM TotalStorage Tape System 3590 Introduction and Planning Guide,* GA32-0329
d) *IBM TotalStorage Tape System 3590 Silo Compatible Frame Introduction, Planning, and User Guide*, GA32-0366
e) *IBM General Information Installation Manual-Physical Planning*, GC22-7072

1.2.3 IBM 3494 Tape Library Dataserver Publications

For additional information about the 3494 Tape Library Dataserver, refer to:

a) *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448
b) *IBM TotalStorage Enterprise Automated Tape Library (3494) Operator's Guide*, GA32-0449
c) *IBM Magstar 3494 Tape Library Physical Planning Template*, GX35-5049
d) *IBM 3494 User's Guide: Media Library Device Driver for AS/400*, GC35-0153

1.2.4 pSeries and RS/6000 Publications

For additional information about RS/6000(R) systems, see:

a) *AIX Getting Started*, GC23-2521
b) *Site and Hardware Planning Information*, SA38-0508

1.2.5 IBM iSeries - AS/400 Publications

For additional information about iSeries(TM) or AS/400(R) systems, visit the infocenter at http://publib.boulder.ibm.com/pubs/html/as400/infocenter.html

1.2.6 Standards Publications

a) *American National Standard Institute Small Computer System Interface X3T9.2/86-109 Revision 10h X3T39/89-042*
b) *Fibre Channel Arbitrated Loop (FC-AL-2)* published by the American National Standards Institute (ANSI). Final draft available as NCITS 332:1999 on the web at http://www.t11.org

c) *Fibre Channel Tape and Tape Medium Changers (FC-TAPE)*, published by the American National Standards Institute (ANSI). Final draft available as NCITS TR-24:1999 on the web at http://www.t11.org; actual document available from ANSI as NCITS TR-24:1999
d) *Fibre Channel Protocol-2 (FCP-2)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org
e) *SCSI-3 Architectural Model (SAM)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org; actual document available from ANSI as X3.270:1996
f) *SCSI Architectural Model-2 (SAM-2)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org
g) *SCSI Architectural Model-3 (SAM-3)*, published by the American National Standards Institute (ANSI). Working draft available on the web at http://www.t10.org
h) *SCSI Primary Commands (SPC)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org; actual document available from ANSI as X3.301:1997
i) *SCSI Primary Commands-2 (SPC-2)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org; actual document available from ANSI as NCITS.351:2001
j) *SCSI Primary Commands-3 (SPC-3)*, published by the American National Standards Institute (ANSI). Working draft available on the web at http://www.t10.org
k) *SCSI-3 Stream Commands (SSC)*, published by the American National Standards Institute (ANSI). Final draft available on the web at http://www.t10.org; actual document available from ANSI as NCITS.335-2000
l) *SCSI Stream Commands-2 (SSC-2)*, published by the American National Standards Institute (ANSI). Working draft available on the web at http://www.t10.org

1.3 Related Software Information

For information regarding software related to the IBM(R) TotalStorage Enterprise Tape Subsystems, refer to:

a) *AIX Parallel and ESCON Channel Tape Attachment/6000 Installation and User's Guide*, GA32-0311
b) *Basic Tape Library Support User's Guide and Reference*, SC26-7016
c) *Environmental Record Editing and Printing (EREP) Program User's Guide and Reference*, GC28-1378
d) *z/OS DFSMS Software Support for IBM TotalStorage Tape System 3592*, SC26-7514
e) *DFSMS/MVS Version 1 Release 5: General Information*, GC26-4900
f) *DFSMS/MVS Version 1 Release 5: Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC26-3051
g) *DFSMS/MVS Version 1 Release 5: Object Access Method Application Programmer's Reference*, SC26-4917
h) *DFSMS/MVS Version 1 Release 3: Master Index*, GC26-4904
i) *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154, available only online at ftp://ftp.software.ibm.com/storage/devdrvr/Doc/
j) *IBM TotalStorage Tape Device Drivers Programming Reference*, GC35-0346, available only online at ftp://ftp.software.ibm.com/storage/devdrvr/Doc/

1.4 Log Parameters

Log parameters are used in relation to *Log Select - 4Ch (see 5.2.7 on page 150)* commands and *Log Sense - 4Dh (see 5.2.8 on page 152)* commands.

1.4.1 Log Page Format

Each log page begins with a four-byte page header followed by zero or more variable-length log parameters defined for that log page. The log page format is defined in *table 1*.

Table 1 — Log page format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF	Page Code					
1	Subpage Code							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
	Log parameter(s) *(see 1.4.2 on page 6)*							
4	Log parameter (First) (Length x)							
x+3								
	. .							
n-y+1	Log parameter (Last) (Length y)							
n								

If the SPF bit is set to 0 then the Subpage Code field is reserved and is set to zero. If the SPF bit is set to one, then the subpage format is being used and the Subpage Code field is used to determine which log parameters are to be returned.

1.4.2 Log Parameter Format

Each log parameter begins with a 4-byte parameter header, followed by 1 or more bytes of parameter data. *Table 2* shows the log parameter format. The fields of byte 2 are described under *clause 1.4.2.1*.

Table 2 — Log Parameter Format

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	MSB	Parameter Code						
1								LSB
2	DU	DS	TSD	ETC	TMC		Reserved	LP
3	Parameter Length (n-3)							
4	MSB	Parameter Value						
n								LSB

1.4.2.1 Log Parameter Byte 2 — Control Byte

A Log Parameter Control Byte is returned for each parameter code described in the log pages. The Log Parameter Control Byte is described here one time only. Any parameters using a different Log Parameter Control Byte have that byte described within that parameter.

The contents of this byte are constant; the user cannot set these values. This byte is part of the returned data described in the SCSI standard; it is described in the following list:

Bit	**Description**
7	DU (Disable Update): 0b
6	DS (Disable Save): 1b
5	TSD (Target Save Disable): 1b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1	Reserved
0	LP (List Parameter): 0b (indicates this is a log counter)

1.4.3 General Log Parameter Reset Behavior

Unless otherwise specified, each log counter is reset when read by the Log Sense command. Specific exceptions include Pages 30h, 37h, and 3Dh. Several pages have values which are reset at load time, as specified.

> The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

1.4.4 LP 00h: Supported Log Pages

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This log page returns the list of log pages supported. There may be log pages which can be read or reset which are not included in this list. Such pages are for engineering or manufacturing use and are not intended for general use. This page does not contain any log parameters.

Byte	Description
0	**Bit** / **Description** 7-6 Reserved 5-0 Page Code (000000b)
1	Reserved
2-3	Page Length (n-3)
4-n	Supported Log Pages: This field is a list of 1-byte log page codes and may include some or all of the following:

Code	Log Page
00h	LP 00h: Supported Log Pages (see 1.4.4 on page 8)
02h	LP 02h: Write Error Counters (see 1.4.5 on page 9)
03h	LP 03h: Read Error Counters (see 1.4.6 on page 10)
06h	LP 06h: Non-Medium Errors (see 1.4.7 on page 11)
0Ch	LP 0Ch: Sequential-Access Device (see 1.4.8 on page 12)
17h	LP 17h: Volume Statistics (see 1.4.9 on page 13)
2Eh	LP 2Eh: TapeAlerts (see 1.4.10 on page 25)
30h	LP 30h: Tape Usage (see 1.4.11 on page 28)
31h	LP 31h: SIM/MIM (see 1.4.12 on page 29)
32h	LP 32h: Write Errors (see 1.4.13 on page 33)
34h	LP 34h: Read Forward Errors (see 1.4.14 on page 35)
36h	LP 36h: Read Backward Errors (see 1.4.15 on page 37)
37h	LP 37h: Performance Characteristics (not J1A) (see 1.4.16 on page 38)
38h	LP 38h: Blocks/Bytes Transferred (see 1.4.17 on page 49)
39h	LP 39h: Host Port 0 Interface Errors (see 1.4.18 on page 51)
3Ah	LP 3Ah: Host Port 1 Interface Errors (see 1.4.19 on page 52)
3Bh	LP 3Bh: Equipment Check Errors (see 1.4.20 on page 53)
3Ch	LP 3Ch: Drive Control Statistics (see 1.4.21 on page 54)
3Dh	LP 3Dh: Subsystem Statistics (see 1.4.22 on page 55)

NOTE 1 - *LP 3Eh: Engineering Use* is for engineering use only and is not reported as a supported log page, but can be used with Log Sense and Log Select commands.

1.4.5 LP 02h: Write Error Counters

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is for Write Errors.

1.4.5.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.5.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 3 — Write Error Counters log parameter codes

Code	Counter: Description	Size
0002h	**Total Write Errors {02h:0002h}:** The sum of the Total Corrected Write Errors and Total Uncorrected Write Errors	2
0003h	**Total Corrected Write Errors {02h:0003h}:** These errors are corrected by ECC and do not require error recovery procedures (ERPs). Each count represents one block in error that was corrected and written.	2
0005h	**Total Write Kilobytes Processed {02h:0005h}:** Each count represents a kilobyte (1024 bytes) of data processed across the host interface during write-type commands. The count does not include ERP retries. This field is identical to the Host Write Kilobytes Processed field of Page Code 38h, parameter code 0001h.	4
0006h	**Total Uncorrected Write Errors {02h:0006h}:** The total number of write errors that could not be corrected by ECC, no servo error was reported, and the error was not a transient error. Each count represents one block in error that was not corrected, but was recovered by ERPs and successfully written.	2

1.4.6 LP 03h: Read Error Counters

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is for Read Errors.

1.4.6.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.6.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 4 — Read Error Counters log parameter codes

Code	Counter: Description	Size
0002h	**Total Read Errors {03h:0002h}:** The sum of the Total Corrected Read Errors and the Total Uncorrected Read Errors.	2
0003h	**Total Corrected Read Errors {03h:0003h}:** These are errors that are corrected by ECC and do not require error recovery procedures (ERPs). Each count represents one block in error that was corrected and read.	2
0005h	**Total Read Kilobytes Processed {06h:0005h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during read-type commands. The count does not include ERP retries. This field is identical to the Host Read Kilobytes Processed field of Page Code 38h, parameter code 0003h.	4
0006h	**Total Uncorrected Read Errors {03h:0006h}:** The total number of read errors that could not be corrected by ECC, no servo error was reported, and the error was not a transient error. Each count represents one block in error that was not corrected, but was recovered by ERPs and successfully read.	2

1.4.7 LP 06h: Non-Medium Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page sums the occurrences of error events other than write or read failures. Parameter codes do not discriminate among the various types of events.

1.4.7.1 Parameter Reset Behavior

1.4.7.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 5 — Non-Medium Errors log parameter codes

Code	Counter: Description	Size
0000h	**Total Non-Medium Error Count {06h:0000h}:**	4

1.4.8 LP 0Ch: Sequential-Access Device

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is for counters specific to tape drives.

1.4.8.1 Parameter Reset Behavior

1.4.8.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

Table 6 — LP 0Ch: Sequential-Access Device log parameters

Code	Counter: Description	Length
0000h	**Total Channel Write Bytes {0Ch:0000h}:** The total number of bytes of data written from the host on this mount.	6
0001h	**Total Device Write Bytes {0Ch:0001h}:** The total number of bytes of data written to tape on this mount, not counting ECC and formatting overhead. This is the number of data bytes after compression.	6
0002h	**Total Device Read Bytes {0Ch:0002h}:** The total number of bytes of data read from tape on this mount, not counting ECC and formatting overhead. This is the number of compressed data bytes read from media before decompression.	6
0003h	**Total Channel Read Bytes {0Ch:0003h}:** The total number of bytes of data read to the host on this mount.	6
0004h	**Approximate native capacity from BOP to EOD {0Ch:0004h}:** This is in megabytes (i.e., 10^6). This is not sensitive to the current position of the medium. The approximate native capacity between EOD and EW is the difference of parameter 0005h and this parameter. Conditions may occur that reduce the amount of data that is written before reaching EW. EOD may be beyond LEOP. A value of all bits set to one indicates that this information is invalid (e.g., no volume is mounted, EOD information needs to be rebuilt).	4
0005h	**Approximate native capacity between BOP and EW of the current partition {0Ch:0005h}:** This is in megabytes (i.e., 10^6). If no volume is mounted or this value is unknown the device server shall set all bits in this parameter to one.	4
0006h	**Minimum native capacity between EW and LEOP of the current partition {0Ch:0006h}:** This is in megabytes (i.e., 10^6). If no volume is mounted the device server shall set all bits in this parameter to one.	4
0007h	**Approximate native capacity from BOP to the current position of the medium {0Ch:0007h}:** This is in megabytes (i.e., 10^6). If no volume is mounted the device server shall set all bits in this parameter to one.	4
0008h	**Maximum native capacity that is currently allowed to be in the device object buffer {0Ch:0008h}:** This is in megabytes (i.e., 10^6). This value may change depending on the current position of the medium (e.g., available native capacity may decrease as the current position of the medium approaches LEOP).	4
0100h	**Cleaning Requested {0Ch:0100h}:** A non-zero value indicates a cleaning action is requested by the drive.	1
8003h	**Remaining Capacity {0Ch:8002h}:** Nominal remaining unwritten capacity of the mounted media in bytes. This is not sensitive to current position. NOTE 2 - When the tape does not have a valid EOD, or if a tape is not loaded, a value of ’all ones’ (-1) is returned.	6

1.4.9 LP 17h: Volume Statistics

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page contains non-volatile information relating to volume usage.

The Volume Statistics log page is included in device models 3592 E06 and later. It is not included in earlier generation drives.

The Volume Statistics log page *(see table 7)* defines data parameters associated with utilization of the tape volume and the medium within the volume. Volume statistics for the most recent mounted volume are reported in the volume Statistics log page parameters. Volume statistics for previously mounted volumes may be reported in Volume Statistics log subpages *(see table 8)*. A device server that implements the Volume Statistics log page shall implement support for the most recent mounted volume and the defined parameters as shown in *table 9*. The parameters shall not be set to zero or changed with the use of a LOG SELECT command.

If a supported log subpage is requested for a mount which has not occurred, then all bytes in the parameter data fields shall be set to 00h.

The device server resets all volume statistics log parameter data fields to 00h after a hard reset.

NOTE 3 - An application client may detect if parameter values in the page are valid by testing for parameter value 0000h, (i.e., page valid) set to zero.

Table 7 — Volume Statistics log page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF	PAGE CODE (17h)					
1	SUBPAGE CODE							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
	Volume Statistics log parameters							
4	Volume Statistics log parameters [first]							
	. . .							
n	Volume Statistics log parameters [last]							

See *table 8* for the definition of the SUBPAGE CODE field.

Table 8 — Volume Statistics log subpage codes

Code	Description
00h	Reserved
01h-0Fh	Volume statistics for previously mounted volumes 1 through 15. Use supage FFh (i.e., Supported subpages log page) to determine which log subpages are supported. This will also indicate how many previous mounts are supported by the drive.
10h-FEh	Reserved
FFh	Supported subpages log page. 3592 E06)The supported subpages log page reports no subpages since there are no volume statitistics log pages saved for previous mounts. 3592 E07)The supported subpages log page reports **<<TBD>>**

1.4.9.1 Parameter reset behavior

Parameters in this page are read-only.

1.4.9.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

Table 9 — Volume statistics log parameters (part 1 of 6)

Parameter Code	Description	Type	Size
0000h	**Page valid {17h:0000h}:** A value of 01h indicates that the values reported in the parameters to follow are valid. A value of 00h indicates the values reported in the parameters that follow are invalid	C	1
0001h	**Volume Mounts {17h:0001h}:** Number of mounts for the current volume (i.e., Thread Count)	C	4
0002h [1]	**Volume Datasets Written {17h:0002h}:** The total number of data sets written to the medium in the volume over the lifetime of the volume. (i.e., Total Datasets Written)	C	8
0003h [1]	**Volume Recovered Write Data Errors {17h:0003h}:** The total number of recovered write data correction errors (e.g., write temps) for the lifetime of the volume. (i.e., Total Write Retries)	C	4
0004h [1]	**Volume Unrecovered Write Data Errors (i.e., Write Perms) {17h:0004h}:** The total number of times that a write type command was terminated with CHECK CONDITION status and a sense key of MEDIUM ERROR or HARDWARE ERROR over the lifetime of the volume. (i.e., Total Unrecovered Write Errors)	C	2
0005h [1]	**Volume Write Servo Errors (updated on both temp and perm) {17h:0005h}:** The total number of times that the device suspended a write due to detection of a servo condition which could result in an incorrectly written track and attempted to write the data at a different location. If a logical block is interrupted more than once this parameter shall only be incremented once. (i.e., Total Number of Suspended Writes)	C	2
0006h [1]	**Volume Unrecovered Write Servo Errors {17h:0006h}:** The total number of times that the device suspended a write due to detection of a servo condition which could result in an incorrectly written track and was unable to write the data at a different location. (i.e., Total Number of Fatal Suspended Writes)	C	2
0007h [1]	**Volume Datasets Read {17h:0007h}:** The total number of data sets read from the medium in the volume over the lifetime of the volume. (i.e., Total Data Sets Read)	C	8
0008h [1]	**Volume Recovered Read Errors {17h:0008h}:** The total number of recovered read errors (e.g., read temps) for the lifetime of the volume. (i.e., Total Read Retries)	C	4

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

Table 9 — Volume statistics log parameters (part 2 of 6)

Parameter Code	Description	Type	Size
0009h [1]	**Volume Unrecovered Read Errors (i.e., Read Perms) {17h:0009h}:** The total number of times that a read type command was terminated with CHECK CONDITION status and a sense key of MEDIUM ERROR or HARDWARE ERROR over the lifetime of the volume. (i.e., Total Unrecovered Read Errors)	C	2
000Ah-000Bh	Not Supported		
000Ch [1]	**Last mount unrecovered write errors {17h:000Ch}:** Count of the number times a write type command was terminated with status of CHECK CONDITION and a sense key of HARDWARE ERROR, or MEDIA ERROR during the last mount	C	2
000Dh [1]	**Last mount unrecovered read errors {17h:000Dh}:** Count of the number times a read type command was terminated with status of CHECK CONDITION and a sense key of HARDWARE ERROR, or MEDIA ERROR during the last mount	C	2
000Eh [1]	**Last mount megabytes written {17h:000Eh}:** Count of the number of megabytes (10^6 bytes) of logical objects that were written to the medium after compression during the last mount. The value reported is rounded up to the next megabyte. The value reported contains bytes written as part of the process of writing a filemark. This value is calculated using information from the current format of the volume. If the volume has been reformatted, then this value may not be accurate.	C	4
000Fh [1]	**Last mount megabytes read {17h:000Fh}:** Count of the number of megabytes (10^6 bytes) of logical objects that were read from the medium before decompression during the last mount. The value reported is rounded up to the next megabyte. The value reported contains bytes read as part of a filemark. This value is calculated using information from the current format of the volume. If the volume has been reformatted, then this value may not be accurate.	C	4
0010h [1]	**Lifetime megabytes written {17h:0010h}:** Count of the number of megabytes (10^6 bytes) of logical objects that have been written to the medium after compression during the lifetime of the volume. The value reported is rounded up to the next megabyte. The value reported contains bytes written as part of the process of writing a filemark. This value is calculated using information from the current format of the volume. If the volume has been reformatted, then this value may not be accurate.	C	8
0011h [1]	**Lifetime megabytes read {17h:0011h}:** Count of the number of megabytes (10^6 bytes) that have been read from the medium before decompression during the lifetime of the volume. The value reported is rounded up to the next megabyte. The value reported contains bytes read as part of a filemark. This value is calculated using information from the current format of the volume. If the volume has been reformatted, then this value may not be accurate.	C	8
0012h [1]	**Last load write compression ratio {17h:0012h}:** (number of bytes transferred out of the logical object buffer to an application client ÷ the number of bytes in logical objects read from the medium) x 100	C	2

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

Table 9 — Volume statistics log parameters (part 3 of 6)

Parameter Code	Description	Type	Size
0013h [1]	**Last load read compression ratio {17h:0017h}:** (number of bytes transferred from an application client into the logical object buffer ÷ the number of bytes in logical objects written to the medium) x 100	C	2
0014h [1]	**Medium mount time {17h:0014h}:** Time in milliseconds from the time when the device server would first report GOOD status to a TEST UNIT READY command upon successful completion of a load operation until the device server did not detect a volume present.	C	6
0015h [1]	**Medium ready time {17h:0015h}:** Time in milliseconds from the time the device server was able to process medium access commands until the device server started the processing of an unload operation.	C	6
0016h	**Total native capacity {17h:0016h}:** The sum of the total native capacity of all partitions in megabytes (i.e., 10^6 bytes) from BOP to EOP. A data counter value with all bytes set to FFh in the partition record data counter field *(see 1.4.9.3.3 on page 22)* indicates that the total native capacity is unknown.	C	4
0017h	**Total used native capacity {17h:0017h}:** The sum of the used native capacity of all partitions in megabytes (i.e., 10^6 bytes) from BOP to EOD. A data counter value with all bytes set to FFh in the partition record data counter field *(see 1.4.9.3.3 on page 22)* indicates that the total used native capacity is unknown	C	4
0018h-003Fh	Reserved		
0040h	**Volume serial number {17h:0040h}:** The volume serial number parameter contains the value from the serial number field of the cartridge manufacturer's information page in the CM.	S	32
0041h [1]	**Tape lot identifier {17h:0041h}:** The tape lot identifier field may contain the tape pancake identifier value extracted from the servorwriter manufacturer field in the media manufacturer's page of the CM or may be extracted from the manufacturer's word in the servo pattern.	S	8
0042h [1]	**Volume barcode {17h:0042h}:** The value from MAM attribute 0806h (i.e., BARCODE, see SPC-4)	S	32
0043h [1]	**Volume manufacturer {17h:0043h}:** The volume manufacturer parameter contains the value from the cartridge manufacturer field of the cartridge manufacturer's information page of the CM.	S	8
0044h [1]	**Volume license code {17h:0044h}:** ASCII code to represent the license under which this volume was manufactured. The volume license code parameter contains the value from the cartridge license code parameter of the cartridge manufacturer's information page of the CM.	S	4

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

Table 9 — Volume statistics log parameters (part 4 of 6)

Parameter Code	Description	Type	Size
0045h [1]	**Volume personality {17h:0045h}:** The volume personality parameter contains an ASCII string to identify the combination of physical volume type and density formatted on the medium. The intent is to provide a designator sufficient for successful volume interchange . The value will be in the format “3592”+<Volume label cartridge type (see bytes 81 and 82 of sense data)>+G+<generation number> (e.g., 3592JBG2)	S	8
0046h	**Volume manufacture date {17h:0046h}:** The volume manufacture date parameter contains the date of manufacture of the volume. The format is YYYYMMDD (i.e., four numeric ASCII characters for the year followed by two numeric ASCII characters for the month followed by two numeric ASCII characters for the day with no intervening spaces).	S	8
0047h-007Fh	Reserved		
0080h [1]	**Write protect {17h:0080h}:** An indication if the volume mounted is write protected. a) A value of 01h indicates that a write protection state that is persistent with this volume is set; b) A value of 00h indicates that no write protection state that is persistent with this volume is set; and c) A value of FFh indicates that it is unknown if there is a persistent write protection condition set.	C	1
0081h [1]	**WORM {17h:0081h}:** An indication if the mounted volume is a WORM volume. a) A value of 01h indicates that the volume is a WORM volume; b) A value of 00h indicates that the volume is not a WORM volume; and c) A value of FFh indicates that it is unknown if the volume is a WORM volume.	C	1
0082h [1]	**Maximum recommended tape path temperature exceeded {17h:0082h}:** An indication if the recommended tape path temperature has been exceeded at some point in the past. a) A value of 01h indicates a drive has detected at some point in the past that the maximum recommended tape path temperature has been exceeded; b) A value of 00h indicates no drive has detected at any point in the past that the maximum recommended tape path temperature has been exceeded; and c) A value of FFh indicates that it is not known if at any point in the past that the maximum recommended tape path temperature has been exceeded.	C	1
0083h-00FFh	Reserved		
0100h [1,2]	**Volume write mounts {17h:}:** The volume write mounts parameter contains a count of the number of mounts in which logical objects on the medium were written or modified.	C	4
0101h [1,2]	**Beginning of medium passes {17h:0101h}:** Count of the total number of times the beginning of medium position has passed over the head. The value from the LP3 passes field of the usage information page of the CM.	C	4

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

Table 9 — Volume statistics log parameters (part 5 of 6)

Parameter Code	Description	Type	Size
0102h [1,2]	**Middle of tape passes {17h:0102h}:** count of the total number of times that the physical middle of the user data region on the tape has passed over the head (e.g., (EOM – BOM) ÷ 2). The value from the (LP5 – LP3) ÷ 2 passes field of the usage information page of the CM.	C	4
0103h-01FFh	Reserved		
0200h [1]	**First encrypted logical object identifier(s) {17h:0200h}:** The logical object identifier(s) for the first logical object on the medium which has been encrypted for each partition on the medium. Each byte in the partition record data counter field(s) is set to FFh if there are no encrypted logical objects or if the partition does not exist. The least significant byte in the partition record data counter field *(see 1.4.9.3.3 on page 22)* is set to FEh and all other bytes is set to FFh if it is not known if there are encrypted logical objects on the medium.	P	6
0201h [1]	**First unencrypted logical object on the EOP side of the first encrypted logical object identifier(s) {17h:0201h}:** The logical object identifiers for the first logical object on the medium which is not encrypted and is on the EOP side of the first encrypted logical object for each partition on the medium. Each byte in the partition record data counter field *(see 1.4.9.3.3 on page 22)* is set to FFh if there are no unencrypted logical objects on the EOP side of the first encrypted logical object identifier or if the partition does not exist. The least significant byte in the partition record data counter field is set to FEh and all other bytes is set to FFh if: a) it is not known if there are unencrypted logical objects on the EOP side of the first encrypted logical object; b) all bytes in the first encrypted logical object identifier are set to FFh; or c) the least significant byte in the first encrypted logical object identifier is set to FEh and all other bytes are set to FFh.	P	6
0202h [1]	**Approximate native capacity of partition(s) {17h:0202h}:** The native capacity of the partition(s) in megabytes (i.e., 10^6 bytes) from BOP to EOP. A data counter value with all bytes set to FFh in the partition record data counter field *(see 1.4.9.3.3 on page 22)* indicates that the native capacity of the partition is unknown.	P	4
0203h [1]	**Approximate used native capacity of partition(s) {17h:0203h}:** The used native capacity of the partition in megabytes (i.e., 10^6 bytes) from BOP to EOD. A data counter value with all bytes set to FFh in the partition record data counter field *(see 1.4.9.3.3 on page 22)* indicates that the used native capacity of the partition is unknown.	P	4

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

Table 9 — Volume statistics log parameters (part 6 of 6)

Parameter Code	Description	Type	Size
0204h [1]	**Approximate remaining native capacity to early warning of partition(s) {17h:0204h}:** The approximate remaining native capacity of the partition(s) in megabytes (i.e., 10^6 bytes) that is less than or equal to the native capacity from EOD to EW. The value reported in this parameter shall be zero once EOD is at or beyond EW. A data counter value with all bytes set to FFh in the PARTITION RECORD DATA COUNTER field *(see 1.4.9.3.3 on page 22)* indicates that the remaining native capacity of the partition is unknown.	P	4
0205h-02FFh	Reserved		
0300h	**Mount History {17h:0300h}:** The mount history parameter contains the T10 vendor identification and unit serial number of the most recent devices into which this volume was mounted.	M	v
0301h-EFFFh	Reserved		
F000h-FFFFh	Vendor specific		

Type Key:
C - Volume statistics data counter log parameter *(see 1.4.9.3.1 on page 20)*
S - Volume statistics string data log parameter *(see 1.4.9.3.2 on page 21)*
P - Volume statistics partition record log parameter *(see 1.4.9.3.3 on page 22)*. The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.
M - Mount history log parameter *(see 1.4.9.3.4 on page 23)*
Size Key:
v - variable size
Note:
If a parameter value is unknown but other parameter values are known, then parameter for the unknown value is not returned. If none of the values are known, then parameter 0000h is set to 00h.
Footnotes:
1 Not supported on device model 3592 E06
2 The value of this parameter may be unknown for some volume personalities. When this occurs, this parameter is not returned.

1.4.9.3 Parameter formats

1.4.9.3.1 Data counter log parameter format

The volume statistics data counter log parameter is used for reporting parameters specified as volume statistics data counter log parameters in *Table 9, Volume statistics log parameters*. The volume statistics data counter log parameter format is specified in *Table 10, Volume statistics data counter log parameter format*.

Table 10 — Volume statistics data counter log parameter format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU	Obsolete	TSD (0b)	ETC(0b)	TMC		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
4	(MSB)	VOLUME STATISTICS DATA COUNTER						
n								(LSB)

The PARAMETER CODE field is defined in *Table 9, Volume statistics log parameters*.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field is set to the values specified in *Table 10, Volume statistics data counter log parameter format*.

The PARAMETER LENGTH field indicates the number of bytes in the VOLUME STATISTICS DATA COUNTER field that follows.

The VOLUME STATISTICS DATA COUNTER field is the value of the data counter associated with the parameter code.

1.4.9.3.2 Volume statistics string data log parameter format

The volume statistics string data log parameter is used for reporting parameters specified as volume statistics string data log parameters in *Table 9, Volume statistics log parameters*. The volume statistics string data log parameter format is specified in *Table 11, Volume statistics string data log parameter format*. The volume statistics string data log parameter shall be a multiple of 4 bytes.

Table 11 — Volume statistics string data log parameter format

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU(0b)	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (01b)	
3	PARAMETER LENGTH (n-3)							
4	STRING DATA							
n								

The PARAMETER CODE field is defined in *Table 9, Volume statistics log parameters*.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. These fields shall be set to the values specified in *Table 11, Volume statistics string data log parameter format*.

The PARAMETER LENGTH field indicates the number of bytes of data that follows.

The STRING DATA field contains an ASCII string describing the volume statistics parameter specified by the PARAMETER CODE value. The STRING DATA field is an ASCII data field (see SPC-4).

1.4.9.3.3 Volume statistics partition record log parameter format

The volume statistics partition record log parameter is used for reporting parameters specified as volume statistics partition record log parameters in *Table 9, Volume statistics log parameters*. The volume statistics partition record log parameter format is specified in *Table 12, Volume statistics partition log parameter format*.

Table 12 — Volume statistics partition log parameter format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
	Volume statistics partition record descriptor(s)							
4	Volume statistics partition record descriptor [first]							
	. . .							
n	Volume statistics partition record descriptor [last]							

The PARAMETER CODE field is defined in *Table 9, Volume statistics log parameters*.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in *Table 12, Volume statistics partition log parameter format*.

The PARAMETER LENGTH field indicates the number of bytes in the volume statistics partition record log descriptors.

The volume statistics partition record descriptor format is specified in *Table 13, Volume statistics partition record descriptor format*.

Table 13 — Volume statistics partition record descriptor format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	PARTITION RECORD DESCRIPTOR LENGTH (n-1)							
1	Reserved							
2	(MSB)	PARTITION NUMBER						
3								(LSB)
4	(MSB)	PARTITION RECORD DATA COUNTER						
n								(LSB)

The PARTITION RECORD DESCRIPTOR LENGTH field specifies the number of bytes that follow.

The PARTITION NUMBER field indicates the number of the partition that the following counter is associated with.

The PARTITION RECORD DATA COUNTER field is the value of the data counter associated with the parameter code and associated with the specified partition.

1.4.9.3.4 Mount history

The mount history parameter contains the T10 vendor identification and unit serial number of the most recent devices into which this volume was mounted. The mount history log parameter format is specified in *table 12*.

Table 14 — Mount history log parameter format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU(0b)	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
	Mount history descriptor(s)							
4	Mount history descriptor [first]							
	⋮							
n	Mount history descriptor [last]							

The PARAMETER CODE field is defined in *Table 9, Volume statistics log parameters*.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in *table 12*.

The PARAMETER LENGTH field indicates the number of bytes that follow in the mount history log descriptors.

There is one mount history descriptor for each of the last four devices into which the volume was mounted. If the volume has been mounted in fewer than four devices there will be fewer than four descriptors (i.e., a descriptor is only returned if the volume has been mounted in that many previous drives).

The mount history descriptor format is specified in *table 13*.

Table 15 — Mount history descriptor format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	MOUNT HISTORY DESCRIPTOR LENGTH (n)							
1	Reserved							
2	(MSB)	MOUNT HISTORY INDEX						
3								(LSB)
4	(MSB)	MOUNT HISTORY VENDOR ID						
11								(LSB)
12	(MSB)	MOUNT HISTORY UNIT SERIAL NUMBER						
n								(LSB)

The MOUNT HISTORY DESCRIPTOR LENGTH field specifies the number of bytes that follow. The MOUNT HISTORY DESCRIPTOR LENGTH field shall contain a value that is a multiple of two.

The MOUNT HISTORY INDEX field indicates which previous mount was to the device specified in this descriptor. The value is incrementing starting at zero (e.g., The current device, or most recent device if not currently mounted, is numbered 0000h, the previous device is numbered 0001h, etc.).

The MOUNT HISTORY VENDOR ID field indicates the value returned in the T10 VENDOR IDENTIFICATION field of the standard inquiry data associated with this mount history index.

The MOUNT HISTORY UNIT SERIAL NUMBER field indicates the value of the PRODUCT SERIAL NUMBER field of the Unit Serial Number vital product data page associated with this mount history index. The MOUNT HISTORY UNIT SERIAL NUMBER field shall be right-aligned and the unused bytes shall be filled with ASCII space characters (i.e., 20h).

1.4.10 LP 2Eh: TapeAlerts

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is used to track significant errors or conditions.

Byte Description

0

Bit	Description
7-6	Reserved
5-0	Page Code: 2Eh

1 Reserved

2-3 Page length: 0140h

Page Code 2Eh is used to report conditions in the tape drive. The TapeAlert log page is unique in that the parameter value is required to be 0000h or 0001h in the Log Sense command. A result of this requirement is that all parameters are requested, so the page length field is always returned 0140h.

1.4.10.1 Parameter Reset Behavior

All log parameters are cleared when this log page is read. Specific flags may be cleared when corrective actions have removed the condition that caused the flag to be set *(see table 16)*. All flags are cleared on POR/Reset.

1.4.10.2 Parameter Definitions

There are 64 parameters numbered from 01h to 40h. However, for this product only parameters listed in *table 16* have meaning. The remaining parameters always return a value of 00h.

All parameters are one byte long. Each parameter is either 00h to indicate the corresponding condition has not occurred or 01h to indicate that the condition has occurred. See *"LP 30h: Tape Usage" on page 28* for parameter clearing behavior.

The following parameters are supported for each TapeAlert. *Table 16* lists the supported TapeAlerts and additional fields as specified in SSC may be supported in the future.

Parameter description:

Byte Description

0-1 Parameter Code

2 Parameter control byte

Bit	Description
7	DU (Disable Update): 0b
6	DS (Disable Save): 1b
5	TSD (Target Save Disable): 0b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1	Reserved
0	LO (List Parameter): 0b

3 Parameter length: 01h

4 TapeAlert Flag

Value	Description
01h	condition occurred
00h	condition did not occur

Table 16 — Supported TapeAlerts (part 1 of 2)

Code	Description	Set	Clear[1]	Type
0001h	**Read Warning {2Eh:0001h}:**		R	Warning
0002h	**Write Warning {2Eh:0002h}:**		R	Warning
0003h	**Hard Error {2Eh:0003h}:**		R	Warning
0004h	**Media {2Eh:0004h}:**		R	Critical
0005h	**Read Failure {2Eh:0005h}:**		R	Critical
0006h	**Write Failure {2Eh:0006h}:**		R	Critical
0007h	**Media Life {2Eh:0007h}:**		L	Warning
0008h	**Not Data Grade {2Eh:0008h}:**		R	Warning
0009h	**Write Protect {2Eh:0009h}:**		R	Critical
000Ah	**No Removal {2Eh:000Ah}:**		R	Informational
000Bh	**Cleaning Media {2Eh:000Bh}:**		R	Informational
000Ch	**Unsupported Format {2Eh:000Ch}:**		R	Informational
000Eh	**Unrecoverable Snapped Tape {2Eh:000Eh}:**		R	Critical
000Fh	**Memory Chip in Cartridge Failure {2Eh:000Fh}:**		R	Warning
0010h	**Forced Eject {2Eh:0010h}:**		L	Critical
0011h	**Read Only Format {2Eh:0011h}:**		R	Warning
0012h	**Tape Directory Corrupted {2Eh:0012h}:**		R	Warning
0013h	**Nearing Media Life {2Eh:0013h}:**		R	Informational
0014h	**Clean Now {2Eh:0014h}:**		C	Critical
0015h	**Clean Periodic {2Eh:0015h}:**		C	Warning
0016h	**Expired Cleaning Media {2Eh:0016h}:**	C	C	Critical
0019h	**Host Channel Failure {2Eh:0019h}:**			Warning
001Ah	**Cooling Fan Failure {2Eh:001Ah}:**	S		Warning
001Bh	**Power Supply Failure {2Eh:001Bh}:**	S		Warning
001Eh	**Hardware A {2Eh:001Eh}:**			Critical
001Fh	**Hardware B {2Eh:001Fh}:**			Critical
0020h	**Interface {2Eh:0020h}:**			Warning
0021h	**Eject Media {2Eh:0021h}:**		U,R	Critical
0022h	**Download Fault {2Eh:0022h}:**			Warning
0024h	**Drive Temperature {2Eh:0024h}:**	S		Warning
0025h	**Drive Voltage {2Eh:0025h}:**	S		Warning
0026h	**Predictive Failure {2Eh:0026h}:**			Critical
0027h	**Diagnostics Required {2Eh:0027h}:**			Warning
0029h	**Loader Stray Tape {2Eh:0029h}:**			Critical
002Ah	**Loader Hardware {2Eh:002Ah}:**			Warning
002Dh	**Loader Magazine {2Eh:002Dh}:**			Critical

Table 16 — Supported TapeAlerts (part 2 of 2)

Code	Description	Set	Clear[1]	Type
0032h	**Lost Statistics {2Eh:0032h}:**		R	Warning
0033h	**Tape Directory Invalid at Unload {2Eh:0033h}:**		L,R	Warning
0034h	**Tape System Area Write Failure {2Eh:0034h}:**		L,R	Critical
0035h	**Tape System Area Read Failure {2Eh:0035h}:**		R	Critical
0036h	**No Start of Data {2Eh:0036h}:**		R	Critical
0037h	**Loading Failure {2Eh:0037h}:**		R	Critical
0038h	**Unrecoverable Unload Failure {2Eh:0038h}:**		R	Critical
0039h	**Automation Interface Failure {2Eh:0039h}:**			Critical
003Ah	**Firmware Failure {2Eh:003Ah}:**			Warning
003Bh	**WORM Medium - Integrity Check Failed {2Eh:003Bh}:**		R	Warning
003Ch	**WORM Medium - Overwrite Attempted {2Eh:003Ch}:**		R	Warning

Legend
- \- Not set/supported
- L Load - medium is loaded
- C Clean - cleaner tape is loaded
- U Unload - medium is ejected
- E Error - error code is posted
- R Removal - medium is FULLY removed
- S Sensor - sensor check

1.4.11 LP 30h: Tape Usage

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page contains non-volatile information relating to volume usage.

1.4.11.1 Parameter Reset Behavior

Parameters in this page are read-only.

1.4.11.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 17 — Tape Usage log parameter codes

Code	Counter: Description	Size
0001h	**Volume Mounts {30h:0001h}:** Number of mounts for the current volume	4
0002h	**Volume Datasets Written {30h:0002h}:** Total number of datasets written	8
0003h	**Volume Write Retries {30h:0003h}:** Total number of write retries	4
0004h	**Volume Write Perms {30h:0004h}:** Total write perms	2
0005h	**Volume Suspended Writes {30h:0005h}:**	2
0006h	**Volume Fatal Suspended Writes {30h:0006h}:**	2
0007h	**Volume Datasets Read {30h:0007h}:** Total number of datasets read	8
0008h	**Volume Read Retries {30h:0008h}:** Total number of read retries	4
0009h	**Volume Read Perms {30h:0009h}:** Total read perms	2
000Ah	**Volume Suspended Reads {30h:000Ah}:**	2
000Bh	**Volume Fatal Suspended Reads {30h:000Bh}:**	2
0100h	**Volume Write Mounts {30h:0100h}:** Number of Mounts in which the current volume was modified.	2
0101h	**Head Pass BOT Count {30h:0101h}:** Number of times the head passes logical beginning of tape (i.e., LP3)	4
0102h	**Head Pass MOT Count {30h:0102h}:** Number of times the head passes physical middle of tape (i.e., [LP3 + LP5]/2)	4

1.4.12 LP 31h: SIM/MIM

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is designed to support SIMs (Service Information Messages), and MIMs (Medium Information Messages) reporting. SIMs and MIMs provide the initiator and operator details on service problems encountered by the device. The first 9 bytes are common to both the SIMs and the MIMs.

1.4.12.1 Parameter Reset Behavior

This page is not reset when a cartridge is loaded. When read with a Log Sense command, only the returned SIM or MIM is no longer available for subsequent retrieval. SIMs and MIMs are stored in and retrieved from a first-in first-out (FIFO) queue. Only 1 SIM or MIM is returned for each Log Sense command that requests Page Code 31h.

1.4.12.2 Parameter Definitions

1.4.12.2.1 SIM/MIM Header Data

Byte Description

0 Page Code

Bit	Description
7-6	Reserved
5-0	Page Code: 31h

1 Reserved

2-3 Page Length: 0044h

4-5 Parameter Code: 0000h

6 Parameter control byte

Bit	Description
7	DU (Disable Update): 0b
6	DS (Disable Save): 1b
5	TSD (Target Save Disable): 1b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1	Reserved
0	LP (List Parameter): 1b

7 Parameter length: 40h

8 SIM/MIM Indicator

Value	Description
00h	Bytes 9 through 71 are invalid.
01h	Bytes 9 through 71 are a SIM message. See *“SIM Messages” on page 29*.
02h	Bytes 9 through 71 are a MIM message. See *“MIM Messages” on page 31*.
03-FF	Bytes 9 through 71 are invalid.

1.4.12.2.2 SIM Messages

The following data are the parameters for the hardware SIM message:

Byte Description

9-15 Vendor-Reserved

16-19 Engineering Data

20-21 SIM Message Code codes

Value (ASCII)	Description
‘00’	No Message
‘41’	Device Degraded. Call for Service
‘42;	Device Hardware Failure. Call for Service
‘43’	Service Circuits Failed, Operations Not Affected. Call for Service
‘55’	Drive Needs Cleaning. Load Cleaning Cartridge
‘57’	Drive Has Been Cleaned
All Others	Device Message message

22-23 Vendor-Reserved

24 Exception Message Code

Value (ASCII)	Description
‘0’	Vendor-Reserved
‘1’	Effect of Failure Is Unknown
‘2’	Device Exception. No Performance Impact
‘3;	Exception on Host Interface xx See bytes 28-29 (Exception Data xx) in this SIM record for the xx value.
‘4’	Device Exception on ACF
‘5’	Device Exception on Operator Panel
‘6’	Device Exception on Tape Path
‘7’	Device Exception in Drive
‘8’	Cleaning Required
‘9’	Cleaning Done
‘A’-’F’	Vendor-Reserved

25 Service Message Code

Value (ASCII)	Description
‘0’	Vendor-Reserved
‘1’	Repair Impact is Unknown
‘2’-’6’	Vendor-Reserved
‘7’	Repair Will Disable Access to Device serno (serno refers to serial number in bytes 52-63 of this SIM record)
‘8’	Repair Will Disable Message Display IDs on Device
‘9’	Clean Device
‘A’	Device Cleaned
‘B’	Device Cleaning For Performance Reasons is Required
‘C’-’F’	Vendor-Reserved

26 Service Message Severity Code

Value (ASCII)	Description
‘0’	SIM severity code “Service”
‘1’	SIM severity code “Moderate”
‘2’	SIM severity code “Serious”
‘3’	SIM severity code “Acute”
‘4’-’9’, ‘A’-’F’	Vendor-Reserved

27 Vendor-Reserved

28-29 Exception Data

Interface Data is returned when byte 24 (Exception Message Code) in this SIM record contains the ASCII value ‘3’.

Value (ASCII)	Description
‘00’	interface 0 is indicated
‘01’	interface 1 is indicated

Byte	Description
30-33	FRU Identifier
34-37	First FSC
38-41	Last FSC
42-45	Product ID: ‘8000’ (these 4 bytes define “TAPE”)
46-63	Product Identifier

Broken out into constituent bytes:

Byte	Description
46-48	Manufacturer: “IBM”
49-50	Plant of Manufacture
51	‘-’ (Dash symbol)
52-63	Serial Number

64-71	Device Type and Model Number (same as Inquiry Standard Data bytes 16-23)

1.4.12.2.3 MIM Messages

Media Information Messages (MIMs) are supported by this device. The following data are the parameters for the MIM:

Byte	Description
9-15	Vendor-Reserved
16-19	Expert Systems Data (microcode link level)
20-21	MIM Message Code codes

Value (ASCII)	Description
‘00’	No Message
‘60’	Bad Media, Read Only permitted
‘61’	Rewrite Media if possible
‘62’	Tape Directory Invalid. Re-read media if possible
‘64’	Bad Media-Cannot Read or Write
‘72’	Replace Cleaner Cartridge
Others	Vendor-Reserved

22-23	Engineering Data-First Failing Test
24	Exception Message Code

Value (ASCII)	Description
‘2’	Data Degraded
‘4’	Medium Degraded
‘6’	Block 0 Error
‘7’	Medium Exception
Others	Vendor-Reserved

25	Media Message Code
26	Media Message Modifier Severity Code

Value (ASCII)	Description
‘0’	Service
‘1’	Moderate-High Temp Read/Write Errors Detected
‘2’	Serious-Permanent Read/Write Errors Detected
‘3’	Acute-Block 0 Error
Others	Vendor-Reserved

27-29	Vendor-Reserved
30-33	Fault Symptom Code (FSC)
34-39	VOLID (in ASCII). Only valid if indicated by VOLID Valid Flag (byte 40)

40 VOLID Valid Flag

Value (ASCII)	Description
‘0’	VOLID (bytes 34-39) not valid
‘1’	VOLID valid, obtained from tape
‘3’	VOLID valid, obtained from library
Others	Vendor-Reserved for future use (odd number will always indicate VOLID valid)

41 Vendor-Reserved

46-63 Product Identifier

Broken out into constituent bytes:

Byte	Description
46-48	Manufacturer: “IBM”
49-50	Plant of Manufacture
51	‘-’ (Dash symbol)
52-63	Serial Number

64-71 Device Type and Model Number (same as Inquiry Standard Data bytes 16-23)

1.4.13 LP 32h: Write Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page contains detailed counters related to write operations.

1.4.13.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.13.2 Parameter Definitions

NOTE 4 - When multiple errors occur on a dataset, the counter that is updated is generally based on the first error detected.

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 18 — Write Errors log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Datasets Corrected {32h:0000h}:** ECC is done by hardware. This is driven by an excessive CQs rewritten condition (TBD). Each count represents one dataset in error that was successfully corrected and written.	2
0001h	**Servo Transients {32h:0001h}:** ERP action was required because of a servo detected error and the first retry was successfully in place (stop write without backhitch, i.e, servo write skip). Each count represents one dataset in error that was successfully recovered and written.	2
0002h	**Data Transients {32h:0002h}:** ERP action was required because of a readback check or ECC detected error and the first retry was successfully in place (no backhitch). Each count represents one dataset in error that was successfully recovered and written.	2
0003h	**Velocity Events {32h0003h:}:** A velocity control problem occurred. Each count represents one occurrence, not just the count of affected datasets. Counts may include occurrences from both temporary and permanent errors.	2
0004h	**Servo Acquisition Temps {32h:0004h}:** A servo error (servo dropout or off-track shutdown) was detected while trying to acquire a DSS or dataset at the beginning of a write append sequence (motion); ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0005h	**Data Acquisition Temps {32h:0005h}:** During read-back check, the read channel failed to acquire a DSS or dataset at the beginning of a write append sequence and no servo error was reported, ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0006h	**Servo Temps {32h:0006h}:** A servo error (servo dropout or off-track shutdown) was detected while writing data, ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0007h	**Data Temps {32h:0007h}:** An uncorrectable error, CRC error, instantaneous speed variation (ISV) error, or no ending burst error occurred during readback check of a dataset, and no servo error was reported; ERP action was required, and readback/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0008h	**Total Retries {32h:0008h}:** The count of the total number of ERP actions. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
0009h	**Vendor-Reserved {32h:0009h}:**	2

Table 18 — Write Errors log parameter codes (part 2 of 2)

Code	Counter: Description	Size
000Ah	**Match Filter ERP (write mode use) {32h:000Ah}:**	2
000Bh	**Servo Skip Events {32h:000Bh}:** The count of long servo write skips, extended DSS or long spaces between datasets written. This is generally servo write skips, but may also include other write scenarios. Each count represents one occurrence, not one count per block. Counts may include occurrences from both temporary and permanent errors.	2
000Ch	**Housekeeping Events {32h:000Ch}:** The count of write problems in the Housekeeping Dataset Region. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
000Dh	**FID Events {32h:000Dh}:** The count of write problems while processing the FID. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
000Eh	**Vendor-Reserved (Blocks Lifted) {32h:000Eh}:**	2
000Fh	**Dataset Underrun {32h:000Fh}:** The number of times that the drive overran the buffer processing capability and had to stop and restart during a write. Each count represents one occurrence, not just one time per write.	2
0010h	**Vendor-Reserved {32h:0010h}:**	2
0011h	**Servo Position Events {32h:0011h}:** The number of servo detected positional compare discrepancies.	2

1.4.14 LP 34h: Read Forward Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page contains detailed counters related to read operations.

1.4.14.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.14.2 Parameter Definitions

NOTE 5 - When multiple errors occur on a dataset, the counter that is updated is generally based on the first error detected. ERP counters indicate which specific ERP methods were successfully employed.

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

Table 19 — Read Error Counters log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Datasets Corrected {34h:0000h}:** ECC is done by hardware. Each count represents one dataset in error that was successfully corrected and read.	2
0001h	**Servo Transients {34h:0001h}:** ERP action was required because of a servo detected error and the first retry was successfully in place. Each count represents one dataset in error that was successfully recovered and read.	2
0002h	**Data Transients {34h:0002h}:** ERP action was required because of a read channel or ECC detected error and the first retry was successfully in place. Each count represents one dataset in error that was successfully recovered and read.	2
0003h	**Velocity Events {34h:0003h}:** A velocity control problem occurred. Each count represents one occurrence, not just the count of affected datasets. Counts may include occurrences from both temporary and permanent errors.	2
0004h	**Servo Acquisition Temps {34h:0004h}:** A servo error (servo dropout or off track shutdown) was detected while trying to acquire an initial DSS or dataset, ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0005h	**Data Acquisition Temps {34h:0005h}:** The read channel failed to acquire an initial DSS or dataset, and no servo error was reported; ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0006h	**Servo Temps {34h:0006h}:** A servo error (servo drop out) was detected while reading a dataset; ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0007h	**Data Temps {34h:0007h}:** An uncorrectable error, CRC error, or no ending burst error occurred while reading a dataset, and no servo error was reported; ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0008h	**Sequence Errors {34h:0008h}:** A dataset number out of sequence was encountered, and no Servo or read/ECC error reported; ERP action was required, and no transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0009h	**Vendor-Reserved (ERP Read Opposite) {34h:0009h}:**	2
000Ah	**Vendor-Reserved (ERP Tension Adjust Hi) {34h:000Ah}:**	2
000Bh	**Vendor-Reserved (ERP Tension Adjust Lo) {34h:000Bh}:**	2

Table 19 — Read Error Counters log parameter codes (part 2 of 2)

Code	Counter: Description	Size
000Ch	**ERP Servo Adjust Hi {34h:000Ch}:** The dataset was recovered by reading with servo off-track variations. Each count represents one dataset in error that was successfully recovered and read.	2
000Dh	**ERP Servo Adjust Lo {34h:000Dh}:** The dataset was recovered by reading with servo off-track variations. Each count represents one dataset in error that was successfully recovered and read.	2
000Eh	**Vendor-Reserved (ERP Dead Reckon Nominal) {34h:000Eh}:**	2
000Fh	**Vendor-Reserved (ERP Dead Reckon Hi) {34h:000Fh}:**	2
0010h	**Servo AGA Gain ERP (read only mode) {34h:0010h}:**	2
0011h	**Vendor-Reserved (ERP Filter Coefficients) {34h:0011h}:**	2
0012h	**Servo Opposite Gap ERP (read only mode) {34h:0012h}:**	2
0013h	**Vendor-Reserved (ERP Dataflow Clock Adjust) {34h:0013h}:**	2
0014h	**Vendor-Reserved {34h:0014h}:**	2
0015h	**Total Retries {34h:0015h}:** The count of the total number of ERP actions. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
0016h	**Match Filter ERP (read mode use) {34h:0016h}:**	2
0017h	**Housekeeping Events {34h:0017h}:** The count of read problems in the Housekeeping Dataset Region. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
0018h	**Vendor-Reserved (Cartridge Init Errors) {34h:0018h}:**	2
0019h	**Dataset Overrun {34h:0019h}:** The number of times that the drive overran the buffer processing capability and had to stop and restart during a read. Each count represents one occurrence, not just one time per read.	2
001Ah	**Vendor-Reserved {34h:001Ah}:**	2
001Bh	**Servo Skip Events {34h:001Bh}:** The count of extended DSS or long spaces between datasets read. This may include servo write skips, but may also include other write scenarios. Each count represents one occurrence, not one count per block. Counts may include occurrences from both temporary and permanent errors.	2
001Ch	**Vendor-Reserved {34h:001Ch}:**	2
001Dh	**FID Events {34h:001Dh}:** The count of read problems while processing the FID. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
001Eh	**Servo Position Events {34h:001Eh}:** The number of servo detected positional compare discrepancies.	2

1.4.15 LP 36h: Read Backward Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page contains parameters related to the device performing Read Backward operations rather than Read Forward operations. The read backwards (physical read reverse) function is not currently implemented in this device, but may be in the future. All host commands and function will not be affected by potential future implementation of this feature.

1.4.15.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.15.2 Parameter Definitions

The parameters supported for *"LP 36h: Read Backward Errors" on page 37* are identical to those described in *"LP 34h: Read Forward Errors" on page 35*, except that this data is recorded when the device is performing Read Backward operations rather than Read Forward operations.

1.4.16 LP 37h: Performance Characteristics (not J1A)

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page includes various performance and capacity measurements across the operation of the drive. Some fields are normalized qualitative measures while others are quantitative.

1.4.16.1 Parameter Reset Behavior

Each parameter has different reset characteristics which are described under the Subpage Code field description for bits *7-6 Scope*.

1.4.16.2 Parameter Definitions

This page uses the Subpage Code mechanism *(see 5.2.8 on page 152)* to select which groups of counters to return. This page has three scopes controlled by the Subpage Code field.

The subpage field in *Log Sense - 4Dh* and *Log Parameter Format* is used as follows:

Bit	Description	
7-6	Scope	
	Value	**Description**
	00b	Transient values: reset on Log Select [all Subpages are reset]
	01b	Mount values: reset on load
	10b	Lifetime values: reset on device power on or device reset (not target reset)
	11b	Vendor-Reserved
5-4	Level	
	Value	**Description**
	00b	Return summary counters
	01b	Return basic counters
	10b	Return advanced counters
	11b	Return development counters
3-0	Group	
	Value	**Description**
	0h	All groups
	1h	Host Interface
	2h	Buffer
	3h	Medium
	4h	Capacity
	5h	Load/Unload
	6h	Servo

The Subpage field in *Log Sense - 4Dh* may be set to 00h when the page code field is 37h. This operation will reset all group and local counters in the transient scope. Other scope cannot be explicitly reset.

The individual log subpage and parameter codes are described in the following table. Note that the counters which are returned depends on the Level and Group fields in the subpage. A group value of 0h will return all counters of a level less than or equal to that specified.

In the following tables, multiple counter codes may be represented by a single row. There will be an aspect symbol in the counter code such as 'p', 'q', 's', or '?'. The Aspect(s) column indicates which of the following values applies to the given code(s).

Aspect	Definition
p=0	primary interface (fibre) all ports (totals)
p=1	primary interface (fibre) port 0
p=2	primary interface (fibre) port 1
p=A	automation interface (RS-422)
q=1	Non-Ready: NOTE: These commands include ALL commands which are processed when the drive is in a Not Ready state.
q=2	Head-of-Queue: NOTE: These commands are commands which may be processed in any order. Such commands include: Inquiry, Report LUNs, Test Unit Ready and Request Sense. These counts are updated only when the drive is in a Ready state.
q=3	Read: NOTE: This aspect has more features detailed below.
q=4	Write: NOTE: This aspect has more features detailed below.
q=5	Sync: NOTE: This aspect has more features detailed below.
q=6	Seek: NOTE: This aspect has more features detailed below.
q=7	Non-Medium: NOTE: These commands are command issued to LUN 0 which are not in any other applicable category. These include many commands such as Log Sense, Log Select, Read Buffer, Reserve, etc. These counts are updated only when the drive is in a Ready state.
q=8	Non-LUN0, Non-Ready: NOTE: These commands include ALL commands which are processed by a LUN other than LUN 0 when the drive is in a Not Ready state.
q=9	Non-LUN0, Head-of-Queue: NOTE: These commands are commands which may be processed in any order. Such commands include: Inquiry, Report LUNs, Test Unit Ready and Request Sense. These counts are updated only when the drive is in a Ready state.
q=A	Non-LUN0: NOTE: These commands include any commands processed by a LUN other than LUN 0. These counts are updated only when the drive is in a Ready state.
s=1	Speed 1: Highest read/write speed
s=2	Speed 2: Second highest read/write speed
s=3	Speed 3: Third highest read/write speed
s=4	Speed 4: Fourth highest read/write speed
s=5	Speed 5: Fifth highest read/write speed
s=6	Speed 6: Sixth highest read/write speed
s=7	Speed 7: Slowest read/write speed
s=F	High speed locate (not read/write capable)
t=0	Partition 0
t=1	Partition 1
t=2	Partition 2
t=3	Partition 3
?=1	write - write phase without host holdoff. NOTE: if no (paused) data is supported for a particular counter, this aspect will include all write information
?=2	write (paused) - write phase while the host is being held off (buffer full)
?=3	read - read phase without host holdoff. NOTE: if no (paused) data is supported for a particular counter, this aspect will include all read information
?=4	read (paused) - read phase while the host is being held off (buffer empty)
?=5	position - during the processing of a seek operation
?=6	load - during the processing of an load operation
?=7	unload - during the processing of an unload operation
?=F	other - not in an above phase

WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING

Table 20 — LP 37h: Performance Characteristics: Quality Summary

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0000h		**Drive Efficiency {37h:0000h}:** Overall measure of the drive's condition. 00 is unknown, from 01 (best) to FF (worst)	rating	1	0	0
0001h		**Media Efficiency {37h:0001h}:** Overall measure of the currently mounted media's condition. X'00' is unknown, from X'01' (best) to X'FF' (worst)	rating	1	0	0
0010h		**Primary Interface Efficiency {37h:0010h}:** Overall measure of the interface (to the host) condition. 00 is unknown, from 01 (best) to FF(worst)	rating	1	0	0
0011h		**Primary Interface Port 0 Efficiency {37h:0011h}:** Overall measure of the per port interface (to the host) condition. X'00' is unknown, from X'01' (best) to X'FF' (worst)	rating	1	0	0
0012h		**Primary Interface Port 1 Efficiency {37h:0012j}:** Overall measure of the per port interface (to the host) condition. 00 is unknown, from 01(best) to FF (worst)	rating	1	0	0
001Ah		**Library Interface Efficiency {37h:001Ah}:** Overall measure of the interface (to the library) condition. 00 is unknown, from 01 (best) to FF (worst)	rating	1	0	0

Table 21 — LP 37h: Performance Characteristics: Device Usage (part 1 of 2)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0040h		**Time {37h:0040h}:** Amount of entire sample duration	msec	6	2	5
0041h		**Medium Empty Time {37h:0041h}:** Duration without a tape present	msec	6	2	5
0042h		**Medium Insert Time {37h:0042h}:** Duration from cartridge insert to load	msec	6	2	5
0043h		**Medium Mount Time {37h:0043h}:** Total time from start of cartridge load until cartridge ejected	msec	6	2	5
0044h		**Medium Load Time {37h:0044h}:** Total time from start of cartridge load to load complete (ready)	msec	6	2	5
0045h		**Medium Ready Time {37h:0045h}:** Total time from load complete (ready) to start of unload	msec	6	2	5
0046h		**Medium Eject Time {37h:0046h}:** Time from start of unload to unload complete	msec	6	2	5
0047h		**Medium Extract Time {37h:0047h}:** Time from cartridge unloaded to removed	msec	6	2	5

Table 21 — LP 37h: Performance Characteristics: Device Usage (part 2 of 2)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0048h		**Medium Dwell Time {37h:0048h}:** Time from cartridge unloaded to (re)loaded. Note - This may include time which cannot be determined as dwell or extract (when time is queried with a cartridge remaining in the unloaded position)	msec	6	2	5
0049h		**Medium Clean Time {37h:0049h}:** Time from cleaner recognized to eject complete	msec	6	2	5
0051h		**Medium Empty Count {37h:0051h}:** Number of times tape was fully removed	count	4	2	5
0052h		**Medium Insert Count {37h:0052h}:** Number of cartridge insertions to load position detected	count	4	2	5
0053h		**Medium Mount Count {37h:0053h}:** Number of mount operations	count	4	2	5
0054h		**Medium Load Count {37h:0054h}:** Number of load operations	count	4	2	5
0055h		**Medium Ready Count {37h:0055h}:** Number of ready transitions	count	4	2	5
0056h		**Medium Eject Count {37h:0056h}:** Number of unloads	count	4	2	5
0057h		**Medium Extract Count {37h:0057h}:** Number of times tape was extracted	count	4	2	5
0058h		**Medium Dwell Count {37h:0058h}:** Number of times tape was reloaded (from unload)	count	4	2	5
0059h		**Medium Clean Count {37h:0059h}:** Number of recognized cleaner loads (does not indicate successful cleans, tape may be expired)	count	4	2	5

Table 22 — LP 37h: Performance Characteristics: Host Commands (part 1 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0q00h	12(3456)789A	**Count {37h:0q00h}:**	count	4	2	1
0q01h	12(3456)789A	**Timing {37h:0q01h}:**	msec	6	2	1
0q02h	12(3456)789A	**Relative Time {37h:0q01h}:**	% * 65536	4	1	1
0q04h	12(3456)789A	**Transfer Count to Host (in) {37h:0q04h}:**	count	4	2	1
0q05h	12(3456)789A	**Transfer Byte Count to Host (in) {37h:0q05h}:**	bytes	8	2	1
0q06h	12(3456)789A	**Transfer Timing to Host (in) {37h:0q06h}:**	msec	6	2	1
0q08h	12(4)789A	**Transfer Count from Host (out) {37h:0q08h}:**	count	4	2	1
0q09h	12(4)789A	**Transfer Byte Count from Host (out) {37h:0q09h}:**	bytes	8	2	1
0q0Ah	12(4)789A	**Transfer Timing from Host (out) {37h:0q0Ah}:**	msec	6	2	1
Note - Read type host commands include Read, Verify and Read Reverse (not all of these may be supported). These counts are updated only when the drive is in a Ready state						
0300h		**Read Count {37h:0300h}:** Number of blocks processed to the host by read type commands	blocks	6	2	1

Table 22 — LP 37h: Performance Characteristics: Host Commands (part 2 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0301h		**Read Timing {37h:0301h}:** Amount of time processing read type commands. Note - Due to device specific performance path resources, this may not reflect the actual time spent processing commands, but may reflect the amount of time where read commands could be processed.	msec	6	2	1
0302h		**Read Relative Time {37h:0302h}:** Ratio of time spent reading with respect to Medium Ready Time	% * 65536	4	1	1
0304h		**Transfer Count to Host (in) {37h:0304h}:**	count	6	2	1
0305h		**Transfer Byte Count to Host (in) {37h:0305h}:**	bytes	8	2	1
0306h		**Transfer Timing to Host (in) {37h:0306h}:**	msec	6	2	1
03D0h		**Read Performance Efficiency {37h:03D0h}:** Ratio of performance read type commands with respect to all read type commands	% * 65536	4	1	1
03D4h		**Read Filemark (perf) Relative Time {37h:03D4h}:** Amount of time spent sending filemark encountered status to the host with respect to time Read Timing.	% * 65536	4	2	1
Note - Write type host commands include Write and Write Filemarks [not including any synchronization portion]. These counts are updated only when the drive is in a Ready state.						
0400h		**Write Count {37h:0400h}:** Number of blocks processed from the host by write type commands	blocks	6	2	1
0401h		**Write Timing {37h:0401h}:** Amount of time processing write type commands. Note - Due to device specific performance path resources, this may not reflect the actual time spent processing commands, but may reflect the amount of time where write commands could be processed.	msec	6	2	1
0402h		**Write Relative Time {37h:0402h}:** Ratio of time spent writing with respect to Medium Ready Time	% * 65536	4	1	1
0404h		**Transfer Count to Host (in) {37h:0404h}:**	count	6	2	1
0405h		**Transfer Byte Count to Host (in) {37h:0405h}:**	bytes	8	2	1
0406h		**Transfer Timing to Host (in) {37h:0406h}:**	msec	6	2	1
0408h		**Transfer Count from Host (out) {37h:0408h}:**	count	6	2	1
0409h		**Transfer Byte Count from Host (out) {37h:0409h}:**	bytes	8	2	1
040Ah		**Transfer Timing from Host (out) {37h:040Ah}:**	msec	6	2	1
04D0h		**Write Performance Efficiency {37h:04D0h}:** Ratio of performance write commands with respect to all write type commands	% * 65536	4	1	1
04D4h		**Write Filemark Relative Time {37h:04D4j}:** Amount of time spent writing filemarks.	% * 65536	4	2	1
Note - Sync type host commands include Write Filemarks [non-immediate]. Implicit sync type commands include mode changes while writing, non-buffered mode and idle time based syncs. These counts are updated only when the drive is in a Ready state.						
0500h		**Sync Count [Host] {37h:0500h}:** Number of host sync operations (non-immediate Write Filemarks, non-buffered writes)	count	4	2	1

Table 22 — LP 37h: Performance Characteristics: Host Commands (part 3 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0501h		**Sync Timing [Host] {37h:0501h}:** Amount of time processing host sync commands	msec	6	2	1
0502h		**Sync Relative Time [Host] {37h:0502h}:** Ratio of time spent processing host sync commands with respect to Medium Ready Time	% * 65536	4	1	1
0504h		**Transfer Count to Host (in) {37h:0504h}:**	count	4	2	1
0505h		**Transfer Byte Count to Host (in) {37h:0505h}:**	bytes	8	2	1
0506h		**Transfer Timing to Host (in) {37h:0506h}:**	msec	6	2	1
05D1h		**Sync Count [Implicit] {37h:05D1h}:** Number of implicit sync commands (time based flushes, mode change flushes)	count	4	2	1
05D2h		**Sync Timing [Implicit] {37h:05D2h}:** Amount of time processing implicit sync commands	msec	6	2	1
05D4h		**Sync Relative Time [Implicit] {37h:05D4h}:** Ratio of time spent processing implicit sync commands with respect to Medium Ready Time	% * 65536	4	1	1
Note - Seek type host commands include Space, Locate, and Rewind. These counts are updated only when the drive is in a Ready state.						
0600h		**Seek Count {37h:0600h}:** Number of positioning host commands	count	4	2	1
0601h		**Seek Timing {37h:0601h}:** Amount of time spent processing host positioning commands	msec	6	2	1
0602h		**Seek Relative Time {37h:0602h}:** Ratio of time spend processing host seek commands with respect to Medium Ready Time	% * 65536	4	1	1
0604h		**Transfer Count to Host (in) {37h:0604h}:**	count	4	2	1
0605h		**Transfer Byte Count to Host (in) {37h:0605h}:**	bytes	8	2	1
0606h		**Transfer Timing to Host (in) {37h:0606h}:**	msec	6	2	1
06D1h		**Seek Block Count {37h:06D1h}:** Number of blocks processed in host positioning commands	blocks	4	2	1
0Cp0h	012A	**Command Count {37h:0Cp0h}:**	count	6	2	1
0Cp1h	012A	**Command Timing {37h:0Cp1h}:**	msec	6	2	1
0Cp2h	012A	**Command Relative Time {37h:0Cp2h}:**	% * 65536	4	2	1
0Cp4h	012A	**Command Transfer Count to Host (in) {37h:0Cp4h}:**	count	6	2	1
0Cp5h	012A	**Command Transfer Byte Count to Host (in) {37h:0Cp5h}:**	bytes	8	2	1
0Cp6h	012A	**Command Transfer Timing to Host (in) {37h:0Cp6h}:**	msec	6	2	1
0Cp8h	012A	**Command Transfer Count from Host (out) {37h:0Cp8h}:**	count	6	2	1
0Cp9h	012A	**Command Transfer Byte Count from Host (out) {37h:0Cp9h}:**	bytes	8	2	1
0CpAh	012A	**Command Transfer Timing from Host (out) {37h:0CpAh}:**	msec	6	2	1
0CpCh	012A	**Command Queue Count {37h:0CpCh}:**	count	6	2	1

Table 22 — LP 37h: Performance Characteristics: Host Commands (part 4 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0CpDh	012A	**Command Queue Latency {37h:0CpDh}:**	msec	6	2	1
0CpEh	012A	**Command Queue Relative Time {37h:0CpEh}:**	% * 65536	4	2	1
0Dp1h	12A	**Port Throughput Rate Maximum Bursting {37h:0Dp1h}:**	bytes/sec	6	2	1
0Dp2h	12A	**Port Throughput Rate Maximum Sustained {37h:0Dp2h}:**	bytes/sec	6	2	1
0Dp3h	12A	**Port Throughput Rate {37h:0Dp3h}:**	bytes/sec	6	2	1
0Dp4h	12A	**Port Throughput Efficiency {37h:0Dp4h}:**	% * 65536	4	1	1
0Dp7h	12A	**Port Rate Changes {37h:0Dp7h}:**	count	4	2	1
0DF0h		**Average Command Latency {37h:0DF0h}:** Average amount of time commands were queued waiting for execution with respect to all commands (including unqueued commands which processed immediately).	usec	4	1	1
0DF1h		**Average Dequeue Latency {37h:0DF1h}:** Average amount of time commands were queued waiting for execution with respect to commands which where queued (not processed immediately).	usec	4	1	1
0DF8h		**Long Queue Latency Count [>1 sec] {37h:0DF8h}:**	count	4	2	1
0DF9h		**Long Queue Latency Count [>10 sec] {37h:0DF9h}:**	count	4	2	1
0DFAh		**Long Queue Latency Count [>100 sec] {37h:0DFAh}:**	count	4	2	1
0DFBh		**Long Queue Latency Count [>1000 sec] {37h:0DFBh}:**	count	4	2	1

Table 23 — LP 37h: Performance Characteristics: Host Initiators

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
Note - In dual port configurations it is possible for the same host to be identified as a different initiator when using a different logical or physical path. This can occur in failover or load balancing applications.						
0E00h		**Active Initiator Count {37h:0E00h}:** Number of initiators which processed one or more commands.	count	4	2	1
0E01h		**Primary Initiator {37h:0E01h}:** Ratio of commands issued by the initiator which is issuing the most commands with respect to all initiators.	% * 65536	4	2	1
0E02h		**Secondary Initiator {37h:0E02h}:** Ratio of commands issued by the initiator which is issuing the second most commands with respect to all initiators.	% * 65536	4	2	1
0E03h		**Current Initiator {37h:0E03h}:** Ratio of commands issued by this (the querying) initiator with respect to all initiators.	% * 65536	4	2	1

Table 24 — LP 37h: Performance Characteristics: Host Recovery (by port)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0Fp0h	12A	**Transfer Recoveries [by port] {37h:0Fp0h}:**	count	4	2	1
0Fp1h	12A	**Transfer Recover Time [by port] {37h:0Fp1h}:**	msec	6	2	1
0Fp2h	12A	**Resource Recoveries [by port] {37h:0Fp2h}:**	count	4	2	1
0Fp3h	12A	**Reset Count [by port] {37h:0Fp3h}:**	count	4	2	1
0Fp8h	12A	**Abort Count [by port] {37h:0Fp8h}:**	count	4	2	1
0Fp9h	12A	**Abort Time [by port] {37h:0Fp9h}:**	msec	6	2	1

Table 25 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 1 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
1000h		**Write Cycles {37h:1000h}:**	count	4	2	2
1001h		**Write Pauses {37h:1001h}:**	count	4	2	2
1010h		**Write Cycle Time {37h:1010h}:**	msec	6	2	2
1020h		**Write Cycle Relative Time {37h:1020h}:** Ratio of time in write mode with respect to Medium Ready Time.	% * 65536	4	1	2
1021h		**Write Setup Relative Time {37h:1021h}:**	% * 65536	4	2	2
1022h		**Write Ready Relative Time {37h:1022h}:**	% * 65536	4	1	2
1023h		**Write Pause Relative Time {37h:1023h}:**	% * 65536	4	1	2
1024h		**Write Exit Relative Time {37h:1024h}:**	% * 65536	4	2	2
1200h		**Read Cycles {37h:1200h}:**	count	4	2	2
1201h		**Read Pauses {37h:1201h}:**	count	4	2	2
1210h		**Read Cycle Time {37h:1210h}:**	msec	6	2	2
1214h		**Read Exit Time {37h:1214h}:**	msec	6	3	2
1215h		**Read Traverse EM Time {37h:1215h}:**	msec	6	3	2
1220h		**Read Cycle Relative Time {37h:1220h}:** Ratio of time in write mode with respect to Medium Ready Time.	% * 65536	4	1	2
1221h		**Read Setup Relative Time {37h:1221h}:**	% * 65536	4	2	2
1222h		**Read Ready Relative Time {37h:1222h}:**	% * 65536	4	1	2
1223h		**Read Pause Relative Time {37h:1223h}:**	% * 65536	4	1	2
1224h		**Read Exit Relative Time {37h:1224h}:**	% * 65536	4	2	2
1225h		**Read Traverse EM Relative Time {37h:1225h}:**	% * 65536	4	2	2
1400h		**Position Count {37h:1400h}:**	count	4	2	2
1410h		**Position Time {37h:1410h}:**	msec	6	2	2
1420h		**Position Relative Time {37h:1420h}:** Ratio of time spent physically and logically positioning with respect to Medium Ready Time.	% * 65536	4	1	2
1430h		**Position Relative Rate {37h:1430h}:**	bytes/sec	4	1	2
1480h		**Position Count (Media) {37h:1480h}:**	count	4	2	2
1490h		**Position Time (Media) {37h:1490h}:**	msec	6	2	2

Table 25 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 2 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
14A0h		**Position Relative Time (Media) {37h:14A0h}:** Ratio of time spent physically positioning media with respect to Medium Ready Time.	% * 65536	4	1	2
14B0h		**Position Relative Rate (Media) {37h:14B0h}:**	bytes/sec	4	1	2
14F0h		**Position Buffer Hits {37h:14F0h}:** Ratio of positioning operations where targets were already present in the buffer.	% * 65536	4	1	2
1500h		**Flush Count {37h:1500h}:** Number of low level buffer write flush operations. These may include operations which only affect the buffer and do not involve media motion.	count	4	1	2
1510h		**Flush Time {37h:1510h}:** Time spend executing operations counted by Flush Count.	msec	6	2	2
1520h		**Flush Relative Time {37h:1520h}:** Ratio of time spent flushing with respect to Medium Ready Time.	% * 65536	4	1	2
1580h		**Flush Count (Media) {37h:1580h}:** Number of low level buffer write flush operations which involve [or continue] media motion.	count	4	1	2
1590h		**Flush Time (Media) {37h:1590h}:** Time spent executing operations counted by Flush Count (Media).	msec	6	2	2
15A0h		**Flush Relative Time (Media) {37h:15A0h}:** Ratio of time spent flushing to media with respect to Write Cycle Time.	% * 65536	4	1	2
15F0h		**Flush Buffer Hits {37h:15F0h}:** Ratio of flush operations which required media motion.	% * 65536	4	1	2
2000h		**Media Idle {37h:2000h}:**	msec	6	2	3
2001h		**Media Write {37h:2001h}:**	msec	6	2	3
2002h		**Media Read {37h:2002h}:**	msec	6	2	3
2003h		**Media Erase {37h:2003h}:**	msec	6	2	3
2004h		**Media Position {37h:2004h}:**	msec	6	2	3
20?0h	1234567F	**Media Phase Timing {37h:20?0h}:**	msec	6	2	3
20?1h	1234567F	**Media Phase Cycles {37h:20?1h}:**	count	4	2	3
2?10h	1234567F	**Wrap Change Count {37h:2?10h}:** Total number of wrap changes.	count	4	2	3
2?11h	1234567F	**Band Change Count {37h:2?11h}:** Total number of changes to different servo bands.	count	4	2	3
2?50h	13	**Datarate Performance Impacting ERPs {37h:2?50h}:**	% * 65536	4	1	3
2?51h	13567F	**Performance Impacting ERPs {37h:2?51h}:**	% * 65536	4	1	3
2?52h	1234567F	**Performance Impact by ERPs {37h:2?52h}:**	% * 65536	4	1	3
2?60h	135	**Uncompressed Data {37h:2?60h}:**	bytes	8	2	2
2?61h	135	**Compressed Data {37h:2?61h}:**	bytes	8	2	2
2?62h	135	**Padded Data {37h:2?62h}:**	bytes	8	2	2
2?63h	135	**Degate Data {37h:2?63h}:**	bytes	8	2	2
2?68h	135	**Datasets Processed {37h:2?68h}:**	datasets	4	2	2
2?6Ch	13	**Compression Ratio {37h:2?6Ch}:**	% * 65536	4	1	2

Table 25 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 3 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
2?71h	13F	**Compressed Data (Medium) {37h:2?71h}:**	bytes	8	2	3
2?72h	13F	**Padded Data (Medium) {37h:2?72h}:**	bytes	8	2	3
2?80h	13	**Maximum Host Transfer Rate {37h:2?80h}:**	bytes/sec	4	1	2
2?81h	13	**Average Host Transfer Rate {37h:2?81h}:**	bytes/sec	4	1	2
2?82h	13	**Average Host Buffer Rate {37h:2?82h}:**	bytes/sec	4	1	2
2?83h	13	**Window Host Buffer Rate {37h:2?83h}:**	bytes/sec	4	1	2
2?84h	13	**Host Buffer Efficiency {37h:2?84h}:**	% * 65536	4	1	2
2?85h	13	**Window Buffer Efficiency {37h:2?85h}:**	% * 65536	4	1	2
2?88h	13	**Average Host Transfer Length {37h:2?88h}:**	bytes	4	2	2
2?8Ch	1	**Average Host Sync Length {37h:2?8Ch}:**	bytes	6	2	2
2?90h	13	**Maximum Comp Transfer Rate {37h:2?90h}:**	bytes/sec	4	1	2
2?91h	13	**Average Comp Transfer Rate {37h:2?91h}:**	bytes/sec	4	1	2
2?92h	13	**Average Comp Buffer Rate {37h:2?92h}:**	bytes/sec	4	1	2
2?93h	13	**Window Comp Buffer Rate {37h:2?93h}:**	bytes/sec	4	1	2
2?94h	13	**Comp Buffer Efficiency {37h:2?94h}:**	% * 65536	4	1	2
2?95h	13	**Window Comp Buffer Efficiency {37h:2?95h}:**	% * 65536	4	1	2
2?98h	13	**Average Comp Transfer Length {37h:2?98h}:**	bytes	4	2	2
2?9Ch	1	**Average Comp Sync Length {37h:2?9Ch}:**	bytes	6	2	2
2?A0h	13	**Maximum Tape Transfer Rate {37h:2?A0h}:**	bytes/sec	4	1	2
2?A1h	13	**Average Tape Buffer Rate {37h:2?A1h}:**	bytes/sec	4	2	2
2?A2h	13	**Window Tape Buffer Rate {37h:2?A2h}:**	bytes/sec	4	2	2
2?A3h	13	**Moving Tape Buffer Rate {37h:2?A3h}:**	bytes/sec	4	2	2
2?A4h	13	**Window Tape Buffer Efficiency {37h:2?A4h}:**	% * 65536	4	2	2
2?A5h	13	**Moving Tape Buffer Efficiency {37h:2?A5h}:**	% * 65536	4	2	2
2?A6h	13	**Tape Buffer Efficiency {37h:2?A6h}:** Ratio of amount of time we are usefully moving and ready with respect to amount of time the buffer is able to process data. A ratio larger than 1 indicates the compressed host data is arriving faster than the native device rate. Lower values indicate the device has under utilized host bandwidth.	% * 65536	4	2	2
2?A7h	13F	**Tape Thrashing {37h:2?A7h}:** Ratio of amount of time we are accelerating, decelerating or backhitching with respect to the time in mode.	% * 65536	4	2	2
2?A8h	13F	**Tape Efficiency {37h:2?A8h}:** Ratio of amount of time we are usefully moving and ready with respect to the time in mode.	% * 65536	4	1	2
2?F0h	13	**Speed Changes {37h:2?F0h}:**	count	4	2	2
2?F1h	13	**Speed Forced {37h:2?F1h}:**	count	4	2	2

Table 26 — LP 37h: Performance Characteristics: Servo Speed Characteristics

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
5Fs0h	123456789ABCDEF	**Servo Speed Relative Time {37h:5Fs0h}:**	% * 65536	4	2	6

Table 27 — LP 37h: Performance Characteristics: Static Capacity

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
7000h		**Static Capacity Efficiency {37h:7000h}:**	% * 65536	4	1	4
7010h		**Static Datasets Media {37h:7010h}:**	datasets	4	2	4
7011h		**Static Datasets Used {37h:7011h}:**	datasets	4	2	4
7020h		**Static Distance Media {37h:7020h}:**	mm	8	2	4
7021h		**Static Distance Used {37h:7021h}:**	mm	8	2	4
7030h		**Static Remaining Capacity in SkipSync Buffer {37h:7030h}:**	% * 65536	4	2	4

Table 28 — LP 37h: Performance Characteristics: Active Capacity

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
7?00h	13F	**Active Capacity Efficiency {37h:7?00h}:**	% * 65536	4	1	4
7?10h	13F	**Active Sync Loss {37h:7?10h}:**	% * 65536	4	2	4
7?11h	13F	**Active Skip Loss {37h:7?11h}:**	% * 65536	4	2	4
7?12h	13F	**Active DSS Loss {37h:7?12h}:**	% * 65536	4	2	4
7?13h	13F	**Active CQs Loss (on-the-fly) {37h:7?13h}:**	% * 65536	4	2	4
7?21h	13F	**Active Distance Skip {37h:7?21h}:**	mm	8	2	4
7?22h	13F	**Active Distance DSS {37h:7?22h}:**	mm	8	2	4
7?23h	13F	**Active Distance CQs (on-the-fly) {37h:7?23h}:**	mm	8	2	4
7?2Fh	13F	**Active Distance Total {37h:7?2Fh}:**	mm	8	2	4

Table 29 — Log Page 37h: Performance Characteristics: Static Capacity per Partition

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
8t00h	01	**Static Capacity Efficiency (Partition t) {37h:8t00h}:**	% * 65536	4	1	4
8t10h	01	**Static Datasets Media (Partition t) {37h:8t10h}:**	datasets	4	2	4
8t11h	01	**Static Datasets Used (Partition t) {37h:8t11h}:**	datasets	4	2	4
8t20h	01	**Static Distance Media (Partition t) {37h:8t20h}:**	mm	8	2	4
8t21h	01	**Static Distance Used (Partition t) {37h:8t21h}:**	mm	8	2	4

1.4.17 LP 38h: Blocks/Bytes Transferred

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page.

1.4.17.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.17.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 30 — LP 38h: Blocks/Bytes Transferred log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Host Write Blocks Processed {38h:0000h}:** Each count represents a block processed across the host interface during a Write. The count does not include ERP retries.	4
0001h	**Host Write Kilobytes Processed {38h:0001h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during a Write. The count does not include ERP retries. This count may be divided by Device Write Kilobytes Processed, 0005, to calculate an approximate write compression ratio.	4
0002h	**Host Read Blocks Processed {38h:0002h}:** Each count represents a block processed across the host interface during a Read. The count does not include ERP retries.	4
0003h	**Host Read Kilobytes Processed {38h:0003h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during a Read. The count does not include ERP retries. This count may be divided by Device Read Kilobytes Processed, 0007, to calculate an approximate read compression ratio.	4
0004h	**Device Write Datasets Processed {38h:0004h}:** Each count represents a dataset processed on the medium. The count does not include ERP retries.	4
0005h	**Device Write Kilobytes Processed {38h:0005h}:** Each count represents a kilobyte (1024 bytes) processed on the medium. The count does not include ERP retries or any tape formatting overhead bytes.	4
0006h	**Device Read Datasets Processed {38h:0006h}:** Each count represents a dataset processed from the medium. The count does not include ERP retries.	4
0007h	**Device Read Kilobytes Processed {38h:0007h}:** Each count represents a kilobyte (1024 bytes) processed from the medium. The count does not include ERP retries or any tape formatting overhead bytes.	4
0008h	**Device Write Datasets Transferred {38h:0008h}:** Each count represents a dataset processed on the medium. The count includes ERP retries.	4
0009h	**Device Write Kilobytes Transferred {38h:0009h}:** Each count represents a kilobyte (1024 bytes) processed on the medium. The count includes ERP retries and any tape formatting overhead bytes.	4
000Ah	**Device Read Datasets Transferred {38h:000Ah}:** Each count represents a dataset processed from the medium. The count includes ERP retries.	4
000Bh	**Device Read Kilobytes Transferred {38h:000Bh}:** Each count represents a kilobyte (1024 bytes) processed from the medium. The count includes ERP retries and any tape formatting overhead bytes.	4
000Ch	**Nominal Capacity of Partition {38h:000Ch}:** The nominal capacity of the current partition (in kilobytes).	4
000Dh	**Fraction of Partition Traversed {38h:000Dh}:** The fractional part of the current partition traversed (N/255).	1

Table 30 — LP 38h: Blocks/Bytes Transferred log parameter codes (part 2 of 2)

Code	Counter: Description	Size
000Eh	**Nominal Capacity of Volume {38h:000Eh}:** The nominal capacity of the mounted volume (in kilobytes). This is determined by the sum of the Nominal Capacity of Partition parameter for each partition.	4
000Fh	**Fraction of Volume Traversed {38h:000Fh}:** The fractional part of the mounted volume traversed (N/255). This reports the value that would be reported by the Fraction of Partition Traversed if the volume were a single partition.	1
0010h	**Remaining Capacity of Volume {38h:0010h}:** The nominal unwritten remaining capacity of the mounted volume (in kilobytes). This is not sensitive to current position. This is determined by the sum of the Remaining Capacity of Partition for each partition. If the tape does not have a valid EOD in at least one existing partition, or if a tape is not loaded, then a value of ’all ones’ (-1) is returned.	4
0011h	**Remaining Capacity of Partition {38h:0011h}:** The nominal unwritten remaining capacity of the current partition (in kilobytes). This is not sensitive to current position. If the tape does not have a valid EOD in the current partition, or if a tape is not loaded, then a value of ’all ones’ (-1) is returned.	

1.4.18 LP 39h: Host Port 0 Interface Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. The count of errors occurring on host interface port 0 (while the device is active on the interface).

1.4.18.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.18.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 31 — LP 39h: Host Port Interface Errors log parameter codes

Code	Counter: Description	Size
0000h	**Host Protocol Errors {39h:0000h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0007h	**Host Aborts {39h:0007h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0008h	**Host Resets {39h:0008h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0009h	**Vendor-Reserved {39h:0009h}:**	2
000Ah	**Vendor-Reserved {39h:000Ah}:**	2
0010h	**Host Recoveries {39h:0010h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors. An example of a host recoveries is a Fibre Channel Sequence Retransmission Request (SRR).	4

1.4.19 LP 3Ah: Host Port 1 Interface Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. The count of errors occurring on host port 1 (while the device is active on the interface).

1.4.19.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.19.2 Parameter Definitions

NOTE 6 - The parameters are identical to those found in *"LP 39h: Host Port 0 Interface Errors" on page 51*, except this data is recorded for incidents which occur on host interface port 1.

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

1.4.20 LP 3Bh: Equipment Check Errors

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. The following counters all deal with errors where a problem in the drive hardware is suspected (as opposed to media processing or host interface quality related problems).

1.4.20.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded.

1.4.20.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 32 — LP 3Bh: Equipment Check Errors log parameter codes

Code	Counter: Description	Size
0001h	**Panel Errors {3Bh:0001h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0002h	**Host Protocol Chip Errors {3Bh:0002h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0003h	**Host Buffer Errors {3Bh:0003h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0004h	**Data Compression Errors {3Bh:0004h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0005h	**Format Buffer Errors {3Bh:0005h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0006h	**Dataflow Hardware Errors {3Bh:0006h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0007h	**ECC Hardware Errors {3Bh:0007h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0008h	**Channel Hardware Errors {3Bh:0008h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0009h	**Internal Interface Errors {3Bh:0009h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
000Ah	**Loader Hardware Errors {3Bh:000Ah}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2

1.4.21 LP 3Ch: Drive Control Statistics

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is for special drive control mode statistics. While is is included in the list of supported pages (page code 00h), this page is not intended for general use.

1.4.21.1 Parameter Reset Behavior

Parameters in this page are reset when a cartridge is loaded. Parameters in this page are not reset when read by a Log Sense command.

1.4.21.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

1.4.22 LP 3Dh: Subsystem Statistics

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. The following counters all deal with subsystem statistics and errors.

1.4.22.1 Parameter Reset Behavior

Most of the counters on this page are never reset. Most counters are maintained in VPD and persist across Log Select, Log Sense, Power On Resets, and even microcode download. Lifetime values are written to VPD every eight operating hours when the drive is in a not ready state. The user may also save these counters to VPD at other times (such as just prior to powering off) by selecting the *Save* option from the CE service panel Statistics menu. The counters lock at maximum values.

1.4.22.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Table 33 — LP 3Dh: Subsystem Statistics log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0020h	**Volume Lifetime Mounts {3Dh:0020h}:** The total number of successful cartridge unloads performed during the lifetime of a cartridge. This field may not be updated for mounts that occur with the volume physically write-protected.	4
0021h	**Volume Lifetime Megabytes Written {3Dh:0021h}:** The total amount of data in Megabytes written during the lifetime of the cartridge. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface. This field may not be updated during mounts that occur with the volume physically write-protected.	4
0022h	**Volume Lifetime Megabytes Read {3Dh:0022h}:** The total amount of data in Megabytes read during the lifetime of the cartridge. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface. This field may not be updated during mounts that occur with the volume physically write-protected.	4
0040h	**Drive Lifetime Mounts {3Dh:0040h}:** The total number of successful cartridge unloads performed during the lifetime of the drive.	4
0041h	**Drive Lifetime Megabytes Written {3Dh:0041h}:** The total amount of data in Megabytes written during the lifetime of the drive. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface.	4
0042h	**Drive Lifetime Megabytes Read {3Dh:0042h}:** The total amount of data in Megabytes read during the lifetime of the drive. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface.	4
0060h	**Clean Lifetime Mounts {3Dh:0060h}:** The total number of successful cleaner cartridge operations performed during the lifetime of the drive.	4
0061h	**Megabytes Written since Clean {3Dh:0061h}:** The total amount of data in Megabytes written since the last successful clean operation. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface.	4
0062h	**Megabytes Read since Clean {3Dh:0062h}:** The total amount of data in Megabytes read since the last successful clean operation. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface.	4

Table 33 — LP 3Dh: Subsystem Statistics log parameter codes (part 2 of 2)

Code	Counter: Description	Size
0063h	**Mounts since Clean {3Dh:0063h}:** The total number of mounts performed since the last successful clean operation.	4
0080h	**Library Interface Messages Received {3Dh:0080h}:** This counter is not stored in VPD and reflects messages since reset.	4
0081h	**Library Interface Messages Transmitted {3Dh:0081h}:** This counter is not stored in VPD and reflects message since reset.	4
0082h	**Library Interface Resets {3Dh:0082h}:** Count of hardware reset or logical reinitializations during normal operation.	4
0083h	**Library Interface Buffer Errors {3Dh:0083h}:** This includes buffer overrun or underrun conditions.	4
0084h	**Library Interface Sync Errors {3Dh:0084h}:**	4
0085h	**Library Interface Framing Errors {3Dh:0085h}:**	4
0086h	**Library Interface Protocol Errors {3Dh:0086h}:**	4
0087h	**Library Interface Logical Errors {3Dh:0087h}:**	4
0088h	**Library Interface Loader Failures {3Dh:0088h}:** This counter reflects load attempts when the drive is in an incorrect state or was otherwise unable to attempt requested loader action.	4
0090h	**Drive Lifetime Write Perms {3Dh:0090h}:** Total number of write permanent errors which occurred on this drive.	4
0091h	**Drive Lifetime Read Perms {3Dh:0091h}:** Total number of read permanent errors which occurred on this drive.	4
0092h	**Drive Lifetime Load Perms {3Dh:0092h}:** Total number of load permanent errors which occurred on this drive.	4
0093h	**Drive Lifetime Unload Perms {3Dh:0093h}:** Total number of unload permanent errors which occurred on this drive.	4
00A0h	**Drive Lifetime Write Temps {3Dh:00A0h}:** Total number of write temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A1h	**Drive Lifetime Read Temps {3Dh:00A1h}:** Total number of read temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A2h	**Drive Lifetime Load Temps {3Dh:00A2h}:** Total number of load temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A3h	**Drive Lifetime Unload Temps {3Dh:00A3h}:** Total number of unload temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
0100h	**Lifetime Power On Seconds {3Dh:0100h}:** Cumulative number of seconds which the drive has been powered on. Note - Since this time is only periodically updated in non-volatile storage, it is possible that this time may not be entirely accurate to the full resolution of the counter.	4
0101h	**Power On Seconds {3Dh:0101h}:** Number of seconds since the drive was powered on or has undergone a hard reset condition.	4
0102h	**Reset Seconds {3Dh:0102h}:** Number of seconds since the drive has undergone a soft reset condition.	4

1.4.23 LP 3Eh: Engineering Use

See *Log Select - 4Ch (see 5.2.7 on page 150)* and *Log Sense - 4Dh (see 5.2.8 on page 152)* for directions on how to use this page. This page is for engineering use only and is not included in the list of supported pages (i.e., page code 00h). As such, the counters on this page are not intended for general use.

1.4.23.1 Parameter Reset Behavior

1.4.23.2 Parameter Definitions

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

Clause 2. Definitions, symbols, abbreviations, and conventions

2.1 Definitions

This clause defines the special terms, abbreviations, and acronyms that are used in this publication. If the term being looked for is not found, refer to http://www-01.ibm.com/software/globalization/terminology/index.jsp.

2.1.1 ABEND Abnormal end of task.

2.1.2 access method A technique for moving data between processor storage and input/output devices.

2.1.3 adapter card A circuit card that adds function to a computer.

2.1.4 AES Advanced Encryption Standard.

2.1.5 AK Authentication Key

2.1.6 ALPA Arbitrated Loop Physical Address.

2.1.7 ANSI American National Standards Institute.

2.1.8 Arbitrated Loop A Fibre Channel Loop topology protocol, also known as L-port.

2.1.9 archiving The storage of backup files and associated journals, usually for a given period of time.

2.1.10 archiving application The retention of records, in machine-readable form, for historical purposes.

2.1.11 argument Any value of an independent variable.

2.1.12 ASC Additional Sense Code.

2.1.13 ASCQ Additional Sense Code Qualifier.

2.1.14 ASN.1 Abstract Syntax Notation One - OSI's encoding (see X.208 standard)

2.1.15 beginning of tape (BOT) The location on a magnetic tape that indicates the beginning of the permissible recording area. Synonymous with BOP 0.

2.1.16 BER Basic Encoding Rules - used with ASN.1 (see X.209 standard)

2.1.17 bezel The frame that fits over the front of the tape drive. This includes a button and a message display.

2.1.18 bit The smallest unit of data in a computer. A bit (short for binary digit) has a single binary value or either 0b or 1b.

2.1.19 block A collection of contiguous records recorded as a unit. Blocks are separated by interblock gaps, and each block may contain one or more records.

2.1.20 BOP Beginning of Partition - logical beginning of a data area (logical block 0)

2.1.21 BOT Beginning of tape.

2.1.22 bpi Bits per inch.

2.1.23 BPI Bytes per inch.

2.1.24 buffer A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another.

2.1.25 buffered mode The buffered mode allows a number of logical blocks to accumulate in the control unit buffer before the data is transferred to the device or channel. This mode is suppressed automatically, if the record exceeds the maximum buffered capacity.

2.1.26 byte A storage unit that contains a certain number of bits (usually 8) which are treated as a unit an represent a character. A byte is a fundamental unit of data.

2.1.27 CA Contingent allegiance.

2.1.28 capacity See *media capacity* .

2.1.29 cartridge See *tape cartridge* .

2.1.30 cartridge loader A standard function for the tape drive that allows the manual loading of single tape cartridges.

2.1.31 cartridge memory An embedded non-contact electronics and interface module that can store and retrieve information relevant to the cartridge.

2.1.32 CC Check Condition.

2.1.33 CDB Command description block.

2.1.34 command A control signal that initiates an action or the beginning of a sequence of actions.

2.1.35 command timeout A host controlled period of time, following the issuance of a command, after which it is determined that a bad connection or severe failing condition exists between the host and drive.

2.1.36 compaction See *data compression* .

2.1.37 compression See *data compression* .

2.1.38 contingent allegiance (1) A condition in which a drive owes a response to a specific channel path because of a unit check. (2) A condition generated by a check condition status during which a target preserves sense data.

2.1.39 control unit A device attached between the tape drive and one or more host systems, often to provide special protocol or attachment features or other advanced function.

2.1.40 conversion The process of changing from one method of data processing to another or from one data-processing system to another.

2.1.41 CU Control Unit - a tape controller subsystem, such as J70 (ESCON/FICON bridge)

2.1.42 DASD Direct-access storage device.

2.1.43 data Any representations such as characters or analog quantities to which meaning is, or might be, assigned.

2.1.44 data base A set of data, consisting of at least one file, that is sufficient for a given purpose or for a given data-processing system.

2.1.45 data compression An algorithmic data-reduction technique that encodes data from the host and stores it in less space than unencoded data. The original data is recovered by an inverse process called decompression.

2.1.46 data compression ratio The number of host data bytes divided by the number of encoded bytes. It is variable depending on the characteristics of the data being processed. The more random the data stream, the lower the opportunity to achieve compression.

2.1.47 data transfer rate The amount of data that can be stored on a tape cartridge with respect to time.

2.1.48 dataset The major unit of data storage and retrieval, consisting of a collection of data in one of several prescribed arrangements and described by control information to which the system has access.

2.1.49 DCC Deferred Check Condition, also known as *deferred unit check* .

2.1.50 DDR Device Data Recovery - a write perm recovery operation performed by a control unit

2.1.51 deferred unit check A condition in which a drive returns a unit check indication for an event that occurred asynchronously with the channel commands. The deferred unit check may not refer to the command that receives the indication.

2.1.52 DER Distinguished Encoding Rules - a subset of *BER*

2.1.53 device Any hardware component or peripheral that can receive and transmit data, such as a tape drive or tape library.

2.1.54 device driver An executable file or program installed on a host system used to control or access a device.

2.1.55 diagnostic A test or procedure designed to detect, recognize, locate, isolate or explain faults in equipment or errors in programs.

2.1.56 diagnostic cartridge A tape cartridge used to perform a diagnostic.

2.1.57 digest a cryptographically strong hash (i.e., SHA-x, MD-x)

2.1.58 DK Data Key - key used for encryption/decryption

2.1.59 DKI Data Key Index - a field in the EEDK(s)/SEDK and part of the DKi/IV recorded on media which associates the encryption of the record to EEDK(s) and ultimately a DK

2.1.60 DKi/IV Combined DKi and IV prepended to each record in the meta format

2.1.61 DKi=0 Data Key Index Zero - a special DKi (value of 0) which indicates that the data is encrypted with a well known method (key of all zeroes). This is used to write “non-encrypted” data in a format consistent with encryption for intermix cases

2.1.62 DKv Data Key Validator - a hash or signature which verifies a DK matches that used for data without requiring data decryption and validation via MAC. Could be an arbitrary clear text constant encrypted with the DK

2.1.63 drive A device used to store data to media and subsequently restore data from media.

2.1.64 drive head The component of a tape drive which converts and records an electrical signal to a magnetic signal on tape, and subsequently detects and converts such signals.

2.1.65 drive loaded A condition of a tape drive in which a tape cartridge has been inserted in the drive, and the tape has been threaded to the beginning-of-tape position.

2.1.66 dump To write the contents of storage, or of a part of storage, usually from an internal storage to a external medium, for a specific purpose such as to allow other use of storage, as a safeguard against faults or errors, or in connection with debugging.

2.1.67 effective data rate The average number of bits, bytes, characters, or blocks per unit time transferred from a data source to a data sink and accepted as valid. The rate is expressed in bits, bytes, characters, or blocks per second, minute, or hour.

2.1.68 effective recording density The number of user bytes per unit of length of the recording medium.

2.1.69 eject To remove or force from within. Generally refers to the last part of the unload process to allow removal of a tape cartridge from the drive.

2.1.70 EKM External Key Manager

2.1.71 enable To provide the means or opportunity. The modification of system, control unit, or device action through the change of a software module or a hardware switch (circuit jumper) position.

2.1.72 end of tape (EOT) The extreme position along the medium in the direction away from the take-up reel that is accessible by the device. This position may be different than an end-of-partition position.

2.1.73 EOD End Of Data - a dataset denoting the end of user data

2.1.74 EOP End of partition. The position at the end of the permissible recording region of a partition.

2.1.75 EOT End of tape.

2.1.76 ERA Error-recovery action performed by the host.

2.1.77 ERP See *error-recovery procedures (ERP)*

2.1.78 error-recovery procedures (ERP) (1) Procedures designed to help isolate and, where possible, to recover from errors in equipment. The procedures are often used in conjunction with programs that record the statistics of machine malfunctions. (2) Error-recovery procedures performed by the subsystem.

2.1.79 explicitly activated A process in which the attributes of an identifier are specified. Contrast with *implicitly activated* .

2.1.80 extended contingent allegiance (1) A condition caused by a permanent buffered-write error in which the drive responds only to the channel path group from which the write command was received. The extended contingent allegiance continues until a controlling computer in the channel path group retrieves the unwritten data from the buffer or issues a tape motion command. (2) A condition generated by an initiate recovery message to assist in extended error recovery procedures in multi-initiator systems.

2.1.81 F-port Fabric port.

2.1.82 FC *Fibre Channel* .

2.1.83 FCP Fibre Channel Protocol - the SCSI mapping to fibre channel

2.1.84 fiber A physical communications cable or connection used to attach two or more Fibre Channel devices.

2.1.85 Fibre Channel A standard interconnection interface used to attach host systems and/or peripheral devices.

2.1.86 FID Format Identification Dataset.

2.1.87 field replaceable unit (FRU) An assembly that is replaced in its entirety when any one of its components fails.

2.1.88 file A set of related records, treated as a unit; for example, in stock control, a file could consist of a set of invoices.

2.1.89 file protected Pertaining to a tape volume from which data can be read only. Data cannot be written on or erased from the tape.

2.1.90 filemark A logical demarcation, recorded on media, often used to separate files or provide other organizational structure to recorded data. Usage and convention of filemarks is controlled by the attached host system(s).

2.1.91 FIPS Federal Information Processing Standards

2.1.92 firmware Proprietary code that is usually delivered as part of an operating system or device. Firmware is more efficient than software loaded from an alterable medium, and is more adaptable to change than hardwired embedded logic.

2.1.93 FL-port Fabric loop port.

2.1.94 FMR Field microcode replacement.

2.1.95 format The arrangement or layout of data on a data medium.

2.1.96 FRU Field replaceable unit *(see 2.1.87 on page 63)*.

2.1.97 GB See *gigabyte* .

2.1.98 Gb See *gigabit* .

2.1.99 GCM Galois Counter Mode

2.1.100 gigabit 1 000 000 000 bits of storage.

2.1.101 gigabyte 1 000 000 000 bytes of storage.

2.1.102 hard addressing A method of specifying a fixed address for a device in a Fibre Channel loop configuration.

2.1.103 hardware The physical equipment or components that form a device or system.

2.1.104 HBA *host bus adapter* .

2.1.105 head See *drive head*

2.1.106 host bus adapter A specific type of adapter card which provides the connection to a physical device interconnect such as Fibre Channel.

2.1.107 host system A data-processing system that is used to prepare programs and the operating environments for use on another computer or controller.

2.1.108 IBM Proprietary Protocol IBM vendor-specific method of configuring and controlling encryption

2.1.109 implicitly activated A process in which the attributes of an identifier are determined by default. Contrast with *explicitly activated* .

2.1.110 initiator A SCSI device that requests an I/O process to be performed by another SCSI device (a target). In many cases, an initiator can also be a target.

2.1.111 install To set up for use or service. The act of adding a product, feature, or function to a system or device either by a singular change or by the addition of multiple components or devices.

2.1.112 interchange application The preparation of tapes for use on other systems or devices, either local or remote, or the use of tape data prepared by another system.

2.1.113 invoke To petition for help or support. The request for a feature or function to be utilized in future processing activities through the use of software or hardware commands.

2.1.114 IPP *IBM Proprietary Protocol*

2.1.115 IV Initialization Vector - a value also called a nonce, used with a key for AES block ciphers

2.1.116 journaling Recording transactions against a dataset so that the dataset can be reconstructed by applying transactions in the journal against a previous version of the dataset.

2.1.117 KB See *kilobyte* .

2.1.118 Kb See *kilobit* .

2.1.119 kilobit 1024 bits of storage.

2.1.120 kilobyte 1024 bytes of storage.

2.1.121 L-port Arbitrated Loop Fibre Channel host connection. May attach to a fabric (switch) FL-port.

2.1.122 LDI Library Drive Interface - a specific interface protocol for tape device to automation interface (over RS422)

2.1.123 LEOT *logical end of tape*

2.1.124 LN-port Fibre Channel host attachment which attempts to negotiate first to Arbitrated Loop, then Point-to-Point. May attach to a fabric (switch) FNL-port.

2.1.125 load Following the insertion of a tape cartridge into the device, the act of positioning the tape (performed by the drive) for subsequent reading or writing.

2.1.126 load point The beginning of the recording area on magnetic tape.

2.1.127 loader See *cartridge loader*

2.1.128 logical end of tape A point on the tape where written data normally ends.

2.1.129 LPOS Longitudinal Position.

2.1.130 LSB Least significant byte.

2.1.131 lsb Least significant bit.

2.1.132 LTO Linear Tape Open.

2.1.133 LUN Logical unit number.

2.1.134 MAC Message Authentication Code - a digest which validates encrypted data. Appended to the record in the meta format for encryption integrity validation

2.1.135 magnetic recording A technique of storing data by selectively magnetizing portions of a magnetizable material.

2.1.136 magnetic tape A tape with a magnetizable surface layer on which data can be stored by magnetic recording.

2.1.137 magnetic tape drive A mechanism for moving magnetic tape and controlling its movement.

2.1.138 manual mode A mode of operation that can be selected on a cartridge loader or library. This mode allows a single tape cartridge feed, performed by the operator.

2.1.139 MB See *megabyte* .

2.1.140 Mb See *megabit* .

2.1.141 media Plural of medium.

2.1.142 media capacity The amount of data that can be contained on storage media and expressed in bytes of data.

2.1.143 medium A physical material in or on which information may be represented, such as magnetic tape.

2.1.144 megabit 1 000 000 bits of storage.

2.1.145 megabyte 1 000 000 bytes of storage.

2.1.146 microcode Embedded device programming which controls the behavior and functioning of the device.

2.1.147 microprocessor An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

2.1.148 migration See *conversion* .

2.1.149 MIM Medium Information Message.

2.1.150 msb Most significant bit.

2.1.151 MSB Most significant byte.

2.1.152 N-port Point-to-Point Fibre Channel host connection. May attach to a fabric (switch) FL-port.

2.1.153 N/A Not Applicable.

2.1.154 native data transfer rate The amount of data that can be stored without compression on a tape cartridge with respect to time.

2.1.155 native storage capacity The amount of data that can be stored without compression on a tape cartridge.

2.1.156 NL-port Fibre Channel host attachment which attempts to negotiate first to Point-to-Point, then Arbitrated Loop. May attach to a fabric (switch) FL-port.

2.1.157 node Fibre channel term for the logical connection to a device.

2.1.158 nonce number used once - a value used in conjunction with the key for AES block ciphers (also IV)

2.1.159 OEM Original equipment manufacturer.

2.1.160 offline An operating condition where the host system cannot interact with the drive through the specified interface.

2.1.161 online An operating condition where the host system can interact normally with the drive through the specified interface.

2.1.162 OOB Out-Of-Band

2.1.163 open system Computer systems whose operating standards and methods are not proprietary.

2.1.164 operating system The master computer control program that translates the user commands and allows software application programs to interact with the computer hardware and attached devices.

2.1.165 overwrite A write operation that records a logical object in a logical position that is not an append point (see 4.13.3).

2.1.166 OSI Open Systems Interconnection - (see X.200 standard)

2.1.167 PEOT *physical end of tape*

2.1.168 physical end of tape A point on the tape beyond which the tape is not permitted to move.

2.1.169 PKCS Public-Key Cryptography Standards

2.1.170 POR Power-on reset.

2.1.171 port Fibre channel term for the physical connection to a device.

2.1.172 primed Pertaining to a condition of a tape drive when the controlling computer addresses the drive but the drive is not in a ready state.

2.1.173 PRNG Pseudo Random Number Generator

2.1.174 processing application The execution of a systematic sequence of operations performed on data to accomplish a specific purpose.

2.1.175 Program Temporary Fix A temporary solution to a problem in the microcode.

2.1.176 PTF *Program Temporary Fix*

2.1.177 quiesce To bring a device or system to a halt by a rejection of new requests for work.

2.1.178 read To acquire or interpret data from a storage device, from a data medium, or from another source.

2.1.179 read-type commands Any commands that cause data to be read from tape.

2.1.180 record A collection of related data or words, treated as a unit; for example, in stock control, each invoice could constitute one record.

2.1.181 recording density The number of bits in a single linear track measured per unit of length of the recording medium.

2.1.182 reset To return a device, circuit, or value to a clear state.

2.1.183 retension (or refresh) The process or function of tightening the tape onto the cartridge, if it is sensed that the tape has a loose wrap on the cartridge.

2.1.184 RSA Method authored by Rivest, Shamir, Adleman

2.1.185 SAN Storage Area Network.

2.1.186 SCSI Small Computer System Interface.

2.1.187 SCSI address The octal representation of the unique address (0-F) assigned to a SCSI device. This address would normally be assigned and set in the SCSI device during system installation.

2.1.188 SCSI device A host adapter or a target controller that can be attached to the SCSI bus.

2.1.189 SCSI ID The identifier used to uniquely identify the address on the bus. When used on Fibre Channel devices this refers to the AL_PA.

2.1.190 SHA Secure Hash Algorithm (can be SHA-256, SHA-384, SHA-512, for bit size)

2.1.191 SIM Service Information Message.

2.1.192 soft addressing A method of specifying a standard arbitration method for assigning an address for a device in a Fibre Channel loop configuration.

2.1.193 special feature A specific design addition to an IBM product that is quoted in the IBM Sales Manual and ordered separately.

2.1.194 standard function The significant design elements of an IBM product that are included as part of the basic standard product.

2.1.195 synchronization The process of coordinating the activities of the controlling computer and the magnetic tape subsystem to obtain the condition in which the buffer is empty and the tape is in the correct position for the next operation.

2.1.196 T10 ANSI group responsible for SCSI model and command sets, see http://www.t10.org

2.1.197 T11 ANSI group responsible for FCP/fibre channel protocols, see http://www.t11.org

2.1.198 tape Commonly refers to magnetic tape or the tape cartridge.

2.1.199 tape cartridge A container holding magnetic tape that can be processed without separating it from the container.

2.1.200 tape drive A device that is used for moving magnetic tape and includes the mechanisms for writing and reading data to and from the tape.

2.1.201 tape unit A device that contains tape drives and their associated power supplies and electronics.

2.1.202 TapeAlert A patented technology and ANSI standard that defines conditions and problems that are experienced by tape drives.

2.1.203 TapeAlert flags Status and error messages that are generated by the TapeAlert utility and are reported to a host system.

2.1.204 target A SCSI device that performs an operation requested by the initiator.

2.1.205 target routine A target routine is an I/O process directed to a target, and not to a logical unit.

2.1.206 TRNG True Random Number Generator

2.1.207 TSM Tivoli Storage Manager

2.1.208 vital product data Non-volatile information including configuration, calibration, etc., used to control the behavior and operation of the device.

2.1.209 volume (1) A certain portion of data, together with its data carrier, that can be handled conveniently as a unit. (2) A data carrier that is mounted and demounted as a unit, for example, a reel of magnetic tape, a disk pack.

2.1.210 volume coherency set: A set of information contained in logical objects including a volume coherency count *(see 4.19 on page 126)* for which coherency across an entire volume is desired.

2.1.211 VPD Vital Product Data - information stored in drive nonvolatile memory

2.1.212 WORM (Write Once, Read Many) A write or append methodology for allowing data to be written only once, disallowing overwriting.

2.1.213 write To store or encode data to a storage device, to data medium, or to another source.

2.1.214 Write Once, Read Many (WORM) A write or append methodology for allowing data to be written only once, disallowing overwriting.

2.1.215 write protected A state disallowing write operations to a device or medium.

2.1.216 write-type commands Any commands that cause data to be written on tape or affect buffered write data.

2.2 Conventions

2.2.1 Bit Numbering

Bit numbering follows ANSI standards as follows:

- Bit 7 is the most significant bit (MSB) occupying the leftmost bit position in the diagrams
- Bits 6 through 1 continue from left to right in descending order
- Bit 0 is the least significant bit (LSB) occupying the rightmost bit position in the diagrams

2.2.2 Units of measure for data storage

This document uses MB and GB as powers of ten (i.e., MB = 1 000 000 and GB = 1 000 000 000) unless explicitly stated otherwise. This document uses powers of 2 for KB (i.e., KB = 1024).

2.2.3 Subpages

When pages have subpages (e.g., Mode Pages, Log Pages) the convention used for Page XXh Subpage YYh is Page XXh[YYh].

When describing Security Protocol XXh with Security Protocol Specific YYYYh in the Security Protocol In command or the Security Protocol Out command XXh[YYYYh] is used.

2.2.4 Text Markers

The source files of this document contains conditional text to aid in maintaining the various versions that are generated from these files. During editing and review, these conditional texts have specific markers that delineate which condition they relate to. These markers include color, underlines, overlines, etc. Those markers contained in this version of the document are:

a) Text contained in all versions of the document (Unconditional)

b) Text removed by a Future feature

c) Text contained in the external version that is replaced by text in the encryption version of the document (Crypto-Removed)

d) Text in the external version that is replaced by text in the Internal version of the document (Internal-Removed)

2.2.5 Hyperlinks

This document contains many hyperlinks. Every place the text says “see clause number” should be a hyperlink. Hyperlinks have been given a special font to offset them from the rest of the text. That font is demonstrated in this following link *(see 2.2.5 on page 69)*

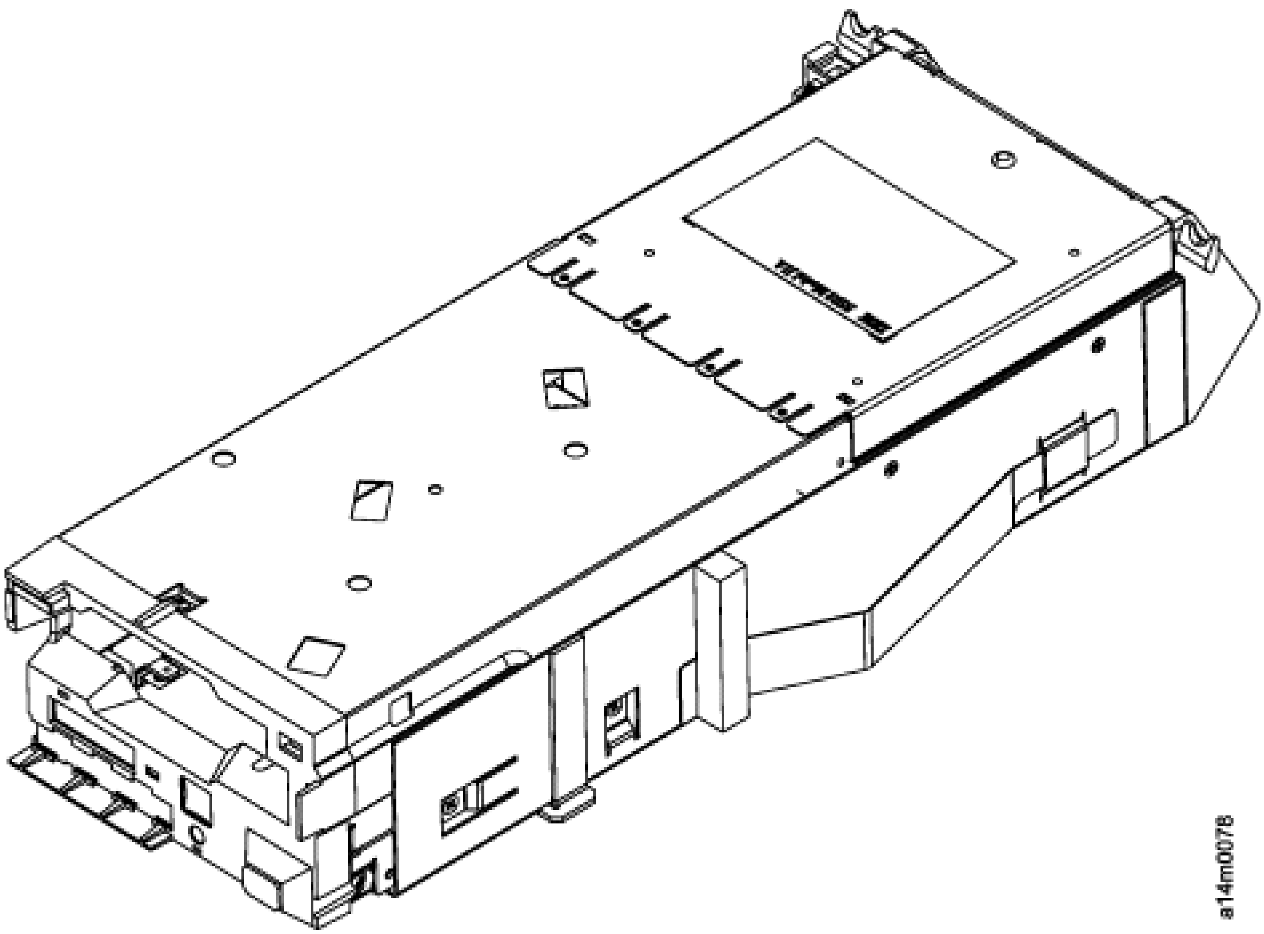
2.3 Tape Drive Model Names

From this section forward, through the remainder of this book, all Tape Drive models are referred to collectively as the IBM Enterprise Tape Drive 3592 Tape Drive or simply as the 3592. The only exceptions are when one specific model is being discussed where the IBM TotalStorage Enterprise Tape System Model J1A is referred to as the 3592 J1A, the IBM System Storage TS1120 Tape Drive (3592 Model E05) is referred to as the 3592 E05, and the IBM System Storage TS1130 Tape Drive (3592 Model E06) is referred to as the 3592 E06.

Clause 3. Introduction

The IBM 3592 Enterprise Tape Drive provides new levels of function, performance, reliability, and cartridge capacity. *Figure 1* shows a drawing of the IBM 3592 Tape Drive.

Figure 1 — IBM 3592 Tape Drive



3.1 Highlights

Highlights of the 3592 Model J1A include:

- Attaches to a wide variety of systems and configurations
- 40 MB/sec (uncompressed) native data rate (110MB/sec with maximum compression) dramatically reduces backup and recovery times.
- 8 meters/sec high-speed search provides rapid access to stored data.
- Cartridges can contain up to 900 GB with 3:1 data compression.
- Up to a 100-fold increase in data integrity over the 3480.
- Dual port 200 MB/s Fibre Channel attachment for increased performance and connectivity. For specific host bus adapters (HBAs) supported see the web at

  http://www-03.ibm.com/systems/support/storage/config/ssic/displayesssearchwith-outjs.wss?start_over=yes.

Highlights of the 3592 Model E05 include:

- Attaches to a wide variety of systems and configurations
- Can read and write 3592 J1A formatted media
- 100 MB/sec (uncompressed) native data rate (260MB/sec with maximum compression) dramatically reduces backup and recovery times.
- 10 meters/sec high-speed search provides rapid access to stored data.
- Speed matching to match host data rate and reduce back-hitching (i.e., shoe-shining)
- Virtual backhitch small file write synchronize handling
- Cartridges can contain up to 1500 GB with 3:1 data compression.
- Up to a 100-fold increase in data integrity over the 3480.
- Dual port 400 MB/s Fibre Channel attachment for increased performance and connectivity. For specific host bus adapters (HBAs) supported see the web at

  http://www-03.ibm.com/systems/support/storage/config/ssic/displayesssearchwith-outjs.wss?start_over=yes.
- Some models of the 3592 E05 contain encryption hardware capable of encrypting data at tape speeds.
- The models of the 3592 E05 that contain encryption hardware support application transparent encryption

Highlights of the 3592 Model E06 include:

- Attaches to a wide variety of systems and configurations
- Can read 3592 J1A formated media
- Can read and write 3592 E05 formatted media
- 160 MB/sec (uncompressed) native data rate (360MB/sec with maximum compression) dramatically reduces backup and recovery times.
- 12 meters/sec high-speed search provides rapid access to stored data.
- Improved speed matching range to better match host data rates and reduce back-hitching (i.e., shoe-shining).
- Improved virtual backhitch small file write synchronize handling.
- Improvement for large files with the new SkipSync feature.
- Cartridges can contain up to 3000 GB with 3:1 data compression.
- Up to a 100-fold increase in data integrity over the 3480.
- Giant Magneto Resistive (GMR) head technology improves head reliability and reduces wear on media.
- Dual port 400 MB/s Fibre Channel attachment for increased performance and connectivity. For specific host bus adapters (HBAs) supported see the web at

  http://www-03.ibm.com/systems/support/storage/config/ssic/displayesssearchwithoutjs.wss?start_over=yes.
- Contains encryption hardware capable of encrypting data at tape speeds.
- Supports application transparent encryption.
- Standby cooling management feature to reduce power and reduce the risk of unnecessary airborne debris contamination when idle.

3.1.1 Exceptional Performance

The IBM Enterprise Tape Drive 3592 has leading-edge streaming and start/stop performance. This is important since many applications operate in start/stop mode. The 3592 streaming performance is more than seven times that of the 3590 and more than twenty times that of the 3490E, with a native data transfer rate of up to 160 MB/sec (360 MB/sec with compression). The maximum instantaneous data rate is 400 MB/sec on a 4 Gbps Fibre Channel Interface.

3.1.2 Improved Reliability and Integrity

The advanced IBM Enterprise Tape Drive 3592 uses a bidirectional serpentine recording technique and a magneto resistive head that writes eight data tracks at a time. Improved Error Correction Code (ECC) and servo tracks with embedded longitudinal position written on tape help ensure data integrity and reliability. Resident diagnostics monitor operations to detect potential problems and aid in fast resolution.

3.1.3 Wide Platform Connectivity

The IBM Enterprise Tape Drive 3592 has two Fibre Channel ports supporting speeds of 1 Gbps, 2 Gbps, and 4 Gbps and topologies of Arbitrated Loop (both private loops (L-Port) and public loops (FL-Port)) and Fabric (attaching to an F-Port) allowing the drive to be shared in a multi-platform open systems environment.

Data can be interchanged across a wide range of platforms. For a current listing of supported configurations, see the web at

http://www-03.ibm.com/systems/storage/tape/pdf/compatibility/ts1120_interop.pdf.

3.1.4 Host Command Compatibility

The IBM Enterprise 3592 Tape Drive host command support is highly compatible with the IBM Enterprise Tape 3590 family of drives, simplifying device driver and overall application and software support.

3.1.5 High Capacity

The IBM Enterprise Tape Cartridges used in the various models of 3592 have capacities as shown in *table 34*.

Table 34 — IBM Enterprise Tape Cartridge capacities

Cartridge	Native capacity (no compression)				3:1 LZ1 compression			
	3592 J1A Format	3592 E05 Format	3592 E06 Format	3592 E07 Format	3592 J1A Format	3592 E05 Format	3592 E06 Format	3592 E07 Format
JJ/JR	60 GB	100 GB	128 GB	-	180 GB	300 GB	384 GB	-
JA/JW	300 GB	500 GB	640 GB	-	900 GB	1 500 GB	1 920 GB	-
JB/JX	-	700 GB	1 000 GB	1 600 GB	-	2 100 GB	3 000 GB	4 800 GB
JK	-	-	-	500 GB	-	-	-	1 500 GB
JC/JY	-	-	-	4000 GB	-	-	-	12 000 GB

Key:
- Not Supported

JA	3592 Enterprise Tape — Standard Cartridge
JB	3592 Enterprise Tape — Extended Cartridge
JC	3592 Enterprise Tape — Advanced Cartridge
JJ	3592 Enterprise Tape — Economy Cartridge
JK	3592 Enterprise Tape — Advanced Economy Cartridge
JR	3592 Enterprise Tape — Economy WORM Cartridge
JW	3592 Enterprise Tape — Standard WORM Cartridge
JX	3592 Enterprise Tape — Extended WORM Cartridge
JY	3592 Enterprise Tape — Advanced WORM Cartridge

IBM Enterprise 3592 media is housed in a cartridge with the same physical size as 3480 and 3590 cartridges, enabling coexistence in an IBM Enterprise Automated Tape Library 3494 and IBM Enterprise 3584 Tape Library, together with current media.

3.1.6 Optimal Data Compression

The IBM Enterprise 3592 uses an optimal dynamic compression method called byte level compression scheme swapping. This insures that the maximum data compression is always achieved, and unlike other tape drive compression methods, the data will never expand.

3.1.7 Hardware Encryption (Some Models)

Some models of the IBM SystemStorage TS1120 Tape Drive and all models of the IBM SystemStorage TS1130 Tape Drive contain encryption hardware capable of encrypting data at tape speeds. Encrypting data at tape speed helps to avoid the need for host-based encryption of data and the concurrent drain on host performance or the use of specialized encryption appliances. This capability supports high volume data encryption of tape data, helping protect information if tape cartridges are lost or stolen.

3.1.8 Media Reuse

The 3592 drive protects future media investments by supporting full forward read and write compatibility into the next generation 3592 drives. The 3592 drive also supports full read compatibility of the previous two generation drives. The 3592 drive provides an automatic reformatting function to allow current media to be reused and achieve higher capacities. *Table 35* shows the media reuse support.

Table 35 — 3592 Formats supported by model

Format on the media	Supported by			
	3592 J1A	3592 E05	3592 E06	3592 E07
J1A Format	Write and Read	Write and Read	Read Only	-
E05 Format	-	Write and Read	Write and Read	Read Only
E06 Format	-	-	Write and Read	Write and Read
E07 Format	-	-	-	Write and Read
- Not Supported				

3.1.9 WORM Media Support

The IBM Enterprise Tape System 3592 supports critical data archive protection by supporting WORM (Write Once, Read Many) media. This special media and writing mode enables protection of permanent user data by disallowing data overwrite.

3.1.10 Cost Effectiveness

High capacity means that less equipment, fewer cartridges, and fewer tape mounts are required. High performance can reduce the number of drives required. This translates into less floor space for tape cartridge storage, tape drives, and tape libraries. Maintenance costs are also lower than those for high-performance helical and 3480/3490/3590 drives.

A reusable storage asset, the IBM Enterprise 3592 protects existing investments and can be used as the foundation for a broad array of storage solutions.

3.1.11 Ease of Use

IBM Enterprise Tape Drive 3592 features a message display showing device status, activities, error conditions, and messages. An optional operator/service display is available in some configurations which enables extended status and serviceability features.

3.1.12 Service

The IBM Enterprise Tape Drive 3592 does not require scheduled preventive maintenance. The IBM Enterprise 3592 is a single Field Replaceable Unit (FRU) and has no required field serviceable components. IBM customer engineers use an optional hot-pluggable service panel to perform service functions.

3.1.13 Models

The IBM Enterprise 3592 is available in several models for Fibre Channel attachment and are designed to be incorporated into the following configurations:

a) The 3592 Model E07:
   A) in the IBM Enterprise TS3500 Tape Library;
   B) in the C06/C07 Controller;
   C) in the TS7700; and
   D) in a Rack mount;
   and
b) The 3592 Model E06, Model E05, and Model J1A:
   A) in the IBM Enterprise TS3500 Tape Library;
   B) in the C06/C07 Controller;
   C) in the TS7700;
   D) in a Rack mount;
   E) in the IBM Enterprise Automated Tape Library (3494);
   F) in the J70 Controller;
   G) in the TotalStorage Model C20 with one to twenty tape drives providing attachment to the StorageTek 4410 and 9310 ACS; and
   H) in the IBM Enterprise TS3400 Tape Library.

3.1.14 Storage Management Software

Tivoli® Storage Manager (TSM) is a client/server storage management product that provides save/restore, archive, hierarchical storage, and disaster recovery functions for networked workstations and servers. TSM uses the full capacity of the IBM Enterprise Tape System 3592. TSM also supports the IBM Enterprise 3592 in an Enterprise Tape Library 3494, including libraries mixed with TotalStorage Enterprise 3590 for data migration.

Many other popular automated storage software products support the IBM Enterprise 3592 Tape Systems and 3494 Tape Libraries. For a complete list of these products see the ISV Compatibility Matrix on the web at

http://www-03.ibm.com/systems/storage/tape/pdf/compatibility/ts1120_isv_matrix.pdf.

Clause 4. Implementation Considerations

4.1 Addressing Assignments

Each Fibre Channel interface port for this device can be independently assigned a specific speed and topology, or may be set to auto-negotiate.

When the topology is set to or negotiates to L-port, a hard or soft ALPA ID may be assigned. The hard ALPA ID is in the range of 01h to EFh with only certain valid values (a total of 126 addresses). Validity is enforced by the entry process. This value should be unique to each device on the Fibre Channel loop. Fibre Channel loop protocol will detect an addressing conflict on the loop, and one of the conflicting drives will not be available for use.

4.2 Multiple Port Behavior

The two Fibre Channel ports provide alternate paths through which the logical unit(s) of the device may be reached. The ports are referred to as Port 0 and Port 1. Each port maintains its own unique settings and address.

Using the CE service panel, the operator may manually set each port in an online or offline state.

When an offline port is set online, all initiators on that port receive a Unit Attention condition.

Offline ports do not generate or maintain Unit Attention conditions for initiators while the port is in an offline state.

Usage of the device with both ports online is required for dual port failover to function correctly. Generally, all initiators, regardless of port, are treated the same as multiple initiators on the same port. The exception to this is the handling of mode pages and reservations when a hard port reset condition occurs (such as loss of light, etc). The following rules are described with respect to a local interface (the host port on which the hard reset condition occurred) and a remote interface (the other host port to which the device is attached).

a) If there are no reservations when a hard reset condition occurs, all mode pages are reset. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface receive a Unit Attention condition for Mode Parameters Changed.
b) If there are one or more reservations when a hard reset condition occurs and all reservations were granted to initiators on the local interface, all mode pages are reset and all SPC-2 reservations are reset. All persistent reservations remain in effect. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface receive a Unit Attention condition for Mode Parameters Changed.
c) If there are one or more reservations when a hard reset condition occurs and one or more of the reservations were granted to an initiator on the remote interface, only those mode pages and SPC-2 reservations unique to each initiator on the local interface are reset. Mode pages and reservations unique to each initiator on the remote interface are not reset. Mode pages which are defined as common to all initiators are not reset. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface see no effects of the hard reset condition on the other interface.

4.3 Programmable early warning

When writing, the application client may need an indication prior to early warning to allow for the application client to prepare to be ready for early warning (e.g., flush buffers in the application client).

Application clients that need this indication may request the device server to create a zone called the programmable-early-warning zone (PEWZ) by setting the PEWS field (see 6.5.8 on page 317) to the requested size of the PEWZ. The EOP side of PEWZ is established at early-warning and extends towards BOP for a distance indicated by the PEWS field. See *figure 2*.

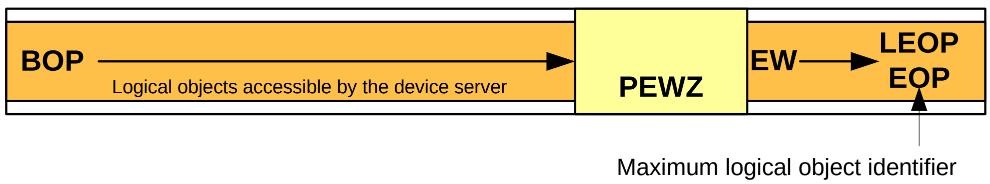


Figure 2 — Programmable early warning example

WARNING

If PEWZ is used, all applications that may access the drive when a PEWZ exists, should support PEWZ or there is a risk of the application that does not support PEWZ detecting an unknown error or a diminished capacity when the PROGRAMMABLE EARLY WARNING error is reported.

WARNING

The REW bit in the Device Configuration mode page (see 6.4.10) shall have no effect on the device server behavior in the PEWZ.

The device server shall return CHECK CONDITION status, with the sense key set to NO SENSE, the EOM bit set to one and the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED at the completion of a command that caused the medium to transition into the PEWZ if that command is:

a) WRITE(6);
b) WRITE(16);
c) WRITE FILEMARKS(6); or
d) WRITE FILEMARKS(16).

Encountering the PEWZ shall not cause the device server to perform a synchronize operation or terminate the command. If processing this command results in any other exception condition except early-warning, the CHECK CONDITION status associated with that exception condition shall be reported instead. If early-warning is crossed prior to the PROGRAMMABLE EARLY WARNING DETECTED additional sense being reported, the PROGRAMMABLE EARLY WARNING DETECTED additional sense shall be reported before the early-warning CHECK CONDITION.

If the PROGRAMMABLE EARLY WARNING DETECTED additional sense code was not reported, the next write in PEWZ or beyond early-warning that would otherwise complete with GOOD status, shall return the programmable-early-warning CHECK CONDITION instead.

If the PEWZ is entered and exited on the BOP side before the PROGRAMMABLE EARLY WARNING DETECTED additional sense code is returned, the device server shall not report CHECK CONDITION status with the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED.

4.4 Logical block protection

4.4.1 Logical block protection overview

The device contains hardware that is capable of checking and generating protection information (i.e., 4-byte CRC) that is transferred with logical blocks between the device server and an application client. This protection information transferred with logical blocks is saved to the medium with each logical block and read from the medium with each logical block. This protection information is validated at the destination prior to completing the task thereby ensuring that the logical block has not been corrupted. This level of detection is not achievable by methods where the application client inserts vendor-specific data protection information in its data. All 3592 devices support logical block protection using a vendor-specific means known by the term CRC Protection (see 4.4.1.1 on page 80). Some devices support a standardized method of logical block protection (see 4.4.1.2 on page 80).

4.4.1.1 CRC Protection (vendor-specific)

The CRC Protection method is supported on all 3592 devices and uses MP 24h: Initiator-Specific Extensions (see 6.4.19 on page 329) for configuration. CRC Protection is enabled by setting the CRC Target Enablement field of the Initiator-Specific Extensions mode page to 02h. CRC Protection is disabled by setting the CRC Target Enablement field of the Initiator-Specific Extensions mode page to 00h. CRC Protection, when enabled checks and transfers the CRC on read data, write data, and recovered buffered data. There is no individual selection.

4.4.1.2 Logical block protection (standardized)

The Logical block protection method is supported on 3592 devices starting with the following code levels:

a) D3I1_F1F;
b) D3I2_7B0; and
c) D3I3_5CD.

The Logical block protection method is not supported on 3592 J1A devices.

A device that supports using protection information in the standardized method configures this capability using MP 0Ah[F0h]: Control Data Protection (see 6.4.8 on page 300). A device that supports using this protection information sets:

a) the PROTECT bit in standard inquiry (see 5.2.6.1 on page 142) to one;
b) the SPT field of the Extended INQUIRY Data VPD page (see 6.2.5 on page 269) to 001b; and
c) the value returned in the MAXIMUM BLOCK LENGTH LIMIT field of the READ BLOCK LIMITS command to a value which when added to the largest value supported in the LOGICAL BLOCK PROTECTION INFORMATION LENGTH field of the Control Data Protection mode page is less than or equal to the maximum length able to be represented in commands that transfer logical blocks between the application client and the device server.

4.4.1.3 Interaction between CRC Protection and Logical block protection

CRC Protection and Logical block protection utilize the same CRC algorithm and transfer the CRC in the same manner. The only differences are how the drive reports support for the method, how the method is enabled and disabled, and how errors in the CRC detected during the transfer of data are reported. Since CRC errors are reported differently between the two methods only one method is allowed to be enabled at any time. An attempt to enable a method when the other method is enabled causes the other method to be disabled and the mode pages settings to be modified to reflect that disablement.

4.4.2 Protection information on a volume

A recorded volume contains logical objects (see 4.2.7.1) and format specific symbols. Logical objects are application client accessible. Format specific symbols are used by the device server to provide methods for recording logical objects on the medium in a manner that allows them to be successfully read at a later date and may not be application client accessible. Format specific symbols contain information used to protect logical objects. The drive includes the protection information field as one of the format specific symbols. The format specific symbol that is the protection information field is written to the medium with each logical block. The protection information used by the drive is a 4-byte Reed-Solomon CRC (see Annex D. on page 413). The protection information field is accessible by the application client when the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page for the I_T_L nexus through which that application client communicates is set to a non-zero value or the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page for the I_T_L nexus through which that application client communicates is set to 02h. A representation of logical objects and format specific symbols is shown in *figure 3*.

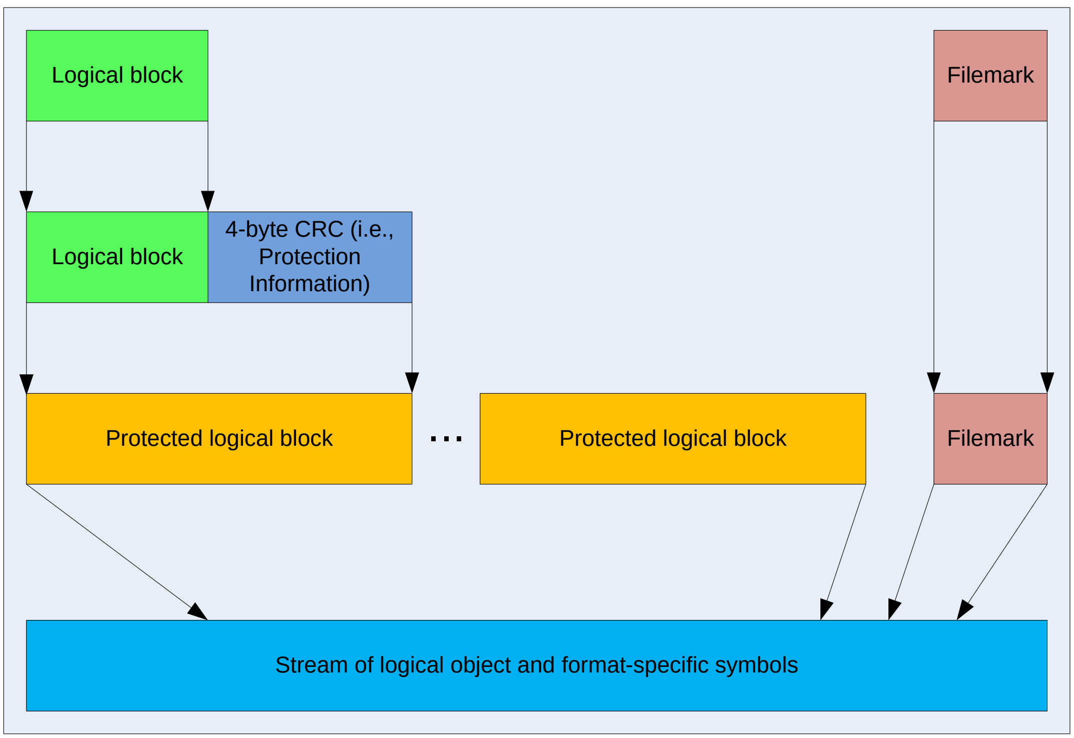


Figure 3 — Protection information shown in relation to logical objects and format specific symbols

The device generates the protection information and adds it to a logical block before recording the logical block to the medium if the command that transferred the logical block being recorded to medium was received on an I_T_L nexus for which the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page is set to zero and the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page:

a) is set to zero; or
b) is set to a non-zero value and the LBP_W bit of the Control Data Protection mode page is set to zero.

The drive reads the protection information from the medium, validates it, and removes it from the logical block before transferring the logical block to the application client if the command that is requesting the transfer of a logical block being read was received on an I_T_L nexus for which the CRC TARGET ENABLEMENT field of the

Initiator-Specific Extensions mode page is set to zero and the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page:

a) is set to zero; or
b) is set to a non-zero value and the LBP_R bit of the Control Data Protection mode page is set to zero.

Protection information may be:

a) compressed;
b) encrypted; or
c) included in byte counts in log parameters.

NOTE 7 - Device side counters reported in log pages generally include bytes from the protection information at all times. Host side counters reported in log pages when CRC Protection and Logical block protection are disabled generally do not include bytes from the protection information. Host side counters reported in log pages when CRC Protection is enabled or when Logical block protection is enabled generally include bytes from the protection information.

4.4.3 Logical blocks and protection information

If the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page is set to zero and the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page is set to zero for a specific I_T_L nexus then:

a) a logical block transferred between the application client and the device server through that I_T_L nexus is defined by *Table 36* if that transfer occurs in response to a:
   A) WRITE(6); and
   B) READ(6);
   C) READ REVERSE(6) with the BYTORD bit set to one; and

Table 36 — Logical block with no protection information

Byte	Bit 7	6	5	4	3	2	1	0
0	Data							
n-1								
n = the TRANSFER LENGTH field specified in CDB for variable length transfers; the BLOCK LENGTH field specified in the mode parameter header (see SPC-4) for fixed block transfers.								

b) a logical block transferred between the application client and the device server through that I_T_L nexus is defined by *Table 37* if that transfer occurs in response to a READ REVERSE(6) with the BYTORD bit set to zero

Table 37 — Logical block for READ REVERSE with BYTORD bit set to zero with no protection information

Byte	Bit 7	6	5	4	3	2	1	0
n-1	Data							
0								
n = the TRANSFER LENGTH field specified in CDB for variable length transfers; the BLOCK LENGTH field specified in the mode parameter header (see SPC-4) for fixed block transfers.								

If the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page is set to a non-zero value or the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page is set to 02h for a specific I_T_L nexus then:

a) a logical block transferred between the application client and the device server through that I_T_L nexus is defined by *Table 38* if that transfer occurs in response to a:
   A) WRITE(6); and
   B) READ(6);
   C) READ REVERSE(6) with the BYTORD bit set to one; and

Table 38 — Logical block with protection information

Byte	Bit 7	6	5	4	3	2	1	0
0	Data							
n-x-1								
n-x	Protection Information							
n-1								
n = the TRANSFER LENGTH field specified in the CDB for variable length transfers; the BLOCK LENGTH field specified in the mode parameter header (see SPC-4) for fixed block transfers. x = the LOGICAL BLOCK PROTECTION INFORMATION LENGTH specified in the Control Data Protection mode page.								

b) a logical block transferred between the application client and the device server through that I_T_L nexus is defined by *Table 39* if that transfer occurs in response to a READ REVERSE(6) with the bytord bit set to zero.

Table 39 — Logical block for READ REVERSE with BYTORD bit set to zero with protection information

Byte	Bit 7	6	5	4	3	2	1	0
n-1	Protection Information							
n-x								
n-x-1	Data							
0								
n = the TRANSFER LENGTH field specified in the CDB for variable length transfers; the BLOCK LENGTH field specified in the mode parameter header (see SPC-4) for fixed block transfers. x = the LOGICAL BLOCK PROTECTION INFORMATION LENGTH specified in the Control Data Protection mode page.								

4.4.4 Protection information for Recover Buffered Data

In response to a RECOVER BUFFERED DATA command the device server transfers unwritten logical blocks from the logical unit's object buffer to the application client. If the ROBO bit in the Device Configuration mode page (see 8.3.3) is set to zero, then the logical blocks are transfered in FIFO (first-in-first-out) order which is the same order in which they were written to the object buffer (see *Table 40*).

Table 40 — Data transferred from the logical units object buffer in response to RECOVER BUFFERED DATA command_

Byte	Bit 7	6	5	4	3	2	1	0
0	Recover Buffered Data descriptor (first)							
n-1								
n	Recover Buffered Data descriptor (second)							
s								
	. . .							
y	Recover Buffered Data descriptor (last)							
x-1								
n = the block length of the first descriptor x = the number of bytes transferred by a single RECOVER BUFFERED DATA command								

If the ROBO bit in the Device Configuration mode page (see 8.3.3) is set to one, then the logical blocks are transfered in LIFO order (last-in-first-out) which is the opposite order from which they were written to the object buffer (see *Table 40*).

Table 41 — Data transferred from the logical units object buffer in response to RECOVER BUFFERED DATA command_

Byte	Bit 7	6	5	4	3	2	1	0
0	Recover Buffered Data descriptor (last)							
n-1								
	. . .							
s	Recover Buffered Data descriptor (second)							
r-1								
r	Recover Buffered Data descriptor (first)							
x-1								
n = the block length of the last descriptor x = the number of bytes transferred by a single RECOVER BUFFERED DATA command								

If the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page is set to zero and the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page is set to zero for a specific I_T_L nexus then the Recover Buffered Data descriptor used on that I_T_L nexus is defined by *Table 36*.

If the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page is set to a non-zero value or the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page is set to 02h for a specific I_T_L nexus then the Recover Buffered Data descriptor used on that I_T_L nexus is defined by *Table 38*

4.4.5 Protecting logical blocks transferred during writes

If CRC Protection is enabled for a specific I_T_L nexus or if the LBP_W bit of the Control Data Protection mode page (see 6.4.8 on page 300) is set to one for a specific I_T_L nexus, each logical block transferred from the application client through that I_T_L nexus due to a WRITE(6) command contains protection information.

For the WRITE(6) command, the device server validates the protection information before the logical block is written to medium. If the FIXED bit in the CDB is set to one each logical block is validated before being written to the medium. If the validation of the protection information for a logical block fails, then the processing of the command terminates prior to writing the failed logical block to the medium. If the validation of the protection information fails, the device server;

a) if Logical block protection (standardized) (see 4.4.1.2 on page 80) is enabled, reports a CHECK CONDITION status with Sense Code of Current or Deferred, the sense key set to HARDWARE ERROR and the additional sense code set to LOGICAL BLOCK GUARD CHECK FAILED; or
b) if CRC Protection (vendor-specific) (see 4.4.1.1 on page 80) is enabled, reports a CHECK CONDITION status with Sense Code of Current or Deferred, the sense key set to HARDWARE ERROR and the additional sense code set to Write Internal CRC Error (47h/81h).

An application client shall add the protection information on each logical block before transferring that logical block and shall increase the TRANSFER LENGTH field by the length of the logical block protection information if it has:

a) set Logical Block Protection by:
   A) setting the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page to a non-zero value; and
   B) setting the LBP_W bit of the Control Data Protection mode page to one;

or

b) set CRC Protection by setting the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page to 02h.

The application client should add the protection information to the logical block at the earliest point possible. If the data has had the protection information added to the logical block at some point in the application client prior to the hardware that transfers the logical block, then the protection information should be validated when it is transferred. If the validation fails, then the application client should abort the command and report a status to the user that validation failed.

NOTE 8 - The device server treats the LOGICAL BLOCK PROTECTION INFORMATION field as the protection information. If the protection information is not added to the logical block, then the validation fails when the bytes used do not validate (e.g., the last 4-bytes of the logical block are treated as the CRC and the last 4-bytes of the logical block do not calculate as the CRC of the previous data)

4.4.6 Protecting logical blocks transferred during reads

If CRC Protection is enabled for a specific I_T_L nexus or if the LBP_R bit of the Control Data Protection mode page (see 6.4.8 on page 300) is set to one or CRC Protection is enabled for a specific I_T_L nexus, the protection information is read from the medium and transferred with the logical block to the application client on that I_T_L nexus. The commands for which this applies are:

a) READ(6);
b) READ REVERSE(6); and
c) READ REVERSE(16);
d) VERIFY(6) with the BYTCMP bit set to zero.

The protection information is validated by the device server before sending status to the command that caused the transfer of the logical block. If the FIXED bit in the CDB is set to one each logical block is validated before being transferred to the application client. If the validation of the protection information for a logical block fails, then the processing of the command is terminated prior to transferring any additional blocks to the application client. If the validation of the protection information fails, then the device server:

a) if Logical block protection (standardized) (see 4.4.1.2 on page 80) is enabled, reports a CHECK CONDITION status with Sense Code of Current Sense, the sense key set to HARDWARE ERROR and the additional sense code set to LOGICAL BLOCK GUARD CHECK FAILED; or
b) if CRC Protection (vendor-specific) (see 4.4.1.1 on page 80) is enabled, reports a CHECK CONDITION status with Sense Code of Current Sense, the sense key set to HARDWARE ERROR and the additional sense code set to Read Internal CRC Error (47h/80h).

An application client should validate the protection information on each logical block at the latest point possible before using the data if it has:

a) set Logical Block Protection by:
   A) setting the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page to a non-zero value; and
   B) setting the LBP_R bit of the Control Data Protection mode page to one;

or

b) set CRC Protection by setting the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page to 02h.

4.4.7 Protecting logical blocks transferred from the object buffer in response to a RECOVER BUFFERED DATA command

If the RBDP bit of the Control Data Protection mode page (see 6.4.8 on page 300) is set to one or the RBD DATA CHECKED bit of the Initiator-Specific Extensions mode page is set to one for a specific I_T_L nexus, each logical block transferred between the device server and the application client on that I_T_L nexus during a RECOVER BUFFERED DATA command (see 5.2.22 on page 187) shall include the protection information. The device server:

a) reads the protection information from the object buffer if it exists; or
b) generates the protection information if it does not exist.

The protection information for each block is validated before sending status to the command. If the validation of the protection information fails for any logical block, the device server terminates the command without transferring any additional logical blocks that may exist in the object buffer and;

a) if Logical Block Protection is enabled, reports a CHECK CONDITION status with Sense Code of Current Sense, the sense key set to HARDWARE ERROR and the additional sense code set to LOGICAL BLOCK PROTECTION ERROR ON RECOVER BUFFERED DATA; or
b) if CRC Protection is enabled, reports CHECK CONDITION status with Sense Code of Current Sense, the sense key set to HARDWARE ERROR and the additional sense code set to Read Internal CRC Error (47h/80h).

An application client should validate the protection information on each logical block at the latest point possible before using the data if:

a) it has enabled Logical Block Protection by:
   A) setting the LOGICAL BLOCK PROTECTION METHOD field of the Control Data Protection mode page to a non-zero value; and
   B) the RBDP bit of the Control Data Protection mode page to one;

or

b) it has enabled CRC Protection by setting the CRC TARGET ENABLEMENT field of the Initiator-Specific Extensions mode page to 02h.

4.4.8 File verification of protection information

An application client may verify that protection information is present on each logical block on the medium between the current position and a specified number of filemarks from the current position and that the protection information validates correctly by using the VBF and VLBPM bits of the VERIFY (6) command (see 5.2.37 on page 222) and setting to one the the LBP_R bit of the Control Data Protection mode page (see 6.4.8 on page 300). The device reads the medium verifying that each logical block between the current position and the nth filemark is protected with the protection information using the LOGICAL BLOCK PROTECTION METHOD specified in the Control Data Protection mode page and that the protection information validates as shown in *figure 4*.

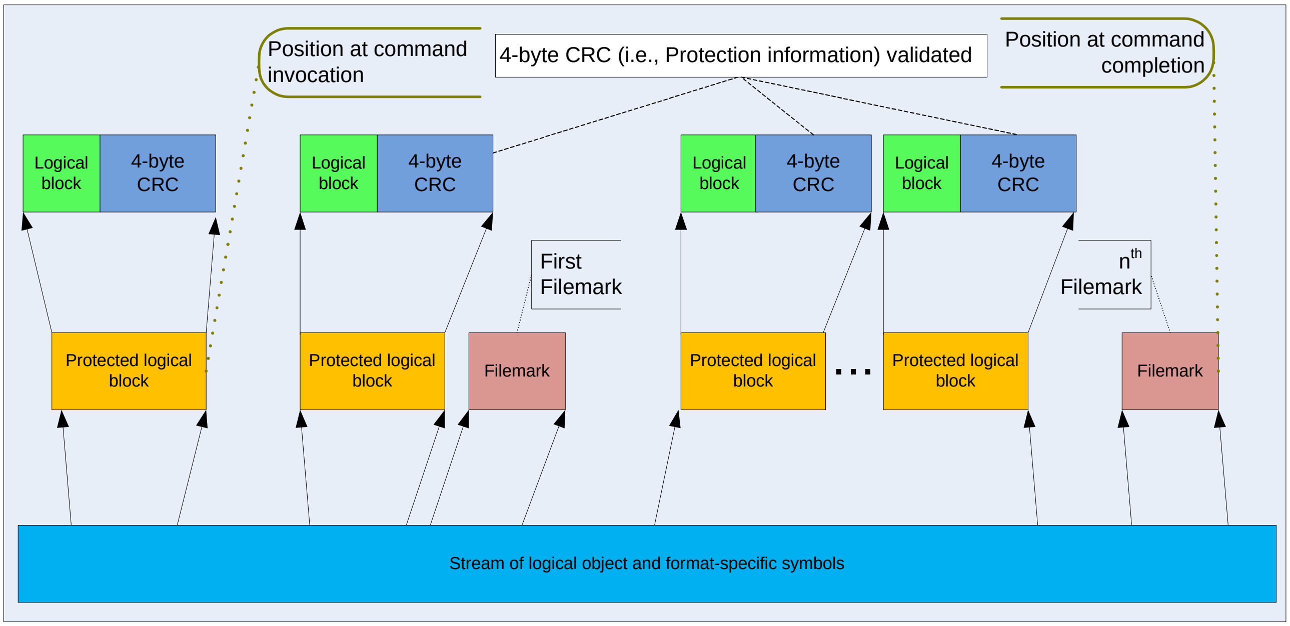


Figure 4 — Example file verification of protection information

4.4.9 Verification to EOD of protection information

An application client may verify that protection information is present on every logical block on the medium between the current position and EOD and that the protection information validates correctly using the VBE and VLBPM bits of the VERIFY (6) command (see 5.2.37 on page 222) and setting to one the the LBP_R bit of the Control Data Protection mode page (see 6.4.8 on page 300). The device reads each logical block between the current position and end-of-data verifying that each logical block is protected with the protection information using the LOGICAL BLOCK PROTECTION METHOD specified in the Control Data Protection mode page and that the protection information validates as shown in *figure 5*.

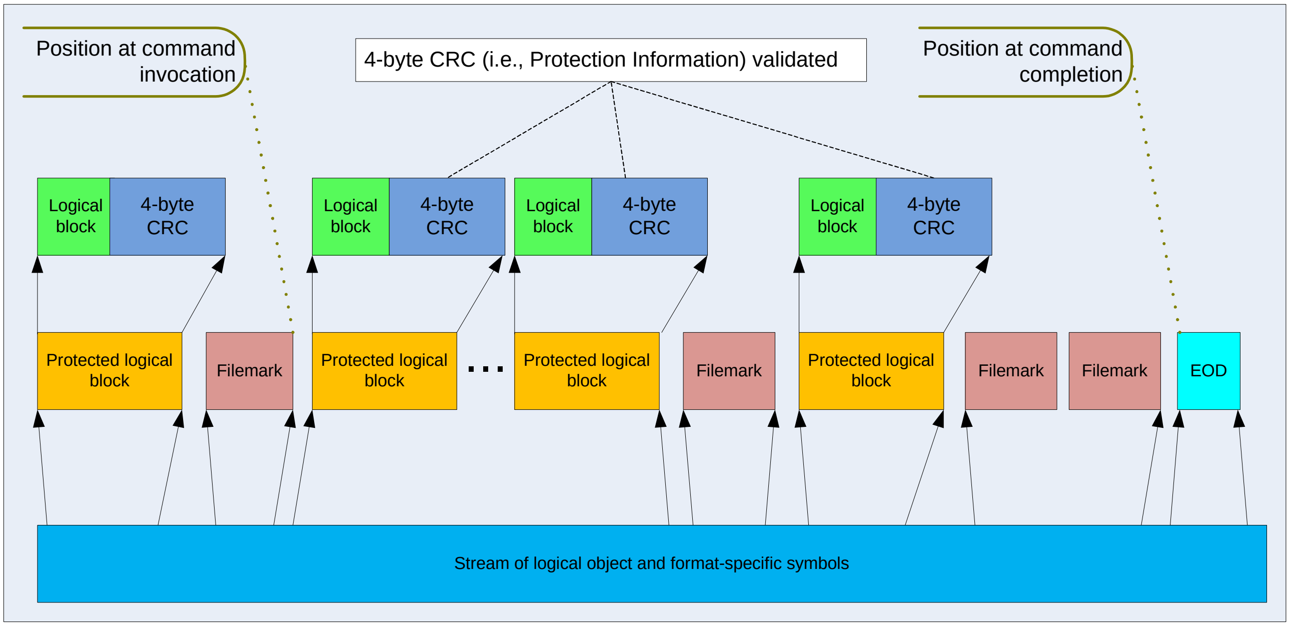


Figure 5 — Example verification to EOD of protection information

4.5 Data Transfer, Block Limits, and Fixed Block Option

This device is designed to buffer multiple records. Logical blocks may be prefetched to the buffer before they are requested by a Read command or held in the buffer after they are written by a Write command. For successive sequential-motion operations, the presence of the buffering in the device does not adversely affect the performance of the subsystem. Non-sequential motion does not result in errors, but may result in delays because of requirements to synchronize buffers or discard read ahead data. Buffer management in the device determines when to read additional data from the medium into the buffer, or when to write data from the buffer to the medium. A logical block is not written to tape until the block is entirely received into the buffer.

When the Fixed bit of the command is set to 1b,each command transfers zero or more logical blocks. The subsystem takes appropriate action to assemble or disassemble the logical blocks being transferred over the interface so that they remain independent blocks on the medium. There is no guarantee that the group of blocks transferred by the Write command is requested as a group by a subsequent Read command, so the device must be prepared to assemble and disassemble on a block boundary. This is managed by treating all blocks and filemarks as independent from one another, both for data compaction and for recording.

When the Fixed bit of the command is set to 0b, each command transfers a single logical block.

After EOP is reached on any Write command, only a single block is transferred before terminating the command with check condition status 0/0000 (No Sense, No Additional Sense Information) and EOM set to 1b.The same is true for Write Filemark commands.

The device supports a minimum logical block length of 1 and a maximum logical block length is 2,097,152 bytes (200000h). Any block length between the limits is also supported. Refer also to *Read Block Limits - 05h (see 5.2.17 on page 171)* for further information on block sizes and limitations.

For read type commands, including Read, Read Reverse, and Recover Buffered Data, transfer lengths larger than the maximum device supported block size are accepted and the underlength condition rules are applied for transfer requests bigger than the actual block size. A transfer Length of 000000h indicates that no bytes/blocks are transferred. This condition is not considered an error and the logical position is not changed.

For write type commands, including Write, and Write Filemarks, a transfer Length of 000000h indicates that no bytes/blocks are transferred. This condition is not considered an error and the logical position is not changed.

4.6 Request Sense Information, ILI, and Command Interactions

The behavior and interactions between some of the commands and the Information and ILI fields in Request Sense are rather complicated. This section details the various commands which may set the Information or ILI fields, and summarizes the relationship between such commands, their parameters, the encountered conditions, the reported status, and the expected behavior of these fields and the resulting device position.

4.6.1 General Read-Type Handling

Commands which return block data from media or the buffer to the host have the same general behavior. These commands include Read, Read Reverse, and Recover Buffered Data. The major difference between these is centered around the logical direction of the read (order of the blocks read with respect to their write order), and its effect on positioning.

Forward commands include Read, and Recover Buffered Data (in FIFO mode). In these cases, the block at the current position is processed first, and subsequent blocks are processed in the order they were written (proceeding towards logical end of partition). The ending position is after the last block processed. For these commands, “after” will refer to the start of the next block towards the logical end of partition, and “before” will refer to the start of referenced block.

Reverse commands include Read Reverse, and Recover Buffered Data (in LIFO mode). In these cases, the block prior to the current position (towards the beginning of partition) is processed first, and subsequent blocks are processed against the order in which they were written (proceeding towards logical beginning of partition). The ending position is at the beginning of the last block processed. For these commands, “after” will refer to the start of the referenced block, and “before” will refer to the start of the next block towards the logical beginning of partition (0).

To illustrate this, from location 'N', a Read operation will return block 'N', and be positioned at 'N+1' (“after” N). From location 'M', a Read Reverse will return block 'M-1', and be positioned at 'M-1' (“after” M-1). This means that such a loop of Reads, then Read Reverses will continuously return the same block.

A successful command with a Fixed bit of 1b transfers the requested Transfer Length, times the current block length in bytes to the initiator. A successful command with a Fixed bit of 0b transfers the requested Transfer Length in bytes to the initiator. Upon completion, the logical position is “after” the last block transferred.

If SILI bit is 1b and the Fixed bit is 0b, the target performs one of the following actions:

a) Reports CHECK CONDITION status for an incorrect block length condition only if the overlength condition exists and the Block Length field in the mode parameter block descriptor is nonzero. The associated sense data is 0/0000 (Incorrect Length, No Sense Data).
b) Does not report CHECK CONDITION status if the only error is the underlength condition, or if the only error is the overlength condition and Block Length field of the mode parameters block descriptor is 0b. (See *note 10 on page 92*.)

If the SILI bit is 1b and the Fixed bit is 1b, the target terminates the command with CHECK CONDITION status with associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

If the SILI bit is 0b and an incorrect length block is read, CHECK CONDITION status is returned and the ILI and valid bits are set to 1b in the sense data. Upon termination, the logical position is “after” the incorrect length block. If the Fixed bit is 1b, the information field is set to the requested Transfer Length, minus the actual number of blocks read (not including the incorrect length block).

If the Fixed bit is 0b, the information field is set to the requested Transfer Length, minus the actual block length in two's complement format.

If the logical unit encounters a filemark during a command, CHECK CONDITION status is returned and the filemark and valid bits are set to 1b in the sense data. The associated sense data is set to 0/0001 (No Sense, Filemark Detected). Upon termination, the logical position is “after” the filemark. If the Fixed bit is 1b, the information field is set to the requested Transfer Length, minus the actual number of blocks read (not including the filemark). If the Fixed bit is 0b the information field is set to the requested Transfer Length.

If the logical unit encounters end-of-partition during a command, CHECK CONDITION status is returned and the EOM and valid bits are set to 1b in the sense data. Associated sense data is set to 3/0002 (Medium Error, End of Partition/Medium).

If the logical unit encounters early warning and the REW bit is set to 1 in the device configuration page, CHECK CONDITION status is returned and the EOM and valid bits are set to 1b in the sense data. Associated sense data is set to D/0002 (Overflow, End-of-Partition/Medium Detected). If the Fixed bit is 1b, the information field is set to the requested Transfer Length, minus the actual number of blocks transferred. If the Fixed bit is 0b, the information field is set to the requested Transfer Length.

If the drive encounters End-of-Data (EOD) while executing this command, the command is terminated at the EOD position and CHECK CONDITION status is returned with associated sense data of 8/0005 (Blank Check, End-of-Data Detected). If the next motion command is another Read command (beyond EOD), and crossing EOD is allowed (*See “MP 25h: Read/Write Control” on page 332.*), the drive accepts the command and attempts to position beyond EOD in order to allow recovery of old data.

NOTE 9 - More than one Read command may be required to cross EOD. When EOD is successfully crossed, a CHECK condition status is returned with associated sense data set to 3/1404 (Medium Error, Block Sequence Error), which indicates that the position may have changed in a non-sequential fashion. It is recommended that Read Position be issued prior to reading data. If the drive encounters a permanent error as the result of a Read command whether or not EOD has been crossed, and crossing permanent errors is allowed (*See “MP 25h: Read/Write Control” on page 332.*) additional Read commands may be issued to attempt to traverse the data in error in a manner similar to reading past EOD.

If the logical unit encounters beginning-of-partition during a command, CHECK CONDITION status is returned and the EOM and valid bits are set to 1b in the sense data. Associated sense data is set to 0/0004 (No Sense, Beginning of Partition/Medium).

NOTE 10 - Because the residue information normally provided in the information field of the sense data may not be available when the SILI bit is set, use other methods to determine the actual block length. For example: include length information in the data block itself, or in the case of underlength transfers, the host adapter or device driver may return accurate transfer length information.

NOTE 11 - In the case of the Fixed bit of 1b with an overlength condition, only the position of the incorrect-length logical block can be determined from the sense data. The actual length of the incorrect block is not reported, and also cannot be derived from the transfer length (the device truncates the overlength block to match the current block length from the mode header). Other means may be used to determine the actual length (for example, backspace and read it again with Fixed bit set to 0b).

4.6.2 Interactions Summary

The following table summarizes various commands with the specified options, the encountered conditions, and the expected results.

Table 42 — Information and ILI Behavior Summary

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
reportable UA	X	X	X	UA	not valid (0)	-	unchanged (no command)
reportable DCC	X	X	X	DCC	not valid (0)	-	unchanged (no command)
Read (any)	1	1	0	5/2400	transfer length	-	unchanged (no read)
	1	0	0	5/2400	transfer length	-	unchanged (no read)
Read transfer length 0	X	X	X	good	-	-	unchanged (no read)
Read (correct length(s))	X	X	X	good	-	-	after last block
Read Underlength	0	0	X	0/0000	transfer length - block size (+)	I	after block
	0	1	X	good	-	-	after block
	1	0	non-0	0/0000	transfer length - blocks read not including incorrect block (+)	I	after incorrect block
Read Overlength	0	0	X	0/0000	transfer length - block size (-)	I	after block
	0	1	0	good	-	-	after block
	0	1	non-0	0/0000	transfer length - block size (-)	I	after block
	1	0	non-0	0/0000	transfer length - blocks read not including incorrect block (+)	I	after incorrect block
Read FM	0	X	X	0/0001	transfer length	F	after filemark
	1	0	non-0	0/0001	transfer length - blocks read not including filemark (+)	F	after filemark
Read EOD	0	X	X	8/0005	transfer length	E[7]	unchanged (at EOD)
	1	0	non-0	8/0005	transfer length - blocks read (+)	E[7]	after last block (at EOD)
Read Perm	0	X	X	perm	transfer length	-	unchanged (at perm)
	1	0	non-0	perm	transfer length - blocks read (+)	-	after last block (at perm)

Table 42 — Information and ILI Behavior Summary

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
Read after EOD/Perm	0	X	X	3/1404	transfer length	-	crossed EOD (position may change in non-predictable fashion, limited commands available)
	1	0	non-0	3/1404	transfer length - blocks read (+)	-	
Read (reverse) BOP	0	X	X	0/0004	transfer length	E	at BOP (0)
	1	0	non-0	0/0004	transfer length - blocks read (+)	E	at BOP (0)
Verify (any)	1	N/A	0	5/2400	transfer length	-	unchanged (no verify)
Verify transfer length 0 (VTE = 0b)	X	N/A	X	good	-	-	unchanged (no verify)
Verify (correct length(s))	X	N/A	X	good	-	-	after last block
Verify Underlength	0	N/A	X	0/0000	transfer length - block size (+)	I	after block
	1	N/A	non-0	0/0000	transfer length - blocks verified not including incorrect block (+)	I	after incorrect block
Verify Overlength	0	N/A	X	0/0000	transfer length - block size (-)	I	after block
	1	N/A	non-0	0/0000	transfer length - blocks verified not including incorrect block (+)	I	after incorrect block
Verify FM (VBF=0b; VTE=0b)	0	N/A	X	0/0001	transfer length	F	after filemark
	1	N/A	non-0	0/0001	transfer length - blocks verified not including filemark (+)	F	after filemark
Verify EOD (VBF=0b; VTE=0b)	0	N/A	X	8/0005	transfer length	E[7]	unchanged (at EOD)
	1	N/A	non-0	8/0005	transfer length - blocks verified (+)	E[7]	after last block (at EOD)
Verify VBF=1b (correct length)	X	N/A	X	good	-	-	after last block
Verify VBF=1b (incorrect length)	0	N/A	X	good	-	-	after last block

Table 42 — Information and ILI Behavior Summary

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
Verify VBF=1b (incorrect length)	1	N/A	non-0	0/0000	transfer length - number of filemarks passed over (+)	I	after incorrect block
Verify VTE=1b (correct length)	X	N/A	X	good	-	E[7]	after last block (at EOD)
Verify VTE=1b (incorrect length)	0	N/A	X	good	-	E[7]	after last block (at EOD)
Verify VTE=1b (incorrect length)	1	N/A	non-0	0/0000	-	I	after incorrect block
Verify Perm	0	N/A	X	perm	transfer length	-	unchanged (at perm)
	1	N/A	non-0	perm	transfer length - blocks verified (+)	-	after last block (at perm)
Write (any)	1	-	0	5/2400	transfer length	-	unchanged (no write)
Write transfer length 0	X	-	X	-	-	-	unchanged (no write)
Write in Early Warning	0	-	X	0/0000 0/0002	0	E	after block
	1	-	non-0	0/0000 0/0002	transfer length - blocks written (usually 1)	E	after blocks written
Write at EOM	X	-	X	D/0002	transfer length	E	unchanged (no write)
Write Perm	0	-	X	perm	transfer length or 0 (if data is in buffer)	-	after last block in buffer
	1	-	non-0	perm	transfer length - blocks trans-ferred into buf-fer	-	after last block in buffer
Write after Perm	X	-	X	3/3100	transfer length	-	unchanged (no write)
Locate (target after EOD)	encountered EOD			8/0005	not valid (0)[5]	E[7]	at EOD[5]
Locate	encountered Perm			perm	not valid (0)[5]	-	indeterminate (unchanged or at perm)[5]

Table 42 — Information and ILI Behavior Summary

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
Space blocks	encountered FM			0/0001	Count - blocks traversed[3]	F	after FM
Space blocks	encountered EOD			8/0005	Count - blocks traversed[3]	E[6]	at EOD
Space blocks	encountered BOP			0/0004	Count - blocks traversed[3]	E	at BOP (0)
Space blocks	encountered perm			perm	Count - blocks traversed[3]	-	indeterminate (unchanged or at perm)[3]
Space filemarks	encountered EOD			8/0005	Count - FMs traversed[4]	E[6]	at EOD[4]
Space filemarks	encountered BOP			0/0004	Count - FMs traversed[4]	E	at BOP (0)
Space filemarks	encountered perm			perm	Count - FMs traversed[4]	-	indeterminate (unchanged or at perm)[4]
Space sequential filemarks	encountered EOD			8/0005	Count - sequential FMs traversed immediately prior to ending position[5]	E[6]	at EOD[5]
Space sequential filemarks	encountered BOP			0/0004	Count - sequential FMs traversed immediately prior to ending position[5]	E	at BOP (0)
Space sequential filemarks	encountered perm			perm	Count - sequential FMs traversed immediately prior to ending position[5]	-	indeterminate (unchanged or at perm)[5]
Space EOD	encountered EOD			good	-[5]	-	at EOD[5]
Space EOD	encountered perm			perm	not valid (0)[5]	-	indeterminate (unchanged or at perm)[5]

Legend:

Flags:

I ILI bit #/#### CC, sense of Sense Key/ASC ASCQ
E EOM bit perm CC, sense as per perm
F Filemark bit good No CC (no sense)

\- None set
\- Not applicable

Notes:

1. These fields are outputs (results) from the scenario operation.
2. Partial blocks are not considered read, written or traversed.
3. Information field will accurately reflect the ending position.
4. Information field will accurately reflect the ending position but it is not in units of logical blocks, so additional means of determining absolute location, such as Read Position, must be used.
5. Information field does not accurately reflect the ending position, another means of determining absolute location, such as Read Position, must be used.
6. The EOM bit may be set only if the current position is in the early warning region or if the end of partition is encountered.
7. The EOM bit will only be set if end of partition is encountered (this condition should never occur), so EOM should not be set in this case. The standard specifies that EOM bit shall be set only if the current position is in the early warning region or if the end of partition is encountered.

4.7 Cleaning the Drive in a Library

In a library, the drive is automatically cleaned.

When the drive determines that either maintenance cleaning is required, or that the SARS thresholds have been reached, a message is sent to the library (via the RS-422 interface) to request cleaning. This occurs when the Cleaning message is normally sent to the CE service panel. The library schedules the mounting of the cleaning cartridge. Thus, the host operating system and application are freed of any responsibility to facilitate the cleaning.

4.8 Drive Cleaning Indicators

For stand-alone drive models, automatic cleaning of the drive is not possible. For library models, automatic cleaning of the drives by the library may be disabled (although it is not recommended). For either case, cleaning of the drives must be managed by the host application or manually, by the operator.

NOTE 12 - Failure to clean a drive may result in data loss.

This section describes how cleaning indicators are presented from the drive. The cleaning indicators may be presented even with automatic cleaning enabled in a library environment. The cleaning indicators can be presented through the following:

a) *Panel Cleaning Indication (see 4.8.1 on page 98)*
b) *Host Interface - Dynamic Cleaning Indicators (see 4.8.2 on page 98)*
c) *Host Interface - Static Cleaning Indicator (Sense Data Byte 70) (see 4.8.3 on page 99)*

4.8.1 Panel Cleaning Indication

A CLEAN message is displayed on the message display and the CE service panel when cleaning with a cleaning cartridge is required. For additional details, see the Operator Guide for this product.

4.8.2 Host Interface - Dynamic Cleaning Indicators

Dynamic cleaning indicators that are sent across the host interface include:

a) ASC/ASCQ codes related to cleaning in *table 202*. Cleaning Indicators reported with Sense Key 1 may only be reported in certain situations, see *"MP 01h: Read-Write Error Recovery" on page 297*.

Table 43 — ASC/ASCQ Codes Related to Cleaning

Code Description	Sense Key	ASC ASCQ
Drive Needs Cleaning	1	00 17
Drive Has Been Cleaned	1	83 83
Cleaning in Progress (cleaner cartridge)	2	30 03
Drive Needs Cleaning, Warning Threshold Exceeded	4	44 00
Drive Has Been Cleaned (CU mode)	6	82 83

b) TapeAlert codes related to cleaning (see 1.4.10 on page 25)
c) Service Information Message (SIM) bytes 20-21 of Log Page 31h (SIM availability is shown in sense data):

Value (ASCII)	**Description**
'55'	Drive Needs Cleaning. Load Cleaning Cartridge
'57'	Drive Has Been Cleaned

NOTE 13 - If the device driver shields the application from dynamic notifications, the information is usually available from the system error log.

4.8.3 Host Interface - Static Cleaning Indicator (Sense Data Byte 70)

The bit significance of sense data byte 70 follows:

Bit	Description
7	Set to 1b "Cleaning Required: Normal Maintenance" when cleaning is required because of the normal preventive maintenance guideline (determined by the device by read/write usage). Reset to 0b when the cleaning cartridge is loaded.
6	Set to 1b "Cleaning Required: Threshold Reached" when cleaning is required based on other internal threshold criteria. Reset to 0b when the cleaning cartridge is loaded.

4.9 Error Information

4.9.1 Sense Data

For a description of Sense data, see Sense Data Format.

4.9.2 Sense Data Management

Sense data returned by the device contains one of two types of errors. These errors are:

Type	Description
Current	The error condition associated with the command that is currently being processed (i.e., SCSI Status for the currently processing command is the status being returned); and
Deferred	The error condition resulting from a command that has been reported as GOOD, but has generated sense data after being reported. This may be a command with the Immediate bit set or may be a buffered write.

Sense data returned is described by the Sense Key (i.e., bits 3-0 of byte 2 of Sense data). Commands that terminate in an error generate Sense data and set the Sense Key depending on the the specifics of the error. Table 8. Supported Common SCSI commands, indicates which commands are allowed to be processed in the presence of specific error conditions and which return an error.

This device communicates on transports that use the autosense protocol. This means that any Sense data generated for return to a command is returned with the SCSI status. Once a particular set of sense data has been returned, that sense data is cleared and a REQUEST SENSE command is not required to be issued to collect the Sense data. Any other sense data that is still pending may still cause CHECK CONDITION status for subsequent commands. When a REQUEST SENSE command is received, typically the only Sense data available will be the default Sense data. While it is possible that a Deferred error may have generated Sense data or that a Unit Attention (see 4.9.4 on page 100) has been established since the status to the last command, Sense data is not likely to exist.

4.9.3 Deferred Check Condition (DCC)

Deferred errors are generated by processing that occurs when that process is not attached to the currently processing command (see 4.9.2 on page 100). Deferred errors are reported as sense data to a deferred check condition (DCC) eligible command (i.e., DCC column of *table 53* is set to ‘Y’).

In the case of a deferred write error if buffered mode 1h is selected and a DCC eligible command is received, then the error is reported to the SCSI initiator device (i.e., I_T nexus) that has deferred error affinity.

If the drive receives a deferred error affinity command (i.e., DEA column of *table 53* is set to ‘Y’), then the drive performs actions in the following order:

1) performs initial checking (e.g., Reservation Conflict, all pending Unit Attentions, and all pending errors to be reported to this I_T nexus) and reports these conditions, if any;
2) if none of the above conditions are reported, then all pending deferred errors are migrated to the I_T nexus through which this command was received;
3) the deferred error affinity is set to this I_T nexus;
4) if the command is DCC eligible, then pending deferred errors, if any, are reported; and
5) if no deferred errors were reported process the command.

4.9.4 Unit Attention Conditions

The drive generates a Unit Attention condition under the following circumstances:

a) Reset condition (for example, power-on, SCSI reset, bus device reset);
b) Tape Loaded condition (for example, media inserted, LOAD command from another initiator);
c) Mode parameters changed by another initiator; and
d) Drive firmware has been upgraded.

The drive only maintains one instance of each type of Unit Attention condition at any one time for any one initiator. If a subsequent Unit Attention condition of the same type is generated, it replaces the existing one. Unit Attentions are returned in priority order. The priorities are in the order listed above, with a reset being highest priority and a firmware upgrade being lowest priority.

4.9.5 Persistent Errors

When errors occur that prevent tape operation, they are reported persistently until the problem is cleared. For medium-related errors (usually reported with a Sense Key of 3), the error is reported until the cartridge is successfully unloaded. For hardware-related errors (usually reported with a Sense Key of 4), the error is reported until the drive successfully performs a power-on self test. These persistent errors are only reported on those commands that are eligible for deferred Check Condition reporting (see Table 4). The error may or may not be reported as Deferred.

4.10 WORM Behavior

This device supports specially formatted WORM media which enables tamper-resistant WORM write and append methods. The drive microcode leverages this support by providing an interface and control mechanisms which allow an application or system to manage this as needed. The control and status mechanisms for this can be found primarily in mode page 23h (see 6.4.18 on page 320) and mode page 24h (see 6.4.19 on page 329). A new medium identifier is specified, as well as a unique Volume Label Cartridge Type identifier (character 2), reported in sense data. Generally, the WORM function may be used without application awareness, however if the write/append behavior is violated (an illegal overwrite is attempted) then a write perm will occur.

To further data performance and provide an audit trail, a unique cartridge identifier is reported in mode page 23h which may be tracked by a host system to insure that the intended cartridge is being processed. This identifier is guaranteed unique and unalterable, and is imbedded into the servo format of the media itself. This identifier may be used to differentiate whether an original tape or a copy is being used. The host should determine the appropriate tracking methodology for the system design. For the most tamper resistant and detection, the host might query this identifier from the drive and add it to header and trailer records within the host written data. This may then be compared during the read process. Provisions may need to be made to allow intentionally copied media to be processed in such a system.

4.10.1 WORM Write/Append General Behavior

The WORM feature was implemented in a manner which is designed for maximum application compatibility, while meeting the necessary data permanence requirements. To accomplish this, methods to identify common label and trailer constructs have been implemented, and a new ASC/ASCQ (7/5001, Data Protect, Write Append Position Error) has been added to indicate that writing is not allowed at the current location. There are several general rules surrounding WORM writing. Mode specific details can be found in following section(s).

a) Appending is always allowed at the EOD location for non-locked medium.
b) Writing is never allowed at any location prior to the start of an identified non-buffered label or trailer construct.
c) Writing may not be allowed after any construct which is followed by data which has been explicitly synchronized. This includes: Write Filemarks 0, Write Filemarks non-immediate, Unload. (depending on WORM mode).
d) Writing may not be allowed after any construct which is followed by data which has been implicitly synchronized by host or operator action. This includes: Space, Locate, Rewind, Load/Unload, etc. (depending on WORM mode).
e) Writing may not be allowed after any construct which is followed by data which has been implicitly synchronized by the drive. This includes: Time-based buffer flush, buffer full conditions, etc. (depending on WORM mode).
f) Writing may be allowed up to and including an overwrite of all or part of the last construct when a construct is either incomplete, or is not followed by additional data or filemarks (depending on WORM mode).
g) Writing may be allowed up to and including an overwrite of the last construct if a permanent write error occurs prior to or during the first host involved synchronize of the data following that construct (depending on WORM mode).
h) Buffered constructs (those where all filemarks are written immediate, and no other synchronizing events occur) may have a longer overwrite horizon in the permanent error cases. This may extend to a location earlier than constructs which were fully written to media. However, on any normal host invoked synchronizing event, the appropriate overwrite location will be locked (depending on WORM mode).
i) Writing may not be allowed at points other than the last complete logical block when a tape is loaded and it's ending disposition can not be definitively determined. This can occur in loss of power and other severe error conditions.

Many common label, header, trailer, and end of volume constructs are recognized by the device. In the following lists:

j) BOP indicates that this sequence must start at the logical beginning of a partition (logical block number 0),
k) <FM> indicates a filemark,
l) <?> indicates any character,
m) <?..?> indicates one or more records of the same type with any character in any order,
n) <#> indicates a sequential numeric character,
o) <n..#> indicates one or more records of the same type with sequential numerical character(s) starting with n,
p) Items listed in quotes indicate that a record must start with that string, in either ASCII or EBCDIC (note that all records in the same construct must be either ASCII or EBCDIC, intermix will terminate the construct). While most common label constructs consist of records of 80 bytes (or more), this is not enforced by the identification process. A minimum record size of 4 bytes is required for identification. There is no further limit for maximum record size for identification beyond the maximum supported device logical block length.
q) In the case of “VOL1” at least six more characters indicating the VOLSER in the same encoding are expected (VOL1 records smaller than 10 bytes are not recognized).
r) The identification process treats synchronizes (Write Filemarks 0 or implicit) as transparent.
s) Repositions are allowed and handled during construct recognition, however, constructs are only recognized within the current mount. If media is unloaded with a partial construct or construct not followed by user data, then the next series of writes must overwrite the existing construct with a new complete construct, otherwise the partial construct on media is treated as user data and subject to normal overwrite rules. In this case, the leading filemark in the general forms below is not required for construct indentification.

The constructs which the device recognizes follow the Labels shown in *4.10.1.1*.

4.10.1.1 Labels

The general form (items listed in brackets [] are optional) is:

BOP<“VOL1<volser>”>[<“VOL<2..#>”>][<“UVL<1..#>”>][<“HDR<1..#>”>[<“UHL<?..?>”>]]<FM>[<FM>]

The following special form is also recognized:

BOP<“VOL1”<volser>>

Some examples of the general form include (but are not limited to):

BOP<“VOL1”<volser>><FM>
BOP<“VOL1”<volser>><FM><FM>
BOP<“VOL1”<volser>><“VOL2”><“VOL3”><“HDR1”><FM>
BOP<“VOL1”<volser>><“HDR1”><“HDR2”><FM><FM>
BOP<“VOL1”<volser>><“HDR1”><“HDR2”><“HDR3”><“UHL6”><“UHLA”><FM>

4.10.1.1.1 Headers

The general form (items listed in brackets [] are optional) is:

<FM><“HDR<1..#>”>[<“UHL<?..?>”>]<FM>[<FM>]

Some examples include (but are not limited to):

<FM><“HDR1”><FM>
<FM><“HDR1”><“HDR2”><FM><FM>
<FM><“HDR1”><“UHLC”><“UHL4”><FM><FM>

4.10.1.1.2 Trailers

The general from (items listed in brackets [] are optional) is:

<FM>[<“EOF<1..#>”>[<“UTL<?..?>][<“OIB<?..?>”>]<FM>][<FM>]

Some examples include (but are not limited to):

<FM>
<FM><FM>
<FM><“EOF1”><FM><FM>
<FM><“EOF1”><“EOF2”><FM>
<FM><“EOF1”><“EOF2”><“EOF3”><“UTL2”><“UTL1”><FM>
<FM><“EOF1”><“OIBD”><“OIB6”><“OIBZ”><FM>
<FM><“EOF1”><“EOF2”><“UTL_”><“UTL5”><“OIB-”><“OIB$”><FM><FM>

4.10.1.1.3 End Of Volume

The END OF VOLUME constructs would normally be written shortly after early warning indicators are raised and will never be overwritten.

The general form (items listed in brackets [] are optional) is:

<FM><“EOV<1..#>”>[<“UTL<?..?>][<“OIB<?..?>”>]<FM>[<FM>]

Some examples include (but are not limited to):

<FM><“EOV1”><FM>
<FM><“EOV1”><“EOV2”><FM><FM>
<FM><“EOV1”><“EOV2”><“EOV3”><“UTLX”><FM><FM>
<FM><“EOV1”><“OIBK”><“OIB3”><“OIB+”><FM><FM>
<FM><“EOV1”><“EOV2”><“UTLL”><“UTLL”><“OIBK”><“OIB3”><“OIB+”><FM><FM>

4.10.1.1.4 Example of a general form construct fully expanded

BOP<“VOL1”<volser of 123456>><“HDR<1..2>”><“UHL<1..3>”><FM><FM>

which can be expanded to:

BOP<“VOL1123456”><“HDR1”><“HDR2”><“UHL1”><“UHL2”><“UHL3”><FM><FM>

and appears on medium as a sequence where:

BOP indicates this sequence must start at LB 0
LB 0 is a record of 10 bytes or more starting with “VOL1123456”
LB 1 is a record of 4 bytes or more starting with “HDR1”
LB 2 is a record of 4 bytes or more starting with “HDR2”
LB 3 is a record of 4 bytes or more starting with “UHL1”
LB 4 is a record of 4 bytes or more starting with “UHL2”
LB 5 is a record of 4 bytes or more starting with “UHL3”
LB 6 is a filemark
LB 7 is a filemark

4.10.2 WORM mode 2h Write/Append Behavior

Refer to *MP 23h: Medium Sense (see 6.4.18 on page 320)* to identify some of the possible operation possibilities and for overall behaviors. Specific details for this mode follow:

a) Writing is not allowed prior to any non-construct record which has been completely written to medium.
b) Overwriting of all or part of the most recent construct (label, header, or trailer) is allowed, provided that the construct is partially or fully recognized and is not followed by unrecognized records (i.e. user data).

4.10.3 WORM Device Driver Application Development/Debug Support

The WORM mode may be set for Data cartridges to enable WORM constraint reporting and other overwrite checks. This mode is active until changed or until the media is unloaded. The effects are not persistent (not stored on medium). Contact IBM for additional details.

4.11 Medium Reuse at Higher (or Lower) Densities

This device is designed to enable the reuse of different medium types and multiple densities across various device generations. Certain device models may only support a subset of densities (such as model J1A, which can only read and write at a single density), while others (such as the model E05 and E06) can read and write at multiple densities. Some models (such as the model E06) may be able to read certain formats or densities, but may be unable to write or append at those densities. Density information is available by using the Report Density Support command (see 5.2.24 on page 189).

NOTE 14 - It should be noted that an entire partition (or tape) must be recorded using the same density. This means that medium at a given density can only have data appended by a device capable of writing at that density. However, medium may be reformatted (destructively written from BOP) to any device and medium supported format.

NOTE 15 - Mode Sense always reports the actual current format/density of the medium and does not reflect any potential (currently pending) change in density.

Media may be reused at a different density. The changing from one density to another is called reformatting and occurs during a write from logical block zero of partition 0 (i.e., BOP 0). This process is subject to the rules of Write modes (see 4.13) including append-only mode.

If a write operation is attempted at BOP 0 (i.e., logical object 0 of partition 0) of a volume, then:

a) if the volume is a single partition volume and if the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h (see 6.4.18) does not match the primary density code (see 5.2.24) of the volume, then the volume is formatted to the density specified in the PENDING WRITE DENSITY AT BOP 0 field;
b) if the volume is partitioned and the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h does not support partitioning, then the volume is unpartitioned and reformatted to the density specified in the PENDING WRITE DENSITY AT BOP 0 field and all data on the volume in all partitions is lost;
c) if the volume is partitioned and the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h matches the primary density code of the volume, then the volume is not unpartitioned and data on other partitions is not lost.

If a write operation is attempted at a location away from BOP of partition 0 (this includes BOP of a partition other than partition 0), then no reformatting occurs and if the device is capable of wrting at the current density then logical objects are written with the current density.

NOTE 16 - If a volume is partitioned, then automatic reformatting to a higher density is not supported on that volume and explicit formatting using the FORMAT MEDIUM command must be used.

4.12 Selecting the Density/Format

The density to use for reformatting is controlled by the density code mechanism found in the Mode Select Block Descriptor (see 6.4.1.2 on page 289), the Default Write Density at BOP 0 field (see 4.12.3 on page 107), and the PENDING WRITE DENSITY AT BOP 0 field (see 4.12.4 on page 108). All reformatting is implicit and only takes effect on commands which would otherwise invalidate or overwrite all data starting at BOP. Such commands are always issued when positioned at BOP and include: Write [non-zero transfer length], Write Filemarks [non-zero transfer length], Erase, Capacity Scaling [Mode Select], Format Medium (unsupported), etc. The density selection itself is a passive process which can be setup or changed without affecting the recorded data currently on the medium. This drives three separate mechanisms found in Mode Select (Block Descriptor and Page 25h), which are:

a) Density Code (*Block Descriptor for Mode Select (6/10) (see 6.4.1.2 on page 289)*)
b) Default Write Density at BOP 0 (*MP 25h: Read/Write Control (see 6.4.20 on page 332)*)
c) PENDING WRITE DENSITY AT BOP 0 (*MP 25h: Read/Write Control (see 6.4.20 on page 332)*)

Any of the previously listed commands which normally cause destructive writing at BOP may additionally reformat the tape to the density specified in the Pending Write Density field if that density differs from the currently recorded density. This operation does not substantively affect the execution time of the command causing the reformat. The Default Write Density field is used to set a default value into the Pending Write Density field at load time, unload time, or if the mode pages are reset to default values. Additionally, the Density Code field may be used to set the Pending Write Density. There are some special considerations which affect the precedence and interaction of the fields, as described below.

NOTE 17 - On devices which support encryption, secondary encryption density codes may be selected but are interchangeable and identical to primary density codes. Use of any density codes has no effect on the encrypted state of medium and only reports encryption state information and cannot be used to control encryption.

4.12.1 Recommended Method for Specifying Density

The simplest and recommended method for explicitly specifying density comprises two parts. The first part is to always set the Density Code field in every mode select command to the special value 7Fh as per the SCSI standard (the same effect will be accomplished by leaving it unchanged from the value returned by Mode Sense, though this is non-standard). Secondly, the PENDING WRITE DENSITY AT BOP 0 field (byte 10) in mode page 25h may then be used for explicit density control. The specified density is used for any write operation from BOP.

4.12.2 Density Code

See also *"Block Descriptor for Mode Select (6/10)" on page 289*.

This is the lowest precedence method for setting density. Since this method has strong existing application usage, care has been taken to prevent accident specification of density, or loss of desired density change by possible overwrite. Since applications are expected to issue a Mode Sense prior to a Mode Select and not all applications use the standard 7Fh value, only explicit changes in this field have any effect. This means that it is not possible to set the Pending Density to the current density of the medium by using an explicit density in this field. However, this may be accomplished by using the FFh density code. This may need to be done if automatic up formatting is not desired. Setting a value of 00h causes the density from the Default Density Code at BOP field to be used. If this field is not changed from the value returned in Mode Sense, or if the special 7Fh density code is specified, the Pending Write Density field will not be evaluated and updated according to this field.

4.12.3 Default Write Density at BOP 0

See also *"MP 25h: Read/Write Control" on page 332*.

This field is used to set the Pending Write density at unload or load time, or if the Density Code field is set to 00h. If this field is changed with Mode Select, the Pending Write Density field will be evaluated and updated according to this field.

4.12.4 Pending Write Density at BOP 0

See also *"MP 25h: Read/Write Control" on page 332*.

This is the actual field for selecting density and when read (Mode Sense) always reflects the actual density which will be used if a command which causes reformatting is issued. This value may be directly modified but the value might be altered to an absolute density code if either 00h, 7Fh, or FFh is specified.

4.13 Write modes

4.13.1 Write mode introduction

Write modes of the device entity specify the allowable behaviors for altering logical objects on a mounted volume. When the write mode rules allow altering of logical objects then the operation is processed following the write protection rules defined in SSC-4.

4.13.2 Write-anywhere mode

Write-anywhere mode is used to allow alteration of any logical object on the medium. Write-anywhere mode is enabled or disabled using the WRITE MODE field of the Device Configuration Extension mode page (see 6.4.11 on page 306). This mode is set in the device entity to enable device server behaviors. The write-anywhere mode does not modify the volume. When the volume is removed from the device no indication of whether write-anywhere mode is enabled or disabled is carried with the volume.

When write-anywhere mode is enabled in the drive, then any command that would result in a write shall be processed normally. If the mounted volume is a WORM volume, then a write type command shall be processed following the WORM rules.

4.13.3 Append-only mode

Append-only mode is used to protect data from being accidently overwritten. Sometimes, due to errors in the configuration of the environment an application client attempts to rewind a drive that it is not transferring data to. Without append-only mode, an application client that is not writing to the volume may cause, by rewinding that volume, a scenario where the writing application client overwrites the data. This may occur if the drive has not been reserved or if a competing application has been installed on the same server (e.g., a monitoring application). With append-only mode enabled, the medium is protected against an overwrite because the drive rejects an attempt to write data anywhere except at an append point.

Append-only mode is enabled or disabled using the WRITE MODE field of the Device Configuration Extension mode page (see 6.4.11 on page 306). Append-only mode is only allowed to be enabled if a volume is not mounted or if the volume is located at BOP 0. Append-only mode is only allowed to be disabled if there is no volume mounted in the drive. This mode is set in the device server to enable device server behaviors. The append-only mode does not modify the volume. When the volume is removed from the device it behaves as a normal volume.

When append-only mode is enabled in the drive, then any command that would result in a write to a location that is not an append point shall be rejected with a CHECK CONDITION status and the Sense Key set to DATA PROTECT with the additional sense code set to OPERATOR SELECTED WRITE PROTECT (7h / 5A02h) and TapeAlert 09h shall be set. An append point is:

a) the logical position zero if there are no logical objects beyond BOP;
b) the current logical position if:
   A) the current logical position is at BOP; and
   B) there are only filemarks between the current logical position and EOD;
c) the current logical position if:

A) the current logical position is between BOP and EOD;
B) there are only filemarks from the current logical position to EOD; and
C) there is at least one filemark immediately before the current logical position;

or

d) the current logical position if the current logical position is at EOD.

The device server maintains an allow_overwrite variable. The allow_overwrite variable defines what operation is currently allowed when in append-only mode. The allow_overwrite variable values are defined in *table 44*.

Table 44 — allow_overwrite variable definition

Name	Description
Disabled	A write type operation at a position that is not an append point is not allowed.
Current Position	A write type operation is allowed at the position specified by the allow_overwrite_position variable. Note that reformatting as defined in Medium Reuse at Higher (or Lower) Densities (see 4.10) is considered a write operation.
Format	An operation that modifies the format of the medium is allowed (e.g., FORMAT MEDIUM command, Capacity Scaling operation in Mode Page 23h, etc.)

The allow_overwrite_position variable specifies the position (i.e., partition and logical object identifier) at which a write to a position that is not an append point is allowed.

Append-only mode is a function of the device server and is not a function of the volume. Append-only mode may be used when accessing Data Volumes or WORM volumes. An application client may overwrite data by using a special command called the ALLOW OVERWRITE command (see 5.2.1 on page 135). The ALLOW OVERWRITE command specifies the logical position where the overwrite is to occur. After succesfully processing an ALLOW OVERWRITE command, a write type command at the specified position is processed normally. If the position of the medium is changed or the volume is unmounted, then the device server shall set the allow_overwrite variable to Disabled (i.e., 0h) and the allow_overwrite_position variable to invalid. The ALLOW OVERWRITE command requires the partition number and the logical position to be passed in the CDB. If the position information passed in the ALLOW OVERWRITE command does not specify the current position of the medium, then the command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to SEQUENTIAL POSITIONING ERROR. If there is no volume loaded and the device server processes an ALLOW OVERWRITE command, then the command is terminated with CHECK CONDITION status with sense key set to NOT READY.

An ALLOW OVERWRITE command that returns GOOD status:

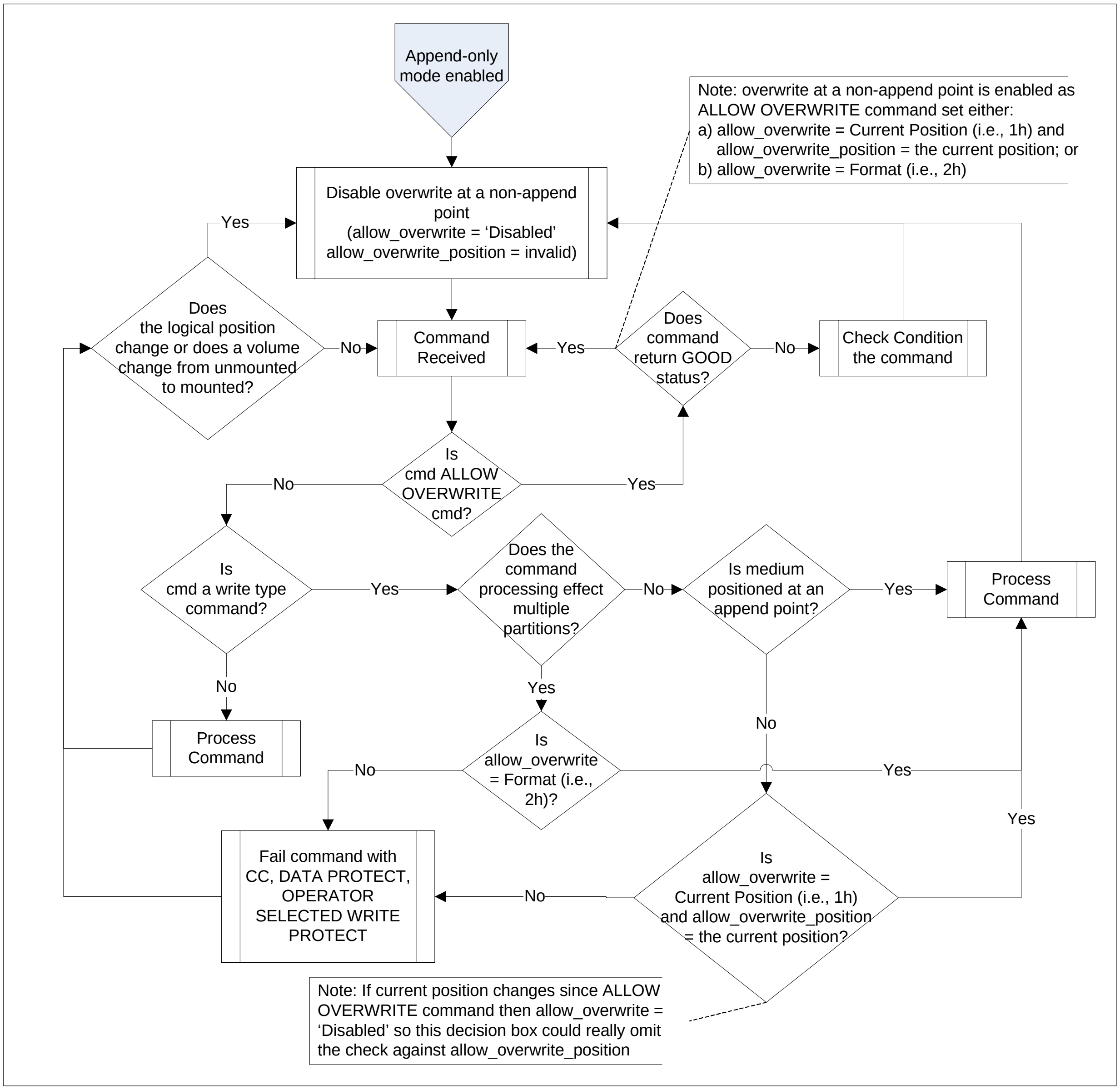
a) sets the allow_overwrite variable to the value in the ALLOW OVERWRITE field of the ALLOW OVERWRITE command; and
b) sets the allow_overwrite_position variable to the current position.

An ALLOW OVERWRITE command that returns a CHECK CONDITION:

a) sets the allow_overwrite variable to Disabled (i.e., 0h); and
b) sets the allow_overwrite_position to invalid.

If append-only mode is enabled, the mounted volume is a WORM volume, and the allow_overwrite variable is not set to Disabled, then a write type command is processed following the WORM rules. *Figure 6* shows a representative flowchart of append-only mode behavior.

Figure 6 — Append-only mode flowchart



If the ALLOW OVERWRITE command is received by the device server and append-only mode is not enabled, the command is rejected with a CHECK CONDITION status and the Sense Key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL COMMAND WHEN NOT IN APPEND-ONLY MODE.

When in append-only mode the allow_overwrite variable shall be set to Disabled (i.e., 0h) and the allow_overwrite_position variable shall be set to invalid if:

a) the WRITE MODE field of the Device Configuration Extension mode page changes to a value of 01h (i.e., The write-type operation shall only allow appends as specified for the append-only mode in *4.13.3*);
b) a change in logical position occurs;
c) a volume changes state from unmounted to mounted;
d) the CDB of a write type command is validated and the write processing begins; or

e) an ALLOW OVERWRITE command returns a CHECK CONDITION.

4.14 Volume partitioning

4.14.1 Volume partitioning overview

Starting with TS1140 (i.e., 3592 E07) volume partitioning is supported by the device on certain media types. A volume is recorded in same format for the entire volume as indicated by the primary density code (see 5.2.24) but each partition may have different secondary density codes. An entire partition is recorded in the same format as indicated by the secondary density code.

The drive supports two different types of partitioning:

a) wrap-wise partitioning (see 4.14.2 on page 112); and
b) longitudinal partitioning (see 4.14.3 on page 116).

This clause and its subclauses describe partitioning and its relationship to:

a) media types (see 4.14.4 on page 118);
b) reformatting (see 4.14.5 on page 118); and
c) encryption (see 4.14.6 on page 118).

4.14.2 Wrap-wise Partitioning

Wrap-wise partitioning uses the full length of the medium for each partition as shown logically in *figure 7*.

Figure 7 — Wrap-wise partitioning

Wrap-wise partitioning generally uses a minimum of two wraps and generally has a guard wrap of two wraps between each partition. This may reduce the usable capacity by as much as 3% per partition boundary.

When using wrap-wise partitioning a maximum of four partitions with any number of partitions between one and four inclusive are supported.

Table 45, and *table 46* show the partition sizes that result from a MODE SELECT of the Medium partition mode page (see 6.4.12 on page 308) with the indicated field settings.

Table 45 — Partition sizes for wrap-wise partitioning (selection fields)

Ref[1]	FDP	SDP	IDP	ADDITIONAL PARTITIONS DEFINED[2]	PARTITION SIZE (first)	PARTITION SIZE (second)	PARTITION SIZE (third)	PARTITION SIZE (last)
row1	1	0	0	X	X	X	X	X
row2	0	1	0	00h				
row3				01h				
row4				02h				
row5				03h				
row6	0	0	1	00h	FFFFh	0	0	0
row7					s[3]			
row8				01h	s	FFFFh		
row9					FFFFh	t		
row10					s[3]	t[3]		
row11				02h	s	t	FFFFh	
row12					s	FFFFh	u	
row13					FFFFh	t	u	
row14					s[3]	t[3]	u[3]	
row15				03h	s	t	u	FFFFh
row16					s	t	FFFFh	v
row17					s	FFFFh	u	v
row18					FFFFh	t	u	v
row19					s[3]	t[3]	u[3]	v[3]
others	All other combinations							

1 The Ref column is the reference that ties the rows in this table to the correcponding rows in *table 46*.
2 When more than one partition is defined there may be overhead that results in a loss of capacity
3 Value must be exact partition size allowed and when summed with other values in the row equal full capacity. This permits a MODE SENSE followed by a MODE SELECT with no change. It is highly recommended that this method only be used in the case where the MODE SELECT data is a return of the MODE SENSE data.

Table 46 — Partition sizes for wrap-wise partitioning (resultant sizes) (part 1 of 2)

Ref [1]	Partition 0 [2]	Partition 1 [2]	Partition 2 [2]	Partition 3 [2]
row1	s=K*n; where n=N_2	t=K	-	-
row2	C_{MAX}	-		
row3	s=K*n; where n=integer of {(N_2+1)/2}	t=K*m; where m=N_2+1-n	-	
row4	s=K*n; where n=integer of {(N_3+2)/3}	t=K*m; where m=integer of {(N_3+2)/3}	s=K*u; where u=N_3+2-n-m	-
row5	s=K*n; where n=integer of {(N_4+3)/4}	t=K*m; where m=integer of {(N_4+3)/4}	s=K*u; where u=integer of {(N_4+3)/4}	s=K*v; where v=N_4+3-n-m-u
row6	C_{MAX}	-		
row7	C_{MAX}			
row8	s=K*n; where 1<=n<=N_2	C_{MAX} - overhead- (partition size 0)	-	
row9	C_{MAX} - overhead- (partition size 1)	t=K*m; where 1<=m<=N_2		
row10	s=K*n; where 1<=n<=N_2 and n+m=N_2+1	t=K*m; where 1<=m<=N_2 and n+m=N_2+1		
row11	s=K*n; where 1<=n<=N_3	t=K*m; where 1<=m<=N_3	C_{MAX} - overhead- (partition size 0)- (partition size 1)	-
row12		C_{MAX} - overhead- (partition size 0)- (partition size 1)	u=K*p; where 1<=p<=N_3	
row13	C_{MAX} - overhead- (partition size 1)- (partition size 2)	t=K*m; where 1<=m<=N_3		
row14	s=K*n; where 1<=n<=N_3 and n+m+p=N_3+2	t=K*m; where 1<=m<=N_3 and n+m+p=N_3+2	u=K*p; where 1<=p<=N_3 and n+m+p=N_3+2	

1 The values in the Ref column refer back to the associated row in *table 45*.
2 The values for C_{MAX}, K, N_2, N_3, N_4, and the sum of existing partitions are specified in *table 47*.

Table 46 — Partition sizes for wrap-wise partitioning (resultant sizes) (part 2 of 2)

<table>
<tr><th>Ref [1]</th><th>Partition 0 [2]</th><th>Partition 1 [2]</th><th>Partition 2 [2]</th><th>Partition 3 [2]</th></tr>
<tr><td>row15</td><td rowspan="3">s=K*n;
where 1<=n<=N_4</td><td rowspan="2">t=K*m;
where 1<=m<=N_4</td><td>u=K*p;
where 1<=p<=N_4</td><td>C_{MAX} - overhead-
(partition size 0)-
(partition size 1)-
(partition size 2)</td></tr>
<tr><td>row16</td><td>C_{MAX} - overhead-
(partition size 0)-
(partition size 1)-
(partition size 2)</td><td rowspan="3">v=K*q;
where 1<=q<=N_4</td></tr>
<tr><td>row17</td><td>C_{MAX} - overhead-
(partition size 0)-
(partition size 2)-
(partition size 3)</td><td rowspan="2">u=K*p;
where 1<=p<=N_4</td></tr>
<tr><td>row18</td><td>C_{MAX} - overhead-
(partition size 1)-
(partition size 2)-
(partition size 3)</td><td>t=K*m;
where 1<=m<=N_4</td></tr>
<tr><td>row19</td><td>s=K*n;
where 1<=n<=N_4
and n+m+p+q=N_4+3</td><td>t=K*m;
where 1<=m<=N_4
and n+m+p+q=N_4+3</td><td>u=K*p;
where 1<=p<=N_4
and n+m+p+q=N_4+3</td><td>v=K*q;
where 1<=q<=N_4
and n+m+p+q=N_4+3</td></tr>
<tr><td>others</td><td colspan="4">Check Condition, Illegal Request, Invalid Field in Parameter Data</td></tr>
<tr><td colspan="5">1 The values in the Ref column refer back to the associated row in table 45.
2 The values for C_{MAX}, K, N_2, N_3, N_4, and the sum of existing partitions are specified in table 47.</td></tr>
</table>

Table 47 — Partition values by density and media type

Parameter in *table 46*	Primary Density Code = 54h		
	Media Type		
	JB	JC	JK
C_{MAX}	1.6 TB	4.0 TB	500 GB
K [1]	57.142 GB	100.000 GB	12.500 GB
N_2	24	34	34
N_3	22	31	31
N_4	20	28	28
Sum of all partitions [1] s+t+[u]+[v]	s+t=1428.571 GB s+t+u=1371.428 GB s+t+u+v=1314.285 GB	s+t=3 500.000 GB s+t+u=3 300.000 GB s+t+u+v=3 100.000 GB	s+t=437.500 GB s+t+u=412.500 GB s+t+u+v=387.500 GB

1 The precision of capacity values able to be expressed is limited by the 2-byte PARTITION SIZE field and the value of the PARTITION UNITS field of the Medium Partition mode page (see 6.4.12 on page 308). Actual size on medium is not limited by the precision of the fields in the mode page.

4.14.3 Longitudinal Partitioning

Longitudinal partitioning is provided for better random access performance. Longitudinal partitioning dissects the tape into two sections of tape, the first spanning from beginning of tape toward end of tape until enough tape has been spanned to accommodate the requested size and uses all wraps for the first partition. A guard gap is created between the first section and the second section which results in less than 1% capacity loss. The second section uses the remaining length of tape and all wraps in that section for the second partition. A logical representation of a longitudinally partitioned volume is shown in *figure 8*. There is a minimum length of tape to use for a partition and this requirement is enforced with automatic rounding if needed during creation of the partition.

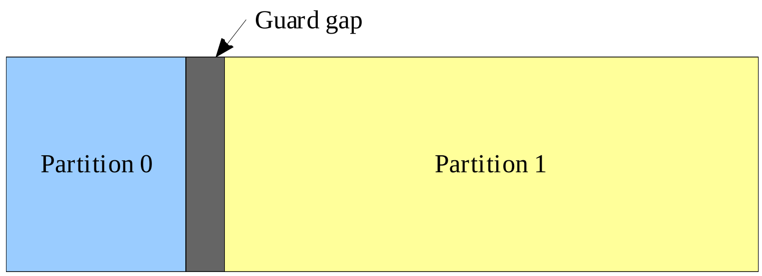


Figure 8 — Longitudinal partitioning

When using longitudinal partitioning a maximum of two partitions are supported.

Table 48, and *table 49* show the partition sizes that result from a MODE SELECT of the Medium partition mode page (see 6.4.12 on page 308) with the indicated field settings.

Table 48 — Partition sizes for longitudinal partitioning (selection fields)

<table>
<tr><th rowspan="2">FDP</th><th rowspan="2">SDP</th><th rowspan="2">IDP</th><th rowspan="2">ADDITIONAL PARTITIONS DEFINED [1]</th><th colspan="2">PARTITION SIZE</th><th colspan="2">Resultant Sizes</th></tr>
<tr><th>(first)</th><th>(second)</th><th>Partition 0 [3]</th><th>Partition 1 [3]</th></tr>
<tr><td>1</td><td>0</td><td>0</td><td>X</td><td colspan="4">FDP set to one dictates wrap-wise partitioning (see 4.14.2 on page 112).</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>00h</td><td rowspan="2">X</td><td rowspan="2">X</td><td>C_{MAX}</td><td>-</td></tr>
<tr><td>01h</td><td>$\frac{\sum Partitions}{2}$</td><td>$\frac{\sum Partitions}{2}$</td></tr>
<tr><td rowspan="5">0</td><td rowspan="5">0</td><td rowspan="5">1</td><td rowspan="2">00h</td><td>FFFFh</td><td rowspan="2">0</td><td rowspan="2">C_{MAX}</td><td rowspan="2">-</td></tr>
<tr><td>s [3]</td></tr>
<tr><td rowspan="3">01h</td><td>s</td><td>FFFFh</td><td>$P_{MIN} <= s <= P_{MAX}$</td><td>C_{MAX} - (size of partition 0) - overhead</td></tr>
<tr><td>FFFFh</td><td>t</td><td>C_{MAX} - (size of partition 1) - overhead</td><td>$P_{MIN} <= t <= P_{MAX}$</td></tr>
<tr><td>s [2,4]</td><td>t [2,4]</td><td>$P_{MIN} <= s <= P_{MAX}$</td><td>$P_{MIN} <= t <= P_{MAX}$</td></tr>
<tr><td colspan="6">All other combinations</td><td colspan="2">Check Condition, Illegal Request, Invalid Field in Parameter Data</td></tr>
</table>

1 When more than one partition is defined a guard gap is created between the partitions which results in less than 1% capacity loss.

2 Value must be exact partition size allowed and when summed with other values in the row equal full capacity. This permits a MODE SENSE followed by a MODE SELECT with no change. It is highly recommended that this method only be used in the case where the MODE SELECT data is a return of the MODE SENSE data.

3 The values of C_{MAX}, P_{MIN}, P_{MAX}, and $\sum Partitions$ are specified in *table 49*.

4 s+t = C_{MAX} - overhead

Table 49 — Longitudinal partition values by density and media type

Parameter in *table 48* [1]	Primary Density Code = 54h	
	Media Type	
	JB	JC
C_{MAX}	1.6 TB	4.0 TB
P_{MIN}	95.860 GB	219.726 GB
P_{MAX}	1376.051 GB	3 447.812 GB
$\sum Partitions$	1471.911 GB	3 667.538 GB

1 The precision of capacity values able to be expressed is limited by the 2-byte PARTITION SIZE field and the value of the PARTITION UNITS field of the Medium Partition mode page (see 6.4.12 on page 308). Actual size on medium is not limited by the precision of the fields in the mode page.

4.14.4 Partitioning and media types

Partitioning of volumes is supported on media in native 3592 E07 logical formats only (i.e., primary density code = 54h; secondary density code = 54h or 74h). The media types that support this density are JB, JC, and JK. In the case of JB media re-use, issuing of a FORMAT MEDIUM command may perform an implicit re-format to the 3592 E07 logical format depending on the settings described in *4.14.5*.

4.14.5 Partitioning and reformatting

Medium Reuse at Higher (or Lower) Densities (see 4.11 on page 106) describes how a partitioned volume may be reused at lower or higher densities.

When not subject to reformatting due to the conditions described in *4.11*, partitions are created and destroyed using FORMAT MEDIUM - 04h (see 5.2.5 on page 140). How a volume is formatted depends on the media type (see 6.4.2.1 on page 292), if the volume is scaled (see 6.4.18 on page 320), the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h (see 6.4.20 on page 332), the settings in the Medium Partition mode page (see 6.4.12 on page 308), and the FORMAT MEDIUM command (see page 140) settings. The FORMAT MEDIUM command specifies how to format the volume and the interactions of these conditions using the FORMAT field.

The Medium Partition mode page is used to specify the group of medium partitions. The partitioning of the mounted volume is not changed until a subsequent FORMAT MEDIUM command is issued while the volume is mounted.

The device ensures consistency of the partitioning values set in Medium Partition mode page by causing a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PARAMETER VALUE INVALID to be returned to a subsequent FORMAT MEDIUM command attempting to use the values set in Medium Partition mode page if values in those values become inconsistent between when they were set and when the FORMAT MEDIUM command is received. The invalidation of the values in this page is accomplished by setting the FDP, SDP, and IDP bits to zero and the other values in this page to:

a) the values dictated by the format of the currently mounted volume, if a volume is mounted; or
b) the default values present after power-on, if no volume is mounted.

The invalidation of values in this page occurs if:

a) the PENDING WRITE DENSITY AT BOP 0 field of MP 25h: Read/Write Control (see 6.4.20 on page 332) is modified;
b) the volume is capacity scaled (see MP 23h: Medium Sense (see 6.4.18 on page 320)); or
c) other events that are determined to make the values in this page inconsistent.

4.14.6 Partitioning and encryption

The relationship between partitioning and encryption is described in Device Hardware Encryption (some models) (see 4.15 on page 119).

4.15 Device Hardware Encryption (some models)

Certain versions and revisions of this device contain hardware which performs user data write encryption and read decryption, protecting all user data written to the medium from unauthorized use [provided it is integrated into a secure system design]. Device support for encryption may be determined by reading mode page *MP 24h: Initiator-Specific Extensions (see 6.4.19 on page 329)* with the Mode Sense command, and medium support for encryption may be determined by reading *MP 23h: Medium Sense (see 6.4.18 on page 320)* with the Mode Sense command.

NOTE 18 - It should be noted that encryption is managed on a partition level. Encryption must be enabled before the initial write/label process, and must be maintained throughout the write/read usage of the medium.

NOTE 19 - It should be noted that encryption enabled cartridges, can only be read by devices with encryption hardware.

Multiple ways of controlling encryption settings is supported on devices that support encryption. The 3592 supported encryption prior to any standardization of a method for controlling encryption. Because of this, 3592 had to devise its own proprietary method for controlling encryption settings and passing keys into the device. IBM did work with the T10 standards committee to derive a standards based method, but those standards were just starting their work when the 3592 with encryption support was first released. As soon as the standards methods were devised 3592 added support from the standards based methods. These encryption control methodologies are called:

a) Encryption Control - IBM Proprietary Protocol (IPP); and
b) Encryption Control - T10 Standards.

On volumes with multiple partitions, the drive handles encryption in each partition differently and may report a different density code. The density code reported for a partition is determined when a write occurs at BOP:

a) If logical block 0 in a partition is encrypted using IBM proprietary methods (see 4.15.1 on page 119) all blocks within the partition are enforced to be encrypted and the density code reported is 74h. If EEDKs are used, then each partition has separate EEDKs;
b) If logical block 0 in a partition is not encrypted, then the density code reported is 54h; and
c) if the encryption method in the drive is set to AME-T10 (see 4.15.2 on page 120), then an intermix of encrypted and unencrypted blocks are allowed and the density code reported is 54h.

4.15.1 Encryption Control - IBM Proprietary Protocol (IPP)

The following terms are used to describe the methods of control that fall into the IPP:

a) Library Managed Encryption (LME);
b) System Managed Encryption (SME); and
c) Application Managed Encryption - IBM (AME-IBM).

Encryption Parameters - IBM Proprietary Protocol (IPP) (see 6.4.20.1 on page 335) provides extensive information on this method.

When a device is enabled to perform encryption using one of the IBM Proprietary Protocols (i.e., LME, SME, or AME-IBM) encryption parameters are determined at first write from BOP. On volumes with multiple partitions this means that on a write from BOP(i.e. LBA 0) of each partition the encryption parameters are determined. Writes away from BOP use the existing encryption parameters. If a logical block is encrypted, then all logical blocks are encrypted. If a logical block is not encrypted then all logical blocks are not encrypted. When a partition change occurs the encryption parameters are cleared.

Please see IBM for additional information on IPP.

4.15.2 Encryption Control - T10 Standards

The 3592 device has added support for controlling encryption and passing clear text keys using T10 standards methods. These methods are described in SSC-4 as well as in this document. Note that not all methods described in SSC-4 are supported.

When a device is enabled to perform encryption using AME-T10 the encryption parameters are set by the application. When the encryption parameters are set to encrypt, logical blocks are encrypted. When encryption parameters are set to not encrypt, logical blocks are not encrypted. Changing partitions when enabled for AME-T10 does not necessarily effect the encryption parameters.

The 3592 device uses the term Application Managed Encryption - T10 (AME-T10) to signify that it is using this standards based method.

The 3592 devices supports the T10 method of passing the key in clear text. For specifics on support refer to *Security Protocol In (SPIN) A2h (see 5.2.30 on page 211)*, *Security Protocol Out (SPOUT) B5h (see 5.2.31 on page 212)*, and *Security Protocol Parameters (SPP) (see 6.5 on page 367)*.

4.16 Device Data Recovery (DDR) using Recover Buffered Data (RBD)

In some system environments it might be more practical to perform error recovery at a low layer which may not have easy access to the source(s) of data which were written to the buffer in previous command(s). When a write error occurs and the device is unable to transfer buffered data to the medium, it might be desirable for the host to read the unwritten data in the device buffer back into the host system. This may be accomplished using the Recover Buffered Data command (see 5.2.22 on page 187).

The recover buffered data command has two operating modes, LIFO and FIFO. In FIFO mode the data is read in a first-in-first-out method (the order it was written in), from lowest logical block number to highest (most recent). In LIFO mode the data is read in a last-in-first-out method (the opposite order it was written in), from highest (most recent) logical block number to lowest. This method is controlled with the RBO (Recover Buffer Order) field (see *"MP 10h: Device Configuration" on page 303*).

Additionally, a Buffer Association mode affects when the RBD command can be used. This is controlled by the Buffer Association Enablement field (see *"MP 24h: Initiator-Specific Extensions" on page 329*).

4.16.1 No Association (Legacy Method)

When no associations are set, any buffered data is retained until the next Rewind command, Load/Unload command, or unload operation. This requires any desirable data to be read from the buffer while the drive is still in the error state. This requires all data to be read and maintained in the host before most error recovery. An example of a DDR operation using this method might be:

1) Application is writing buffered data
2) Permanent Write Error Occurs
3) Drive prepares for RBD and determines amount of data in buffer
4) Application queries the amount of data in the buffer
5) DDR begins, host uses RBD to read data into host memory
6) Tape is unloaded
7) Another drive is selected and same tape is loaded
8) Seek to point of (or before) perm
9) Data is written from host memory
10) Job resumes at point of failure

4.16.2 Unload with Write Error Association

When this association is set, the device host data buffer remains unaltered in the write error case after the medium has been unloaded. This allows the buffered data to be available for recovery after the cartridge has been removed. An example of a DDR operation using this method might be:

1) Application is writing buffered data
2) Permanent Write Error Occurs
3) Drive prepares for RBD and determines amount of data in buffer
4) Application queries the amount of data in the buffer (could be after unload, but probably drives some aspect of the DDR and the unload is special on the DDR path)
5) Tape is unloaded (without rewind, etc), and drive is held reserved/allocated
6) Another drive is selected and same tape is loaded
7) Seek to point of (or before) perm
8) DDR begins, host uses RBD to read data into host memory then to ready drive (until complete)
9) Drive which experienced perm is released (can be used for other jobs)
10) Job resumes at point of failure

4.17 String Search Function (not J1A)

A function is provided to have the device perform searches on the medium for various data patterns. This can be configured with *MP 37h: String Search (not J1A) (see 6.4.22 on page 353)*. The search operation itself is invoked with a vendor-unique String Search command (see 5.2.35 on page 219), a variant of the Space command (see 5.2.34 on page 217), a vendor-unique variation of the Read command (see 5.2.15 on page 164), or a Send Diagnostic command (see 5.2.32 on page 213). This function allows searches of up to eight (8) strings of up to thirty two (32) bytes each that can be masked or selected on a bit and byte level. All logical AND and OR combinations of these strings within a single logical block can be used as a search match criteria.

NOTE 20 - Only eight (8) strings of sixteen (16) bytes are supported. Longer criteria may be specified, but only the first sixteen (16) bytes of each string are significant for matches.

4.17.1 Truth Table Usage

The Truth Table is a bitwise field which supports all AND/OR/NOT combinations of the eight (8) [Masked] Search Strings. The table is easiest to understand with the following representation, where each bit represents an OR combination. A successful match will occur if exactly ALL (AND) strings listed in any cell corresponding to a set bit is found. Since combinatorial matches may occur, all bits with the AND conditions should be set, even if they include other values that are not part of the search.

For example, is the desire is to search for string (5 AND 6) or (7 AND 8), all bits with 56 and all bits with 78 should be set. This would result in a Truth Table of: 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh, 11h, 1Fh.

All combinations are possible, but some are tricky. This is especially true depending on the values of the byte masks. Special care should be taken with combinatorial sets like (1 AND 2 AND 3 AND 4) OR (1 AND 2 AND 5 AND 6). All combinations of 1,2,3,4,5,6 which include all of 1234 or 1256 must be set.

If String Search Byte Mask(s) are set to 00h then a string match will not result. Due to this, bits in the Truth Table which have strings which are not part of the search may not need to be included in the Truth Table setup. The search would also work correctly those which do not have unused strings set, (provided the String Search Byte Mask(s) are set to 00h). The same search of (5 AND 6) or (7 AND 8) could be properly executed with a Truth Table of: 11h, 1Fh, 11h, 1Fh, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h, 00h. If strings 1 through 4 had specified valid criteria, the preceding truth table represents the expression (NOT(1) AND NOT(2) AND NOT(3) AND NOT(4) AND 5 AND 6) OR (NOT(1) AND NOT(2) AND NOT(3) AND NOT(4) AND 7 AND 8).

Special care should be taken with combinatorial sets like (1 AND 2 AND 3 AND 4) OR (1 AND 2 AND 5 AND 6). All combinations of 1,2,3,4,5,6 which include all of 1234 or 1256 must be set. If strings and masks 7 and 8 are set to 00h then only those which do not include 7 or 8 need be set.

Excluded strings may also be set for string matches by insuring that truth table bit entries which include the NOT string are set to 0b. This may be applied to any combination of AND or OR logic.

NOTE 21 - For programmers wanting to take an algorithmic approach, the table may be viewed as a bit array of 256 bits (numbered 0 to 255 corresponding to the table respectively from byte 0 bit 7... byte 0 bit 0, byte 1 bit 7... byte 31 bit 0). Each AND set can calculate a value by setting all of the 2^(8-string) bits in that AND group. Any bit array offset which has all of these string bits set should be set to 1b, The same process should be repeated for each OR clause.

Table 50 — String Search Truth Table

Bit Byte	7 msb	6	5	4	3	2	1	lsb 0
0	-	8	7	78	6	68	67	678
1	5	58	57	578	56	568	567	5678
2	4	48	47	478	46	468	467	4678
3	45	458	457	4578	456	4568	4567	45678
4	3	38	37	378	36	368	367	3678
5	35	358	357	3578	356	3568	3567	35678
6	34	348	347	3478	346	3468	3467	34678
7	345	3458	3457	34578	3456	34568	34567	345678
8	2	28	27	278	26	268	267	2678
9	25	258	257	2578	256	2568	2567	25678
10	24	248	247	2478	246	2468	2467	24678
11	245	2458	2457	24578	2456	24568	24567	245678
12	23	238	237	2378	236	2368	2367	23678
13	235	2358	2357	23578	2356	23568	23567	235678
14	234	2348	2347	23478	2346	23468	23467	234678
15	2345	23458	23457	234578	23456	234568	234567	2345678
16	1	18	17	178	16	168	167	1678
17	15	158	157	1578	156	1568	1567	15678
18	14	148	147	1478	146	1468	1467	14678
19	145	1458	1457	14578	1456	14568	14567	145678
20	13	138	137	1378	136	1368	1367	13678
21	135	1358	1357	13578	1356	13568	13567	135678
22	134	1348	1347	13478	1346	13468	13467	134678
23	1345	13458	13457	134578	13456	134568	134567	1345678
24	12	128	127	1278	126	1268	1267	12678
25	125	1258	1257	12578	1256	12568	12567	125678
26	124	1248	1247	12478	1246	12468	12467	124678
27	1245	12458	12457	124578	12456	124568	124567	1245678

Table 50 — String Search Truth Table

Bit Byte	7 msb	6	5	4	3	2	1	lsb 0
28	123	1238	1237	12378	1236	12368	12367	123678
29	1235	12358	12357	123578	12356	123568	123567	1235678
30	1234	12348	12347	123478	12346	123468	123467	1234678
31	12345	123458	123457	1234578	123456	1234568	1234567	12345678
Each digit represents one of the strings set by Mode Page 37h Subpage (criteria) - String Descriptor 10h. Each set of digits in a specific cell represents an AND condition of all the specified strings, while any digits not present in the cell indicates either a string that is not setup, or must not appear. Each cell that is selected is OR'ed with the other cells that are selected. If the NOT logic is used, then the converse is also true.								

4.18 Medium auxiliary memory

Some types of media, especially removable media, include a non-volatile memory referred to as MAM (medium auxiliary memory). Medium auxiliary memory is used to store data describing the media and its contents. This standard supports medium auxiliary memory with the READ ATTRIBUTE command (see 5.2.16 on page 166) and the WRITE ATTRIBUTE command (see 5.2.39 on page 225). These commands are used to retrieve and store information in the medium auxiliary memory in the form of MAM attributes.

A MAM attribute is represented in a format described in *6.3.1 on page 277* and is composed of:

a) an attribute identifier;
b) an attribute format code;
c) a bit indicating whether the identified attribute is read only;
d) an attribute length specifying the number of bytes in the identified attribute value; and
e) the value of the identified attribute.

There are three types of MAM attributes *(see table 51)*.

Table 51 — Types of MAM attributes

Attribute Type	Attribute Source	Example	Readable with READ ATTRIBUTE	Writable with WRITE ATTRIBUTE
Medium	Permanently stored in the medium auxiliary memory during manufacture.	Media Serial Number	Yes	No
Device	Maintained by the device server.	Load Count	Yes	No
Host	Maintained by the application client.	Backup Date	Yes	Yes

Depending on that attribute type, MAM attributes have the states shown in *table 52*.

Table 52 — MAM attribute states

Attribute Type	Attribute State	Description
Medium or Device	Read Only	An application client may read the contents of the MAM attribute with the READ ATTRIBUTE command, but an attempt to clear or change the MAM attribute using the WRITE ATTRIBUTE command shall result in the command being terminated with CHECK CONDITION status. When the READ ONLY bit (see 6.3.1 on page 277) is one, the attribute is in the read only state.
	Unsupported	The device server does not support the MAM attribute and shall not return it in response to a READ ATTRIBUTE command.
Host	Nonexistent	A host attribute does not exist in the medium auxiliary memory until a WRITE ATTRIBUTE command creates it.
	Read/Write	The MAM attribute has been created using the WRITE ATTRIBUTE command. After the MAM attribute has been created, the contents may be altered using subsequent WRITE ATTRIBUTE commands. A read/write MAM attribute may be returned to the nonexistent state using a WRITE ATTRIBUTE command with the attribute length set to zero. When the READ ONLY bit (see 6.3.1 on page 277) is zero, the MAM attribute is in the read/write state.

4.19 Volume Coherency

An application client may need to be able to determine if all logical objects on a volume are coherent with the last time an application client wrote to this volume. The VOLUME COHERENCY INFORMATION attribute (see 6.3.2.4.11 on page 285) of MAM is provided for an application client to collect and save information necessary for this determination.

The VOLUME COHERENCY INFORMATION attribute for each partition is written to MAM by the application client when it has completed a write job (e.g., the volume is demounted). The VOLUME COHERENCY INFORMATION attribute contains references to a volume coherency set that the application client has written to logical objects on a partition. An application client should not create a VOLUME COHERENCY INFORMATION attribute unless it has written a volume coherency set to that partition. The volume coherency set shall include a volume coherency count. The application client shall maintain one volume coherency count for an entire volume and shall monotonically increase the volume coherency count when the state of the volume coherency set changes (e.g., writing identical volume coherency sets on each partition does not force a change of volume coherency count). When the application client writes the VOLUME COHERENCY INFORMATION attribute to MAM for a specific partition the VOLUME CHANGE REFERENCE VALUE field of the VOLUME COHERENCY INFORMATION attribute for a partition shall contain the value returned in the ATTRIBUTE VALUE field of the VOLUME CHANGE REFERENCE attribute after the last volume coherency set was written to the volume. The VOLUME COHERENCY COUNT field of the VOLUME COHERENCY INFORMATION attribute shall contain the volume coherency count that was written to the last volume coherency set written to that partition. The VOLUME COHERENCY SET IDENTIFIER field of the VOLUME COHERENCY INFORMATION attribute for a partition contains the logical object identifier of the first byte of the last volume coherency set written to that partition. The APPLICATION CLIENT SPECIFIC INFORMATION field of the VOLUME COHERENCY INFORMATION attribute for a partition contains information the application client binds with the coherency set referenced by the VOLUME COHERENCY SET IDENTIFIER field.

NOTE 22 - The application client needs to guarantee that no other application client updates the logical objects on the volume between the time it completes writing and the time it updates the MAM parameter (e.g., use reservations)

An application client may verify that the volume coherency set written in a partition has not changed since the VOLUME COHERENCY INFORMATION attribute was written when the application client reads the VOLUME COHERENCY INFORMATION attribute for a partition (e.g., when a volume is mounted) and compares the value in the VOLUME CHANGE REFERENCE VALUE field with the value returned in the ATTRIBUTE VALUE field of the VOLUME CHANGE REFERENCE attribute. If the values match, then the volume coherency set written in that partition is unchanged.

To find the most recently written volume coherency set, the application client searches the VOLUME COHERENCY INFORMATION attributes of the partitions for which the volume coherency set is unchanged and finds the largest value in the VOLUME COHERENCY COUNT field. The application client then verifies the largest value in the VOLUME COHERENCY COUNT field with the volume coherency count stored in the volume coherency set beginning at the logical object specified by the VOLUME COHERENCY SET IDENTIFIER field. If this matches, then this is the volume coherency set that was most recently written.

The APPLICATION CLIENT SPECIFIC INFORMATION field may also be used by the application client as part of this coherency check. If the information verifies for a partition, then the volume is coherent with the last access by this application. If the information does not verify for a partition, then the volume is not coherent with the last access by this application.

4.20 Diagnostics

4.20.1 Extended Write/Read Test diagnostic

This clause shows a comparision of an example manual Write/Read test sequence (see Figure 9) to an example test sequence using the Extended Write/Read Test diagnostic (see Figure 10). In this example test sequence the Extended Write/Read Test diagnostic (see 6.1.7 on page 241) is run in immediate mode (i.e., the IMMED bit set to one) and temporary / permanent errors are retrieved with normal DCC (i.e., deferred check condition) reporting. The Receive Diagnostic Results (see 6.1.7.2 on page 247) are checked for the correct termination code.

Figure 9 — Manual Write/Read Test Sequence

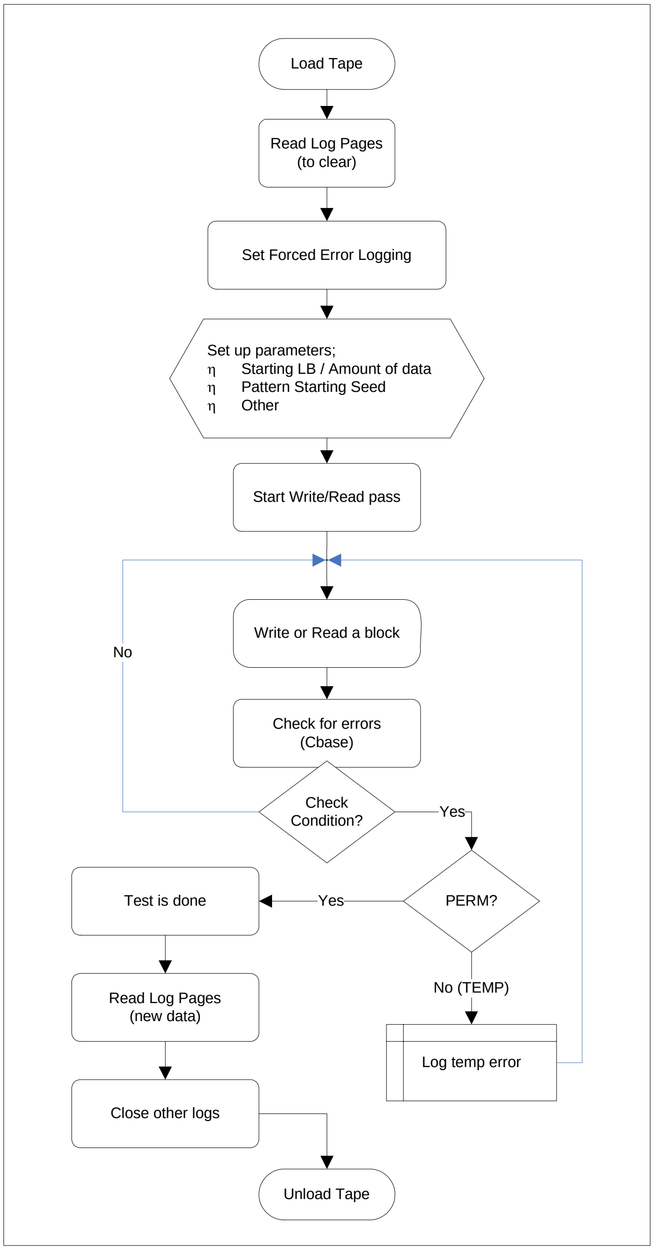
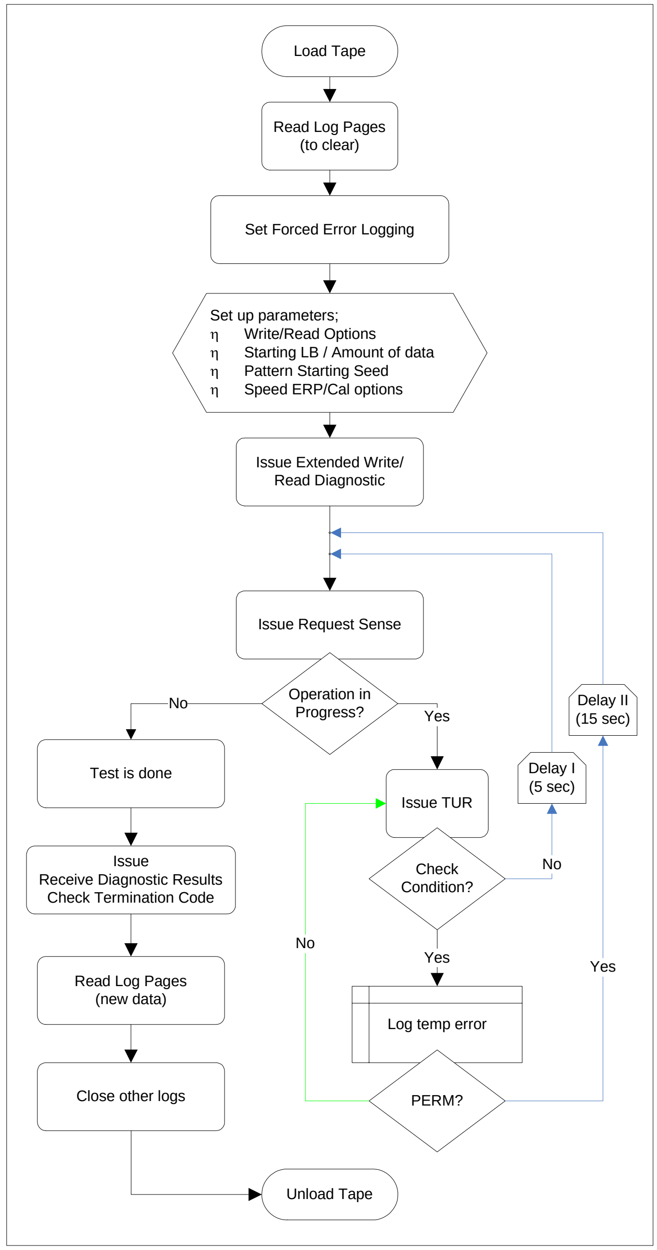


Figure 10 — Extended Write/Read Diag Test



Sequence

Clause 5. SCSI Commands

This chapter describes the SCSI commands supported (LUN 0).

The following SCSI command descriptions have a table describing the fields in the Command Descriptor Block (CDB), similar to the style used in the *American National Standard of the National Committee for Information Technology Standards (NCITS)* documents.

Any data required by each command follow these descriptions and are described in a “term-definition” format. In this format, the bits or bytes to be described are highlighted and listed on the left. The definition for the bits or bytes is to the right (not highlighted).

Parameters are described in *Clause 6.*

5.1 SCSI Commands Overview

5.1.1 Unsupported SCSI Commands

Certain commands or features of some commands defined in SPC-4 or SSC-3 are not currently supported but may be in the future.

The *Read Buffer* and *Write Buffer* commands are supported but not all buffers are described in this document because many buffers are intended only to be read or written by the Service Representative or by Manufacturing. OEM customers who intend to support host microcode download on a new platform should contact IBM for a complete description of the *Write Buffer* command for this purpose. Note that new microcode may also be loaded without requiring the use of the SCSI *Write Buffer* command, by using the Field Microcode Replacement (FMR) tape process described in the maintenance information manual for this product.

5.1.2 Supported SCSI Commands

The 3592 tape drive accepts commands on LUN 0 for drive related commands (i.e., Peripheral Device Type returned in Standard Inquiry is Sequential Access Device). When in a library the 3592 tape drive also accepts commands on LUN 1 for library related commands (i.e., Peripheral Device Type returned in Standard Inquiry is Medium Changer Device).

5.1.2.1 Supported SCSI Commands on LUN 1

The commands supported on LUN 1 is dependant on the Library in which the drive is contained. To determine the model of the library in which the drive is contained use the Inquiry command. Bytes 8-15 contain the T10 Vendor Identification. Bytes 16 - 31 contain the Product Identification.

This document contains no additional information about commands supported on LUN 1. For a list of all commands supported please see the appropriate Library SCSI Reference.

5.1.2.2 Supported SCSI Commands on LUN 0

Table 53 provides a list of all commands supported by this product for the sequential access devices (i.e., LUN 0). For each command, the operation code, reference page for this specification, recommended host command time-out, type of support required for the command as defined by the SCSI-3 standard, and applicability of certain conditions to the command are shown in *table 53*.

It is strongly recommended that device drivers or host software implement device reservations using the Reserve or Persistent Reserve commands. Due to the sequential nature of tape devices, many host commands are serialized, and command time-outs consequently have an additive effect. Using reservations will prevent this from causing application disruptions in a multi-initiator or SAN environment. Similar additive time-out effects can occur if the host is using command queueing (simple queueing).

NOTE 23 - The time-outs in the following table are based on the time from the start of processing of the command, to its reported completion. Since applications are generally concerned with the time from the command being issued, to its reported completion, it should be noted that this overall time may be affected by currently processing operations. Some of these conditions include:

- A prior command was issued with the Immediate bit set in the CDB
- Multiple concurrent commands with Simple queueing are executed
- Multi-initiator configurations without reservations
- Non-host operations, such as manual unloads, power-on self tests, etc.
- Commands issued shortly after certain aborted commands
- Commands which force flushes when unwritten write data is in the buffer

Table 53 — Drive Commands (LUN 0) (part 1 of 4)

Command Name	SCSI	Op Code	See Page	Host time-out	Applicable Conditions:							
					RVC[1]	UAT	NRD	WRP	MFC	DCC	DEA	CK1[14]
Allow Overwrite	SSC-4	82h	135	30 sec	Y	Y	Y	-	Y	-	-	Y
Change Definition	SCSI-2	40h	136	30 sec	Y	Y	-	-	-	-	-	-
Display Message	VU	C0h	137	30 sec	Y	Y	-	-	-	-	-	Y
Erase (long = 0)	SSC	19h	139	15 min[19,20]	Y	Y	Y	Y	Y	Y	Y	Y
Erase (long = 1)	SSC			235 min[19,20]								
Format Medium	SSC-4	04h	140	25 min	Y	Y	Y	Y	Y	Y	Y	Y
Inquiry	SPC	12h	142	30 sec	-	-	-	-	-	-	-	-
Load (Cartridge Insert to BOT)	SSC	1Bh	147	12 min[20]	Y	Y	Y[4]	-	Y[5]	Y	Y	Y
Loaded (EOT to BOT)	SSC			8 min[20]								
Unload (BOT to Cartridge Eject)	SSC			10 min[20]								
Unload (EOT to Cartridge Eject)	SSC			11 min[20]								
Locate	SSC	2Bh	148	14 min[18,19,20]	Y	Y	Y	-	Y	Y	Y	Y
Log Select	SPC	4Ch	150	30 sec	Y	Y	-	-	-	-	-	Y
Log Sense	SPC	4Dh	152	30 sec	Y	-	-	-	-	-	-	-
Mode Select(6/10) (not page 23h)	SPC	15h/55h	153	30 sec	Y	Y	-	-[9]	-	Y[8]	-	Y
Mode Select(6/10) (page 23h)	SPC			15 min								
Mode Sense(6/10)	SPC	1Ah/5Ah	155	30 sec	-	Y	-	-	-	-	-	Y
Persistent Reserve In	SPC	5Eh	157	30 sec	-	Y	-	-	-	-	-	-
Persistent Reserve Out	SPC	5Fh	160	15 min[20]	-[1,2]	Y	-	-	-	-	-	-
Prevent Allow Medium Removal	SSC	1Eh	162	30 sec	Y	Y	-	-	-	-	-	Y
Read	SSC	08h	163	18 min	Y	Y	Y	-	Y	Y	Y	Y
Read (String Search) (not J1A)	VU	08h	164	18+ min[22]	Y	Y	Y	-	Y	Y	Y	Y
Read Attribute	SPC	8Ch		1 min	Y	Y	-	-	-	Y	-	-
Read Block Limits	SSC	05h	171	30 sec	Y	Y	-	-	-	-	-	Y

Table 53 — Drive Commands (LUN 0) (part 2 of 4)

Command Name	SCSI	Op Code	See Page	Host time-out	Applicable Conditions:							
					RVC[1]	UAT	NRD	WRP	MFC	DCC	DEA	CK1[14]
Read Buffer	SPC	3Ch	173	5 min	Y	-	-	-	-	-	-	-
Read Position	SSC	34h	178	30 sec	Y	Y	-	-	-	-	-	Y
Read Reverse	SSC	0Fh	185	18 min	Y	Y	Y	-	Y	Y	Y	Y
Receive Diagnostic Results	SPC	1Ch	186	30 sec	Y	Y	-	-	-	-	-	Y
Recover Buffered Data	SSC	14h	187	1 min	Y	Y	Y[15]	-	-	Y	Y	Y
Release Unit (6)[16]	SPC	17h	188	30 sec	-[2]	Y	-	-	-	-	-	-
Report Density Support	SSC	44h	189	30 sec	Y	Y	-	-	-	-	-	Y
Report LUNs	SPC	A0h	192	30 sec	-	-	-	-	-	-	-	-
Report Supported Operation Codes	SPC	A3h[0Ch]	200	30 sec	-	-	-	-	-	-	-	-
Request Sense	SPC	03h	193	30 sec	-	-	-	-	-	-	-	-
Reserve Unit (6)[17]	SPC	16h	209	15 min[20]	Y[3]	Y	-	-	-	-	-	-
Rewind	SSC	01h	210	8 min[19,20]	Y	Y	Y	-	Y[5]	Y	Y	Y
Security Protocol In (SPIN)	SPC	A2h	211	5 min	y	y	-	-	-	-	-	y
Security Protocol Out (SPOUT)	SPC	B5h	212	5 min	y	y	-	-	-	-	-	y
Send Diagnostic	SPC	1Dh	213	35 min[21]	Y	Y	Y[10]	-	Y[6]	-	-	Y
Space(6/16)	SSC	11h/91h	215	14 min[18,19,20]	Y	Y	Y	-	Y	Y	Y	Y
Space(6/16) (String Search)	VU	11h/91h	217	18+ min[18,19,20,22]	Y	Y	Y	-	Y	Y	Y	Y
String Search	VU	E3h	219	18+ min[22]	Y	Y	Y	-	-	Y	Y	-
Test Unit Ready	SPC	00h	221	30 sec	Y	Y	Y	-	-	Y[11]	-	Y
Verify (VTE=0 and VTF=0)	SSC	13h	222	18 min	Y	Y	Y	-	Y	Y	Y	Y
Verify (VTE=1 or VTF=1)	SSC			360 min[19,20]								
Write	SSC	0Ah	224	18 min	Y	Y	Y	Y	Y	Y	Y	Y
Write Attribute	SPC	8Dh		1 min	Y	Y	-	-	-	Y	-	-
Write Buffer	SPC	3Bh	228	8 min	Y	Y	-	-	-	-	-	-
Write Filemarks	SSC	10h	229	18 min[19]	Y	Y	Y	Y	Y	Y	Y	Y

Table 53 — Drive Commands (LUN 0) (part 3 of 4)

Command Name	SCSI	Op Code	See Page	Host time-out	Applicable Conditions:							
					RVC[1]	UAT	NRD	WRP	MFC	DCC	DEA	CK1[14]

Legend

M	Mandatory	RVC	Reservation Conflict status
O	Optional	UAT	CHECK CONDITION status for Unit Attention
VU	Vendor-Unique	NRD	CHECK CONDITION status for Not Ready
-	Not Applicable	WRP	CHECK CONDITION status for Write Protected
NS	Not Supported	MFC	CHECK CONDITION status for Medium Format Corrupted
SPC	SPC-n	DCC	Deferred CHECK CONDITION
SSC	SSC-n	CK1	CHECK CONDITION B/4400 for Post Check 1 State
		DEA	Deferred Error (DCC) affinity (see 4.9.3 on page 100)
		Y	Yes (Condition applies)
		Y^n	Yes (Condition applies per note n below)

Notes:

1 If an I/O process consists of linked commands and begins with a command that is not subject to the RVC condition, subsequent commands in the I/O process may be subject to Reservation Conflict status, if a linked command is subject to the RVC condition and a reservation conflict exists. Linked commands are not supported by this device.

2 Performs no operation if the logical unit is reserved to another initiator.

3 Condition applies if the logical unit is reserved to another initiator.

4 CHECK CONDITION status for a not ready device is not presented to a Load Unload command that requests the load function. CHECK CONDITION status for a not ready device is presented to a Load Unload command that requests the unload function.

5 The command is not subject to the condition unless the medium format corrupted condition has not yet been reported to the initiator on some prior command.

6 This CHECK CONDITION is diagnostic dependent. Refer to the specific diagnostic in question.

7 The medium must be contain a factory written servo format. If the media is completely blank (i.e., degaussed with a strong degausser) then it is rendered unusable and cannot be reformatted with the Format Medium command.

8 The deferred CHECK CONDITION and CHECK CONDITION status for Write Protected only applies to *“MP 23h: Medium Sense” on page 320*

9 Only *“MP 23h: Medium Sense” on page 320* is treated as write protected. All other mode pages are not.

10 Some diagnostics require either READY (cartridge loaded) or NOT READY (no loaded cartridge) states prior to their invocation. Refer to the specific diagnostic in question.

11 Reporting of deferred CHECK CONDITION status for the Test Unit Ready command is optional based on a vendor-unique field in the CDB.

12 These commands are not supported by this device.

13 Reservation Conflict is reported as appropriate for the type of Service Action and Reservation Type requested, and the current reservation state of the drive.

14 If the drive is in a Post Check 1 State (after a fatal error has occurred), the drive will repeatedly report B/4400 to these commands. This condition may be cleared by a Change Definition command (see *“Change Definition - 40h” on page 136* or by a LUN or Target Reset. This insures that the application or driver acknowledges the condition and can gather and log any debug or error information. check 1

15 If a write error has occurred, the buffer state is unchanged (unwritten data is in the buffer), and Unload with Write Error Association is set to 1b (see *“MP 24h: Initiator-Specific Extensions” on page 329*), then these commands will not post a Not Ready condition, even if the drive is Not Ready (not loaded). The command will be processed in this case.

16 If the drive sets the CRH bit to one in the parameter data returned by the REPORT CAPABILITIES service action of the Persistent Reserve In command, then in the presence of a Persistent Reservation, a Release(6) command will complete with GOOD status, but the persistent reservation will not be released, if the command is received from:
a) An I_T nexus that is a persistent reservation holder; or
b) An I_T nexus that is registered if a registrants only type persistent reservation is present.
In all other cases, the command will be processed as defined in SPC-2.

17 A Reserve(6) command will complete with GOOD status, but no reservation will be established and the persistent reservation will not be changed, if the command is received from:
a) An I_T nexus that is a persistent reservation holder; or
b) An I_T nexus that is registered if a registrants only type persistent reservation is present.
In all other cases, the command will be processed as defined in SPC-2.

Table 53 — Drive Commands (LUN 0) (part 4 of 4)

Command Name	SCSI	Op Code	See Page	Host time-out	Applicable Conditions:							
					RVC[1]	UAT	NRD	WRP	MFC	DCC	DEA	CK1[14]

Notes (Host time-out Related):

18 Spacing and locate commands will automatically rebuild the portions of the High Resolution Tape Directory if required. This operation can be completed within the recommended time-out if the Cartridge Memory (CM) is valid. Otherwise linear processing of tape is needed and the time-out increases by up to 220 minutes.

19 When the immediate bit is set, the command will return quickly. It is recommended that the host issues Request Sense commands to poll for completion. Other commands may not begin execution until completion of the immediate command, resulting in an additive effect of the command time-outs.

20 Depending on the current state of the drive and the command parameters, a media synchronize operation may be performed during the execution of this command. This primarily relates to conditions where unwritten buffered write data is present when the command is issued.

21 The time required for diagnostics can vary widely based on the particular diagnostic invoked.

22 The time required can vary based on options and an optional time may be specified.

23

5.1.3 Control Byte Definition

This description of the control byte fields is to be used for all of the supported commands. The control byte occurs in the last byte of a command, that is, byte 5 (6-byte commands), byte 9 (10-byte commands), byte 11 (12-byte commands), or byte 15 (16-byte commands). Table 54 shows the bit significance of the control byte.

Table 54 — Control Byte Definition

Bit Byte	7 msb	6	5	4	3	2	1	0 lsb
5, 9, or 11	Vendor Specific 00		Reserved 0000				Flag 0	Link 0

NOTE 24 - This device does not support command linking. Therefore both the Flag and Link bit are required to be 0b.

5.2 SCSI Commands Listing

5.2.1 Allow Overwrite - (82h)

When Append-only mode (see 4.13.3 on page 108) is enabled an application client may issue the ALLOW OVERWRITE command to enable the overwrite of the medium at a non-append point. The processing of the ALLOW OVERWRITE command sets the allow_overwrite and allow_overwrite_position variables as specified in 4.13.3.

Table 55 — ALLOW OVERWRITE command

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (82h)							
1	Reserved							
2	Reserved				ALLOW OVERWRITE			
3	PARTITION							
4	(MSB)							
...	LOGICAL OBJECT IDENTIFIER							
11								(LSB)
12								
13	Reserved							
14								
15	CONTROL							

The ALLOW OVERWRITE field specifies what type of overwrite is allowed. Table 56 defines the actions for the value specified in the ALLOW OVERWRITE field.

Table 56 — ALLOW OVERWRITE field definition

Value	Definition
0h	The allow_overwrite variable shall be set to Disabled
1h	The allow_overwrite variable shall be set to Current Position
2h	The allow_overwrite variable shall be set to Format
3h-Fh	The command shall be rejected with CHECK CONDITIONstatus with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

If the ALLOW OVERWRITE field is set to Current Position (i.e., 1h), then:

a) the PARTITION field is set to the active partition; and
b) the LOGICAL OBJECT IDENTIFIER field is set to the current position.

If the ALLOW OVERWRITE field is set to Current Position (i.e., 1h), then the allow_overwrite_position variable is set to the current position.

If the ALLOW OVERWRITE field is not set to Current Position (i.e., 1h), then the PARTITION field and LOGICAL OBJECT IDENTIFIER field are ignored.

The device server terminates the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to SEQUENTIAL POSITIONING ERROR if:

a) the ALLOW OVERWRITE field is set to Current Position (i.e., 1h); and
b) the logical position of the medium is not at the location specified by the PARTITION field and LOGICAL OBJECT IDENTIFIER field.

If the device server terminates that command with any status other than GOOD, then the allow_overwrite variable is set to Disabled and the allow_overwrite_position variable is set to invalid.

5.2.2 Change Definition - 40h

The Change Definition command is defined in SCSI-2 (see http://www.t10.org/cgi-bin/ac.pl?t=f&f=s2-r10l.pdf). This clause specifies the specific implementation.

Table 57 — Change Definition CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (40h)							
1	Obsolete (LUN)			Reserved				
2	Reserved							Save
3	Reserved	Definition Parameter						
4	Reserved							
7								
8	Parameter Data Length							
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Save: 0
- Definition Parameter:

  An initiator can request one of several operating definitions to be established. If the command is accepted, the new operating definition applies to all initiators. After a power on condition, the drive sets its operating definition to its default value as determined by non-volatile configuration. Any other hard reset condition does not affect the current operating definition.

  The operating modes available for this command are intended for manufacturing, engineering, or specialized controller or OEM environments. Contact IBM for additional information on these modes.

  Definition Parameter description:

Value	**Description**
00h	Use Current Operating Definition
60h	Clear Post Check 1 State

NOTE 25 - This parameter is used to clear the Post Check 1 State, which is repeatedly reported as a B/4400 to eligible commands (see Table 1 on page 6) until cleared by this command or by a LUN Reset or Target Reset action. The drive will report a 6/2900 if this state was cleared by this Change Definition, just in case any initiator had cleared but was unable to fully process its original unit attention. It should be noted that this is not a true bus reset and normal clearing effects may or may not have occurred.

Parameter Data Length: 00h

5.2.3 Display Message - C0h

Table 58 — Display Message CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (C0h)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3								
4	Parameter List Length							
5	Control Byte (see 5.1.3 on page 134)							

The Display Message command allows the initiator to use the device to display messages to the operator regarding the status and the needs of the device. Having this information at the device allows for more efficient use of the device.

The Display Message command is a vendor-unique command and, therefore, is not described in the SCSI standard. This document describes the fields in the Parameter list in general terms, such as the SCSI standard might, and follows each item with the device implementation of that field.

- Parameter List Length: 18h

  The parameter list length field specifies the length in bytes of the message display parameter list that is transferred from the initiator to the target.

The Display Message parameter list follows:

Parameter List

Byte **Description**

0 Display Type
This field is not meaningful. Any value is allowed (and ignored).

1 Message Processing
The Message Processing field specifies the types of messages and how to process the messages.

Bit **Description**

7-5 Message Type

Value **Description**

0 General Status Message

Message 0, Message 1, or both are displayed according to bits 4-2, until the drive next initiates tape motion or the message is updated with a new message.

1 Demount/Verify Message

Message 0, Message 1, or both are displayed according to bits 4-2, until the current volume is unloaded. If the volume is currently unloaded, the message display is not changed and the command performs no operation.

2 Mount with Immediate Action Indicator

Message 0, Message 1, or both are displayed according to bits 4-2, until the volume is loaded. An attention indicator is activated. If the volume is currently loaded, the message display is not changed and the command performs no operation.

3-6 Vendor-Reserved

7 Demount/Mount with Immediate Action Indicator

When Message Control bits 4-2 are set to a value of 4 (100), Message 0 and Message 1 are displayed alternately until the currently mounted volume, if any, is unloaded. When Message Control bits 4-2 are set to any other value, Message 0 is displayed until the currently mounted volume, if any, is unloaded. Message 1 is displayed from the time the volume is unloaded (or immediately, if the volume is already unloaded) until another volume is loaded. An attention indicator is activated.

4-2 Message Control

Value	**Description**
0	Display Message 0
1	Display Message 1
2	Flash Message 0
3	Flash Message 1
4	Alternate Message 0 and Message 1
5-7	Vendor-Reserved (Invalid)

The life and sequences of each message must interact with the requirements of other messages, both sent or internally generated by the device.

1-0 Vendor-Reserved

2-5 Vendor-Reserved

6-7 Message Length: 0010h

8-15 Message 0

Eight-character ASCII message. If both Message 0 and Message 1 consist entirely of blanks, all messages are cleared, except for ATTN, FID, and CLEAN messages.

The Message 0 field contains the data to be displayed. Characters in the message are limited to uppercase alphabetic, numeric, blank, and the following special characters:

@ $ #,. / ' ( ) * & + - =%: _ < >?; ¢

All lowercase alphabetic characters are converted to uppercase. All other characters not listed above, including nulls (00), are displayed as if they had been blanks. Real blanks (20) must be used to force the message clearing function described above.

16-23 Message 1 (see Message 0 description above)

5.2.4 Erase - 19h

The Erase command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 59 — Erase CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (19h)							
1	Obsolete (LUN)			Reserved			Immed	Long
2 - 4	Reserved							
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Immed (Immediate)

Value	Description
0b	return status when the erase operation has completed.
1b	return status when the CDB has been validated and the buffer flushed.

- Long

Value	Description
0b	All remaining medium in the current partition is logically erased beginning at the current logical position.
1b	All remaining medium in the current partition is physically erased and overwritten beginning at the current logical position. This operation may take an extended amount of time to complete.

The Erase command performs either a logical or a physical medium erase from the current position to the end of the current or only partition.

5.2.5 FORMAT MEDIUM - 04h

The FORMAT MEDIUM command (see *table 11*) is used to prepare the medium for use by the logical unit. If buffered logical objects are stored by the device server when processing of a FORMAT MEDIUM command begins, the command shall be rejected with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM.

See Partitioning and reformatting (see 4.14.5 on page 118) for restrictions related to scaled volumes.

The FORMAT MEDIUM command is not allowed against a WORM cartridge. If a WORM cartridge is loaded when the FORMAT MEDIUM command is received, then the command will be rejected with CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code shall be set to WORM MEDIUM - OVERWRITE ATTEMPTED.

Table 11 — FORMAT MEDIUM command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (04h)							
1	Reserved						VERIFY	IMMED
2	Reserved				FORMAT			
3	(MSB)	TRANSFER LENGTH						
4								(LSB)
5	CONTROL							

The FORMAT MEDIUM command shall be accepted only when the medium is at beginning-of-partition 0 (BOP 0). If the medium is logically at any other position, the command shall be rejected with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM.

At the successful completion of a FORMAT MEDIUM command, the medium shall be positioned at BOP 0.

During the format operation, the device server shall respond to commands as follows:

a) in response to all commands except REQUEST SENSE and INQUIRY, the device server shall return CHECK CONDITION with a sense key of NOT READY and the additional sense code set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS unless a reservation conflict exists. In that case RESERVATION CONFLICT status shall be returned; or
b) in response to the REQUEST SENSE command, assuming no error has occurred, the device server shall return a sense key of NOT READY and the additional sense code shall be set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS, with the sense key specific bytes set for process indication (see SPC-4).

The following parameters apply:

- IMMED (immediate):

  An IMMED bit of zero specifies the device server shall not return status until the FORMAT MEDIUM command has completed. An IMMED bit of one specifies the device server shall return status as soon as the valid medium location has been verified and the command descriptor block of the FORMAT MEDIUM command has been validated. If CHECK CONDITION status is returned for a FORMAT MEDIUM command with an IMMED bit of one, the format operation shall not be performed.

- VERIFY: (0b)

The drive does not perform any verification of the format.

- FORMAT: Dictates what actions to be taken and whether or not to use the settings in mode page 11h.

Value	Description
0h	Default format: (Re)format the volume to a single unscaled partition using the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h (see 6.4.20 on page 332) and all data on the volume is lost.
1h	Partition volume: (see table below) See MP 23h: Medium Sense (see 6.4.18 on page 320) for a description of scaled volumes.
2h	Partition volume from default format: Unscale the volume and (re)format the volume as specified in the Medium Partition mode page using the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h and all data on the volume is lost. If the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h specifies a density that does not support partitioning, a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PARAMETER VALUE INVALID is returned. See MP 23h: Medium Sense (see 6.4.18 on page 320) for a description of scaled volumes.

Partition volume (1h):

Volume State	Behavior
Scaled	Return a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PARAMETER VALUE INVALID
Unscaled	(Re)format the volume as specified in the Medium Partition mode page (see 6.4.18 on page 320) using the density specified in the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h. All data on the volume is lost. If the PENDING WRITE DENSITY AT BOP 0 field of mode page 25h specifies a density that does not support partitioning, a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB is returned.

When the FORMAT field contains 1h or 2h, some errors related to mode page field contents may not be detected until the FORMAT MEDIUM command is processed. Therefore, some error conditions described in MP 11h: Medium Partition Page (see 6.4.12 on page 308) may be returned in response to a FORMAT MEDIUM command with 1h or 2h in the FORMAT field.

For an example but not an inclusive list, a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PARAMETER VALUE INVALID is returned if:

a) the PENDING WRITE DENSITY AT BOP 0 field of MP 25h: Read/Write Control (see 6.4.20 on page 332) has been modified since MP 11h: Medium Partition Page (see 6.4.12 on page 308) has been updated;
b) the FDP, SDP, and IDP bits of MP 11h: Medium Partition Page (see 6.4.12 on page 308) are all set to zero; and
c) other unspecified conditions.

Additional information on how the FORMAT MEDIUM command interacts with partitioning, capacity scaling, and reformatting are specified in Partitioning and reformatting (see 4.14.5 on page 118).

- TRANSFER LENGTH: (0000h)

5.2.6 Inquiry - 12h

The Inquiry command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 12 — Inquiry CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (12h)							
1	Obsolete (LUN)			Reserved			Obsolete	EVPD
2	Page Code							
3	Reserved							
4	Allocation Length							
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- EVPD

Value	**Description**
0b	Inquiry Standard Data is returned: *"Inquiry Standard Data: Valid LUN (Logical Unit Number)" on page 143* *"Inquiry Standard Data: Invalid LUN" on page 145*
1b	Vital Product Data is returned

- Page Code

  If EVPD bit is set to one, then the Page Code field refers to the Vital Product Data page being requested. Supported pages are:

  IP 00h: Supported Inquiry Pages (see 6.2.1 on page 263)
  IP 03h: ASCII Information (see 6.2.2 on page 264)
  IP 80h: Unit Serial Number (see 6.2.3 on page 265)
  IP 83h: Device Identification (see 6.2.4 on page 266)
  IP C1h: Drive Serial Numbers (see 6.2.9 on page 276)

  In addition there are some attachment specific pages:

  Inquiry Page D0h-DFh or E0h-EFh (the contents of these pages are not specified in this document)

- Allocation Length

5.2.6.1 Inquiry Standard Data

The standard INQUIRY data format is shown in *table 13*. Inquiry Standard Data is returned with *table 13* populated in in one of two different ways. If the command is received on a valid LUN then the data returned is shown in *"Inquiry Standard Data: Valid LUN (Logical Unit Number)" on page 143*. If the command is received on an invalid LUN then the data returned is shown in *"Inquiry Standard Data: Invalid LUN" on page 145*.

Table 13 — Standard INQUIRY data format

Byte \ Bit	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	RMB	Reserved						
2	VERSION							
3	Obsolete	Obsolete	NORMACA	HISUP	RESPONSE DATA FORMAT			
4	ADDITIONAL LENGTH (n-4)							
5	SCCS	ACC	TPGS		3PC	Reserved		PROTECT
6	Obsolete	ENCSERV	VS	MULTIP	Obsolete	Obsolete	Obsolete	ADDR16
7	Obsolete	Obsolete	WBUS16	SYNC	Obsolete	Obsolete	CMDQUE	VS
8	(MSB)	T10 VENDOR IDENTIFICATION						
15								(LSB)
16	(MSB)	PRODUCT IDENTIFICATION						
31								(LSB)
32	(MSB)	PRODUCT REVISION LEVEL						
35								(LSB)
36	IBM PLANT OF MANUFACTURE CODE							
37								
38	SERIAL NUMBER							
49								
50	PORT NUMBER							
51								
52	Equipment Flags							
	ENCR_C	ENCR_E	Reserved	A-SHARE	IMCI	LIB ATTACH	ACF	MD ATTACH
53	SCSI CUSTOMIZATION							
54	LIBRARY TYPE							
55	MESSAGE DISPLAY TYPE							

5.2.6.1.1 Inquiry Standard Data: Valid LUN (Logical Unit Number)

The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 0b
- Page Code: 00h
- Allocation Length: 38h (56) bytes available

For a logical unit number (LUN) that is associated with an installed device (see 4.1 on page 77), the following standard inquiry data is returned (character fields are in ASCII):

Byte	Description
0	
	Bit **Description** 7-5 Peripheral Qualifier: 000b 4-0 Peripheral Device Type: 01h (Sequential Access Device)
1	
	Bit **Description** 7 RMB (Removable Medium Bit): 1b 6-0 Reserved
2	VERSION: 06h
3	
	Bit **Description** 7 Obsolete: 0b 6 Obsolete: 0b 5 NormACA (Normal ACA Supported): 0b 4 HiSupport (Hierarchical Support): 0b 3-0 Response Data Format: 0010b
4	Additional Length (n-4): 33h
5	
	Bit **Description** 7 SCCS (An SCC Supported): 0b 6 ACC (Access Controls Coordinator): 0b 5-4 TPGS (Target Port Group Support): 00b 3 3PC (Third-Party Copy): 0b 2-1 Reserved 0 PROTECT (Logical Block Protection - see 4.4): 1b
6	This byte supports SCSI-3 changes. In SCSI-2, this byte was Reserved.
	Bit **Description** 7 Obsolete: 0b 6 EncServ (Enclosure Service): 0b 5 VS: 0b 4 MULTIP (Multi-Port): 1b 3 Obsolete: 0b 2 Obsolete: 0b 1 Obsolete: 0b 0 Addr16: 0b
7	
	Bit **Description** 7 Obsolete: 0b 6 Obsolete: 0b 5 WBUS16 (Wide Bus 16): 0b 4 SYNC (Synchronous Transfer): 0b 3 Obsolete: 0b 2 Obsolete: 0b 1 CMDQUE (Command Queuing): 0b 0 VS: 0b
8-15	T10 VENDOR IDENTIFICATION (Manufacturer): 'IBM ' (in ASCII)
16-31	PRODUCT IDENTIFICATION (Device Type and Model Number): '03592xxx ' (in ASCII) The device type is 03592 and the model number is xxx; xxx can be 'J1A', 'E05', 'E06', or 'E07'.
32-35	Product Revision Level (Drive Microcode Revision Level in ASCII)

36-37 IBM Plant of Manufacture Code
38-49 Serial Number of device, right justified with leading zeroes, in ASCII
50-51 PORT NUMBER: For Port 0: ' 0' (in ASCII); For Port 1: ' 1' (in ASCII)
52 Equipment Flags

Bit **Description**

7 ENCR_C: Device Supports Encryption - Capable

Value	**Description**
0b	Device does not support encryption (does not have encryption hardware)
1b	Device supports encryption (encryption interface(s) are not necessarily enabled)

6 ENCR_E: Device Supports Encryption - Enabled

Value	**Description**
0b	Device does not support encryption
1b	Device supports encryption (encryption interface(s) are enabled)
Value	**Description**

5 Vendor-Reserved

4 A-SHARE: Auto-Share Feature Installed (see 4.2 on page 78)

Value	**Description**
0b	Indicates Auto-Share feature is not installed
1b	Indicates Auto-Share feature is installed

3 IMCI: Independent Medium Changer Installed (see byte 0, bits 4-0)

Value	**Description**
0b	a Medium Changer is not addressable at LUN 1
1b	a Medium Changer is addressable at LUN 1

2 LIB ATTACH: Library Attached attached

Value	**Description**
0b	the device is not attached to a library facility (3494)
1b	the device is attached to a library facility (3494)

1 ACF Attached

Value	**Description**
0b	the device does not support an ACF

0 MD ATTACH: Message Display Attached: 1b

Value	**Description**
0b	a message display is not attached
1b	a message display is attached

53 SCSI Customization: 00h
54 Library Type
55 Message Display Type: 81h

5.2.6.1.2 Inquiry Standard Data: Invalid LUN

The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 0b
- Page Code: 00h
- Allocation Length: 24h (36) bytes available

For a LUN that is not associated with an installed device (see 4.1 on page 77), the following standard inquiry data is returned (character fields are in ASCII):

Byte **Description**

0

Bit	**Description**
7-5	Peripheral Qualifier: 011b
4-0	Peripheral Device Type: 1Fh (no device type)

1

Bit	Description
7	RMB (Removable Medium Bit): 0b
6-0	Reserved

2

Bit	Description
7-6	ISO/IEC Version: 00b
5-3	ECMA Version: 000b
2-0	ANSI Approved Version: 011b

3

Bit	Description
7	AERC (Asynchronous Event Reporting Capability): 0b
6	Obsolete: 0b
5	NormACA (Normal ACA Supported): 0b
4	HiSupport (Hierarchical Support): 0b
3-0	Response Data Format: 0010b

4 Additional Length (n-4): 1Fh (31)

5

Bit	Description
7	SCCS (An SCC Supported): 0b
6-0	Reserved

6 This byte supports SCSI-3 changes. In SCSI-2, this byte was Reserved.

Bit	Description
7	BQue (Basic Queueing): 0b
6	EncServ (Enclosure Service): 0b
5	BarC: 0b
4	MultiP (Multi-Port): 1b
3	Mchngr (Medium Changer): 0b
2	AckReqQ: 0b
1	Addr32: 0b
0	Addr16: 0b

7

Bit	Description
7	RelAdr (Relative Addressing): 0b
6	WBus32 (Wide Bus 32): 0b
5	WBus16 (Wide Bus 16): 0b
4	Sync (Synchronous Transfer): 0b
3	Linked: 0b
2	TranDis (Transfer Disable): 0b
1	CmdQue (Command Queuing): 0b
0	SftRe (Soft Reset): 0b

8-15 Manufacturer: ‘IBM   ‘ (in ASCII)

16-31 Device Type and Model Number: (all ASCII blanks)

32-35 Product Revision Level: (all ASCII blanks)

5.2.7 Load Unload - 1Bh

The Load Unload command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 14 — Load Unload CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (1Bh)							
1	Obsolete (LUN)			Reserved				Immed
2	Reserved							
3								
4	Reserved					EOT	Re-Ten	Load
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Immed (Immediate)

Value	Description
0b	Indicates the drive is to present status when the command is completed.
1b	Indicates the drive is to present status as soon as all buffered commands have completed execution and the CDB of the Load Unload command has been validated. With the exception of Inquiry, Request Sense, and Test Unit Ready, subsequent commands are queued until the load/unload operation is complete. The completion status of the load/unload operation may be polled by sending a Request Sense command until the sense data returned is no longer 2/0407 (Not Ready, Logical Unit Not Ready, Operation in Progress).

- EOT (End of Tape): 0b
- Re-Ten (Retention): 0b
- Load:

Value	Description
0b	In all models, causes an eject of the cartridge from the drive. If this command is received and there is no cartridge present in the drive, the command is presented with CHECK CONDITION status and associated sense data of 2/3A00 (Not Ready, Medium Not Present). NOTE 26 - Load Unload command with the Load bit set to 0b is sometimes called an unload command.
1b	This causes a cartridge, if present in the loader tray in a loadable position, to become loaded and READY. If the cartridge is currently loaded and ready, the logical position will be changed to logical block 0 of partition 0 (i.e., BOP 0) (this is not equivalent to a Rewind command as the active partition changes to partition 0). NOTE 27 - The Load Unload command with the Load bit set to 1b is sometimes called a reload command.

NOTE 28 - In certain automation environments (such as 3494) this command cannot be executed successfully if the cartridge is in the unloaded position. In this case, the command is presented with CHECK CONDITION status and associated sense data of 2/0403 (Not Ready, Manual Intervention Required).

5.2.6 Locate (10/16) - 2Bh/92h

The Locate commands are defined in SSC (see http://www.t10.org/drafts.htm#SSC_Family). This clause specifies the specific implementation. The LOCATE(16) command *(see table 16)* adds the ability to position the medium to a logical object or to a logical file, whereas the LOCATE(10) command *(see table 15)* only allows positioning to a logical object. It is recommended that the LOCATE (16) command be used for all new implementations.

Table 15 — LOCATE(10) command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Bh)							
1	Reserved					BT	CP	IMMED
2	Reserved							
3	(MSB)	LOGICAL IDENTIFIER						
4								
5								
6								(LSB)
7	Reserved							
8	PARTITION							
9	CONTROL (see 5.1.3 on page 134)							

Table 16 — LOCATE(16) command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (92h)							
1	Reserved			DEST_TYPE		Rsvd	CP	IMMED
2	Reserved							BAM (0b)
3	PARTITION							
4	(MSB)	LOGICAL IDENTIFIER						
5								
6								
7								
8								
9								
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	CONTROL (see 5.1.3 on page 134)							

The following parameters apply:

- BT (Block address Type): 0b - LOCATE(10) only

Value	Description
0b	use standard locate positioning

- DEST_TYPE (Destination Type) - LOCATE(16) only

  This is used in conjunction with the LOGICAL IDENTIFIER field to locate to the appropriate position of the medium.

Value	Description
00b	The LOGICAL IDENTIFIER field specifies to which logical object identifier on whose BOP side the medium be located
01b	The LOGICAL IDENTIFIER field specifies to which logical file identifier on whose BOP side the medium be located
others	Reserved

- CP (Change Partition):

Value	Description
0b	no partition change is to be made; locate to the specified block address within the current partition. The PARTITION field is to be ignored.
1b	change to the partition specified by the PARTITION field prior to locating to the specified Block Address within the partition.

- IMMED (Immediate):

Value	Description
0b	present status when command is completed.
1b	present status when all buffered commands have completed execution and the CDB of the Locate command is validated.

- BAM (Block Addess Mode type): 0b (process this command as an implicit address command)
- LOGICAL IDENTIFIER: The destination of the locate operation. In the LOCATE(10) command this field specifies the logical object identifier. In the LOCATE(16) command, the DEST_TYPE field specifies if the locate is of logical objects or logical files.
- PARTITION:

  The partition field specifies the partition to select, when the CP field is 1b.

If the drive encounters End-of-Data (EOD) while processing this command, the command is terminated at the EOD position and CHECK CONDITION status is returned with associated sense data of 8/0005 (Blank Check, End-of-Data Detected).

5.2.7 Log Select - 4Ch

The Log Select command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 17 — Log Select CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (4Ch)							
1	Reserved						PCR	SP
2	PC		Page Code					
3	Subpage Code							
4	Reserved							
6								
7	MSB	Parameter List Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- PCR (Parameter Code Reset):

Value	Description
0b	Indicates that the log parameters will not be reset.
1b	If the parameter list length is zero, all cumulative and threshold log counter values will be reset to their default values as specified in that pages reset behavior section. If the parameter list length is not zero, the command is terminated with CHECK CONDITION status and associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

- SP (Save Parameters): 0b (Saving of the Log Select parameters is not supported)
- PC (Page Control):

Value	Description
00b	(Threshold Values): Supported for all log pages with log counters (LP field set to 0 in the Log Parameter Control Byte) except for *LP 3Dh: Subsystem Statistics (see 1.4.22 on page 55)*.

  NOTE 29 - This device treats each threshold value as a maximum value for the log counter field. Generally, when a threshold/maximum is reached, all log counters in that specific log page are locked (no longer updated) until a subsequent reset via a Log Select command.

  NOTE 30 - Only the overflowed log counter is locked for*LP 38h: Blocks/Bytes Transferred (see 1.4.17 on page 49)* - all other log counters continue incrementing for this log page.

  NOTE 31 - Most log counters for*LP 3Dh: Subsystem Statistics (see 1.4.22 on page 55)* lock at maximum values and cannot be reset.

  NOTE 32 - If the RLEC bit is set to 1b in *"MP 0Ah: Control Mode" on page 299* and a log counter reaches its threshold/maximum, the drive will report a deferred CHECK CONDITION status with associated sense data of 1/5B02 (Recovered Error, Log Counter at Maximum) on the next command eligible for a deferred check condition (see *table 53 on page 130*). The drive does not report error sense associated with the threshold condition being met.

01b	(Cumulative Values): Supported for all log pages with log counters (LP field set to 0 in the Log Parameter Control Byte) except for *LP 3Dh: Subsystem Statistics (see 1.4.22 on page 55)*.
10b	(Default Threshold Values): The default threshold value for all log counter fields is the maximum value (every byte is FF).
11b	(Default Cumulative Values): The default cumulative value for all log counter fields is zero (every byte is 00h). If the PCR field is set to 1b, the PC field is ignored.

- Page Code
- Subpage Code
- Parameter List Length:

  This field specifies the length in bytes of the parameter list that is to be transferred to the drive. A parameter list length of zero indicates that no pages are to be transferred. If the parameter list length is zero and the PC field is set to 00b (Current Threshold Values), the current threshold parameters are set to the default threshold values. If the parameter list length is zero and the PC field is set to 01b (Current Cumulative Values), the current cumulative parameters are set to the default cumulative values (zero).

  NOTE 33 - If the PCR field is set to 1b, this field must be set to zero.

  If the parameter list length results in the truncation of any log parameter, the command is terminated with CHECK CONDITION status and associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

Only one log page is accepted for each Log Select command. For each log page, any combination of the supported log parameters may be sent. If multiple log parameters are sent, they must be sent in ascending order by parameter code value. Only the Parameter Value field may be changed from the log parameters that are returned from Log Sense (see *"Log Parameter Format" on page 6*). Changes to the Log Parameter Control Byte are not supported.

NOTE 34 - Initiators should issue a Log Sense command prior to issuing a Log Select command to determine supported log parameter fields.

If a parameter list is received with an unsupported log page, a log parameter code out of order, or a change to a log parameter field other than the Parameter Value, the command is terminated with CHECK CONDITION status and associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

The following log pages are supported for the Log Select command:

LP 02h: Write Error Counters (see 1.4.5 on page 9)
LP 03h: Read Error Counters (see 1.4.6 on page 10)
LP 06h: Non-Medium Errors (see 1.4.7 on page 11)
LP 0Ch: Sequential-Access Device (see 1.4.8 on page 12)
LP 2Eh: TapeAlerts (see 1.4.10 on page 25)
LP 32h: Write Errors (see 1.4.13 on page 33)
LP 34h: Read Forward Errors (see 1.4.14 on page 35)
LP 36h: Read Backward Errors (see 1.4.15 on page 37)
LP 37h: Performance Characteristics (not J1A) (see 1.4.16 on page 38)
LP 38h: Blocks/Bytes Transferred (see 1.4.17 on page 49)
LP 39h: Host Port 0 Interface Errors (see 1.4.18 on page 51)
LP 3Ah: Host Port 1 Interface Errors (see 1.4.19 on page 52)
LP 3Bh: Equipment Check Errors (see 1.4.20 on page 53)
LP 3Ch: Drive Control Statistics (see 1.4.21 on page 54)
LP 3Eh: Engineering Use (see 1.4.23 on page 57)

5.2.8 Log Sense - 4Dh

The Log Sense command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 18 — Log Sense CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (4Dh)							
1	Obsolete (LUN)			Reserved			PPC	SP
2	PC		Page Code					
3	Subpage Code							
4	Reserved							
5	MSB	Parameter Pointer						
6								LSB
7	MSB	Allocation Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The Log Sense command supports the page code listing in *LP 00h: Supported Log Pages (see 1.4.4 on page 8)*.

The following parameters apply:

- PPC (Parameter Pointer Control): 0b
- SP (Save Parameters): 0b
- PC (Page Control):

Value	**Description**
00b	(Threshold Values): Supported for all log pages with log counters (LP field set to 0b in the Log Parameter Control Byte). For additional information, see Threshold Values *page 150*.
01b	(Cumulative Values): Supported for all log pages.
10b	(Default Threshold Values): Supported for all log pages with log counters. The default threshold value for all 2-byte log counter fields is FFFFh. The default threshold value for all 4-byte log counter fields is FFFF FFFFh.
11b	(Default Cumulative Values): The default cumulative value for all 2-byte log counter fields is 0000h. The default cumulative value for all 4-byte log counter fields is 0000 0000h.

- Page Code
- Subpage Code:

  Subpage supported by selected log pages only as described in the log page sections (see 1.4 on page 5).

Unless otherwise specified, each log counter is reset when read by the Log Sense command. Specific exceptions include Pages 30h, 37h, and 3Dh. Several pages have values which are reset at load time, as specified.

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

5.2.9 Mode Select (6/10) - 15h/55h

The Mode Select commands are defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

NOTE 35 - In the future, the length of the mode parameter list for Mode Sense Page Code 3Fh (All Pages) may exceed 255 bytes. At that time, use of the Mode Select (10) and Mode Sense (10) commands will be required in order to transfer all mode pages with one command. Some mode pages today exceed 255 bytes. For this reason, use of the Mode Select (6) and Mode Sense (6) commands is not recommended.

Table 19 — Mode Select (6) CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (15h)							
1	Obsolete (LUN)			PF	Reserved			SP
2	Reserved							
3								
4	Parameter List Length							
5	Control Byte (see 5.1.3 on page 134)							

Table 20 — Mode Select (10) CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (55h)							
1	Obsolete (LUN)			PF	Reserved			SP
2	Reserved							
6								
7	MSB	Parameter List Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following standards-based mode pages are supported for the Mode Select command:

“MP 01h: Read-Write Error Recovery” on page 297
“MP 02h: Disconnect-Reconnect” on page 298
“MP 0Ah: Control Mode” on page 299
“MP 0Fh: Data Compression” on page 302
“MP 10h: Device Configuration” on page 303
“MP 18h: Fibre Channel Logical Unit Control” on page 315
“MP 19h: Fibre Channel Port Control” on page 316
“MP 1Ch: Informational Exceptions Control” on page 317

The following vendor-specific mode pages are also supported for the Mode Select command:

"MP 21h: TOD Control" on page 318
"MP 22h: Language" on page 319
"MP 23h: Medium Sense" on page 320
"MP 24h: Initiator-Specific Extensions" on page 329
"MP 25h: Read/Write Control" on page 332
"MP 37h: String Search (not J1A)" on page 353
"MP 3Eh: Engineering Support" on page 365

NOTE 36 - Mode page 3Eh is for engineering use only.

The following parameters apply:

- PF (Page Format): 1b

  The PF (Page Format) bit is explicitly not checked.
- SP (Save Pages): 0b
- Parameter List Length:

  This field specifies the length in bytes of the mode parameter list that is transferred from the initiator to the target. A parameter list length of zero indicates that no data is transferred. This condition is not considered as an error.

  The target terminates the command with CHECK CONDITION status with associated sense data of 5/1A00 (Illegal Request, Parameter List Length Error) if the parameter list length results in the truncation of the mode parameter header, the mode parameter block descriptor, or any mode page.

NOTE 37 - Issuing a Mode Sense for current values before a Mode Select is generally recommended to avoid accidentally attempting to set fields that cannot be changed by the initiator.

Changing some *MP 23h: Medium Sense* or *MP 10h: Device Configuration* parameters causes an implicit write to tape. At Beginning Of Tape, any tape written in one format may be changed to another format when an Erase, Write, or Write Filemarks command is issued. If an attempt to change any such parameters when an incompatible format tape is loaded (even when at Beginning Of Tape), CHECK CONDITION status is returned with associated sense data of 5/3005 (Illegal Request, Cannot Write Medium - Incompatible Format).

Listed below are the Mode Parameters that cause implicit writes:

Mode Page 10, Byte 15, Bit 1 PERSWP
Mode Page 10, Byte 15, Bit 0 PRMWP
Mode Page 23, Byte 10, Bit 4 Persistent Write Protect
Mode Page 23, Byte 10, Bit 3 Reset Persistent Write Protect
Mode Page 23, Byte 10, Bit 0 Permanent Write Protect
Mode Page 23, Byte 11, Bit 0 CapScalV

NOTE 38 - For Reserved and Vendor-Reserved fields, appropriate values to issue on a Mode Select may be non-zero. Mode Selects to pages with these fields should use a value obtained by issuing a Mode Sense just prior to the Mode Select.

Clause *6.4 on page 287* has a listing of all mode parameters.

5.2.10 Mode Sense (6/10) - 1Ah/5Ah

The Mode Sense commands are defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

NOTE 39 - In the future, the length of the mode parameter list for Mode Sense Page Code 3Fh (All Pages) may exceed 255 bytes. At that time, use of the Mode Select (10) and Mode Sense (10) commands will be required in order to transfer all mode pages with one command. For this reason, use of the Mode Select (6) and Mode Sense (6) commands is not recommended.

NOTE 40 - See *"Mode Sense (6/10) - 1Ah/5Ah" on page 155* for a description of the supported mode pages, recommended command usage, and the behavior of parameters for this command.

Table 21 — Mode Sense (6) CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (1A)							
1	Obsolete (LUN)			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Subpage Code							
4	Allocation Length							
5	Control Byte (see 5.1.3 on page 134)							

Table 22 — Mode Sense (10) CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (5A)							
1	Obsolete (LUN)			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Subpage Code							
4	Reserved							
6								
7	MSB	Allocation Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- DBD (Disable Block Descriptors): 0b or 1b. (See Block Descriptor Length, below.)
- PC (Page Control): 00b, 01b; or 10b supported
- Page Code

The following standards-based mode pages are supported

“MP 01h: Read-Write Error Recovery” on page 297
“MP 02h: Disconnect-Reconnect” on page 298
“MP 0Ah: Control Mode” on page 299
“MP 0Fh: Data Compression” on page 302
“MP 10h: Device Configuration” on page 303
“MP 18h: Fibre Channel Logical Unit Control” on page 315
“MP 19h: Fibre Channel Port Control” on page 316
“MP 1Ch: Informational Exceptions Control” on page 317

The following vendor-specific mode pages are also supported

“MP 21h: TOD Control” on page 318
“MP 22h: Language” on page 319
“MP 23h: Medium Sense” on page 320
“MP 24h: Initiator-Specific Extensions” on page 329
“MP 25h: Read/Write Control” on page 332
“MP 37h: String Search (not J1A)” on page 353
“MP 3Eh: Engineering Support” on page 365
“Mode Page 3Fh: All Pages”

NOTE 41 - Mode page 37h is not included in page 3Fh.

NOTE 42 - Mode page 3Eh is for engineering use only and is not included in page 3Fh

- Subpage Code
- Allocation Length: The maximum number of bytes to be transferred.

  If the allocation length specified is less than the amount available, then the allocated amount is transferred and no error is reported.

Clause *6.4 on page 287* has a listing of all mode parameters.

5.2.11 Persistent Reserve In - 5Eh

The Persistent Reserve In command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 23 — Persistent Reserve In Command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Opcode: 5Eh							
1	Reserved			Service Action				
2	Reserved							
5								
6	MSB	Allocation Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Service Action:

  Value **Description**
  00h Reads all registered Reservation Keys
  01h Reads all current persistent reservations
  02h Returns capability information, (Not supported on earlier code levels).
  03h Reads complete information about all registrations and the persistent reservations, if any. (Not supported on earlier code levels).

- Allocation Length: The maximum number of bytes to be transferred.

The Persistent Reserve In parameter data for Read Keys is defined below. (Not supported on earlier code levels):

Byte	Description
0-3	Generation: Counter for Persistent Reserve Out Command requests
4-7	Additional length: A count of the number of bytes in the Reservation key list
8-15	First Reservation Key
16-n	Additional Reservation keys: a maximum of 1 reservation key per initiator is supported

The Persistent Reserve In parameter data for Read Reservations is defined below:

Byte	Description
0-3	Generation: Counter for Persistent Reserve Out Command requests
4-7	Additional length: A count of the number of bytes in the Reservation key list
8-n	Reservation descriptors: (defined below)

The Persistent Reserve In Read Reservations Descriptor is defined below:

Byte	Description
0-7	Reservation Key
8-11	Scope-specific address: 00000000h

12 Reserved
13

Bit	Description
7-4	Scope: persistent reservation applies to the entire logical unit: 0h
4-0	Type:

Value	Descriptor
3h	Exclusive Access
6h	Exclusive Access, Registrants only

14-15 Extent Length: 0000h

The Persistent Reserve In Read Capabilities Descriptor is defined below (Not available on earlier code levels):

Byte Description

0-1 Length: 0008h
2

Bit	Description
7-5	Reserved
4	Compatible Reservation Handling (CRH): 1b
3	Specify Initiator Ports Capable (SIP_C): 1b
2	All Target Ports Capable (ATP_C): 1b
1	Reserved 0Persist Through Power Loss Capable (PTPL_C): 0b

3

Bit	Description
7	Type Mask Valid (TMV): 1b
6-1	Reserved
0	Persist Through Power Loss Activated (PTPL_A): 0b

4 Persistent Reservation Type Mask (byte 1)

Bit	Description
7	Write Exclusive - All Registrants (WR_EX_AR): 0b
6	Exclusive Access - Registrants Only (EX_AC_RO): 1b
5	Write Exclusive - Registrants Only (WR_EX_RO): 0b
4	Reserved
3	Exclusive Access (EX_AC): 1b
2	Reserved
1	Write Exclusive (WR_EX): 0b
0	Reserved

5 Persistent Reservation Type Mask (byte 2)

Bit	Description
7-1	Reserved
0	Exclusive Access - Registrants Only (EX_AC_AR): 0b

6-7 Reserved

The Persistent Reserve In Read Full Status Descriptor is defined below

Byte Description

0-3 PRGeneration
4-7 Additional Length (n-7)
7-p First full status descriptor
.
.
.
q-n Last full status descriptor

The Persistent Reserve In Full Status Descriptor format is defined below:

Byte	Description
0-7	Reservation Key
8-11	Reserved
12	Persistent Reservation Type Mask (byte 2)
	Bit **Description**
	7-2 Reserved
	1 All Target Ports (All_TG_PT)
	0 Reservation Holder (R_HOLDER)
13	
	Bit **Description**
	7-4 Scope
	3-0 Type Byte Description
14-17	Reserved
18-19	Relative Target Port Identifier
20-23	Additional Descriptor Length (n-23)
24-n	TransportID

5.2.12 Persistent Reserve Out - 5Fh

The Persistent Reserve Out command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 24 — Persistent Reserve Out Command

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Opcode: 5Fh							
1	Reserved			Service Action				
2	Scope				Type			
3	Reserved							
6								
7	MSB	Parameter List Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Service Action:

Value	Description
00h	Register a reservation key with the device server
01h	Create a persistent reservation using a reservation key
02h	Release a persistent reservation
03h	Clear all reservation keys and all persistent reservations
04h	Preempt persistent reservations from another initiator
05h	Preempt persistent reservations from another Initiator and clear the task set for the preempted initiator
07h	Register And Move the registration to another I_T nexus. (Not supported on earlier code levels).

- Scope: 0h
- Type:

Value	Description
3h	Exclusive Access
6h	Exclusive Access, Registrants only

- Parameter List Length: 0018h for all Service Actions except Register and Move (07h)

  Parameter List Length: variable for Service Action Register and Move (07h)

The Persistent Reserve Out parameter list for all Service Actions except Register and Move (07h) is defined below:

Byte	Description
0-7	Reservation Key
8-15	Service Action Reservation Key
16-19	Scope-specific address: 00000000h
20	

Bit	Description
7-1	Reserved
0	APTPL: Activate Persist Through Power Loss: 0b

21	Reserved
22-23	Obsolete: 0000h

The Persistent Reserve Out parameter list for the Register and Move (07h) Service Action is defined below (Not available on earlier code levels):

Byte	Description
0-7	Reservation Key
8-15	Service Action Reservation Key
16	Reserved
17	

Bit	Description
7-2	Reserved
1	UNREG: Unregister
0	APTPL: Activate Persist Through Power Loss: 0b

18-19	Relative Target Port Identifier
20-23	Additional Descriptor Length (n-23)
24-n	TransportID

5.2.13 Prevent Allow Medium Removal - 1Eh

The Prevent Allow Medium Removal command is defined in SSC-3 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

The Prevent Allow Medium Removal command is supported only for the Prevent Cartridge Removal option. Table 25 shows the command format.

Table 25 — Prevent Allow Medium Removal Command

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (1Eh)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved						Prevent	
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Prevent:

Value	**Description**
00b	Allow Cartridge Removal
01b	Prevent Cartridge Removal prevent cartridge
10b	(unsupported)
11b	(unsupported)

The device supports Prevent Cartridge Removal by removing the Unload option from the CE service panel menu. The option is still available via the button on the front of the drive, but pressing this when prevented will not cause the cartridge to be ejected. Cartridge removal is enabled again when the initiator issues the Prevent Allow Medium Removal command with the Prevent field set to 00b (Allow Cartridge Removal). A reset (bus device reset, reset message, or power on reset) also restores the drive to the allow removal state. In the case of the bus device reset or the reset message, the reset restores the allow state only if the reset occurs on the same port that originally set Prevent.

NOTE 43 - The Prevent Allow Medium Removal command has no effect on any library commands that may be received.

5.2.14 Read - 08h

The Read command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 26 — Read CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (08h)							
1	Obsolete (LUN)			Reserved			SILI	Fixed
2	MSB	Transfer Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- SILI (Suppress Incorrect Length Indicator) (per SCSI-2 standard) (see 4.6 on page 91)
- Fixed (see 4.5 on page 90)
- Transfer Length(see 4.5 on page 90)

For more information, see *“General Read-Type Handling” on page 91*

5.2.15 Read 08h (String Search) (not J1A)

See *"MP 37h: String Search (not J1A)" on page 353*, and *"String Search Function (not J1A)" on page 122* for additional information.

Table 27 — Read - 08h (String Search) (not J1A)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation Code: (X'08')							
1	Obsolete (LUN)			Reserved			SILI	Fixed
2	MSB	Transfer Length						
4								LSB
5	Search b'1'	FMKS	Control Byte (see 5.1.3 on page 134)					

The device logical position may be changed by this command.

If no valid search criteria exists, the command presents CHECK CONDITION status with sense key 5/2C00 (Illegal Request - Command Sequence Error).

If Fixed is set to 1b it only affects the read of records after the first matching record is found. Blocks which are not the same length of the current set Block Length are fully checked for matches, but will not stop the search portion of the Read operation. The data returned includes the matching record and the sequentially following records (not necessarily matching search criteria).

The following parameters differ from the standard Read command:

- Search:

Value	**Description**
0b	this command is a standard Read command
1b	this command is a Read (String Search) command

- FMKS:

Value	**Description**
0b	filemarks stop the search operation with the logical position left after the filemark and are reported per the standard Read command.
1b	filemarks will be ignored (treated as a logical block with no data) - will not match any criteria If a matching record is found, the command will return the record data with GOOD STATUS and the device will be logically positioned after the matching record (another Read (String Search) command may be issued to read the next matching record).

If a matching record is not found before the criteria of the command is fulfilled, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/1401 (No Sense - Record Not Found).

If a matching record is not found before Search Time elapses, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/2E00 (No Sense - Insufficient Time for Operation).

Other reportable statuses for the Read command also apply in conditions where the command stops due to other issues before a matching record is found (i.e., filemark is encountered if FMKS is 0b, EOD encountered, etc.)

The method to get results depends on the active operating mode. For snoop operations, individual matches could be reported during the operation via a check condition as described above sections. Summary results (first/last record and match count) may be found by reading the Search String mode page.

Detailed results (Match List) can be read using Read Buffer ID 40h, which will present data in the format detailed in the String Search command returned data description.

5.2.16 READ ATTRIBUTE - 8Ch

The READ ATTRIBUTE command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation. The READ ATTRIBUTE command *(see table 28)* allows an application client to read attribute values from medium auxiliary memory.

Table 28 — READ ATTRIBUTE command

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (8Ch)							
1	Reserved			SERVICE ACTION				
2 – 4	Obsolete							
5	LOGICAL VOLUME NUMBER							
6	Reserved							
7	PARTITION NUMBER							
8	(MSB)	FIRST ATTRIBUTE IDENTIFIER						
9								(LSB)
10	(MSB)	ALLOCATION LENGTH						
13								(LSB)
14	Reserved							
15	Control Byte (see 5.1.3 on page 134)							

If the medium auxiliary memory is not accessible because there is no medium present, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to NOT READY, and the additional sense code set to MEDIUM NOT PRESENT.

If the medium is present but the medium auxiliary memory is not accessible, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE.

If the medium auxiliary memory is not operational, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to AUXILIARY MEMORY READ ERROR.

The following parameters apply:

- SERVICE ACTION:

Value	Description
00h	ATTRIBUTE VALUES: Return attribute values as specified in ATTRIBUTE VALUES service action (see 5.2.16.1 on page 167)
01h	ATTRIBUTE LIST: Return a list of available attribute identifiers – identifiers that are in the read only state or in the read/write state (see 4.13 on page 60) as specified in ATTRIBUTE LIST service action (see 5.2.16.2 on page 168)
02h	LOGICAL VOLUME LIST: Return a list of known logical volume numbers as defined in LOGICAL VOLUME LIST service action (see 5.2.16.3 on page 168)
03h	PARTITION LIST: Return a list of known partition numbers as defined in PARTITION LIST service action (see 5.2.16.4 on page 169)
05h	SUPPORTED ATTRIBUTES: Return a list of supported attribute identifiers – identifiers that are in the read only state, in the read/write state, or in the nonexistent state (see 4.13 on

page 60) as defined in SUPPORTED ATTRIBUTES service action (see 5.2.16.5 on page 169)

- LOGICAL VOLUME NUMBER: 00h
- PARTITION NUMBER: The partition of the attribute to be accessed.
- FIRST ATTRIBUTE IDENTIFIER: The attribute identifier of the first attribute to be returned.
- ALLOCATION LENGTH: The number of bytes allowed to be returned

5.2.16.1 ATTRIBUTE VALUES service action

The READ ATTRIBUTE command with ATTRIBUTE VALUES service action returns parameter data containing the attributes that are in the read state or read/write state (see 4.13 on page 60) specified by the PARTITION NUMBER, LOGICAL VOLUME NUMBER, and FIRST ATTRIBUTE IDENTIFIER fields in the CDB. The returned parameter data shall contain the requested attributes in ascending numerical order by attribute identifier value and in the format shown in *table 29*.

Table 29 — READ ATTRIBUTE with ATTRIBUTE VALUES service action parameter list format

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	(MSB)							
	AVAILABLE DATA (n-3)							
3								(LSB)
	Attribute(s)							
4								
	Attribute 0 (see 6.4.1 on page 295)							
	⋮							
	Attribute x (see 6.4.1 on page 295)							
n								

The following parameters apply to the READ ATTRIBUTE command with ATTRIBUTE VALUES service action parameter list:

Byte Description

0-3 The AVAILABLE DATA field shall contain the number of bytes of attribute information in the parameter list.

4-n The attribute values for the attributes being returned. Attribute format (see 6.4.1 on page 295) describes the format of the attributes.

5.2.16.2 ATTRIBUTE LIST service action

The READ ATTRIBUTE command with ATTRIBUTE LIST service action returns parameter data containing the attribute identifiers for the attributes that are in the read only state or in the read/write state (see 4.13 on page 60) in the specified partition and volume number. The contents of FIRST ATTRIBUTE IDENTIFIER field in the CDB shall be ignored. The returned parameter data shall contain the requested attribute identifiers in ascending numerical order by attribute identifier value and in the format shown in *table 30*.

Table 30 — READ ATTRIBUTE with ATTRIBUTE LIST service action parameter list format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
				AVAILABLE DATA (n-3)				
3								(LSB)
				Attribute identifiers				
4								
				ATTRIBUTE IDENTIFIER 0				
5								
				⋮				
n-1								
				ATTRIBUTE IDENTIFIER X				
n								

The following parameters apply to the READ ATTRIBUTE command with ATTRIBUTE LIST service action parameter list:

Byte	Description
0-3	The AVAILABLE DATA field shall contain the number of bytes of attribute identifiers in the parameter list.
4-n	An ATTRIBUTE IDENTIFIER field is returned for each attribute that is in the read only state or in the read/write state (see 4.13 on page 60) in the specified partition and volume number. Attribute identifier values (see 6.4.2 on page 296) provides a description of the attribute identifier values.

5.2.16.3 LOGICAL VOLUME LIST service action

The READ ATTRIBUTE command with LOGICAL VOLUME LIST service action returns parameter data *(see table 31)* identifying the supported number of logical volumes. The contents of LOGICAL VOLUME NUMBER, PARTITION NUMBER, and FIRST ATTRIBUTE IDENTIFIER fields in the CDB shall be ignored.

Table 31 — READ ATTRIBUTE with LOGICAL VOLUME LIST service action parameter list format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
				AVAILABLE DATA (0002h)				
1								(LSB)
2				FIRST LOGICAL VOLUME NUMBER				
3				NUMBER OF LOGICAL VOLUMES AVAILABLE				

The following parameters apply to the READ ATTRIBUTE command with LOGICAL VOLUME LIST service action parameter list:

Byte	Description
0-1	The AVAILABLE DATA field shall contain two.

2 The FIRST LOGICAL VOLUME NUMBER field indicates the first volume available. Logical volume numbering should start at zero.

3 The NUMBER OF LOGICAL VOLUMES AVAILABLE field indicates the number of volumes available.

5.2.16.4 PARTITION LIST service action

The READ ATTRIBUTE command with PARTITION LIST service action returns parameter data *(see table 32)* identifying the number of partitions supported in the specified logical volume number. The contents of PARTITION NUMBER and FIRST ATTRIBUTE IDENTIFIER fields in the CDB shall be ignored.

Table 32 — READ ATTRIBUTE with PARTITION LIST service action parameter list format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
1	AVAILABLE DATA (0002h)							(LSB)
2	FIRST PARTITION NUMBER							
3	NUMBER OF PARTITIONS AVAILABLE							

The following parameters apply to the READ ATTRIBUTE command with PARTITION LIST service action parameter list:

Byte Description

0-1 The AVAILABLE DATA field shall contain two.

2 The FIRST PARTITION NUMBER field indicates the first partition available on the specified logical volume number. Partition numbering starts at zero.

3 The NUMBER OF PARTITIONS AVAILABLE field indicates the number of partitions available on the specified logical volume number.

5.2.16.5 SUPPORTED ATTRIBUTES service action

The READ ATTRIBUTE command with SUPPORTED ATTRIBUTES service action returns parameter data containing the attribute identifiers for the attributes that are in the read only state, in the read/write state, or in the nonexistent state (see 4.13 on page 60) in the specified partition and volume number. The contents of FIRST ATTRIBUTE IDENTIFIER field in the CDB shall be ignored. The returned parameter data shall contain the requested attribute identifiers in ascending numerical order by attribute identifier value and in the format shown in *table 33*.

Table 33 — READ ATTRIBUTE with SUPPORTED ATTRIBUTES service action parameter list format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
3	AVAILABLE DATA (n-3)							(LSB)
	Attribute identifiers							
4	ATTRIBUTE IDENTIFIER 0							
5								
	⋮							
n-1	ATTRIBUTE IDENTIFIER X							
n								

The following parameters apply to the READ ATTRIBUTE command with SUPPORTED ATTRIBUTES service action parameter list:

Byte	Description
0-3	The AVAILABLE DATA field shall contain the number of bytes of attribute identifiers in the parameter list.
4-n	An ATTRIBUTE IDENTIFIER field is returned for each attribute that is in the read only state, in the read/write state, or in the nonexistent state (see 4.13 on page 60) in the specified partition and volume number. Attribute identifier values (see 6.4.2 on page 296) describes the attribute identifier values.

5.2.17 Read Block Limits - 05h

The Read Block LImits command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 34 — Read Block Limits CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (05h)							
1	Obsolete (LUN)			Reserved				MLOI
2 – 4	Reserved							
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- maximum logical object identifier (MLOI):

  Value Description
  - 0b The data returned is the READ BLOCK LIMITS block length data (see 5.2.17.1 on page 171).
  - 1b The data returned is the READ BLOCK LIMITS maximum logical object identifier data (see 5.2.17.2 on page 172).

5.2.17.1 READ BLOCK LIMITS block length data

The format of the data returned in the READ BLOCK LIMITS Descriptor is shown in *table 35*.

Table 35 — READ BLOCK LIMITS block length data

Byte	Bit 7	6	5	4	3	2	1	0
0	Reserved			GRANULARITY (0h)				
1 – 3	(MSB) MAXIMUM BLOCK LENGTH LIMIT (LSB)							
4 – 5	(MSB) MINIMUM BLOCK LENGTH LIMIT (LSB)							

The following parameters apply to the Read Block Limits block length data:

Byte Description

0

Bit Description
- 7-5 Reserved
- 4-0 GRANULARITY (0h)

1-3 MAXIMUM BLOCK LENGTH LIMIT: 200000h (2,097,152 bytes

4-5 MINIMUM BLOCK LENGTH LIMIT: 0001h (1 byte)

Any block length in the range of MINIMUM BLOCK LENGTH LIMIT to MAXIMUM BLOCK LENGTH LIMIT is supported.

For further explanation, see *“Data Transfer, Block Limits, and Fixed Block Option” on page 90*

5.2.17.2 READ BLOCK LIMITS maximum logical object identifier data

The READ BLOCK LIMITS maximum logical object identifier data (see *table 36*) specifies the maximum value of the logical object identifier the logical unit supports.

Table 36 — READ BLOCK LIMITS maximum logical object identifier data

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Reserved							
…								
11								
12	(MSB)	MAXIMUM LOGICAL OBJECT IDENTIFIER						
…								
19								(LSB)

The following parameters apply to the Read Block Limits maximum logical object identifier data:

Byte Description

0-11 Reserved

12-19 MAXIMUM LOGICAL OBJECT IDENTIFIER: The maximum value the device server supports in a logical object identifier field. This field is set to 0000_FFFF_FFFF_FFFFh.

5.2.18 Read Buffer - 3Ch

The Read Buffer command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 37 — Read Buffer CDB

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td colspan="8">Operation code (3C)</td></tr>
<tr><td>1</td><td colspan="3">Obsolete (LUN)</td><td colspan="2">Reserved</td><td colspan="3">Mode</td></tr>
<tr><td>2</td><td colspan="8">Buffer ID</td></tr>
<tr><td>3</td><td>MSB</td><td colspan="6" rowspan="2">Buffer Offset</td><td></td></tr>
<tr><td>5</td><td></td><td>LSB</td></tr>
<tr><td>6</td><td>MSB</td><td colspan="6" rowspan="2">Allocation Length</td><td></td></tr>
<tr><td>8</td><td></td><td>LSB</td></tr>
<tr><td>9</td><td colspan="8">Control Byte (see 5.1.3 on page 134)</td></tr>
</table>

The following parameters apply:

- Mode:

Value	Description
1h	Vendor Specific mode (returns data contained in the buffer specified by Buffer ID)
2h	Data mode (returns data contained in the buffer specified by Buffer ID, same as 1h)
3h	Descriptor mode (returns the offset boundary and buffer size in bytes, for the buffer specified in Buffer ID)

- Buffer ID: The supported buffers are described in *table 38*.
- Buffer Offset: In mode 1h and 2h, this is the starting address in the buffer to be read. For mode 3h, this field must be 000000h.

  NOTE 44 - If the Buffer Offset is not on the boundary specified in *table 38*, the device returns CHECK CONDITION status with associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

- Allocation Length: The maximum number of bytes to be transferred starting at the offset specified in Buffer Offset.

  The device transfers the number of bytes specified in the Allocation Length field or the number of bytes in the header or buffer being read, whichever is less. This is not an error. The host may use mode 3h to query the amount of data in the specified buffer prior to reading such data with mode 1h or 2h.

Each buffer image has its own unique format, describing where certain key data may be found. Certain buffers contain embedded data in the buffer image describing the length of the total buffer image, and a CRC field that checks the total buffer image. Uploading the microcode buffer is one such example.

5.2.18.1 Supported Buffers

Table 38 lists the supported buffers and their IDs:

Table 38 — Supported Buffer IDs

ID[1]	R/W	Buffer Description	Offset Boundary
00h	R	Dump Data - Microcode Dump	4
00h,01h[1]	W	Microcode	4
01h	R	Microcode	5
09h	R	Dump Data - Tapemap	4
0Ah	R/W	Test Buffer	4
20h	R	Cartridge Memory	4
30h	W	Microcode (do not reset)	4
40h	R	String Search Match List[3]	4
50h	R	Active IP addresses	TBD
81h	R	Dump Data - Tapemap (same as 09h)	4

Legend
R Read Only
W Write Only
R/W Read/Write
\- Not Applicable
NS Not Supported
1 For Write Buffer, If Mode is 4, 5, 6 or 7 then the Buffer ID is ignored and the command is treated as a Buffer ID 01h - Microcode.
2 For this buffer, the Buffer Offset must be 000000h.
3 Depending on the search methodology, the size of the search buffer results may be returned as a constant and may be larger than the amount of data actually returned. The structure of the returned data contains sufficient descriptive lengths for proper parsing and is defined in *5.2.35 on page 219*.
4

5.2.18.2 Buffer ID 50h: Active IP addresses

The Active IP addresses buffer returns a list of IP addresses that have successfully completed negotiation on the Ethernet link and are active. This list does not contain IP addresses that the drive attempts but cannot use due to conflicts or other errors. The format of the Data field of the active IP addresses buffer depends on the value in byte 0. If byte 0 contains a non-zero value, then the format is defined in *Active IP addresses fixed buffer (see 5.2.18.2.1 on page 174)*. If byte 0 contains a zero value, then the format is defined in the *Active IP addresses variable buffer (see 5.2.18.2.2 on page 176)*.

5.2.18.2.1 Active IP addresses fixed buffer

The format of the Data field of the active IP addresses fixed buffer is described in *table 39*

.

Table 39 — Active IP addresses fixed buffer format

Byte	Bit 7	6	5	4	3	2	1	0
0	NUMBER OF ETHERNET PORTS							
List of Ethernet port descriptors								
1	Ethernet port fixed descriptor [first]							
x								
⋮								
y	Ethernet port fixed descriptor [last]							
n								

The following parameters apply:

Byte **Description**

0 NUMBER OF ETHERNET PORTS - The number of physical Ethernet ports functioning in the drive.

1-n List of Ethernet port descriptors. There will be one Ethernet port descriptor *(see table 40)* for each physical Ethernet port functioning in the drive. The size of each descriptor may vary from Ethernet port to Ethernet port.

The Ethernet port descriptor format is defined in *table 40*

Table 40 — Ethernet port fixed descriptor format

Byte	Bit 7	6	5	4	3	2	1	0
0	SIZE OF SOCKADDR (m-1)							
1	NUMBER OF SOCKADDR STRUCTURES							
List of sockaddr structures (see 6.4.21.3.1.1)								
2	sockaddr [first]							
m								
⋮								
n-m	sockaddr [last]							
n								

The following parameters apply:

Byte **Description**

0 SIZE OF SACKADDR - The size of each sockaddr. All sockaddr's are the same size

1 number of sockaddr - The number of sockaddr structures returned.

2-n List of sockaddr structures. Each sockaddr structure describes one active IP address. The sockaddr structure is defined in clause 6.4.21.3.1.1.

5.2.18.2.2 Active IP addresses variable buffer

The format of the Data field of the active IP addresses buffer is described in *table 39*

.

Table 41 — Active IP addresses variable buffer format

Byte	Bit 7	6	5	4	3	2	1	0
0	Reserved							
1								
2	ACTIVE IP ADDRESSES BUFFER LENGTH (n-3)							
3								
4	Reserved							
6								
7	NUMBER OF ETHERNET PORTS							
List of Ethernet port descriptors								
1	Ethernet port variable descriptor [first]							
⋮								
	Ethernet port variable descriptor [last]							
n								

The following parameters apply:

Byte Description

0 NUMBER OF ETHERNET PORTS - The number of physical Ethernet ports functioning in the drive.

1-n List of Ethernet port descriptors. There will be one Ethernet port descriptor *(see table 42)* for each physical Ethernet port functioning in the drive. The size of each descriptor may vary from Ethernet port to Ethernet port.

The Ethernet port variable descriptor format is defined in *table 42*

Table 42 — Ethernet port variable descriptor format

Byte	Bit 7	6	5	4	3	2	1	0
0	DESCRIPTOR LENGTH (m-1)							
1								
2	PORT IDENTIFIER							
3								
4	Reserved							
6								
7	NUMBER OF SOCKADDR STRUCTURES							
List of Ethernet socket address descriptors 6.4.21.3.1.1								
8	Ethernet socket address descriptor [first]							
⋮								
	Ethernet socket address descriptor [last]							
m								

The following parameters apply:

Byte Description

0 SIZE OF SACKADDR - The size of each sockaddr. All sockaddr's are the same size

1 number of sockaddr - The number of sockaddr structures returned.

2-n List of Ethernet socket address descriptors. Each Ethernet socket address descriptor describes one active IP address and has the RELATIVE SOCKET ADDRESS IDENTIFIER field set to zero. The Ethernet socket address descriptor is defined in 6.4.21.3.1.1.

5.2.19 READ POSITION - 34h

5.2.19.1 READ POSITION command description

The Read Position command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The READ POSITION command (see *table 43*) reports the current position and provides information about logical objects contained in the object buffer. No medium movement shall occur as a result of responding to the command.

Table 43 — READ POSITION command

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (34h)							
1	Reserved			SERVICE ACTION				
2 – 6	Reserved							
7	(MSB)	ALLOCATION LENGTH						
8	ALLOCATION LENGTH							(LSB)
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- SERVICE ACTION:

  Value **Description**

  00h SHORT FORM-- BLOCK ID: Device server shall return 20 bytes of data with the FIRST LOGICAL OBJECT LOCATION and LAST LOGICAL OBJECT LOCATION fields as logical object identifier values, relative to a partition (see 5.2.19.2 on page 178). The ALLOCATION LENGTH field shall be zero.

  WARNING

  The SHORT FORM -- BLOCK ID may become obsolete in future standards.

  WARNING

  06h LONG FORM: Device server shall return 32 bytes of data (see 5.2.19.3 on page 181). The ALLOCATION LENGTH field shall be zero.

  08h EXTENDED FORM: Device server shall return 32 bytes of data up to the maximum length specified by the ALLOCATION LENGTH field (see 5.2.19.4 on page 182).

  others The command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

- ALLOCATION LENGTH: Length of the data to return. Shall be set to 0000h if the SERVICE ACTION field is set to 00h or 06h.

5.2.19.2 READ POSITION data format, short form

Table 44 specifies the READ POSITION data that shall be returned if the SERVICE ACTION field is 00h.

The short form is included for legacy applications. It is highly recommended that the LONG FORM (06h) (see 5.2.19.3 on page 181) or the EXTENDED FORM (08h) (see 5.2.19.4 on page 182) be used instead.

WARNING

The short form breaks when there are greater than 2^{32} logical objects on medium and may become obsolete in future standards.

WARNING

Table 44 — READ POSITION data format, short form

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Position information/validity							
	BOP	EOP	LOCU	BYCU	Rsvd	LOLU	PERR	BPEW
1	PARTITION NUMBER							
2	Reserved							
3	Reserved							
4	(MSB)	FIRST LOGICAL OBJECT LOCATION						
7								(LSB)
8	(MSB)	LAST LOGICAL OBJECT LOCATION						
11								(LSB)
12	Reserved							
13	(MSB)	NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER						
15								(LSB)
16	(MSB)	NUMBER OF BYTES IN OBJECT BUFFER						
19								(LSB)

Byte Description

0 Position Information/Validity:

Bit Description

7 BOP (beginning of partition):

Value	Description
0b	the current logical position is not at the beginning of partition.
1b	the device is at the beginning of the current partition.

6 EOP (end of partition)

Value	Description
0b	the device is not between early warning and end of partition.
1b	the device is positioned between early warning and end of the current partition.

5 LOCU (logical object count unknown)

Value	Description
0b	block count is exact
1b	block count is an estimate

4 BYCU (byte count unknown)

Value	Description
0b	byte count is exact
1b	byte count is an estimate

3 Reserved

2 LOLU (logical object location unknown)

Value	Description
0b	block position is exact
1b	block position is an estimate

1 PERR (position error):

Value Description

0b	An overflow has not occurred in any of the returned position data fields.
1b	An overflow has occurred in at least one of the returned position data fields. The application should use the LONG FORM (06h) (see 5.2.19.3 on page 181) to obtain the current position or the application should use the EXTENDED FORM (08h) (see 5.2.19.4 on page 182) to obtain the current position and number of bytes in the object buffer.

0 BPEW (beyond programmable early warning)

Value	Description
0b	The LOLU bit is set to one, the PEWS field of the MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
1b	The logical object location is in a PEWZ or on the EOP side of EW.

1 PARTITION NUMBER:

Reports the partition number for the current logical position. When the volume has only one partition, this field is set to 00h.

2-3 Reserved

4-7 FIRST LOGICAL OBJECT LOCATION:

Specifies the logical object address associated with the current logical position, in the range 0000 0000h to FFFF FFFFh. The value indicates the logical object address of the next data block or filemark to be transferred between the initiator and the target if a READ or WRITE command is issued.

8-11 LAST LOGICAL OBJECT LOCATION:

After a write command, this field specifies the logical object address associated with the next logical object to be transferred from the buffer to the medium, in the range 0000 0000h to FFFF FFFFh. After a read command, this field specifies the logical object address associated with the last (most recent) data block or filemark to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value reported for the LAST LOGICAL OBJECT LOCATION is equal to the value reported for the FIRST LOGICAL OBJECT LOCATION.

12 Reserved

13-15 NUMBER OF LOGICAL OBJECTS IN THE OBJECT BUFFER:

The number of data blocks and filemarks in the buffer that have not been written to the medium. (This value is zero if the device is reading rather than writing.)

16-19 NUMBER OF BYTES IN THE OBJECT BUFFER: The total number of write data bytes (before compaction) in the buffer that have not been written to the medium.

5.2.19.3 READ POSITION data format, long form

Table 45 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 06h.

Table 45 — READ POSITION data format, long form

Byte	7 msb	6	5	4	3	2	1	0 lsb
0	Position information/validity							
	BOP	EOP	Reserved		MPU	LONU	Rsvd	BPEW
1 – 3	Reserved							
4 – 7	(MSB) PARTITION NUMBER (LSB)							
8 – 15	(MSB) LOGICAL OBJECT NUMBER (LSB)							
16 – 23	(MSB) LOGICAL FILE IDENTIFIER (LSB)							
24 – 31	(MSB) Obsolete (LSB)							

Byte Description

0 Position Information/Validity:

Bit	Description
7	BOP (beginning of partition):
	Value **Description**
	0b the current logical position is not at the beginning of partition.
	1b the device is at the beginning of the current partition.
6	EOP (end of partition)
	Value **Description**
	0b the device is not between early warning and end of partition.
	1b the device is positioned between early warning and end of the current partition.
5-4	Reserved
3	MPU (mark position unknown)
	Value **Description**
	0b the LOGICAL FILE IDENTIFIER field contains valid position information.
	1b the logical file identifier is not known or accurate reporting is not currently available.
2	LONU (logical object number unknown)
	Value **Description**
	0b the LOGICAL OBJECT NUMBER and PARTITION NUMBER fields contain exact information.
	1b The logical object number is an estimate.
1	Rsvd (Reserved)
0	BPEW (beyond programmable early warning)
	Value **Description**
	0b The LOLU bit is set to one, the PEWS field in the MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
	1b The logical object location is in a PEWZ or on the EOP side of EW.

1-3 Reserved
4-7 PARTITION NUMBER: The partition number for the current logical position.
8-15 LOGICAL OBJECT NUMBER: The number of logical objects between beginning-of-partition and the current logical position. A filemark counts as one logical object.
16-23 LOGICAL FILE NUMBER: The number of filemarks between beginning-of-partition and the current logical position. This value is the current logical file identifier.
24-31 Obsolete.

5.2.19.4 READ POSITION data format, extended form

Table 46 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 08h.

Table 46 — READ POSITION data format, extended form

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Position information/validity							
	BOP	EOP	LOCU	BYCU	Rsvd	LOLU	PERR	BPEW
1	PARTITION NUMBER							
2	(MSB)	ADDITIONAL LENGTH (1Ch)						
3								(LSB)
4	Reserved							
5	(MSB)	NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER						
7								(LSB)
8	(MSB)	FIRST LOGICAL OBJECT LOCATION						
15								(LSB)
16	(MSB)	LAST LOGICAL OBJECT LOCATION						
23								(LSB)
24	(MSB)	NUMBER OF BYTES IN OBJECT BUFFER						
31								(LSB)

The fields are defined the same as for the corresponding fields in the READ POSITION data format, short form (see *table 44*).

The ADDITIONAL LENGTH field shall contain 1Ch. If the information transferred to the Data-In Buffer is truncated because of an insufficient ALLOCATION LENGTH value, the ADDITIONAL LENGTH field shall not be altered to reflect the truncation.

Byte Description

0 Position Information/Validity:

Bit Description

7 BOP (beginning of partition):

Value	Description
0b	the current logical position is not at the beginning of partition.
1b	the device is at the beginning of the current partition.

6 EOP (end of partition)

Value	Description
0b	the device is not between early warning and end of partition.
1b	the device is positioned between early warning and end of the current partition.

5 LOCU (logical object count unknown)

Value	Description
0b	block count is exact
1b	block count is an estimate

4 BYCU (byte count unknown)

Value	Description
0b	byte count is exact
1b	byte count is an estimate

3 Reserved

2 LOLU (logical object location unknown)

Value	Description
0b	block position is exact
1b	block position is an estimate

1 PERR (position error):

Value	Description
0b	An overflow has not occurred in any of the returned position data fields.
1b	An overflow has occurred in at least one of the returned position data fields.

0 BPEW (beyond programmable early warning)

Value	Description
0b	The LOLU bit is set to one, the PEWS field in MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
1b	The logical object location is in a PEWZ or on the EOP side of EW.

1 PARTITION NUMBER:

Reports the partition number for the current logical position. When the volume has only one partition, this field is set to 00h.

2-3 ADDITIONAL LENGTH: 1Ch

4 Reserved

5-7 NUMBER OF LOGICAL OBJECTS IN THE OBJECT BUFFER:

The number of data blocks and filemarks in the buffer that have not been written to the medium. (This value is zero if the device is reading rather than writing.)

8-15 FIRST LOGICAL OBJECT LOCATION:

Specifies the logical object address associated with the current logical position, in the range 0000 0000h to FFFF FFFFh. The value indicates the logical object address of the next data block or filemark to be transferred between the initiator and the target if a READ or WRITE command is issued.

16-23 LAST LOGICAL OBJECT LOCATION:

After a write command, this field specifies the logical object address associated with the next logical object to be transferred from the buffer to the medium, in the range 0000 0000h to FFFF FFFFh. After a read command, this field specifies the logical object address associated with the last (most recent) data block or filemark to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value reported for the LAST LOGICAL OBJECT LOCATION is equal to the value reported for the FIRST LOGICAL OBJECT LOCATION.

24-31 NUMBER OF BYTES IN THE OBJECT BUFFER: The total number of write data bytes (before compaction) in the buffer that have not been written to the medium.

5.2.20 Read Reverse - 0Fh

The Read Reverse command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 47 — Read Reverse CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (0Fh)							
1	Obsolete (LUN)			Reserved		Byte Order	SILI	Fixed
2	MSB	Transfer Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Byte Order field: 1b

  This field defines the order in which bytes are transferred to the initiator.

  Byte Order to the initiator is in the logical forward direction (first byte written is transferred to the initiator before the last byte written).

NOTE 45 - The Byte Order field is Vendor-Unique and not specified in any standards document. In those documents this bit is Reserved and is a 0b. The current product does not support reversed byte order and the bit is required to be set to 1b. An attempt to set this bit to 0b results in a check condition with associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB). Nevertheless, as specified in the standard, the ending position of the medium is before the last block transferred.

- SILI (Suppress Incorrect Length Indicator) (per SCSI-2 standard) (see 4.6 on page 91)
- Fixed (see 4.5 on page 90)
- Transfer Length(see 4.5 on page 90)

For more information, see *“General Read-Type Handling” on page 91*

5.2.21 Receive Diagnostic Results - 1Ch

The Receive Diagnostic Results command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

After a Send Diagnostic command completes, use the Receive Diagnostic Results command to receive the results.

As allowed by the SCSI standards, devices may implement Send Diagnostic and handle status and return information for diagnostics in somewhat different manners. To work correctly with all common variations, the following sequence should be used by the host.

The Send Diagnostic command is issued. If a CHECK CONDITION status occurs, and a non-deferred permanent error results, then the test failed (or was not started if sense key=ILLEGAL REQUEST). If GOOD status is returned, then a Receive Diagnostics Results command should be issued, and:

a) the “blocked” and “error” bit should be checked (byte 8, bits 2 and 0 respectively), and if either is set, the diagnostic was either not run or failed; and
b) if byte 8 bit 1 is set, the SIM/MIM data in the results is valid and contains additional information relating to the failure

NOTE 46 - This process is required by this device to determine diagnostics results for those diagnostics which indicate diagnostics results data is returned. GOOD status returned from the Send Diagnostic only indicates that the diagnostic was accepted but does not indicate the ultimate result of its execution.

NOTE 47 - For diagnostics that produce diagnostic results, the device should be reserved using the Reserve or Persistent Reserve Out command to protect the results from actions of other initiators.

Table 48 shows the command format.

Table 48 — Receive Diagnostic Results CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (1Ch)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3	MSB	Allocation Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Allocation Length is the maximum number of bytes to be returned in the page of data following the command (if any).

Clause *6.1* has a listing of all diagnostic parameters.

5.2.22 Recover Buffered Data - 14h

The Recover Buffered Data command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 49 — Recover Buffered Data CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (14)							
1	Obsolete (LUN)			Reserved			SILI	Fixed
2	MSB	Transfer Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- SILI (Suppress Incorrect Length Indicator) (per SCSI-2 standard) (see 4.6 on page 91)
- Fixed (see 4.5 on page 90)
- Transfer Length(see 4.5 on page 90)

For more information, see *“Data Transfer, Block Limits, and Fixed Block Option” on page 90*.

NOTE 48 - When no permanent write error condition has occurred, this command performs a synchronize and attempts to write all buffered data to media. No data will be returned.

NOTE 49 - Having begun to recover data through the use of the Recover Buffer Data command, the initiator should not change the RBO (Recover Buffer Order) field in mode page 10h, until all the data in the buffer is read or until the device has received and successfully executed a Locate command, a Load Unload command, or a Rewind command. If the initiator attempts to change the RBO field while the device still has data in the buffers, the device rejects the command with associated sense data of with 5/2602 (Illegal Request, Parameter Value Invalid).

5.2.23 Release Unit - 17h

The Release Unit command is defined in SPC-2 (see http://www.t10.org/cgi-bin/ac.pl?t=f&f=spc2r20.pdf). This clause specifies the specific implementation.

Table 50 — Release Unit CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (17)							
1	Obsolete (LUN)			3rdPty	Third Party Device ID			Reserved
2	Reserved							
4								
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- 3rdPty (Third Party): 0b
- Third Party Device ID: 000b

5.2.24 Report Density Support - 44h

The Report Density Support command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 51 — Report Density Support CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (44)							
1	Reserved							Media
2	Reserved							
6								
7	MSB	Allocation Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Media:

Value	Description
0b	report all supported densities for all supported medium types
1b	report all supported densities for the current medium in the drive. If the device is not ready, the drive will return 2/0400 (Not Ready, Not Ready Cause Not Reportable).

- Allocation Length is the maximum number of bytes to be transferred.

5.2.24.1 Report Density Support data format

5.2.24.1.1 Density descriptor overview

Density descriptors contain information that may be returned by the drive. While the information is reported in a manner useful to applications, SSC-4 specifies fields that have been found to not be useful by applications in selecting which density to use. Instead applications have been found to ignore the Bits Per MM field and the Tracks field. The device does not change the values returned in these fields by the format type media type combinations and instead returns the largest value for the set of supported format type media type combinations. The Capacity field is used by applications and does report values based on the format type - media type combinations. The Density code fields, the Assigning Organization field, the Density Name field, and the Description field are constant per density and are correctly reported.

The device may return different combinations of the descriptors in the Report Density Support data depending on drive generation, medium loaded, setting of the media bit, and settings of various mode parameters related to densities.

The Report Density Support data format is shown in *table 52*.

Table 52 — REPORT DENSITY SUPPORT data format

Byte	Bit 7	6	5	4	3	2	1	0
0	(MSB)	AVAILABLE DENSITY SUPPORT LENGTH						
1								(LSB)
2	Reserved							
3	Reserved							
	Density support data block descriptors							
4	Density support data block descriptor [first]							
	⋮							
	Density support data block descriptor [last]							
n								

The Density support data block descriptor format is shown in *table 53*.

Table 53 — Density support data block descriptor format

Byte	Bit 7	6	5	4	3	2	1	0
0	PRIMARY DENSITY CODE							
1	SECONDARY DENSITY CODE							
2	WRTOK	DUP	DEFLT	Reserved				DLV
3	(MSB)	DESCRIPTOR LENGTH						
4								(LSB)
5	(MSB)	BITS PER MM						
7								(LSB)
8	(MSB)	MEDIA WIDTH						
9								(LSB)
10	(MSB)	TRACKS						
11								(LSB)
12	(MSB)	CAPACITY						
15								(LSB)
16	ASSIGNING ORGANIZATION							
23								
24	DENSITY NAME							
31								
32	DESCRIPTION							
51								

5.2.24.1.2 Density information

The density information is shown in *table 54*.

Table 54 — Density information

Field	PRIMARY DENSITY CODE			
	51h [1]	52h [2]	53h [3]	54h [4]
PRIMARY DENSITY CODE	51h	52h	53h	54h
SECONDARY DENSITY CODE	51h (cleartext) 71h (encrypted)	52h (cleartext) 72h (encrypted)	53h (cleartext) 73h (encrypted)	54h (cleartext@LBA0) 74h (encrypted@LBA0)
WRTOK	0b The device cannot write this format 1b The device can write this format			
DUP	0	0	0	0
DEFLT	0b This density is not currently selected for use on a write from BOP 1b This density is currently selected for use on a write from BOP			
DLV	0	0	0	0
DESCRIPTOR LENGTH	0000h	0000h	0000h	0000h
BITS PER MM	002E18h	002E18h	00348Ch	004CE6h
MEDIA WIDTH (mm)	000Dh	000Dh	000Dh	000Dh
TRACKS	0200h	0380h	0480h	0A00h
CAPACITY (10^6)	0004_93E0h [0,JA/JW] 0000_EA60h [JJ/JR]	000A_AE60h [0,JB/JX] 0007_A120h [JA/JW] 0001_86A0h [JJ/JR]	000F_4240h [0,JB/JX] 0009_C400h [JA/JW] 0001_F400h [JJ/JR]	003D_0900h [0,JC/JY] 0007_A120h [JK] 0018_6A00h [JB/JX]
ASSIGNING ORGANIZATION (ASCII)	‘IBM ‘	‘IBM ‘	‘IBM ‘	‘IBM ‘
DENSITY NAME (ASCII)	‘3592A1 ‘	‘3592A2 ‘	‘3592A3 ‘	‘3592A4 ‘
DESCRIPTION (ASCII)	‘ ‘ (20 ASCII spaces)	‘ ‘ (20 ASCII spaces)	‘ ‘ (20 ASCII spaces)	‘ ‘ (20 ASCII spaces)

[0] Value when MEDIA = 0b
[1] Density descriptor (51h/71h) may be returned on device models J1A, E05, and E06
[2] Density descriptor (52h/72h) may be returned on device models E05, E06 and E07
[3] Density descriptor (53h/73h) may be returned on device models E06 and E07
[4] Density descriptor (54h/74h) may be returned on device models E07
[JA/JW] Value when MEDIA =1b and Standard Cartridge (JA) or Standard WORM Cartridge (JW) is loaded
[JJ/JR] Value when MEDIA =1b and Economy Cartridge (JJ) or Economy WORM Cartridge (JR) is loaded
[JB/JX] Value when MEDIA =1b and Extended Cartridge (JB) or Extended WORM Cartridge (JX) is loaded
[JC/JY] Value when MEDIA =1b and Advanced Cartridge (JC) or Advanced WORM Cartridge (JY) is loaded
[JK] Value when MEDIA =1b and Advanced Economy Cartridge (JK) is loaded

5.2.25 Report LUNs - A0h

The Report LUNs command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 55 — Report LUNs CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation Code (A0h)							
1	Reserved							
5								
6	MSB	Allocation Length						
9								LSB
10	Reserved							
11	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Allocation Length is the maximum number of bytes to be transferred.

5.2.25.1 Report LUNs data format

Byte	Description
0-3	LUN List Length: **Value** **Description** 00000008h LUN 1 does not exist; bytes 16-23 are not returned 00000010h LUN 1 exists; bytes 16-23 are returned.
4-7	Reserved
8-15	LUN 0: 0000000000000000h
16-23	LUN 1: 0001000000000000h (returned only if LUN 1 exists)

5.2.26 Request Sense - 03h

The Request Sense command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 56 — Request Sense CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (03h)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3								
4	Allocation Length							
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Allocation Length: The maximum number of bytes to be transferred.

  This device generates up to 96 bytes of sense data. If the allocation length specified is less than the generated sense data length, then the allocated amount is transferred, the remaining sense data is lost, and no error is reported. If the allocated length specified is greater, then the entire sense data is transferred and no error is reported.

  In read ILI conditions only 18 bytes of sense data may be generated. While processing sense data, the host should use byte 7 to determine the amount of sense data generated to insure that only valid transferred fields are examined.

NOTE 50 - Since this device uses autosense, 96 bytes of unsolicited sense will always be generated using this command. Autosense may generate and return either 18 or 96 bytes.

5.2.26.1 Sense Data Format

Byte **Description**

0

Bit **Description**

7 Valid

Value	**Description**
0b	information bytes 3-6 are not valid
1b	information bytes 3-6 are valid

6-0 Response Code

Value	**Description**
70h	current (non-deferred)
71h	deferred

1 Segment Number: 00h

2

Bit **Description**

7 Filemark (see *Table 42, "Information and ILI Behavior Summary," on page 93*)

Value	Description
0b	the current command has not encountered a filemark
1b	the current command has encountered a filemark. This device does not report Setmarks, per Mode Page 10h, byte 8, bit 5.

6 EOM (End-Of-Medium):

Value	Description
0b	indicates that the device is not at the end of medium.
1b	indicates that the device is at the end of medium.

5 ILI (Incorrect Length Indicator): see *Table 42, "Information and ILI Behavior Summary," on page 93*. ILI residual counts are in the Information field.

4 Reserved

3-0 Sense Key (see Annex B. on page 395)

3-6 Information: The content of this field varies depending on the failing command and error. This field is only valid when the Valid bit (byte 0, bit 7) is set to 1. This field is generally only valid for non-deferred errors. See *Table 42, "Information and ILI Behavior Summary," on page 93*

7 Additional Sense Length (n-7): 0Ah or 58h

This device returns 96 bytes of sense data (a value of 58h in the Additional Sense Length field). The first 18 bytes are standard.

Only the first 18 bytes of sense data may be returned (a value of 0Ah in the Additional Sense Length field) in association with ILI conditions for read-type commands.

8-11 Command-Specific Information: 0000 0000h

The 3592 drive does not support the commands associated with this field.

12 Additional Sense Code (ASC) (see Annex B. on page 395)

13 Additional Sense Code Qualifier (ASCQ) (see Annex B. on page 395)

14 Field Replaceable Unit Code (FRU)

This field indicates a possible component or area which is related to the error or failure. Since this device is a single FRU product, this does not necessarily mean a replaceable component has been identified. Instead, this is used for extended fault isolation information.

15-17 Sense Key Specific

When the SKSV bit is 1b (often set when sense key is Illegal Request), bytes 15-17 are interpreted as follows:

Byte **Description**

15 Sense Key Specific

Bit **Description**

7 SKSV (Sense Key Specific Valid): 1b

6 C/D (Control/Data):

Value	**Description**
0b	specifies that the error is in a data field of the parameter list.
1b	specifies that the error is in a CDB field.

5-4 Reserved

3 BPV (Bit Pointer Valid):

Value	**Description**
0b	specifies that the Bit Pointer Field is not valid.
1b	specifies that the Bit Pointer Field is valid.

2-0 Bit Pointer field

When BPV is set to 1b, this field points to the bit in error of the field specified by the Field Pointer.

16-17 Field Pointer

Points to the CDB byte or parameter byte in error.

When the SKSV bit is 0b, bytes 15-17 are interpreted as follows:

Byte **Description**

15 Vendor-Unique Indicators

Bit **Description**

7 SKSV (Sense Key Specific Valid): 0b

6-3 Tape Position Indicators

Value	**Description**
0h	BOP (Beginning of Partition)
1h	Data between BOP and LEOP-EW
2h	LEOP-EW (Logical End of Partition - Early Warning)
3h	Data between LEOP-EW and LEOP
4h	LEOP (Logical End of Partition)

2 Vendor-Reserved

1 Permanent Error

Value	**Description**
0b	Indicates that the error was recovered
1b	Indicates that the error is permanent

0 SIM/MIM Flag

Value	**Description**
0b	Indicates that a SIM/MIM is not available
1b	Indicates that a SIM/MIM is available in Log Page 31

16-17 First Error Code

18

Bit	Description
7	Vendor-Reserved (Record Sense Request)
6	Sequential Medium Loader Active 0b This device does not support sequential loaders.
5	Microcode Dump Available

Value	Description
0b	Indicates there is no microcode dump currently available.
1b	Indicates a microcode dump is available. The microcode dump may be retrieved with the Read Buffer command, and can be used by IBM Service personnel to analyze the state of the device.

NOTE 51 - The dump is lost at the next power off.

4 Tape Directory Invalid

Value	Description
0b	Indicates the Tape Directory is valid
1b	Indicates the Tape Directory is invalid

NOTE 52 - The Tape Directory Invalid field may not be valid if the drive is not ready or when the sense data is associated with a CHECK CONDITION status (contingent allegiance or autosense condition). The Request Sense command should be used to return unsolicited sense to insure the field is valid. An invalid Tape Directory will be automatically rebuilt using a performance optimized method during any space or locate operation. There is no need to fully read the media for directory rebuilding.

3 Vendor-Reserved (Media Test Mode)
2 EOD is in Performance Segment
1 Current location is in Performance Segment
0 Port Reporting Sense

Value	Description
0b	Indicates this sense reported on port 0
1b	Indicates this sense reported on port 1

19 Vendor-Reserved (Drive Identifier)
20 Vendor-Reserved (ACF Status - unsupported)
21 Vendor-Reserved (RAC)
22 Vendor-Reserved (BRAC)
23

Bit	Description
7-4	Medium Access Field

Value	Description
0h	Position unknown (during power-on initialization or unusual conditions)
1h	Load error (cartridge loaded, but drive not ready)
2h	Unload error (error occurred while attempting to unload)
3h	Path error (only rewind or unload commands allowed)
4h	Cartridge unloaded or removed
5h	Cartridge is currently loading
6h	Cartridge is currently unloading
9h	Cartridge is loaded

NOTE 53 - Other values are possible, but undefined.

3-0 Medium Association State

Value	Description
0h	Medium Unassociated
1h	Medium Associated (loaded and Ready)

24 Medium Descriptor flags

Bit **Description**

7 Initialization Required

Value	**Description**
0b	Medium is initialized.
1b	The medium requires initialization. The device cannot detect initialization on the volume at BOT.

6 Housekeeping Integrity Check

Value	**Description**
0b	No error.
1b	An error condition was detected

5 Partitioned

Value	**Description**
0b	The volume does not have multiple partitions.
1b	The volume has multiple partitions.

4 Partitioning Integrity

Value	**Description**
0b	No Error.
1b	An error condition is detected in the partition definition of the volume.

3 Medium Check

Value	**Description**
0b	No error.
1b	A medium check was detected for the medium, and the medium cannot be processed by the device.

2 Incompatible Format

Value	**Description**
0b	Format is recognized.
1b	The device does not recognize the format of the medium.

1 PWP (Physical Write Protect)

Value	**Description**
0b	The volume Physical Write Protect switch is off.
1b	The volume Physical Write Protect switch is on.

0 Logical Write Protect

Value	**Description**
0b	The volume is not logically write protected.
1b	The volume is logically write protected.

25 Vendor-Reserved (LPOS Region)

26-29 Vendor-Reserved (Error Summary)

30 Failing Command

Request under execution at time of error

31-32 First Error Code Flag Data

Optional encoded flag data for bytes 16-17

33-34 Second Error Code

Second error code encountered

35-36 Second Error Code Flag Data

Optional encoded flag data that relates to the second error code

37-38 Next-to-Last Error Code

Next-to-last error code encountered

39-40 Next-to-Last Error Code Flag Data

Optional encoded flag data that relates to the next-to-last error code

41-42 Last Error Code

Last error code encountered

43-44 Last Error Code Flag Data

Optional encoded flag data that relates to the last error code

45 Vendor-Reserved (Load Status)

46-49 Logical Block Number

The next block that would be accessed in the forward direction

50-52 Dataset Number

The number of the current physical dataset. Valid values are from 000000h to FFFFFFh

53 Physical Wrap Number

Physical wrap number relates to actual location on media and may change in a non-incrementing fashion due to segment mapping or other drive features

54 Partition Information

Bit	Description
7-4	PARTITIONING TYPE - The type of partitioning currently in use on the volume (see 6.4.12 on page 308)
3-0	Reserved

55 ACTIVE PARTITION - The partition number of the current logical position.

56-59 Relative LPOS

Longitudinal position relative to beginning of user data (LP3)

60 Logical Wrap Number

Logical wrap number operates in a consistently increasing manner in normal use

61 Last Speed Index

The last used speed index

62 SARS Drive Relative Quality

Overall SARS Relative Quality determination of the drive where 00h is unknown, and otherwise ranges from best 01h to worst FFh.

63 SARS Media Relative Quality

Overall SARS Relative Quality determination of the currently mounted media where 00h is unknown, and otherwise ranges from best 01h to worst FFh.

64 Vendor-Reserved (Library Address)

65-69 Vendor-Reserved (Recovery Summary)

70 Cleaning Required Indicator (Static) (see<<“Drive Cleaning Indicators” on page 271)>>)

Bit	Value
7	1b: Cleaning Required - Normal Maintenance
6	1b: Cleaning Required - Threshold Reached
5-0	Vendor-Reserved

71 Vendor-Reserved (Library Error Code)

72-78 Microcode EC Number (in ASCII)

79 Vendor-Reserved (Library Drive Status)

80 Volume Label Flags

Bit **Description**

7 Volume Label Fields Valid

Value	Description
0b	Indicates sense bytes 81-88 are not valid.
1b	Indicates sense bytes 81-88 are valid for the media that is loaded.

6 Volume Label Source External

Value	Description
0b	Indicates the source of sense bytes 81-88 is block 0 of the media.
1b	Indicates the source of sense bytes 81-88 is the cartridge bar code label.

5 Volume Label is EBCDIC

Value	Description
0b	Indicates Volume Label is in ASCII
1b	Indicates Volume Label is in EBCDIC

4-0 Reserved

81 Volume Label Cartridge Type (character 2)

Value (in ASCII)	**Description**
'A'	3592 Enterprise Tape — Standard Cartridge (JA)
'B'	3592 Enterprise Tape — Extended Cartridge (JB)
‘C’	3592 Enterprise Tape — Advanced Cartridge (JC)
'J'	3592 Enterprise Tape — Economy Cartridge (JJ)
‘K’	3592 Enterprise Tape — Advanced Economy Cartridge (JK)
'R'	3592 Enterprise Tape — Economy WORM Cartridge (JR)
'W'	3592 Enterprise Tape — Standard WORM Cartridge (JW)
'X'	3592 Enterprise Tape — Extended WORM Cartridge (JX)
‘Y’	3592 Enterprise Tape — Advanced WORM Cartridge (JY)

82 Volume Label Cartridge Type (character 1)

Value (in ASCII)	**Description**
'J'	3592 Enterprise Tape Cartridge

83-88 Volume Label (in ASCII or EBCDIC, depending on the source)

89-95 Vendor-Reserved (Error Summary)

5.2.27 REPORT SUPPORTED OPERATION CODES - A3h (beginning with E07)

5.2.27.1 REPORT SUPPORTED OPERATION CODES command introduction

Device models 3592 E07 and later support the REPORT SUPPORTED OPERATION CODES command. The REPORT SUPPORTED OPERATION CODES command *(see table 57)* requests information on commands the addressed logical unit supports. An application client may request a list of all operation codes and service actions supported by the logical unit or the command support data for a specific command.

The REPORT SUPPORTED OPERATION CODES command is a service action of the MAINTENANCE IN command.

Table 57 — REPORT SUPPORTED OPERATION CODES command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A3h)							
1	Reserved			SERVICE ACTION (0Ch)				
2	RCTD	Reserved				REPORTING OPTIONS		
3	REQUESTED OPERATION CODE							
4	(MSB)	REQUESTED SERVICE ACTION						
5								(LSB)
6	(MSB)	ALLOCATION LENGTH						
9								(LSB)
10	Reserved							
11	CONTROL							

A return command timeouts descriptor (RCTD) bit set to one specifies that the command timeouts descriptor (see 5.2.27.4 on page 204) shall be included in each command descriptor (see 5.2.27.2 on page 202) that is returned or in the one_command parameter data (see 5.2.27.3 on page 203) that is returned. A RCTD bit set to zero specifies that the command timeouts descriptor shall not be included in any parameter data returned.

The REPORTING OPTIONS field *(see table 58)* specifies the information to be returned in the parameter data.

Table 58 — REPORT SUPPORTED OPERATION CODES REPORTING OPTIONS field

Code	Description	Parameter Data Reference
000b	A list of all operation codes and service actions supported by the logical unit shall be returned in the all_commands parameter data format. The REQUESTED OPERATION CODE CDB field and REQUESTED SERVICE ACTION CDB field shall be ignored.	5.2.27.2
001b	The command support data for the operation code specified in the REQUESTED OPERATION CODE field shall be returned in the one_command parameter data format. The REQUESTED SERVICE ACTION CDB field shall be ignored. If the REQUESTED OPERATION CODE field specifies an operation code that has service actions, then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.	5.2.27.3
010b	The command support data for the operation code and service action specified in the REQUESTED OPERATION CODE CDB field and REQUESTED SERVICE ACTION CDB field shall be returned in the one_command parameter data format. If the REQUESTED OPERATION CODE CDB field specifies an operation code that does not have service actions, then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.	5.2.27.3
011b to 111b	Reserved	

The REQUESTED OPERATION CODE field specifies the operation code of the command to be returned in the one_command parameter data format (see 5.2.27.3 on page 203).

The REQUESTED SERVICE ACTION field specifies the service action of the command to be returned in the one_command parameter data format.

The ALLOCATION LENGTH field specifies the maximum number of bytes or blocks that an application client has allocated in the Data-In Buffer.

5.2.27.2 All_commands parameter data format

The REPORT SUPPORTED OPERATION CODES all_commands parameter data format *(see table 59)* begins with a four-byte header that contains the length in bytes of the parameter data followed by a list of supported commands. Each command descriptor contains information about a single supported command CDB (i.e., one operation code and service action combination, or one non-service-action operation code). The list of command descriptors shall contain all commands supported by the logical unit.

Table 59 — All_commands parameter data

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			COMMAND DATA LENGTH (n-3)				
3								(LSB)
				Command descriptors				
4				Command descriptor 0 *(see table 60)*				
				⋮				
n				Command descriptor x *(see table 60)*				

The COMMAND DATA LENGTH field indicates the length in bytes of the command descriptor list.

Each command descriptor *(see table 60)* contains information about a single supported command CDB.

Table 60 — Command descriptor format

Bit / Byte	7	6	5	4	3	2	1	0
0				OPERATION CODE				
1				Reserved				
2	(MSB)			SERVICE ACTION				
3								(LSB)
4				Reserved				
5				Reserved			CTDP	SERVACTV
6	(MSB)			CDB LENGTH				
7								(LSB)
8 - 19				Command timeouts descriptor, if any (see 5.2.27.4 on page 204)				

The OPERATION CODE field contains the operation code of a command supported by the logical unit.

The SERVICE ACTION field contains a supported service action of the supported operation code indicated by the OPERATION CODE field. If the operation code indicated in the OPERATION CODE field does not have a service actions, the SERVICE ACTION field shall be set to 00h.

A command timeouts descriptor present (CTDP) bit set to one indicates that the command timeouts descriptor (see 5.2.27.4 on page 204) is included in this command descriptor. A CTDP bit set to zero indicates that the command timeouts descriptor is not included in this command descriptor.

A service action valid (SERVACTV) bit set to zero indicates the operation code indicated by the OPERATION CODE field does not have service actions and the SERVICE ACTION field contents are reserved. A SERVACTV bit set to one indicates the operation code indicated by the OPERATION CODE field has service actions and the contents of the SERVICE ACTION field are valid.

The CDB LENGTH field contains the length of the command CDB in bytes for the operation code indicated in the OPERATION CODE field, and if the SERVACTV bit is set to the service action indicated by the SERVICE ACTION field.

If the RCTD bit is set to one in the REPORT SUPPORTED OPERATION CODES CDB (see 5.2.27.1 on page 200), the command timeouts descriptor (see *table 63* in 5.2.27.4) shall be included. If the RCTD bit is set to zero, the command timeouts descriptor shall not be included.

5.2.27.3 One_command parameter data format

The REPORT SUPPORTED OPERATION CODES one_command parameter data format *(see table 61)* contains information about the CDB and a usage map for bits in the CDB for the command specified by the REPORTING OPTIONS, REQUESTED OPERATION CODE, and REQUESTED SERVICE ACTION fields in the REPORT SUPPORTED OPERATION CODES CDB.

Table 61 — One_command parameter data

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	CTDP	Reserved				SUPPORT		
2	(MSB)	CDB SIZE (n-3)						
3								(LSB)
4	CDB USAGE DATA							
n								
n+1	Command timeouts descriptor, if any (see 5.2.27.4 on page 204)							
n+12								

A command timeouts descriptor present (CTDP) bit set to one indicates that the command timeouts descriptor (see 5.2.27.4 on page 204) is included in the parameter data. A CTDP bit set to zero indicates that the command timeouts descriptor is not included in the parameter data.

The SUPPORT field is defined in *table 62*.

Table 62 — SUPPORT values

Support	Description
000b	Data about the requested SCSI command is not currently available. All data after byte 1 is not valid. A subsequent request for command support data may be successful.
001b	The device server does not support the requested command. All data after byte 1 is undefined.
010b	Reserved
011b	The device server supports the requested command in conformance with a SCSI standard. The parameter data format conforms to the definition in *table 61*.
100b	Reserved
101b	The device server supports the requested command in a vendor specific manner. The parameter data format conforms to the definition in *table 61*.
110b to 111b	Reserved

The CDB SIZE field contains the size of the CDB USAGE DATA field in the parameter data, and the number of bytes in the CDB for command being queried (i.e., the command specified by the REPORTING OPTIONS, REQUESTED OPERATION CODE, and REQUESTED SERVICE ACTION fields in the REPORT SUPPORTED OPERATION CODES CDB).

The CDB USAGE DATA field contains information about the CDB for the command being queried. The first byte of the CDB USAGE DATA field shall contain the operation code for the command being queried. If the command being queried contains a service action, then that service action code shall be placed in the CDB USAGE DATA field in the same location as the SERVICE ACTION field of the command CDB. All other bytes of the CDB USAGE DATA field shall contain a usage map for bits in the CDB for the command being queried.

The bits in the usage map shall have a one-for-one correspondence to the CDB for the command being queried. If the device server evaluates a bit in the CDB for the command being queried, the usage map shall contain a one in the corresponding bit position. If any bit representing part of a field is returned as one, all bits for the field shall be returned as one. If the device server ignores or treats as reserved a bit in the CDB for the command being queried, the usage map shall contain a zero in the corresponding bit position. The usage map bits for a given CDB field all shall have the same value.

For example, the CDB usage bit map for the REPORT SUPPORTED OPERATION CODES command is: A3h, 0Ch, 87h, FFh, FFh, FFh, FFh, FFh, FFh, FFh, 00h, 07h. This example assumes that the logical unit only supports the low-order three bits of the CDB CONTROL byte. The first byte contains the operation code, and the second byte contains three reserved bits and the service action. The remaining bytes contain the usage map.

If the RCTD bit is set to one in the REPORT SUPPORTED OPERATION CODES CDB (see 5.2.27.1 on page 200), the command timeouts descriptor (see *table 63* in 5.2.27.4) shall be included. If the RCTD bit is set to zero, the command timeouts descriptor shall not be included.

5.2.27.4 Command timeouts descriptor

5.2.27.4.1 Overview

The command timeouts descriptor *(see table 63)* returns timeout information for commands supported by the logical unit based on the time from the start of processing for the command to its reported completion.

Values returned in the command timeouts descriptor do not include times that are outside the control of the device server (e.g., prior commands with the IMMED bit set to one in the CDB, concurrent commands from the same or different I_T nexuses, manual unloads, power-on self tests, prior aborted commands, commands that force cache synchronization, delays in the service delivery subsystem).

For commands that cause a change in power condition, values returned in the command timeouts descriptor do not include the power condition transition time (e.g., the time to thread the media).

Values returned in the command timeouts descriptor should not be used to compare products.

Table 63 — Command timeouts descriptor format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)	DESCRIPTOR LENGTH (0Ah)						
1								(LSB)
2	Reserved							
3	COMMAND SPECIFIC							
4	(MSB)	NOMINAL COMMAND PROCESSING TIMEOUT						
7								(LSB)
8	(MSB)	RECOMMENDED COMMAND TIMEOUT						
11								(LSB)

The DESCRIPTOR LENGTH field indicates the number of bytes that follow in the command timeouts descriptor.

The COMMAND SPECIFIC field contains timeout information *(see table 64)* that is specific to one or more commands

Table 64 — Command timeouts descriptor COMMAND SPECIFIC field usage in this standard

Command	Reference
WRITE BUFFER	5.2.27.4.2

A non-zero value in the NOMINAL COMMAND PROCESSING TIMEOUT field indicates the minimum amount of time in seconds the application client should wait prior to querying for the progress of the command identified by the parameter data that contains this command timeouts descriptor. A value of zero in the NOMINAL COMMAND PROCESSING TIMEOUT field indicates that no timeout is indicated.

NOTE 54 - The value contained in the NOMINAL COMMAND PROCESSING TIMEOUT field may include time required for typical device error recovery procedures expected to occur on a regular basis.

A non-zero value in the RECOMMENDED COMMAND TIMEOUT field specifies the recommended time in seconds the application client should wait prior to timing out the command identified by the parameter data that contains this command timeouts descriptor. A value of zero in the RECOMMENDED COMMAND TIMEOUT field indicates that no time is indicated.

The device server should set the recommended command timeout to a value greater than or equal to the nominal command processing timeout.

Application clients should use the Report Supported Operation Codes command to discover command timoeut values. Table 65 lists the command timeout values at the time this document was published for the commands supported at the time the document was published. These values may have changed since publication.

Table 65 — 3592 command timeout values (at publication) (part 1 of 2)

OpCode [Service Action]	Command Name	Host time-out (seconds)	
		Nom	Rec
00h	TEST UNIT READY	1	30
01h	REWIND	80	480
03h	REQUEST SENSE	1	30
04h	FORMAT MEDIUM	420	1 500
05h	READ BLOCK LIMITS	1	30
08h	READ	300	1 080
0Ah	WRITE	300	1 080
0Fh	READ REVERSE	300	1 080
10h	WRITE FILEMARKS	300	1 080
11h	SPACE(6)	380	840
12h	INQUIRY	1	30
13h	VERIFY	18 000	21 600
14h	RECOVER BUFFERED DATA	30	60
15h	MODE SELECT(6)	300	900
16h	RESERVE UNIT (6)	300	900
17h	RELEASE UNIT (6)	30	30
19h	ERASE	18 000	21 600
1Ah	MODE SENSE(6)	1	30
1Bh	LOAD/UNLOAD	400	720
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	30
1Dh	SEND DIAGNOSTIC	2 100	2 100
1Eh	PREVENT ALLOW MEDIUM REMOVAL	1	30
2Bh	LOCATE	380	840
34h	READ POSITION	1	30
3Bh	WRITE BUFFER	60	480
3Ch	READ BUFFER	60	300
40h	CHANGE DEFINITION	1	30

Table 65 — 3592 command timeout values (at publication) (part 2 of 2)

OpCode [Service Action]	Command Name	Host time-out (seconds)	
		Nom	Rec
44h	REPORT DENSITY SUPPORT	1	30
4Ch	LOG SELECT	1	30
4Dh	LOG SENSE	1	30
55h	MODE SELECT(10)	300	900
56h	RESERVE UNIT (10)	300	900
57h	RELEASE UNIT (10)	30	30
5Ah	MODE SENSE(10)	1	30
5Eh	PERSISTENT RESERVE IN	1	30
5Fh	PERSISTENT RESERVE OUT	300	900
82h	ALLOW OVERWRITE	1	30
8Ch	READ ATTRIBUTE	60	60
8Dh	WRITE ATTRIBUTE	60	60
91h	SPACE(16)	380	840
92h	LOCATE (16)	380	840
A0h	REPORT LUNS	1	30
A2h	SECURITY PROTOCOL IN (SPIN)	300	300
A3h[0Ch]	REPORT SUPPORTED OPERATION CODE	1	30
A3h[0Fh]	REPORT TIMESTAMP	1	30
A4h[0Fh]	SET TIMESTAMP	1	30
B5h	SECURITY PROTOCOL OUT (SPOUT)	300	300
C0h	DISPLAY MESSAGE	1	30
E3h	STRING SEARCH	380	1 080+

5.2.27.4.2 WRITE BUFFER command timeouts descriptor COMMAND SPECIFIC field usage

For the WRITE BUFFER command, the COMMAND SPECIFIC field usage is reserved for all modes except the following:

a) Download microcode mode (04h);
b) Download microcode and save mode (05h);
c) Download microcode with offsets mode (06h);
d) Download microcode with offsets and save mode (07h);
e) Download microcode with offsets and defer activation mode (0Eh) only if the microcode is activated by an event other than an activate deferred microcode mode; and
f) Activate deferred microcode mode (0Fh).

If the command timeouts descriptor describes one of the WRITE BUFFER modes listed in this subclause, then the COMMAND SPECIFIC field indicates the maximum time, in one second increments, that access to the SCSI device is limited or not possible through any SCSI ports associated with a logical unit that processes a WRITE BUFFER command that specifies one of the named modes. A value of zero in the COMMAND SPECIFIC field indicates that the no maximum time is indicated.

5.2.28 Reserve Unit - 16h

The Reserve Unit command is defined in SPC-2 (see http://www.t10.org/cgi-bin/ac.pl?t=f&f=spc2r20.pdf). This clause specifies the specific implementation.

Table 66 — Reserve Unit CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (16h)							
1	Obsolete (LUN)			3rdPty	Third Party Device ID			Reserved
2	Reserved							
4								
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- 3rdPty (Third Party): 0b
- Third Party Device ID: 000b

NOTE 55 - Reserves are honored across initiator as well as port boundaries. For additional information, see “Multiple Port Behavior” on page 263.

5.2.29 Rewind - 01h

The Rewind command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 67 — Rewind CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (01h)							
1	Obsolete (LUN)			Reserved				Immed
2	Reserved							
4								
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Immed (Immediate):

Value	**Description**
0b	present status when command is completed.
1b	present status when all buffered data is successfully written to the media.

5.2.30 Security Protocol In (SPIN) A2h

The Security Protocol In command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

The SECURITY PROTOCOL IN command (see *table 68*) is:

1) supported in encryption capable drives that are configured for AME-T10 mode (see 4.15.2 on page 120); and
2) is used to retrieve security protocol information (see 5.2.31 on page 212) or the results of one or more SECURITY PROTOCOL OUT commands (see 5.2.31 on page 212).

Table 68 — Security Protocol In - A2h CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (A2h)							
1	Security Protocol							
2	Security Protocol Specific							
3								
4	INC_512 (0b)	Reserved						
5	Reserved							
6	(MSB)	Allocation Length						
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Security Protocol

Table 69 — Security Protocol Definitions

Code	Description	Reference
00h	Security protocol information	see *6.5.1*
20h	Tape Data Encryption	see *6.5.2*
all others	Reserved	

- Security Protocol Specific - The contents depend on the protocol specified by the Security Protocol field (see *table 69*).
- Allocation Length

Clause *6.5* has a listing of all security protocol parameters.

5.2.31 Security Protocol Out (SPOUT) B5h

The Security Protocol Out command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

The SECURITY PROTOCOL OUT command (see Table 70) is:

1) supported in encryption capable drives that are configured for AME-T10 mode (see 4.15.2 on page 120); and
2) used to send data to the logical unit. The data sent specifies one or more operations to be performed by the logical unit. The format and function of the operations depends on the contents of the SECURITY PROTOCOL field (see table 178). Depending on the protocol specified by the SECURITY PROTOCOL field, the application client may use the SECURITY PROTOCOL IN command (see 5.2.30 on page 211) to retrieve data derived from these operations.

NOTE 56 - The operation code, B5h has been recovered from a seldom used media changer (i.e. LUN 1) command (Request Volume Element Address). If the device driver being used still uses the LUN field of the CDB from SCSI-2 days, this command will be routed to the incorrect LUN. Because it is a DATA OUT type command, whereas the Request Volume Element Address is a DATA IN type command this can cause strange system behaviors.

Table 70 — Security Protocol Out B5h CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (B5h)							
1	Security Protocol							
2	Security Protocol Specific							
3								
4	INC_512 (0b)	Reserved						
5	Reserved							
6	(MSB) Allocation Length							
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Security Protocol

  Value **Description**

  20h Tape Data Encryption security protocol
- Security Protocol Specific - The contents depend on the protocol specified by the Security Protocol field.
- Allocation Length

Clause *6.5* has a listing of all security protocol parameters.

5.2.32 Send Diagnostic - 1Dh

The Send Diagnostic command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

After a Send Diagnostic command completes, use the Receive Diagnostic Results command to receive the results.

For diagnostics that produce diagnostic results, the LUN should be reserved to allow the I_T nexus that issued the Send Diagnostic command to issue the Receive Diagnostic Results command before a different I_T nexus clears the results by reading them.

Table 71 — Send Diagnostic CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (1Dh)							
1	Obsolete (LUN)			PF	Reserved	SelfTest	DevOfl	UnitOfl
2	Reserved							
3	MSB	Parameter List Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- PF (Page Format): 1b
- SelfTest:

Value	Description
0b	Perform the diagnostic operation specified in the parameter list.
1b	Perform self test. See *6.1.3* for details of this diagnostic.

NOTE 57 - When Self Test is requested, no other diagnostic may be simultaneously requested.

- DevOfL (Device Off Line):

Value	Description
0b	is supported and prohibits any diagnostic operations that may be detected by subsequent I/O processes.
1b	is supported and grants permission to the target to perform diagnostic operations that may affect all the logical units on a target; that is, alteration of reservations, log parameters, or sense data.
x	in the diagnostic description indicates that either 0b or 1b may be used with identical effects.

NOTE 58 - DevOfl and UnitOfl are set by the system. These bits grant permission to the target to perform vendor-specific diagnostic operations on the target that may be visible to attached initiators. Thus, by preventing operations that are not enabled by these bits, the target assists the operating system in protecting its resources.

- UnitOfL (Unit Off Line):

Value	Description
0b	is supported and prohibits any diagnostic operations that may be detected by subsequent I/O processes.
1b	is supported and grants permission to the target to perform diagnostic operations that may affect the user medium on the logical unit; for example, write operations to the

user-accessible medium, or operations that reposition the medium on sequential access devices.

x — in the diagnostic description indicates that either 0b or 1b may be used with identical effects.

- Parameter List Length: This field specifies the length in bytes of the parameter list that is transferred from the initiator to the target. A parameter list length value of zero specifies that no data is transferred. This condition is not considered an error. If the specified parameter list length results in truncation of one or more pages (PF bit set to 1b), the target returns CHECK CONDITION status with associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

Clause *6.1* has a listing of all diagnostic parameters.

5.2.33 Space (6/16) - 11h/91h

The Space commands are defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

The Space command is implemented similar to the Locate command, causing the tape to move at maximum speed when appropriate.

Table 72 — Space (6) CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (11h)							
1	Obsolete (LUN)			Reserved		Code		
2	MSB	Count						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The Space(16) command *(see table 73)*, operates identically to the Space(6) command, but allows specifying a Count field up to eight bytes in length. The Space (16) command is not supported on J1A devices. Following completion of a Space(16) command a Read Position command should be issued to obtain positioning information.

This command is newly added to the standards. The only exceptions to SSC-3 for this command are that the explicit command set is not supported and the list of values supported in the Code field.

Table 73 — Space(16) command (not J1A)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation Code (91h)							
1	Reserved				Code			
2	Reserved							
3								
4	(MSB)	Count						
11								(LSB)
12	(MSB)	Parameter Length (0000h)						
13								
14	Reserved							
15	Control							

The following parameters apply:

- Code

Value	Description
000b	Blocks
001b	Filemarks
010b	Sequential Filemarks
011b	End of Data

- Count

  When spacing over blocks or filemarks, the count field specifies the number of blocks or filemarks to be spaced over in the current partition. A positive value N in the count field causes forward positioning (toward End of Partition) over N blocks or filemarks ending on the End of Partition side of the last block or filemark. A zero value in the count field causes no change of logical position. A negative value -N (two's complement notation) in the count field causes reverse positioning (toward Beginning Of Partition) over N blocks or filemarks ending on the Beginning of Partition side of the last block or filemark.

- Parameter Length

  If the Parameter Length field is set to any value other than zero, the command is terminated with a Check Condition status. The sense key is set to Illegal Request and the additional sense code is set to Invalid Field In CDB (5/2400h).

If the drive encounters End-of-Data (EOD) while processing this command, the command is terminated at the EOD position and CHECK CONDITION status is returned with associated sense data of 8/0005 (Blank Check, End-of-Data Detected).

5.2.34 Space (6/16) - 11h/91h (String Search) (not J1A)

"MP 37h: String Search (not J1A)" on page 353, and *"String Search Function (not J1A)" on page 122* for additional information.

Table 74 — Space (6) command (String Search)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation Code: 11h							
1	Obsolete (LUN)			Reserved (00b)		Code		
2	MSB	Count						
4								LSB
5	Search 1b	FMKS	Control Byte (see 5.1.3 on page 134)					

The Space (16) (String Search) command allows specifying a Count field up to eight bytes in length. Following completion of a Space(16) command, a Read Position command should be issued to obtain positioning information.

Table 75 — Space (16) command (String Search)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation Code (91h)							
1	Reserved				Code			
2	Reserved							
3								
4	(MSB)	Count						
11								(LSB)
12	(MSB)	Parameter Length (0000h)						
13								
14	Reserved							
15	Search 1b	FMKS	Control Byte (see 5.1.3 on page 134)					

NOTE 59 - The device logical position may be changed by this command.

NOTE 60 - Reverse direction Space (String Search) operations run very slowly and are not recommended.

NOTE 61 - If no valid search criteria exists, the command presents CHECK CONDITION status with sense key 5/2C00 (Illegal Request - Command Sequence Error).

The following parameters differ from the standard Space command:

- Search:

Value	Description
0b	this command is a standard Space command
1b	this command is a Space -String Search command

- FMKS:

Value	Description
0b	filemarks will be handled as per the standard Space command.
1b	filemarks will be ignored (treated as a logical block with no data - will not match any criteria) (only meaningful when Code field is 000b)

- Parameter Length

  This field shall be set to 0. If the Parameter Length field is set to any other value, the command is terminated with a Check Condition status. The sense key is set to Illegal Request and the additional sense code is set to Invalid Field In CDB (5/2400h).

If a matching record is found, the command will return GOOD STATUS and the device will be logically positioned before the matching record (a Read command may be issued to read the matching record).

If a matching record is not found before the criteria of the Space command is fulfilled, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/1401 (No Sense - Record Not Found).

If a matching record is not found before Search Time elapses, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/2E00 (No Sense - Insufficient Time for Operation).

Other reportable statuses for the space command also apply in conditions where the Space stops due to other issues before a matching record is found (i.e., filemark is encountered on space blocks, BOP or EOD encountered, etc.).

5.2.35 String Search - E3h (not J1A)

Snoop searches are performed during normal command processing, according to search parameters as setup in the String Search Mode Page (Search Control)

Explicit searches are performed using the new vendor unique command.

Table 76 — String Search - E3h

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td colspan="8">Operation Code: E3h</td></tr>
<tr><td>1</td><td colspan="3">Obsolete (LUN)</td><td colspan="2">Reserved</td><td>SMKS</td><td>FMKS</td><td>Immed</td></tr>
<tr><td>2</td><td>MSB</td><td colspan="6" rowspan="2">Search Count</td><td></td></tr>
<tr><td>4</td><td></td><td>LSB</td></tr>
<tr><td>5</td><td>MSB</td><td colspan="6" rowspan="2">Match Count</td><td></td></tr>
<tr><td>6</td><td></td><td>LSB</td></tr>
<tr><td>7</td><td>MSB</td><td colspan="6" rowspan="2">Allocation Length</td><td></td></tr>
<tr><td>8</td><td></td><td>LSB</td></tr>
<tr><td>9</td><td colspan="8">Control Byte (see 5.1.3 on page 134)</td></tr>
</table>

NOTE 62 - The device logical position may be changed by this command.

NOTE 63 - If no valid search criteria exists, the command presents CHECK CONDITION status with sense key 5/2C00 (Illegal Request - Command Sequence Error).

The following parameters apply:

- Immed (Immediate) (not supported):

Value	**Description**
0b	present status when command is completed
1b	present status when command is started, results must be acquired through Mode Sense or Read Buffer

- FMKS:

0b	stop when a filemark is encountered
1b	filemarks will be ignored (treated as a logical block with no data - will not match any criteria)

- Search Count: The maximum number of records to search. If this field is set to 000000h, then all records from the current location to EOD are searched (limited to Match Count and Search Time).
- Match Count: The maximum number of matches to gather in the Match List.

Value	**Description**
0000h	If Match Count is set to 0000h, then the search will stop on the next record (within Search Count) which matches the search criteria. If a matching record is found, the command will return GOOD STATUS and the device will be logically positioned before the matching record (a Read command may be issued to read the matching record). If a matching record is not found before the criteria of the Search command is fulfilled, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/1401 (No Sense - Record Not Found). If a matching record is not found before Search Time elapses, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/2E00 (No Sense - Insufficient Time for Operation). Other reportable statuses for the space command also

apply in conditions where the Space stops due to other issues before a matching record is found (i.e., filemark is encountered with FMKS set to 0b, EOD encountered, etc.).

other — If Match Count is non-zero, the search will stop once the Match List is full or Search Time elapses. The device will be logically positioned after the last record processed.
If a matching record is not found before Search Time elapses, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/2E00 (No Sense - Insufficient Time for Operation).
Other reportable statuses for the space command also apply in conditions where the operation stops due to other issues before a matching record is found (i.e., filemark is encountered with FMKS set to 0b, EOD encountered, etc.).

- Allocation Length: The length of the record found list, if zero, the search is performed but no results are returned. Use Mode Sense (String Search page) for summary results, or Read Buffer for full results.

The Search String method will return results via the return data. Results will also remain in Read Buffer ID 40h.

5.2.35.1 String Search Results Buffer (Match List)

Byte	Description
0	Page Code: 40h
1	Control Field
2-3	Page Length
5-63	Same as bytes 5-63 as defined by *"MP 37h: String Search (not J1A)" on page 353*
64-123	Vendor Reserved
124	Match List Entry Type
125	Match List Entry Length: size in bytes of each element 00h, 004h, 008h, or 10h
126-127	Match List Length: size of the results which follow
128-n	Match List: entries for matching block(s) in format determined by Match List Entry Type as specified below

The Match List entry for Match List Entry Type of 01h is defined below:

Byte	Description
0-3	Matching logical block number

The Match List entry for Match List Entry Type of 02h is defined below:

Byte	Description
0-3	Matching logical block number
4-7	Matching file number

The Match List entry for Match List Entry Type of 03h is defined below:

Byte	Description
0-7	Matching logical block number

The Match List entry for Match List Entry Type of 04h is defined below:

Byte	Description
0-7	Matching logical block number
8-15	Matching file number

5.2.36 Test Unit Ready - 00h

The Test Unit Ready command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 77 — Test Unit Ready CDB

Byte	**Bit**							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (00h)							
1	Obsolete (LUN)			Reserved				
2	Reserved							EDCC
3	Reserved							
4								
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- EDCC (Enable Deferred CHECK CONDITION):

Value	**Description**
0b	Deferred CHECK CONDITION status is not to be reported for this command.
1b	Deferred CHECK CONDITION status may be reported for this command.

NOTE 64 - This is a vendor unique field and behavior which is different than the SPC standards.

5.2.37 VERIFY(6) - 13h

The VERIFY command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation. The VERIFY(6) command *(see table 78)* requests that the device server verify one or more logical block(s) or one or more logical file(s) beginning at the current logical position. Prior to performing the verify operation, the device server performs a synchronize operation (see 4.2.11).

Table 78 — VERIFY (6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (13h)							
1	Reserved		VTE	VLBPM	VBF	IMMED	BYTCMP	FIXED
2	(MSB)	VERIFICATION LENGTH						
4								(LSB)
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- VTE - If the verify to end-of-data (VTE) bit is set to one, then all logical blocks shall be verified between the current position and EOD (see 4.4.9 on page 88). The behavior related to encrypted logical blocks is the same as if they are read with a READ command. The logical position upon successful completion of a verify with the VTE bit set to one shall be at EOD. If the VTE bit is set to one and the verification of a logical block fails, then the command shall terminate with CHECK CONDITION status, the SENSE VALID bit shall be set to zero, the INFORMATION field shall be set to zero, and the sense key, sense code, and additional sense code shall be set the same as it would be on a read. Upon termination, the medium shall be positioned after the logical block on which the verification failed (i.e., end-of-partition side). If the VTE bit is set to one, then the BYTCMP bit and the VBF bit shall be set to zero. If the VTE bit is set to one, then the VERIFICATION LENGTH field shall be ignored. If the VTE bit is set to one and the FIXED bit is set to one, then the length of each logical block shall be verified to be the current block length reported in the mode parameters block descriptor. If the VTE bit is set to one and the FIXED bit is set to zero, then the length of each logical block shall not be verified. If the VTE bit is set to zero, then a verify to EOD is not requested.
- VLBPM - If the verify logical block protection method (VLBPM) bit is set to one then the verification being performed also includes a verification that each logical block uses the logical block protection method specified in the Control Data Protection mode page. If the VLBPM bit is set to one and the verification fails because a logical block did not use the logical block protection method specified by the Control Data Protection mode page, then the device server terminates the command with CHECK CONDITION status, with the sense key set to MISCOMPARE and the additional sense code set to LOGICAL BLOCK PROTECTION METHOD ERROR. Upon termination, the medium is positioned after the logical block on which the verification failed (end-of-partition side). If the VLBPM bit is set to zero then the verification being performed does not require a verification that each logical block uses the logical block protection method specified in the Control Data Protection mode page. If a logical block is encrypted, then the behavior is the same as attempting to read an ecnrypted logical block with the READ command.
- VBF - If the verify by filemarks (VBF) bit is set to one, then the VERIFICATION LENGTH field contains a count of filemarks to be traversed. All logical blocks starting at the current position and continuing to the n^{th} filemark, where n is the value in the VERIFICATION LENGTH field shall be verified (see 4.4.8 on page 88). The behavior related to encrypted logical blocks is the same as it is for a READ command. The logical position upon successful completion of a verify with the VBF bit set to one shall be after the n^{th} filemark. If the VBF bit is set to one and the verification of a logical block fails, then the command shall terminate with CHECK CONDITION status, the SENSE VALID bit shall be set to one, the INFORMATION field shall be set to the requested verification length minus the actual number of filemarks successfully traversed, and the sense key, sense code, and additional sense code values shall be the same as for a READ ocmmand. Upon termination, the medium shall be positioned after the logical block on which the verification failed (end-of-par-

tition side). If the VBF bit is set to one, then the BYTCMP bit and the VTE bit shall be set to zero. If the VBF bit is set to one and the FIXED bit is set to one, then the length of each logical block shall be verified to be the current block length reported in the mode parameters block descriptor. If the VBF bit is set to one and the FIXED bit is set to zero, then the length of each logical block shall not be verified. If the VBF bit is set to zero, then the VERIFICATION LENGTH field does not contain a count of filemarks to be traversed.

- IMMED: 0b

Value	Description
0b	The command does not return status until the verify operation has completed.
1b	Status is returned as soon as the command descriptor block has been validated.

- BYTCMP: 0b

  The verification is a verification of logical blocks on the medium (e.g., CRC, ECC). No data is transferred from the application client to the device server.

- FIXED (see 4.4 on page 31)
- VERIFICATION LENGTH (see 4.4 on page 31): The amount of data to verify in, logical files, logical blocks or bytes, as specified by the VBF bit and the FIXED bit. If the VTE bit is one, then the VERIFICATION LENGTH field shall be ignored. If the VERIFICATION LENGTH field is zero and the VTE bit is zero, then no data is verified and the current logical position is not changed. This condition is not considered an error.

The VERIFY(6) command terminates as follows:

a) when conditions related to encryption are met;
b) when the verification length has been satisfied and the VTE bit is zero;
c) when an incorrect-length logical block is encountered;
d) when a filemark is encountered and the VBF bit and VTE bit are zero;
e) when end-of-data is encountered;
f) when the end-of-partition is encountered;
g) when early-warning is encountered (if the REW bit is one in the Device Configuration mode page) and the VTE bit is zero;
h) when the logical block protection method used by the logical block is not the logical block protection method specified in the Control Data Protection mode page and the VLBPM bit is one; or
i) when an unrecoverable read error is encountered.

General Read-Type Handling (see 4.5.1 on page 33) provides additional information.

5.2.38 Write - 0Ah

The Write command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 79 — Write CDB

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (0Ah)							
1	Obsolete (LUN)			Reserved				Fixed
2	MSB	Transfer Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Fixed (see 4.5 on page 90)
- Transfer Length(see 4.5 on page 90)

5.2.39 WRITE ATTRIBUTE - 8Dh

The WRITE ATTRIBUTE command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The WRITE ATTRIBUTE command *(see table 80)* allows an application client to write attributes to medium auxiliary memory. The READ ATTRIBUTE command (see 5.2.13) is used to read these attribute. Application clients should issue READ ATTRIBUTE commands prior to using this command to discover device server support for medium auxiliary memory.

Table 80 — WRITE ATTRIBUTE CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Dh)							
1	Reserved							WTC
2 – 4	Reserved							
5	VOLUME NUMBER (00h)							
6	Reserved							
7	PARTITION NUMBER							
8 – 9	Reserved							
10 – 13	(MSB) PARAMETER LIST LENGTH (LSB)							
14	Reserved							
15	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

Byte Description

0 OPERATION CODE (8Dh)

1 Byte 1

Bit Description

7-1 Reserved

0 WTC - Write-through cache

Value	Description
0b	The attributes in the parameter list may be cached.
1b	The attributes in the parameter list shall be synchronized with the medium auxiliary memory during the processing of the WRITE ATTRIBUTE command and GOOD status shall not be returned until the attributes have been synchronized with the medium auxiliary memory.

2-4 Reserved

5 VOLUME NUMBER (00h)

6 Reserved

7 PARTITION NUMBER - The number of the partition to which these attributes belong. This shall be zero if there is only one partition on the volume. The number of partitions of the medium auxiliary memory equals that of the attached medium.

8-9 Reserved

10-13 PARAMETER LIST LENGTH - The length in bytes of the parameter list contained in the Data-Out Buffer. A parameter list length of zero specifies that no parameter data is present; this shall not be considered an error. If the parameter list length results in the truncation of an attribute, the WRITE ATTRIBUTE command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to PARAMETER LIST LENGTH ERROR.

14 Reserved

15 CONTROL (see 5.1.3 on page 134)

The parameter list shall have the format shown in *table 81*. Attributes shall be sent in ascending numerical order. If the attributes are not in order, then no attributes are changed and the WRITE ATTRIBUTE command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 81 — WRITE ATTRIBUTE parameter list format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
	PARAMETER DATA LENGTH (n-3)							
3								(LSB)
	Attribute(s)							
4	Attribute 0 (see 6.4 on page 295)							
	⋮							
n	Attribute x (see 6.4 on page 295)							

The PARAMETER DATA LENGTH field should contain the number of bytes of attribute data and shall be ignored by the device server.

The format of the attributes is described in “READ ATTRIBUTE” on page 252.

If there is not enough space to write the attributes to the medium auxiliary memory, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to AUXILIARY MEMORY OUT OF SPACE.

If the medium auxiliary memory is not accessible because there is no medium present, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to NOT READY, and the additional sense code set to MEDIUM NOT PRESENT.

If the medium is present but the medium auxiliary memory is not accessible, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE.

If the medium auxiliary memory is not operational (e.g., bad checksum), the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to AUXILIARY MEMORY WRITE ERROR.

If the WRITE ATTRIBUTE command parameter data contains an attribute with an ATTRIBUTE LENGTH field set to zero, then one of the following actions shall occur:

a) if the attribute state is unsupported or read only (see 4.13 on page 60), then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST;

b) if the attribute state is read/write, the attribute shall be changed to the nonexistent state. This attribute shall not be returned in response to a READ ATTRIBUTE command and not be reported by the READ ATTRIBUTE command with ATTRIBUTE LIST service action; or
c) if the attribute state is nonexistent, the attribute in the WRITE ATTRIBUTE command parameter list shall be ignored; this shall not be considered an error.

No attributes shall be changed, the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST if the parameter data contains any of the following:

a) an attempt to change an attribute in the read only state;
b) an attribute with incorrect ATTRIBUTE LENGTH field contents; or
c) an attribute with unsupported ATTRIBUTE VALUE field contents.

5.2.40 Write Buffer - 3Bh

The Write Buffer command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

The Write Buffer command is supported, but not all buffers are described in this document because most buffers are intended only to be written by the service representative or by manufacturing. OEM customers who intend to support host microcode download on a new platform should contact IBM for a complete description of the Write Buffer command for this purpose. Note that new microcode may also be loaded without requiring the use of the SCSI Write Buffer command, by using the Field Microcode Replacement (FMR) tape process described in the maintenance information manual for this product. See *"Supported Buffers" on page 174* for a list of the buffers supported by the drive. Table 82 shows the command format.

Table 82 — Write Buffer CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (3Bh)							
1	Obsolete (LUN)			Reserved		Mode		
2	Buffer ID							
3	MSB	Buffer Offset						
5								LSB
6	MSB	Parameter List Length						
8								LSB
9	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- Modes:

Value	**Description**
001b	(Vendor Unique) is supported.
010b	(Data) is supported (same as Mode 1).
100b	(Download Microcode) is supported.
101b	(Download Microcode and Save) is supported.
110b	(Download Microcode With Offsets) is supported
111b	(Download Microcode With Offsets and Save) is supported.

- Buffer ID: This field is ignored if Mode field is set to 100b, 101b, 110b, or 111b. The supported buffers are described in *table 38 on page 174*.
- Buffer Offset: The buffer offset field is the relative byte location within the buffer to write the data transferred by this command.
- Parameter List Length field: The number of bytes to be transferred.

5.2.41 Write Filemarks - 10h

The Write Filemarks command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause specifies the specific implementation.

Table 83 — Write Filemarks CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (10h)							
1	Obsolete (LUN)			Reserved			WSmk	Immed
2	MSB	Transfer Length						
4								LSB
5	Control Byte (see 5.1.3 on page 134)							

The following parameters apply:

- WSmk (Write Setmark): 0b
- Immed (Immediate):

Value	**Description**
0b	present status when command is completed.
1b	present status when command is verified.

- Transfer Length:

  Because the WSmk is set to 0b, the field indicates the number of filemarks to be written. After any buffered write operation completes, the initiator can issue a Write Filemarks command with the Immed bit set to 0b and the Transfer Length set to 000000b to ensure that all buffered data and filemarks are successfully written to the medium (synchronized).

Clause 6. Parameters for SCSI Commands

This clause describes the parameters used in SCSI commands that are supported on LUN 0.

Parameters are described in a “term-definition” format. In this format, the bits or bytes to be described are highlighted and listed on the left. The definition for the bits or bytes is to the right (not highlighted).

6.1 Diagnostic Parameters

Diagnostic parameters are used with the Send Diagnostic command *(see 5.2.32 on page 213)* and the Receive Diagnostic Results command *(see 5.2.21 on page 186)*.

6.1.1 Diagnostic Page Formats

The drive supports two diagnostic pages for normal use: Page Code 00h and 80h. Page Code 81h is for engineering use only.

6.1.1.1 Page Code 00h

6.1.1.2 Send Diagnostic Data - Page Code 00h

The format for the Send Diagnostic command follows:

Byte	Description
0	Page Code: 00h
1	Reserved (00h)
2-3	Page Length: 0000h

6.1.1.3 Receive Diagnostic Data - Page Code 00h

The format for the Receive Diagnostic Results command follows:

Byte	Description
0	Page Code: 00h
1	Reserved
2-3	Page Length: 0002h
4	Page Code Supported: 00h
5	Page Code Supported: 80h

6.1.1.4 Page Code 80h

Page Code 80h is a general purpose page for sending flags and diagnostic parameters to the target.

6.1.1.4.1 Send Diagnostic Command - Page Code 80h

The format for the Send Diagnostic command follows:

Byte	Description
0	Page Code: 80h
1	Reserved

2-3 Page Length (n-3)

4-5 Diagnostic ID

This field specifies the diagnostic that is to be run

6 Flags (Send Diagnostic command)

Bits	Description
7-1	Reserved
0	Cartridge Required Set to 1b when a cartridge is required for a diagnostic. When 1b, a cartridge must be loaded and ready for the Send Diagnostic command to be accepted. See specific diagnostic descriptions for cartridge use: some diagnostics require this bit to be set to 1b, some require it to be set to 0b, and some do not require a specific bit setting. • 0b: No cartridge required • 1b: Cartridge required

7 Reserved

8-n Diagnostic Parameters

The Diagnostic Parameters field contains the parameters required to run the diagnostic.

See 6.1.2 for a list of supported diagnostic page 80h routines.

6.1.1.5 Receive Diagnostic Results - Page Code X80

The format for the Receive Diagnostic Results command follows:

Byte	Description
0	Page Code: 80h
1	Reserved
2-3	Page Length (n-3)
4-5	Diagnostic ID This field contains the same value as that sent with the Send Diagnostic command for which this response is associated.
6	Flags Set to 00h for the Receive Diagnostic Results command
7	Reserved
8-n	Diagnostic Results The Diagnostic Results field contains the results from the diagnostic.

See the individual Send Diagnostic parameter descriptions for the field contents. Refer to *Supported Page 80h Diagnostics (see 6.1.2 on page 233)* for a list of diagnostic parameters supported by the drive.

6.1.1.6 Page Code 81h

This is a special page for media manufacturing use only (Arbitrary Commands).

For more information on this page, please contact IBM.

6.1.2 Supported Page 80h Diagnostics

Table 84 shows the supported diagnostic page 80h routines and indicates values required in the Send Diagnostic CDB. These diagnostics reside in the device. (See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands.) Individual diagnostic descriptions follow *table 84*.

Table 84 — Supported Page 80 Diagnostic Routines

ID	Name/Description	See Page	Parm Length	Result Length [2]	Self Test	Dev Ofl	Unit Ofl	Cart Req'd
None	Self Test	*213*	0000h	-	1	0	0	-
0100h	POST A Diagnostic	*235*	0008h	0057h	0	X	X	X
0101h	POST B Diagnostic[1]	*237*	0008h	0057h	0	X	1	1
010Ah	Retension Medium	*239*	000Eh	000Eh	0			1
0110h	Extended Write / Read Test[1]	*241*	0020h	000Ch	0	X	1	1
0160h	Force Dump	*248*	0008h	-	0	1	X	X
0161h	Write Dump to Cartridge[1]	*249*	0008h	0057h	0	X	1	1
0170h	Create FMR Cartridge[1]	*251*	0008h	0057h	0	X	1	1
0190h	Set Traps	*253*	000Ah	-	0	X	X	X
0191h	Remove Traps	*254*	000Ah	-	0	X	X	X
0210h	Terminate Immediate Command	*255*	000Ah	-	0	X	1	1
2001h	Reset Volume SARS	*257*	0008h	-	0	1	X	1
2002h	Reset Drive (Soft)	*258*	0008h	-	0	X	X	0

Legend
- Not Applicable
1 These diagnostics will destroy all data on the currently mounted cartridge.
2 GOOD status is returned for diagnostics which expect result data based solely on validation of the diagnostic. The Receive Diagnostics Results command must be used to determine the success or failure of the actual execution of such diagnostics. Diagnostic procedures are recommended above.
3

6.1.3 Diagnostic - SelfTest: Self Test

When the SelfTest bit is 1b in the Send Diagnostic command (See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands), the target runs the normal power-on self test (POST A) diagnostics that occur at bring-up. No diagnostic results are returned.

6.1.3.1 Send Diagnostic Command - Self Test

Table 85 shows the Send Diagnostic command format to specify Self Test (the SelfTest bit is set to 1b).

Table 85 — Send Diagnostic CDB - Self Test

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Operation code (1Dh)							
1	Obsolete (LUN)			PF (1b)	Reserved (0b)	SelfTest (1b)	DevOfl (0b)	UnitOfl (0b)
2	Reserved (00h)							
3	MSB	Parameter List Length (0000h)						
4								LSB
5	Control Byte *(see 5.1.3 on page 134)*							

When the SelfTest bit is 1b in the Send Diagnostic command, the target will execute its default power-on self test. If the self test successfully passes, the command is terminated with Good status. If the self test detects a failure, the command is terminated with CHECK CONDITION status and the sense key is set to Hardware Error.

6.1.3.2 Receive Diagnostic Results Data - Self Test

There are no diagnostic results for the self test.

6.1.4 Diagnostic - 0100h: POST A

This diagnostic runs the POST A (power-on self test) diagnostics, as does running the Self Test diagnostic by setting the SelfTest bit to 1b in a Send Diagnostic command. However, unlike Self Test, the POST A diagnostic returns data through the Receive Diagnostic Results command. (See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands)

6.1.4.1 Send Diagnostic Parameter Data - POST A

Table 86 shows the parameter data for the Send Diagnostic command.

Table 86 — Send Diagnostic Parameter Data - POST A

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0100h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (x)
7	Reserved (00h)							
1 The Cartridge Required flag can be set to 0b or 1b. If a cartridge is in the drive when this diagnostic is received, some diagnostics will not run. If the diagnostic is blocked because a cartridge is loaded in the drive or for any other reason, the Diagnostic Blocked bit is set in the Receive Diagnostics Results data.								

6.1.4.2 Receive Diagnostic Results Data - POST A

Table 87 shows the diagnostic results data received from the POST A diagnostic.

Table 87 — Receive Diagnostic Results Data - POST A

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0100h)						
5								LSB
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnos-tic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

1 The Error bit in byte 8 is set when the diagnostic detects an error.
2 The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
3 SIM/MIM messages are defined exactly as described in *LP 31h: SIM/MIM (see 1.4.12 on page 29)*; the SIM/MIM is not valid if the SIM/MIM Present bit is 0b.
4 The Diagnostic Blocked bit is set when the diagnostic cannot run all its tests. This occurs if a cartridge is in the drive.

6.1.5 Diagnostic - 0101h: POST B

This diagnostic causes all of the device read, write, and motion test diagnostics to be executed. Thus, a cartridge is required to be loaded to run the diagnostic. See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands.

6.1.5.1 Send Diagnostic Parameter Data - POST B

Table 88 shows the parameter data for the Send Diagnostic command.

Table 88 — Send Diagnostic Parameter Data - POST B

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0101h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							
1 Cartridge Required=1b, a cartridge must be loaded and ready.								

6.1.5.2 Receive Diagnostic Results Data - POST B

Table 89 shows the diagnostic results data received from the POST B diagnostic.

Table 89 — Receive Diagnostic Results Data - POST B

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (004Dh)						
3								LSB
4	MSB	Diagnostic ID (0101h)						
5								LSB
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnostic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

1 The Error bit in byte 8 is set when the diagnostic detects an error.
2 The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
3 SIM/MIM messages are defined exactly as described in *LP 31h: SIM/MIM (see 1.4.12 on page 29)*; the SIM/MIM is not valid if the SIM/MIM Present bit is 0.

6.1.6 Diagnostic -010Ah: Retension Medium

This diagnostic causes the media to be located to end of tape and back while the drive performs a servo verify to generate a Media Quality status. A cartridge is required to be loaded to run this diagnostic. See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands.

6.1.6.1 Send Diagnostic Parameter Data - Retension Medium

Table 90 shows the parameter data for the Send Diagnostic command.

Table 90 — Send Diagnostic Parameter Data - Retension Medium

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	Page Length (000Ah)							
3								
4	Diagnostic ID (010Ah)							
5								
6	Flags (0000000b)							Cart Req'd (1b)
7	Refresh Type (01h)							
8	Reserved (00h)							
9	Reserved (0000h)							
10								

1 Cartridge Required=1b, a cartridge must be loaded and ready.
2 Refresh Type=01h, Media Refresh with servo verify

6.1.6.2 Receive Diagnostic Results Data - Retension Medium

Table 91 shows the diagnostic results data received from the Retension Medium diagnostic.

Table 91 — Receive Diagnostic Results Data - Retension Medium

Byte	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2 - 3	Page Length (000Ah)							
4 - 5	Diagnostic ID (010Ah)							
6 - 9	Reserved (00000000h)							
10	Media Quality							
11	Reserved (00000b)					Step complete flag (0b)	Seq complete flag (0b)	Fail flag
12 - 13	Reserved (0000h)							

1 Media Quality: media quality metric value from 00h to FFh, where 00h is the best quality and FFh is the poorest quality. If the Fail Flag is active, the Media Quality number is invalid
2 Fail Flag: indicates whether the Media Quality number exceeds the fail quality threshold.
3 Pass = 0b, Fail = 1b.

6.1.7 Diag 0110h: Extended Write / Read Test (Not J1A)

The Extended Write / Read Test diagnostic causes the drive to execute an extended write/read test. A large set of parameters are provided to allow the controlling program flexibility in specifying the test sequence.

The Extended Write / Read Test diagnostic may be run in ‘Immediate mode’. When this mode is selected, ending status is presented after initial parameter checking is complete. Command progress or completion is determined by checking for sk/asc/ascq = 0/0016 (No Sense / Operation In Progress) with a Request Sense command. In addition, when the diagnostic is run in Immed mode, the command may be terminated by using the Send Diagnostic Command - Terminate Immed Command option *(see 6.1.13 on page 255)*.

A cartridge must be loaded and ready prior to running this diagnostic.

The design of the Extended Write / Read Test diagnostic is such that any temp or perm errors that occur while it is running may be retrieved through normal Deferred Check Condition reporting. If the diagnostic is run in non-Immed mode, then those errors may be retrieved following completion. If the diagnostic is run in Immed mode, the errors may be retrieved while it is still running, through use of a Request Sense / TUR command loop. In either mode, the Diagnostic Termination code in the Receive Diagnostic Results data should be checked at completion. See 4.20.1 for an example sequence an application client could use.

6.1.7.1 Send Data – Extended Write / Read Test

Table 92 shows the Send Diagnostic parameter data for the Extended Write / Read Test diagnostic.

Table 92 — Send Data – (Diag 0110h) Extended Write / Read Test

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td colspan="8">PAGE CODE (80h)</td></tr>
<tr><td>1</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>2</td><td>(MSB)</td><td colspan="6" rowspan="2">PAGE LENGTH (001ch)</td><td></td></tr>
<tr><td>3</td><td></td><td>(LSB)</td></tr>
<tr><td>4</td><td>(MSB)</td><td colspan="6" rowspan="2">DIAGNOSTIC ID (0110h)</td><td></td></tr>
<tr><td>5</td><td></td><td>(LSB)</td></tr>
<tr><td>6</td><td colspan="7">FLAGS (0000000b)</td><td>CR(1b)</td></tr>
<tr><td>7</td><td>TSTLC</td><td>TSTLF</td><td>UNCTL</td><td>TESCTL</td><td colspan="3">Reserved (000b)</td><td>IMMED</td></tr>
<tr><td>8</td><td>WRTTST</td><td>RDTST</td><td colspan="4">Reserved (0000b)</td><td>STCTL</td><td>ENDCTL</td></tr>
<tr><td>9</td><td>CHGPAT</td><td>SDCTL</td><td colspan="2">Reserved (00b)</td><td colspan="4">DATAPAT</td></tr>
<tr><td>10</td><td>WSCTL</td><td>RSCTL</td><td>ERPCTL</td><td>ROLLCTL</td><td colspan="2">rsvd (00b)</td><td colspan="2">CALCTL</td></tr>
<tr><td>11</td><td colspan="4">WRITE SPEED</td><td colspan="4">READ SPEED</td></tr>
<tr><td>12</td><td colspan="8">TEMP ERR STOP COUNT</td></tr>
<tr><td>13</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>14</td><td>(MSB)</td><td colspan="6" rowspan="2">TEST LOOP COUNT</td><td></td></tr>
<tr><td>15</td><td></td><td>(LSB)</td></tr>
<tr><td>16</td><td>(MSB)</td><td colspan="6" rowspan="2">STARTING LB NUMBER</td><td></td></tr>
<tr><td>19</td><td></td><td>(LSB)</td></tr>
<tr><td>20</td><td>(MSB)</td><td colspan="6" rowspan="2">LOGICAL BLOCK SIZE</td><td></td></tr>
<tr><td>23</td><td></td><td>(LSB)</td></tr>
<tr><td>24</td><td>(MSB)</td><td colspan="6" rowspan="2">LOGICAL BLOCK COUNT</td><td></td></tr>
<tr><td>27</td><td></td><td>(LSB)</td></tr>
<tr><td>28</td><td>(MSB)</td><td colspan="6" rowspan="2">STARTING SEED</td><td></td></tr>
<tr><td>31</td><td></td><td>(LSB)</td></tr>
</table>

The following parameters apply:

Byte	Description
0	PAGE CODE - Selects the diagnostic page as 80h which is the IBM general purpose page.
1	Reserved
2-3	PAGE LENGTH - The length in bytes of the diagnostic parameters that follow this field.
4-5	DIAGNOSTIC ID - The ID of the specific general purpose diagnostic.

6 FLAGS - Flags specific to this diagnostic.

Bit Description

7-1 Reserved

0 CR - Cartridge Required (1b)

Value	Description
0b	A cartridge is not required to be loaded and ready.
1b	A cartridge must be loaded and ready.

7 Test Loop / Immed Mode Options

Bit Description

7 TSTLC - test loop count flag

Value	Description
0b	The test will be run one time.
1b	The entire test will be repeated as specified in the TEST LOOP COUNT field (i.e., bytes 14-15).

6 TSTLF - test loop forever flag

Value	Description
0b	The entire test will not be looped forever.
1b	The entire test will continually loop forever if the IMMED bit is set to one.

If the TSTLF flag and the IMMED bit are both set to one, then the TSTLC flag and the TEST LOOP COUNT field (i.e., bytes 14-15), are ignored. This flag is ignored if the IMMED bit is set to zero.

5 UNCTL - unload control flag

Value	Description
0b	The tape will not be unloaded following write or read tests.
1b	The tape will be unloaded following the completion of each write or read test. If the entire test is not yet complete, the tape will be reloaded prior to starting the next portion of the test.

4 TESCTL - temp error stop control flag

Value	Description
0b	The test will not terminate based on a temp error count.
1b	The test will terminate when the number of temp errors exceeds the value in the TEMP ERR STOP COUNT field (i.e., byte 12).

3-1 Reserved (ignored)

0 IMMED – immediate status bit

Value	Description
0b	Present status when the command is completed.
1b	Present status when parameter checking is completed and the command is started.

8 Write/Read Options

Bit Description

7 WRTTST - perform write test

Value	Description
0b	No write test will be performed.
1b	A write test will be performed as specified in the remaining parameters.

6 RDTST - perform read test

Value	Description
0b	No read test will be performed.
1b	A read test will be performed as specified in the remaining parameters.

5-2 Reserved (ignored)

1 STCTL - start control flag

Value	Description
0b	All write and read tests will start at LB 0.
1b	All write and read tests will start at the LB Number specified in the STARTING LB NUMBER field (i.e., bytes 16-19).

0 ENDCTL - end control flag

Value	Description
0b	All write and read tests will continue until LEOT.
1b	All write and read tests will continue as specified in the LOGICAL BLOCK SIZE field (i.e., bytes 20-23) and the LOGICAL BLOCK COUNT field (i.e., bytes 24-27).

9 Data Pattern Options: These fields specify what type of data pattern will be loaded into the data buffer prior to starting a write test.

Bit Description

7 CHGPAT - change pattern flag

Value Description

0b The data pattern will not change if the write test is looped.

1b For each loop of a write test, the data pattern will cycle through the data pattern types listed in the DATAPAT field (i.e., bits 3-0) starting with its current value.

6 SDCTL - seed control flag

Value Description

0b No starting seed is specified.

1b The starting seed for Random, Incrementing, and Repeating data patterns is specified in the STARTING SEED field (i.e., bytes 28-31).

5-4 Reserved (ignored)

3-0 DATAPAT - data pattern type

Table 93 — DATAPAT description

Value	Pattern Type	Description
0h	Random	If SDCTL = 0b, then a predefined pseudo-random pattern is used If SDCTL = 1b, then each word of the predefined pseudo-random pattern is modified by the value in the STARTING SEED field (i.e., bytes 28-31) per the following psuedocode: *pseudo-random pattern: pattern[] = {random_word_1, random_word_2, random_word_3, ...};* *word[TEST LOOP COUNT];* seed = STARTING SEED; for (index=0; index++;TEST_LOOP_COUNT) word[index] = pattern[index] | seed++;
1h	Incrementing	If SDCTL = 0b, then the pattern increments starting at 00000000h (i.e., 00000000h, 00000001h, 00000002h, etc.) If SDCTL = 1b, then the pattern increments starting from the value in the STARTING SEED field
2h	Repeating	If SDCTL = 0b, then the pattern used is all 0's (00000000h repeated) If SDCTL = 1b, then the pattern used is the value in the STARTING SEED field repeated
3h	All zeros	00000000h repeated
4h	All ones	FFFFFFFFh repeated
5h	Alt A	0FF0F00Fh repeated
6h	Alt B	A55A5AA5h repeated
7h-Fh	Reserved	Ignored (Random pattern is used)

10 Speed / ERP / Cal Options

Bit Description

7 WSCTL - write speed control flag

Value	Description
0b	Writing speed will be controlled by the default drive methods.
1b	Writing speed will be fixed to the value set in the WRITE SPEED field (see byte 11).

6 RSCTL - read speed control flag

Value	Description
0b	Reading speed will be controlled by the default drive methods.
1b	Reading speed will be fixed to the value set in the READ SPEED field (see byte 11).

5 ERPCTL – write/read ERP control flag

Value	Description
0b	Regular write/read ERPs will be controlled by default drive methods.
1b	Regular write/read ERPs will be limited (equivalent to setting Mode Page 01h Write Retry Limit and Read Retry Limit both to 05h).

4 ROLLCTL - rolling cal control flag

Value	Description
0b	Rolling cal (sticky / intervention ERPs) will be controlled by default drive methods.
1b	Rolling cal ERPs will be disabled

3-2 Reserved (ignored)

1-0 CALCTL - channel calibration control

Value	Description
00b	Channel calibrations will be controlled by default drive methods.
01b	Normal channel calibration will be disabled.
10b	An IFC channel calibration will be performed prior to starting each write pass
11b	An IFC channel calibration will be performed prior to starting the first write pass only

11 Write/read Fixed Speed Setting

Bit Description

7-4 WRITE SPEED: When the WSCTL flag is set to one, this field specifies the fixed speed setting to be used while writing.

3-0 READ SPEED: When the RSCTL flag is set to one, this field specifies the fixed speed setting to be used while reading.

12 TEMP ERR STOP COUNT: When the TESCTL flag is set to one, this field specifies the count of temp errors, which when exceeded, will cause the test to terminate.

14-15 TEST LOOP COUNT: When the TSTLC flag is set to one, this count specifies the number of times the entire test is repeated.

16-19 STARTING LB NUMBER: When the STCTL flag is set to one, this field specifies the LB Number to be used for the start of all write and read tests.

20-23 LOGICAL BLOCK SIZE: This field specifies the logical block size (in bytes) of each block to be written or read. The value of LOGICAL BLOCK SIZE is limited to the same values supported by the device for host write and read commands (i.e., the value reported in the READ BLOCK LIMITS command).

24-27 LOGICAL BLOCK COUNT: When the ENDCTL flag is set to one, this count specifies the number of logical blocks that will be processed during each write or read test.

28-31 STARTING SEED: When the SDCTL flag is set to one, this field specifies the pattern starting seed value.

6.1.7.2 Results Data – Extended Write / Read Test

Table 2 shows the Receive Diagnostic Results data received from the Extended Write / Read Test diagnostic.

Table 94 — Results Data – (Diag 0110h) Extended Write / Read Test

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PAGE CODE (80h)							
1	Reserved (00h)							
2	(MSB)	PAGE LENGTH (0007h)						
3								(LSB)
4	(MSB)	DIAGNOSTIC ID (0110h)						
5								(LSB)
6	FLAGS (00h)							
7	Reserved (00h)							
8	DIAGNOSTIC TERMINATION CODE							
9	(MSB)	TOTAL TEMP ERROR COUNT						
10								(LSB)

The following parameters apply:

Byte Description

0 PAGE CODE - Identifies the diagnostic page as 80h which is the IBM general purpose page.

1 Reserved

2-3 PAGE LENGTH - The length in bytes of the diagnostic parameters that follow this field.

4-5 DIAGNOSTIC ID - The ID of the specific general purpose diagnostic.

6 FLAGS - Flags specific to this diagnostic.

7 Reserved

8 DIAGNOSTIC TERMINATION CODE

ValueDescription

00h Diagnostic completed all tests.

01h Diagnostic was terminated by a perm error condition.

02h Diagnostic was terminated due to the Temp Err Stop Count.

03h Diagnostic was terminated by the Send Diagnostic – Terminate Immed Command routine.

04h Diagnostic was terminated due to a 'blocked' starting condition. This would typically be an indication of a firmware problem, or a write protected volume.

9-10 TOTAL TEMP ERROR COUNT: The total number of temp write/read errors that occurred while running the diagnostic. This count will freeze at a maximum value of FFFFh.

6.1.8 Diagnostic - 0160h: Force Dump

This diagnostic forces a dump. The dump data is stored in device control storage and can be read by the Read Buffer command (Buffer ID of 00h) *(see 5.2.18 on page 173)*

When a higher priority dump has been generated automatically by the drive but has not yet been read, the drive will ignore this Send Diagnostic command and return GOOD status.

See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands.

6.1.8.1 Send Diagnostic Parameter Data - Force Dump

Table 95 shows the parameter data for the Send Diagnostic command.

Table 95 — Send Diagnostic Parameter Data - Force Dump

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0160h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (x)
7	Reserved (00h)							
1 The Cartridge Required flag may be set to 0b or 1b.								

6.1.8.2 Receive Diagnostic Results Data - Force Dump

There are no diagnostic results for this function.

6.1.9 Diagnostic - 0161h: Write Dump to Cartridge

This diagnostic causes dump information residing in the device control storage to be written to a cartridge without the need to retrieve the dump data across the host interface. A cartridge is required to be loaded to run the diagnostic. See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands.

6.1.9.1 Send Diagnostic Parameter Data - Write Dump to Cartridge

Table 96 shows the parameter data for the Send Diagnostic command.

Table 96 — Send Diagnostic Parameter Data - Write Dump to Cartridge

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0161h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							
1 Cartridge Required=1b, a cartridge must be loaded and ready.								

6.1.9.2 Receive Diagnostic Results Data - Write Dump to Cartridge

Table 97 shows the diagnostic results data received from the Write Dump to Cartridge diagnostic.

Table 97 — Receive Diagnostic Results Data - Write Dump to Cartridge

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td colspan="8">Page Code (80h)</td></tr>
<tr><td>1</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>2</td><td>MSB</td><td colspan="6" rowspan="2">Page Length (004Dh)</td><td></td></tr>
<tr><td>3</td><td></td><td>LSB</td></tr>
<tr><td>4</td><td>MSB</td><td colspan="6" rowspan="2">Diagnostic ID (0161h)</td><td></td></tr>
<tr><td>5</td><td></td><td>LSB</td></tr>
<tr><td>6</td><td colspan="8">Flags (00h)</td></tr>
<tr><td>7</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>8</td><td colspan="5">Reserved (00000b)</td><td>Diagnos-
tic
Blocked</td><td>SIM/MIM
Present</td><td>Error</td></tr>
<tr><td>9</td><td></td><td colspan="6" rowspan="2">SIM/MIM message or all zeros</td><td></td></tr>
<tr><td>80</td><td></td><td></td></tr>
<tr><td colspan="9">1 The Error bit in byte 8 is set when the diagnostic detects an error.
2 The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
3 SIM/MIM messages are defined exactly as described in LP 31h: SIM/MIM (see 1.4.12 on page 29); the SIM/MIM is not valid if the SIM/MIM Present bit is 0b.</td></tr>
</table>

6.1.10 Diagnostic - 0170h: Create FMR Cartridge

See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands. This diagnostic causes the device microcode to be written to a cartridge, creating a field microcode replacement (FMR) cartridge. A cartridge is required to be loaded to run the diagnostic.

This copies the functional microcode load onto a cartridge for transporting to another drive when a FMR cartridge is not available.

NOTE 65 - This function is also available from the CE service panel.

6.1.10.1 Send Diagnostic Parameter Data - Create FMR Cartridge

Table 98 shows the parameter data for the Send Diagnostic command.

Table 98 — Send Diagnostic Parameter Data - Create FMR Cartridge

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (0170h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							
1 Cartridge Required=1b, a cartridge must be loaded and ready.								

6.1.10.2 Receive Diagnostic Results Data - Create FMR Cartridge

Table 99 shows the diagnostic results data received from the Create FMR Cartridge diagnostic.

Table 99 — Receive Diagnostic Results Data - Create FMR Cartridge

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (004Dh)						
3								LSB
4	MSB	Diagnostic ID (0170h)						
5								LSB
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (000000b)					Diagnostic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

1 The Error bit in byte 8 is set when the diagnostic detects an error.
2 The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
3 SIM/MIM messages are defined exactly as described in *LP 31h: SIM/MIM (see 1.4.12 on page 29)*; the SIM/MIM is not valid if the SIM/MIM Present bit is 0b.

6.1.11 Diagnostic - 0190h: Set Traps

See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands. This diagnostic permits a SCSI interface user to set a microcode trap that causes a dump to occur when the trap is sprung. The drive continues to operate after the dump completes.

6.1.11.1 Send Diagnostic Parameter Data - Set Traps

Table 100 shows the parameter data for the Send Diagnostic command.

Table 100 — Send Diagnostic Parameter Data - Set Traps

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0006h)						
3								LSB
4	MSB	Diagnostic ID (0190h)						
5								LSB
6	Flags (0000000b)							Car-tridge Required (x)
7	Reserved (00h)							
8	MSB	Fault Symptom Code						
9								LSB
1 Cartridge Required=1, a cartridge must be loaded and ready before the diagnostic is run.								

6.1.11.2 Receive Diagnostic Results Data - Set Traps

There are no diagnostic results for this function.

6.1.12 Diagnostic - 0191h: Remove Traps

See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands. This diagnostic permits a SCSI interface user to remove a microcode trap that was set either via the CE service panel or the SCSI Set Traps Diagnostic.

6.1.12.1 Send Diagnostic Parameter Data - Remove Traps

Table 101 shows the parameter data for the Send Diagnostic command.

Table 101 — Send Diagnostic Parameter Data - Remove Traps

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0006h)						
3								LSB
4	MSB	Diagnostic ID (0191h)						
5								LSB
6	Flags (0000000b)							Car-tridge Required (x)
7	Reserved (00h)							
8	MSB	Fault Symptom Code						
9								LSB
1 Cartridge Required=1, a cartridge must be loaded and ready before the diagnostic is run.								

6.1.12.2 Receive Diagnostic Results Data - Remove Traps

There are no diagnostic results for this function.

6.1.13 Diag 0210h: Terminate Immediate Command (Not J1A)

This diagnostic will terminate all processing associated with the specified command that had been previously issued with the Immediate bit set to one. The command to be terminated is specified by the OPERATION CODE / SERVICE ACTION pair. If the command specified to terminate exists, the drive returns Good status after the termination is complete. If the command specified to terminate does not exist, the drive will behave as specified by the setting of the CC bit. If an error occurs during the processing of this Send Diagnostic command, Good status will be returned and the error will be reported as a deferred error to the next eligible command.

6.1.13.1 Send Data – Terminate Immed Command

Table 3 shows the Send Diagnostic parameter data for the Terminate Immed Command diagnostic.

Table 102 — Send Data – (Diag 0210h) Terminate Immed Command

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	PAGE CODE (80h)							
1	Reserved (00h)							
2	(MSB)	PAGE LENGTH (0006h)						
3								(LSB)
4	(MSB)	DIAGNOSTIC ID (0210h)						
5								(LSB)
6	FLAGS (0000000b)							CR(1b)
7	Reserved (00h)							
8	OPERATION CODE							
9	CC	Reserved (00b)		SERVICE ACTION				

The following parameters apply:

Byte Description

0 PAGE CODE - Selects the diagnostic page as 80h which is the IBM general purpose page.

1 Reserved

2-3 PAGE LENGTH - The length in bytes of the diagnostic parameters that follow this field.

4-5 DIAGNOSTIC ID - The ID of the specific general purpose diagnostic.

6 FLAGS - Flags specific to this diagnostic.

Bit Description

7-1 Reserved

0 CR - Cartridge Required (1b)

Value	Description
0b	A cartridge is not required to be loaded and ready.
1b	A cartridge must be loaded and ready.

7 Reserved

8 OPERATION CODE - The operation code of the command to terminate.

9

Bit Description

7 CC - Check Condition bit

Value Description

0b Return Good status if the command specified by the OPERATION CODE / SERVICE ACTION pair is not currently active.

1b Return Check Condition – Invalid Field in Parameter Data (5/2600) with Field pointer set to the OPERATION CODE field if the command specified by the OPERATION CODE / SERVICE ACTION pair is not currently active.

6-4 Reserved

4-0 SERVICE ACTION - The service action of the command to terminate. If there is no service action, then the service action field shall be set to zero

Table 103 lists the commands supported by the Terminate Immediate Command diagnostic.

Table 103 — Supported Commands in the Terminate Immediate Command diagnostic

Command	Op Code	Service Action	State of Drive after Command is Terminated
Erase	19h	00h	The drive stops processing and leaves the drive positioned at the stopping point. After completion, the drive will reject any subsequent tape motion commands (with sk/asc/ascq = 3/3100) except for Rewind or Unload.
Send Diagnostic	1Dh	00h	The drive stops processing, clears the buffer, and rewinds to BOP.

6.1.13.2 Results Data – Terminate Immed Command

There is no Receive Diagnostic Results data for this function.

6.1.14 Diagnostic - 2001h: Reset Volume SARS

See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands. This diagnostic resets the VOLUME SARS data in the currently loaded cartridge.

6.1.14.1 Send Diagnostic Parameter Data - Reset Volume SARS

Table 104 shows the parameter data for the Send Diagnostic command.

Table 104 — Send Diagnostic Parameter Data - Reset Volume SARS

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (2001h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							

6.1.14.2 Receive Diagnostic Results Data - Reset Volume SARS

There are no diagnostic results for this function.

6.1.15 Diagnostic - 2002h: Reset Drive

See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands. This diagnostic aborts all current drive operations and restarts the functional microcode. This reset is equivalent to a power on reset. (This function can also be specified from the CE service panel.)

6.1.15.1 Send Diagnostic Parameter Data - Reset Drive

Table 105 shows the parameter data for the Send Diagnostic command.

Table 105 — Send Diagnostic Parameter Data - Reset Drive

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	MSB	Page Length (0004h)						
3								LSB
4	MSB	Diagnostic ID (2002h)						
5								LSB
6	Flags (0000000b)							Cartridge Required (0b)
7	Reserved (00h)							

6.1.15.2 Receive Diagnostic Results Command - Reset Drive

There are no diagnostic results for this function.

6.1.16 Diagnostic - 3000h: String Search (not J1A)

See *"Send Diagnostic - 1Dh" on page 213* and *"Receive Diagnostic Results - 1Ch" on page 186* for additional information on the commands. This diagnostic performs a String Search operation as specified. See *"MP 37h: String Search (not J1A)" on page 353*, and *"String Search Function (not J1A)" on page 122* for additional information.

NOTE 66 - The device logical position may be changed by this command.

NOTE 67 - If valid search criteria is not specified, the command presents CHECK CONDITION status with sense key 5/2C00 (Illegal Request - Command Sequence Error).

NOTE 68 - Mode Page 37h and its subpage(s) may be altered by this command. See *"Search Criteria 01h - String Descriptor 10h" on page 357* for a detailed description of descriptors.

6.1.16.1 Send Diagnostic Parameter Data - String Search

Table 106 — Send Diagnostic Parameter Data - String Search

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Page Code: 80h							
1	Reserved (00h)							
2	MSB	Page Length (n-3)						
3								LSB
4	MSB	Diagnostic ID (3000h)						
5								LSB
6	Flags (00000000b)							Cart req'd (1b)
7	Reserved					SMKS	FMKS	Immed
8	MSB	Search Count						
11								LSB
12	MSB	Match Count						
15								LSB
16	Match List Entry Type							
17	MSB	Reserved						
27								LSB
28	MSB	Search Time						
29								LSB
30	Reserved							
31	Search Method (01h)							
32	Search Criteria 01h Descriptor(s)							
n								

The following parameters apply:

- FMKS:

  Value **Description**
  0b stop when a filemark is encountered
  1b filemarks will be ignored (treated as logical blocks with no data - will not match any criteria

- Search Count: The maximum number of records to search. If this field is set to 00000000h, then all records from the current location to EOD are searched (limited to Match Count).

- Match Count: The maximum number of matches to gather in the Match List.

  Value **Description**
  0000h If Match Count is set to 0000h, then the search will stop on the next record (within Search Count) which matches the search criteria. If a matching record is found, the command will return GOOD STATUS and the device will be logically positioned before the matching record (a Read command may be issued to read the matching record). If a matching record is not found before the criteria of the Search command is fulfilled, the command presents NON-DEFERRED CHECK CONDITION status with sense key 0/1401 (No Sense - Record Not Found). If a matching record is not found before Search Time elapses, the command

presents NON-DEFERRED CHECK CONDITION status with sense key 0/2E00 (No Sense - Insufficient Time for Operation). Other reportable statuses also apply in conditions where the operation stops due to other issues before a matching record is found (i.e., filemark is encountered with FMKS set to 0b, EOD encountered, etc.).

Other If Match Count is non-zero, the search will stop once the Match List is full or Search Time elapses. The device logical position may be changed, the command will return good status, and any results must be acquired with Receive Diagnostics Results and/or Read Buffer (Buffer ID 40h).

- Match List Entry Type
- Search Time
- Search Criteria - as per *MP 37h[01h]: String Search Criteria (see 6.4.22.2 on page 356)*. Minimal descriptor forms are recommended.

6.1.16.2 Receive Diagnostic Results Data - String Search

The Send Diagnostic method will return results via the Receive Diagnostics Result command. Results will also remain in Read Buffer ID 40h

Table 107 — Receive Diagnostic Results Command- String Search

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Page Code: 80h							
1	Reserved (00h)							
2	MSB	Page Length (n-3)						
3								LSB
4	MSB	Diagnostic ID (3000h)						
5								LSB
6	Flags (00000000b)							
7	Reserved (00h)							
8	Reserved (00000b)					Blocked	SIM/MIM	Error
9	String Search Results Buffer (Match List)							
n								

String Search Results Buffer (Match List) - for a complete definition of this structure see *5.2.35.1 on page 220*.

NOTE 69 - If an error is encountered during a search operation, the Error bit is set to 1b and the SIM/MIM may be set, and a SIM/MIM with additional error information may be presented. These fields should be checked to determine search result validity before string search results are examined

6.1.17 Cryptographic Diagnostics

See *“Send Diagnostic - 1Dh” on page 213* and *“Receive Diagnostic Results - 1Ch” on page 186* for additional information on the commands. The cryptographic diagnostics are specified in the Encryption version of the SCSI Reference.

6.2 Inquiry Vital Product Data Parameters

Inquiry vital product data parameters are returned to the Inquiry command. *Inquiry - 12h (see 5.2.6 on page 142)* describes how to request these pages.

6.2.1 IP 00h: Supported Inquiry Pages

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 00h
- Allocation Length: 0Ah

6.2.1.1 Returned Data - IP 00h: Supported Inquiry Pages

For a LUN that is associated with an installed device *(see 4.1 on page 77)* the following data is returned:

Byte **Description**

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: 00h

2 Reserved

3 Page Length (n-3)

4-n Supported Inquiry Pages: This field is a list of 1-byte long page codes and may include some or all of the following:

Code	Inquiry Page
00	"IP 00h: Supported Inquiry Pages" on page 263
03	"IP 03h: ASCII Information" on page 264
80	"IP 80h: Unit Serial Number" on page 265
83	"IP 83h: Device Identification" on page 266
86	"IP 86h: Extended INQUIRY Data" on page 269
B0	"IP B0h - Sequential-Access device capabilities (E07 and later)" on page 272
B1	"IP B1h - Manufacturer-assigned Serial Number" on page 273
C0	"IP C0h: Drive Component Revision Levels" on page 274
C1	"IP C1h: Drive Serial Numbers" on page 276
D0-DF	Vendor-Reserved (Attachment Specification Information)

6.2.2 IP 03h: ASCII Information

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 03h
- Allocation Length: 25h (37) bytes available

6.2.2.1 Returned Data - IP 03h: ASCII Information

For a LUN that is associated with an installed device *(see 4.1 on page 77)* the following data is returned:

Byte Description

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: 03h

2 Reserved

3 Page Length: 21h

4 ASCII Length: 00h

5-7 Reserved

8-11 Load ID

The Load ID of ROM microcode, represented by eight hex characters, is used to determine if the microcode to be downloaded is compatible with the device electronics. This value can be used to compare with bytes 8-11 in the microcode image file to insure that the microcode level is intended for this device type and model.

12-15 Rev Level

The Revision Level of the device microcode, represented with four ASCII characters, is used to determine if the latest level of microcode is downloaded. As each change is implemented, the Rev Level chosen must be numerically larger than any previous Rev Level used, as determined by converting the ASCII characters to numerical format and subtracting. For example, if the old Rev Level is ASCII ‘032C’, and the new Rev Level is ASCII ‘03B1’, that is equivalent to 3033323Ch and 30333B31h, respectively. When the two values are compared numerically, the new Rev Level is greater than the old Rev Level, which satisfies the requirement.

16-19 PTF Number: (unsupported)

21-23 Patch Number: (unsupported)

24-31 RU Name

Used by the attaching system. This is an 8-byte EBCDIC field that is incremented each time the Load ID is incremented. This value can be compared with bytes 28-31 in the microcode image file to insure that the microcode level is intended for this device type and model.

32-36 Library Sequence Number (in ASCII).

This field applies to the IBM 3494 Library only. This field matches the information returned in RS/422 initialization response, bytes 38-42.

6.2.3 IP 80h: Unit Serial Number

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 80h
- Allocation Length: 10h (16) bytes available

6.2.3.1 Returned Data - IP 80h: Unit Serial Number

For a LUN that is associated with an installed device *(see 4.1 on page 77)* the following data is returned:

Byte	Description
0	Peripheral Data **Bit** **Description** 7-5 Peripheral Qualifier: 000b 4-0 Peripheral Device Type: 01h
1	Page Code: 80h
2	Reserved
3	Page Length: 0Ch
4-15	Serial Number of device, right-justified with leading zeroes, in ASCII (same as Inquiry Standard Data bytes 38-49)

6.2.4 IP 83h: Device Identification

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 83h
- Allocation Length: 60h (96) bytes available

6.2.4.1 Returned Data - IP 83h: Device Identification

For a LUN that is associated with an installed device *(see 4.1 on page 77)* the following data is returned:

Byte	Description
0	Peripheral Data
	Bit **Description**
	7-5 Peripheral Qualifier: 000b
	4-0 Peripheral Device Type: 01h
1	Page Code: 83h
2	Reserved
3	Page Length: 5Ch
4	Device ID (T10 vendor identification)
	Bit **Description**
	7-4 Reserved
	3-0 Code Set: 2h (Identifier is all ASCII)
5	
	Bit **Description**
	7-6 Reserved
	5-4 Association: 00b
	3-0 Identifier Type: 1h
6	Reserved
7	Identifier Length: 24h
8-15	Vendor ID (same as Inquiry Standard Data bytes 8-15)
16-31	Device Type and Model Number (same as Inquiry Standard Data bytes 16-31)
32-43	Serial Number of device (same as Inquiry Standard Data bytes 38-49)
44	World Wide Node Name (NAA)
	Bit **Description**
	7-4 Reserved
	3-0 Code Set: 1h
45	
	Bit **Description**
	7-6 Reserved
	5-4 Association Type: 00b
	3-0 Identifier Type: 3h
46	Reserved
47	Identifier Length: 8h
48-55	World Wide Node Name
56	World Wide Port Name (NAA)
	Bit **Description**
	7-4 Reserved
	3-0 Code Set: 1h

57

Bit	Description
7-6	Reserved
5-4	Association Type: 01b
3-0	Identifier Type: 3h

58 Reserved

59 Identifier Length: 8h

60-67 World Wide Port Name

NOTE 70 - This relates to the port on which the Inquiry command was received.

68 Port Identifier (Relative target port)

Bit	Description
7-4	Reserved
3-0	Code Set: 1h

69

Bit	Description
7-6	Reserved
5-4	Association Type: 01b
3-0	Identifier Type: 4h

70 Reserved

71 Identifier Length: 4h

72-75 Port Identifier

Value	Description
00000001h	Fibre port 0
00000002h	Fibre port 1

NOTE 71 - This relates to the port on which the Inquiry command was received.

76 Alternate World Wide Port Name (NAA)

Bit	Description
7-4	Reserved
3-0	Code Set: 1h

77

Bit	Description
7-6	Reserved
5-4	Association Type: 10b
3-0	Identifier Type: 3h

78 Reserved

79 Identifier Length: 8h

80-87 World Wide Port Name

NOTE 72 - This relates to a different port than the port on which the Inquiry command was received.

88 Alternate Port Identifier (Relative target port)

Bit	Description
7-4	Reserved
3-0	Code Set: 1h

89

Bit	Description
7-6	Reserved
5-4	Association Type: 10b
3-0	Identifier Type: 4h

90 Reserved

91 Identifier Length: 4h

92-95 Port Identifier

Value	Description
00000001h	Fibre port 0
00000002h	Fibre port 1

NOTE 73 - This relates to a different port than the port on which the Inquiry command was received.

6.2.5 IP 86h: Extended INQUIRY Data

The Extended INQUIRY Data VPD page *(see table 108)* provides the application client with a means to obtain information about the logical unit.

Table 108 — Extended INQUIRY Data VPD page

Bit / Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (86h)							
2	Reserved							
3	PAGE LENGTH (3Ch)							
4	ACTIVATE MICROCODE		SPT			GRD_CHK (0b)	APP_CHK (0b)	REF_CHK (0b)
5	Reserved		UASK_SUP (0b)	GROUP_SUP (0b)	PRIOR_SUP (0b)	HEADSUP (0b)	ORDSUP (0b)	SIMPSUP (1b)
6	Reserved				WU_SUP (0b)	CRD_SUP (0b)	NV_SUP (0b)	V_SUP (0b)
7	Reserved			P_I_I_SUP (0b)	Reserved			LUICLR (0b)
8	Reserved			R_SUP (0b)	Reserved			CBCS (0b)
9	Reserved				MULTI I_T NEXUS MICROCODE DOWNLOAD			
10 - 63	Reserved							

The following data is returned.

Byte Description

0

Bit Description

7-5 PERIPHERAL QUALIFIER: 000b

4-0 PERIPHERAL DEVICE TYPE: 01h (Sequential Access Device)

1 PAGE CODE (86h)

2 Reserved

3 PAGE LENGTH (3Ch)

4

Bit	Description
7-6	ACTIVATE MICROCODE (00b)

The ACTIVATE MICROCODE field indicates how the device server activates microcode and establishes a unit attention condition when a WRITE BUFFER command *(see 5.2.40 on page 228)* with the download microcode mode set to 05h or 07h is processed.

Value	Description
00b	The actions of the device server may or may not be as defined for values 01b or 10b.
01b-10b	Not supported
11b	Reserved

5-3 SPT

A supported protection type (SPT) field indicates the type of protection the logical unit supports. The SPT field is reserved if the PROTECT bit *(see 5.2.6.1 on page 142)* is set to zero.

Value	Protection type supported
001b	Logical block protection
others	Reserved

Bit	Description
2	GRD_CHK (0b)
1	APP_CHK (0b)
0	REF_CHK (0b)

5

Bit	Description
7-6	Reserved
5	UASK_SUP (0b)
4	GROUP_SUP (0b)
3	PRIOR_SUP (0b)
2	HEADSUP (0b)
1	ORDSUP (0b)
0	SIMPSUP (1b) - The device server supports simple queing.

6

Bit	Description
7-4	Reserved
3	WU_SUP (0b)
2	CRD_SUP (0b)
1	NV_SUP (0b)
0	V_SUP (0b)

7

Bit	Description
7-4	Reserved
3	P_I_I_SUP (0b)
2-1	Reserved
0	LUICLR (0b)

8

Bit	Description
7-4	Reserved
3	R_SUP (0b)
2-1	Reserved
0	CBCS (0b)

9

Bit	Description
7-4	Reserved
3-0	MULTI I_T NEXUS MICROCODE DOWNLOAD (0b)

The MULTI I_T NEXUS MICROCODE DOWNLOAD field indicates how the device server handles concurrent attempts to download microcode using the WRITE BUFFER command (see 5.2.38) from multiple I_T nexuses.

Value	Description
0h	The handling of concurrent WRITE BUFFER download microcode operations from multiple I_T nexus is vendor specific.
1h-3h	Not Supported
4h-Fh	Reserved.

10-63 Reserved

6.2.6 IP B0h - Sequential-Access device capabilities (E07 and later)

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: B0h
- Allocation Length: 06h bytes available

6.2.6.1 Returned Data - IP B0h: Sequential-Access device capabilities

For LUN 0, the following data is returned:This page provides the application client with the means to determine if the features specified in this page are supported by the drive.

Table 109 — Table 23. Sequential-Access Device Capabilities Page

Byte	Bit 7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (B0h)							
2	Page Length (2)							
3								
4	Reserved							WORM
5	Reserved							

If the write once read many (WORM) bit is set to one, the device server supports WORM mode operation (see 4.2.24.3). If the WORM bit is set to zero, the device server does not support WORM mode operation.

6.2.7 IP B1h - Manufacturer-assigned Serial Number

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: B1h
- Allocation Length: 10h (16) bytes available

6.2.7.1 Returned Data - IP B1h: Manufacturer-assigned Serial Number

Table 110 specifies the Manufacturer-assigned Serial Number VPD page.

Table 110 — Manufacturer-assigned Serial Number VPD page

Bit Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (B1h)							
2	(MSB)	PAGE LENGTH (000Ch)						
3								(LSB)
4	(MSB)	MANUFACTURER-ASSIGNED SERIAL NUMBER						
15								(LSB)

Byte Description

0 Peripheral Data

Bit	Description
7-5	PERIPHERAL QUALIFIER: 000b
4-0	PERIPHERAL DEVICE TYPE: 01h

1 PAGE CODE: B1h

2-3 PAGE LENGTH: 0Ch

4-15 MANUFACTURER-ASSIGNED SERIAL NUMBER: Right-aligned ASCII data that is the manufacturer-assigned serial number. If the manufacturer-assigned serial number is not available, the device returns ASCII spaces (20h) in this field. If the manufacturer-assigned serial number differs from the value in the UNIT SERIAL NUMBER field of IP 80h: Unit Serial Number (see 6.2.3), then the value in the UNIT SERIAL NUMBER field is used in building the T10 vendor ID descriptor.

6.2.8 IP C0h: Drive Component Revision Levels

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C0h
- Allocation Length: 39(27h) bytes available

6.2.8.1 Returned Data - IP C0h: Drive Component Revision Levels

For LUN 0, the following data is returned:

Table 111 — IP C0h: Drive Component Revision Levels

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (C0h)							
2	Reserved							
3	PAGE LENGTH (27h)							
4 - 15	CODE NAME							
16 - 22	TIME(HHMMSS)							
23 - 30	DATE (YYYYMMDD)							
31 - 42	PLATFORM							

Byte Description

0 Peripheral Data

Bit	Description
7-5	PERIPHERAL QUALIFIER: 000b
4-0	PERIPHERAL DEVICE TYPE: 01h

1 PAGE CODE: C0h

2 Reserved

3 PAGE LENGTH: 27h

4-15 CODE NAME - The code name definition isnot published.

16-22 TIME - Time the code was built in HHMMSS format with a trailing NULL (i.e., 00h). Prior to May 2010, this field was set to ASCII zeros (i.e., 30h)

23-30 DATE - The date the code was built.

31-42 PLATFORM - ASCII characters containing the <protocol>_<package>[_<variant>] for the drive. This is left-aligned with ASCII spaces padded at the end.

Table 112 — PLATFORM definition

Symbol	Description	
<protocol>	**Value**	**Transport Protocol**
	sas	Serial Attached SCSI (SAS)
	fcp	Fibre Channel (FC)
<package>	**Value**	**Type**
	fj	Jaguar (3592)
<variant>	**Value**	**Type**
	f	FIPS

6.2.9 IP C1h: Drive Serial Numbers

Inquiry - 12h (see 5.2.6 on page 142) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C1h
- Allocation Length: 1Ch (28) bytes available

6.2.9.1 Returned Data - IP C1h: Drive Serial Numbers

For LUN 0, the following data is returned:

Byte	Description
0	Peripheral Data **Bit** **Description** 7-5 Peripheral Qualifier: 000b 4-0 Peripheral Device Type: 01h
1	Page Code: C1h
2	Reserved
3	Page Length: 18h
4-15	Manufacturing Serial Number (set at time of manufacture), right-justified with leading zeroes, in ASCII
16-27	Reported Serial Number over the primary interface (e.g. Inquiry pages 80h and 83h), right-justified with leading zeroes, in ASCII

6.3 Medium auxiliary memory attributes (MAM)

6.3.1 Attribute format

Each medium auxiliary memory attribute shall be communicated between the application client and device server in the format shown in *table 113*. This format shall be used in the parameter data for the WRITE ATTRIBUTE command (see 5.2.39 on page 225) and the READ ATTRIBUTE command (see 5.2.13). The attribute format in this standard implies nothing about the physical representation of an attribute in the medium auxiliary memory.

Table 113 — MAM ATTRIBUTE format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	ATTRIBUTE IDENTIFIER						
1								(LSB)
2	READ ONLY	Reserved					FORMAT	
3	(MSB)	ATTRIBUTE LENGTH (n-4)						
4								(LSB)
5		ATTRIBUTE VALUE						
n								

The ATTRIBUTE IDENTIFIER field contains a code value identifying the attribute (see 6.3.2 on page 278).

The READ ONLY bit indicates whether the attribute is in the read only state (see 4.18 on page 125). If the READ ONLY bit is set to one, the attribute is in the read only state. If the READ ONLY bit is set to zero, the attribute is in the read/write state.

The FORMAT field *(see table 114)* specifies the format of the data in the ATTRIBUTE VALUE field.

Table 114 — MAM attribute FORMAT field

Format	Name	Description
00b	BINARY	The ATTRIBUTE VALUE field contains binary data.
01b	ASCII	The ATTRIBUTE VALUE field contains left-aligned ASCII data.
10b	TEXT	The attribute contains textual data.
11b		Reserved

The ATTRIBUTE LENGTH field specifies the length in bytes of the ATTRIBUTE VALUE field.

The ATTRIBUTE VALUE field contains the current value, for the READ ATTRIBUTE - 8Ch (see 5.2.16 on page 166) command, or intended value, for the WRITE ATTRIBUTE - 8Dh (see 5.2.39 on page 225) command, of the attribute.

6.3.2 Attribute identifier values

6.3.2.1 Attribute identifier values overview

The values in the ATTRIBUTE IDENTIFIER field (see 6.3.1 on page 277) are assigned according to the attribute type (see 4.18 on page 125) and whether the attribute is standard or vendor specific *(see table 115)*.

Table 115 — MAM attribute identifier range assignments

Attribute Identifiers	Attribute Type	Standardized	Subclause
0000h to 03FFh	Device	Yes	*6.3.2.2*
0400h to 07FFh	Medium	Yes	
0800h to 0BFFh	Host	Yes	*6.3.2.4*
0C00h to 0FFFh	Device	Vendor specific	
1000h to 13FFh	Medium	Vendor specific	
1400h to 17FFh	Host	Vendor specific	
1800h to FFFFh	Reserved		

Device servers may accept and process a WRITE ATTRIBUTE command containing standardized host type attribute identifier values (i.e., 0800h-0BFFh) or vendor specific host type attribute identifier values (i.e., 1400h-17FFh). Standardized host type attribute identifier values may be checked as described in *6.3.2.4*.

6.3.2.2 Device type attributes

Device type attributes *(see table 116)* shall be maintained and updated by the device server when the medium and associated medium auxiliary memory are present. All supported medium type attributes shall have a status of read only (see 4.18 on page 125).

Table 116 — Device type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
0009h	VOLUME CHANGE REFERENCE	4	BINARY	*6.3.2.2.5*

6.3.2.2.1 VOLUME CHANGE REFERENCE: IThe VOLUME CHANGE REFERENCE attribute indicates changes in the state of the medium related to logical objects or format specific symbols of the currently mounted volume. There is one value for the volume change reference and the VOLUME CHANGE REFERENCE attribute for each partition shall use the same value. The VOLUME CHANGE REFERENCE attribute value shall:

a) be written to non-volatile medium auxiliary memory before the change on medium is valid for reading; and
b) change in a non-repeating fashion (i.e., never repeat for the life of the volume) and defined to be in a consistent manner per volume format.

The VOLUME CHANGE REFERENCE attribute value shall change when:

a) the first logical object for each mount is written on the medium in any partition;
b) the first logical object is written after GOOD status has been returned for a READ ATTRIBUTE command with the service action field set to ATTRIBUTE VALUES (i.e., 00h) and the first attribute identifier field set to VOLUME CHANGE REFERENCE (i.e, 0009h);
c) any logical object on the medium (i.e., in any partition) is overwritten; or
d) the medium is formatted.

The VOLUME CHANGE REFERENCE attribute may change at other times when the contents on the medium change.

The VOLUME CHANGE REFERENCE attribute should not change if the logical objects on the medium do not change.

A value of zero in the VOLUME CHANGE REFERENCE attribute indicates that the medium has not had any logical objects written to it (i.e., the volume is blank and has never been written to) or the value is unknown.

A value of all ones (e.g., 0xFFFFh) in the VOLUME CHANGE REFERENCE attribute indicates that all values have been used. This value indicates the VOLUME CHANGE REFERENCE value is no longer able to indicate changes to the volume. The device server does not allow further modifications of the medium.

When adding or modifying logical objects the VOLUME CHANGE REFERENCE attribute should only be read after all writing to the volume has completed and been synchronized.

6.3.2.3 Host type attributes

Application clients may use the WRITE ATTRIBUTE and READ ATTRIBUTE commands to maintain the attributes shown in *table 120*. All existent host type attributes shall have a status of read/write (see 4.18 on page 125).

Table 117 — Host type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
080Ch	VOLUME COHERENCY INFORMATION		BINARY	*6.3.2.4.11*
080Bh to BFFh	Reserved			

6.3.2.3.1 VOLUME COHERENCY INFORMATION: Contains information used to maintain coherency of information on a volume (see 4.19 on page 126). The VOLUME COHERENCY INFORMATION attribute ATTRIBUTE VALUE field is defined in *table 122*

Table 118 — VOLUME COHERENCY INFORMATION attribute format

Byte	7 msb	6	5	4	3	2	1	0 lsb
0	VOLUME CHANGE REFERENCE VALUE LENGTH (n)							
1	VOLUME CHANGE REFERENCE VALUE							
n								
n+1	VOLUME COHERENCY COUNT							
n+8								
n+9	VOLUME COHERENCY SET IDENTIFIER							
n+16								
n+17	APPLICATION CLIENT SPECIFIC INFORMATION LENGTH (y-(n+18))							
n+18								
n+19	APPLICATION CLIENT SPECIFIC INFORMATION							
y								

The contents of the VOLUME CHANGE REFERENCE VALUE field, the VOLUME COHERENCY SET IDENTIFIER field, the VOLUME COHERENCY COUNT field, and the APPLICATION CLIENT SPECIFIC INFORMATION field are described in 4.19 on page 126.

The VOLUME CHANGE REFERENCE VALUE LENGTH field contains the length of the VOLUME CHANGE REFERENCE VALUE field.

6.4 Mode Parameters

Mode parameters are used with the *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* commands and the *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* commands.

6.4.1 Mode Parameter List for Mode Select (6/10)

For Mode Select (6) the mode pages are preceded by a 4-byte mode parameter header below, and an optional 8-byte block descriptor (see 6.4.2.2 on page 293). *Table 123* shows the format of the mode parameter list for Mode Select (6).

Table 123 — Mode Parameter List for Mode Select (6)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0 – 3	Mode Parameter Header							
4 – 4+n-1	Block Descriptor (n = 0 or n = 8; if n=0 Block Descriptor does not exist)							
4+n – n	Mode Pages							

For Mode Select (10) the mode pages are preceded by a 8-byte mode parameter header (see *“Mode Parameter Header for Mode Select (6/10)” on page 288*) and an optional 8-byte block descriptor (see *“Block Descriptor for Mode Select (6/10)” on page 289*). Mode page descriptions begin at *“MP 01h: Read-Write Error Recovery” on page 297*.

Table 124 shows the format of the mode parameter list for Mode Select (10).

Table 124 — Mode Parameter List for Mode Select (10)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0 – 7	Mode Parameter Header							
8 – 8+n-1	Block Descriptor (n = 0 or n = 8; if n=0 Block Descriptor does not exist)							
8+n – n	Mode Pages							

6.4.1.1 Mode Parameter Header for Mode Select (6/10)

There is one copy of the mode parameter header for each initiator. *Table 125* shows the format of the mode parameter header for Mode Select (6).

Table 125 — Mode Parameter Header for Mode Select (6)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Reserved (Mode Data Length)							
1	Medium Type							
2	WP	Buffer Mode			Read/Write Speed			
3	Block Descriptor Length							

Table 126 shows the format of the mode parameter header for Mode Select (10).

Table 126 — Mode Parameter Header for Mode Select (10)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	MSB	Reserved (Mode Data Length)						
1								LSB
2	Medium Type							
3	WP	Buffer Mode			Read/Write Speed			
4	Reserved							
5								
6	MSB	Block Descriptor Length						
7								LSB

Mode parameter header field descriptions follow:

Byte Description

0-1 Reserved (Mode Data Length): must be zero.
2 Medium Type: (changeable-ignored)
3 Device-Specific Parameter - Sequential Access Devices

Bit Description

7 Undefined: (changeable-ignored
6-4 Buffered Mode: 001b (changeable)

Value	Description
000b	Good status is reported when data on medium
001b	Good status is reported when data is in buffer
010b	Good status is reported when data in buffer and data from other initiators is written on medium
011b - 111b	Reserved

3-0 Read/Write Speed: 0b (use default speed) (changeable)

NOTE 75 - Selecting a specific speed is not recommended. The drive is designed to dynamically select the optimal speed to achieve maximum systemic performance. This is based on complex criteria including interface bandwidth, host throughput, data compressibility, etc.

4-5 Reserved

6-7 Block Descriptor Length: (changeable)

Value	Description
0000h	No block descriptor follows
0008h	A single block descriptor follows

6.4.1.2 Block Descriptor for Mode Select (6/10)

The presence of the block descriptor in the Mode Select command depends on the value of the Block Descriptor Length in the mode parameter header. There is one copy of the block descriptor for each initiator. *Table 127* shows the format of the block descriptor. The format of the block descriptor is the same for Mode Select (6) and Mode Select (10).

Table 127 — Block Descriptor for Mode Select

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Density Code							
1	MSB	Number of Blocks						
3								LSB
4	Reserved							
5	MSB	Block Length						
7								LSB

The block descriptor field definitions follow:

Byte Description

0 Density Code: (changeable (ignored on J1A)) (see *"Report Density Support - 44h" on page 189*)

NOTE 76 - Changing density and logical format with this mechanism is now supported. The new density will be applied on the next write-type operation when positioned at BOP (Write, Write Filemarks (>0), Erase, Format Medium, etc.) and will not be reported in the Mode Sense Block Descriptor Density Code field before the format is performed. If this value is changed from the value reported in Mode Sense, that change will be remembered until the next write at BOP or until another change is made. Any pending, but unrealized density change will be cleared on unload. Such a pending density code change may also be read or written using Mode Sense/Select (see *"MP 25h: Read/Write Control" on page 332*).

NOTE 77 - If a specific density (e.g., 51h) is specified, this value will only have an effect if it is different than the value returned in Mode Sense. If the same density is returned in Mode Sense is desired, then the value FFh should be used. If the same value is specified, then no change is made to default or previously specified density.

Value	Description
00h	Medium present unidentified for one of the following reasons: • No medium present • Unknown/Unsupported medium present
51h	Medium present is 3592 Enterprise Tape Cartridge (J1A format) density (only JA/JW; JJ/JR medium)
52h	Medium present is 3592 Enterprise Tape Cartridge (E05 format) density (only JA/JW; JJ/JR; JB/JX medium)
53h	Medium present is 3592 Enterprise Tape Cartridge (E06 format) density (only JA/JW; JJ/JR; JB/JX medium)
54h	Medium present is 3592 Enterprise Tape Cartridge (E07 format) density (only JB/JX; JC/JY/JK) medium)
71h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (J1A format) density (only JA/JW; JJ/JR medium)
72h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E05 format) density (only JA/JW; JJ/JR; JB/JX medium)
73h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E06 format) density (only JA/JW; JJ/JR; JB/JX medium)
74h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E07 format) density (only JB/JX; JC/JY/JK) medium)
7Fh	Do not change density (set only - NOOP)
FFh	Use current medium density (set only)

NOTE 78 - On devices which support encryption, secondary encryption density codes may be selected but are interchangeable and identical to primary density codes. Use of any density codes has no effect on the encrypted state of medium and only reports encryption state information and cannot be used to control encryption.

1-3 Number of Blocks: 000000h

4 Reserved

5-7 Block Length: 000000h (changeable)

Any value of block length can be specified between the minimum and the maximum block lengths, inclusive, specified in the Read Block Limits command.

A Block Length value of 000000h indicates that the logical block size to be written to or read from the medium must be explicitly specified by the Transfer Length field in the CDB and the fixed bit must be 0b (see *“Read - 08h” on page 163* and *“Write - 0Ah” on page 224*). Additionally the read-type overlength ILI reporting will be suppressed (see 4.6.1 on page 91).

6.4.2 Mode Parameter List for Mode Sense (6/10)

For Mode Sense (6) the mode pages are preceded by a 4-byte mode parameter header below and an optional block descriptor. If the DBD field is 0b, an 8-byte block descriptor follows the mode parameter header (see *“Block Descriptor for Mode Sense (6/10)” on page 293*). If the DBD field is 1b, the block descriptor is not present and the first mode page follows the mode parameter header. *Table 128* shows the format of the mode parameter list.

Table 128 — Mode Parameter List for Mode Sense (6)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0 – 3	Mode Parameter Header							
4 – 4+n-1	Block Descriptor (if DBD = 0b, then n = 8 an m=12 else DBD = 1b, n = 0,and m=4)							
m – p	Mode Pages							

For Mode Sense (10) the mode pages are preceded by an 8-byte mode parameter header (see *“Mode Parameter Header for Mode Sense (6/10)” on page 292*) and an optional block descriptor. If the DBD field is 0b, an 8-byte block descriptor follows the mode parameter header (see *“Block Descriptor for Mode Select (6/10)” on page 289*). If the DBD field is 1b, the block descriptor is not present and the first mode page follows the mode parameter header. Mode page descriptions begin at *“MP 01h: Read-Write Error Recovery” on page 297*. *Table 129* shows the format of the mode parameter list.

Table 129 — Mode Parameter List for Mode Sense (10)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0 – 7	Mode Parameter Header							
8 – 8+n-1	Block Descriptor (if DBD = 0b, then n = 8 an m=16 else DBD = 1b, n = 0,and m=8)							
m – p	Mode Pages							

6.4.2.1 Mode Parameter Header for Mode Sense (6/10)

There is one copy of the mode parameter header for each initiator. *Table 130* shows the format of the mode parameter header for Mode Sense (6).

Table 130 — Mode Parameter Header for Mode Sense (6)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Mode Data Length							
1	Medium Type							
2	WP	Buffer Mode			Read/Write Speed			
3	Block Descriptor Length							

Table 131 shows the format of the mode parameter header for Mode Sense (10).

Table 131 — Mode Parameter Header for Mode Sense (10)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	MSB	Mode Data Length						
1								LSB
2	Medium Type							
3	WP	Buffer Mode			Read/Write Speed			
4	MSB	Reserved						
5								LSB
6	MSB	Block Descriptor Length						
7								LSB

Mode parameter header field descriptions follow:

Byte **Description**

0-1 Mode Data Length

The length in bytes of the following data that is available to be transferred. The mode data length does not include itself; that is, the length value is total length of the data available minus the size of this field (1 or 2, depending on Mode Sense (6) or (10), respectively).

2 Medium Type:

Value	Description
00h	No medium present or the drive does not support loaded cartridge type
91h	Medium present is 3592 Enterprise Tape — Standard Cartridge (JA)
92h	Medium present is 3592 Enterprise Tape — Extended Cartridge (JB)
93h	Medium present is 3592 Enterprise Tape — Advanced Cartridge (JC)
A1h	Medium present is 3592 Enterprise Tape — Standard WORM Cartridge (JW)
A2h	Medium present is 3592 Enterprise Tape — Extended WORM Cartridge (JX)
A3h	Medium present is 3592 Enterprise Tape — Advanced WORM Cartridge (JY)
B1h	Medium present is 3592 Enterprise Tape — Economy Cartridge (JJ)
B2h	Medium present is 3592 Enterprise Tape — Advanced Economy Cartridge (JK)
C1h	Medium present is 3592 Enterprise Tape — Economy WORM Cartridge (JR)

3 Device-Specific Parameter - Sequential Access Devices

Bit **Description**

7 WP (Write Protect): (changeable-ignored)

Value	**Description**
0b	medium is not write protected
1b	medium is write protected

6-4 Buffered Mode: 001b (changeable)

Value	**Description**
000b	Good status is reported after data is on the medium
001b	Good status is reported after data is in the buffer
010b	Good status is reported after data is in the buffer and data from other initiators is written on the medium
011b - 111b	Reserved

3-0 Read/Write Speed: 0h (use default speed) (changeable)

4-5 Reserved

6-7 Block Descriptor Length:

If DBD = 0, the Block Descriptor Length field is set to 0008h and a block descriptor follows. If DBD = 1, the Block Descriptor Length field is set to 0000h and no block descriptor follows.

6.4.2.2 Block Descriptor for Mode Sense (6/10)

The presence of the block descriptor in the Mode Sense command depends on the value of the DBD bit in the CDB. There is one copy of the block descriptor for each initiator. *Table 132* shows the format of the block descriptor.

Table 132 — Block Descriptor for Mode Sense (10) or Mode Sense (6)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Density Code							
1	MSB			Number of Blocks				
3								LSB
4	Reserved							
5	MSB			Block Length				
7								LSB

The block descriptor definition follows:

Byte	Description
0	Density Code: (see 5.2.24 on page 189)

Value	Description
00h	Medium present unidentified for one of the following reasons: • No medium present • Unknown/Unsupported medium present
51h	Medium present is 3592 Enterprise Tape Cartridge (J1A format) density (only JA/JW; JJ/JR medium)
52h	Medium present is 3592 Enterprise Tape Cartridge (E05 format) density (only JA/JW; JJ/JR; JB/JX medium)
53h	Medium present is 3592 Enterprise Tape Cartridge (E06 format) density (only JA/JW; JJ/JR; JB/JX medium)
54h	Medium present is 3592 Enterprise Tape Cartridge (E07 format) density (only JB/JX; JC/JY/JK medium)
71h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (J1A format) density (only JA/JW; JJ/JR medium)
72h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E05 format) density (only JA/JW; JJ/JR; JB/JX medium)
73h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E06 format) density (only JA/JW; JJ/JR; JB/JX medium)
74h	Medium present is 3592 Enterprise Tape Cartridge Encrypted (E07 format) density (only JB/JX; JC/JY/JK medium)
7Fh	Do not change density (set only - NOOP)
FFh	Use current medium density (set only)

NOTE 79 - On devices which support encryption, secondary encryption density codes may be selected but are interchangeable and identical to primary density codes. Use of any density codes has no effect on the encrypted state of medium and only reports encryption state information and cannot be used to control encryption.

Byte	Description
1-3	Number of Blocks: 000000h
4	Reserved
5-7	Block Length: 000000h (changeable) Any value of block length can be specified between the minimum and the maximum block lengths, inclusive, specified in the Read Block Limits command. A Block Length value of 000000h indicates that the logical block size to be written to or read from the medium must be explicitly specified by the Transfer Length field in the CDB and the fixed bit must be 0b (see *"Read - 08h" on page 163* and *"Write - 0Ah" on page 224*). Additionally the read-type overlength ILI reporting will be suppressed (see 4.6.1 on page 91).

6.4.3 Mode Page Format

Table 133 shows the format of mode pages that do not use subpages.

Table 133 — Mode Page Format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0b)	Page Code					
1	Page Length (n-1)							
2	Mode Parameters							
n								

Table 134 shows the format of mode pages that use subpages.

Table 134 — Mode Page Subpage Format

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(1b)	Page Code					
1	Subpage Code							
2	(MSB)	Page Length (n-3)						
3								(LSB)
4	Mode Parameters							
n								

The individual mode page descriptions that follow include the field descriptions. Each field is non-changeable unless specifically identified otherwise.

6.4.4 Supported Mode Pages

The following standards-based mode pages are supported

MP 01h: Read-Write Error Recovery (see 6.4.5 on page 297)
MP 02h: Disconnect-Reconnect (see 6.4.6 on page 298)
MP 0Ah: Control Mode (see 6.4.7 on page 299)
MP 0Ah[F0h]: Control Data Protection (see 6.4.8 on page 300)
MP 0Fh: Data Compression (see 6.4.9 on page 302)
MP 10h: Device Configuration (see 6.4.10 on page 303)
MP 10h[01h]: Device Configuration Extension (see 6.4.11 on page 306)
MP 11h: Medium Partition Page (see 6.4.12 on page 308)
MP 18h: Fibre Channel Logical Unit Control (see 6.4.13 on page 315)
MP 19h: Fibre Channel Port Control (see 6.4.14 on page 316)
MP 1Ch: Informational Exceptions Control (see 6.4.15 on page 317)

The following vendor-specific mode pages are also supported

MP 21h: TOD Control (see 6.4.16 on page 318)
MP 22h: Language (see 6.4.17 on page 319)
MP 23h: Medium Sense (see 6.4.18 on page 320)
MP 24h: Initiator-Specific Extensions (see 6.4.19 on page 329)
MP 25h: Read/Write Control (see 6.4.20 on page 332)
MP 30h: Device Attribute Settings (see 6.4.21 on page 337)
MP 37h: String Search (not J1A) (see 6.4.22 on page 353)
MP 3Eh: Engineering Support (see 6.4.23 on page 365)
“Mode Page 3Fh: All Pages”

NOTE 80 - Mode page 37h is not included in page 3Fh.

NOTE 81 - Mode page 3Eh is for engineering use only and is not included in page 3Fh

6.4.5 MP 01h: Read-Write Error Recovery

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

This page is defined as common to all initiators.

Byte Description

0

Bit	**Description**
7	PS (Parameter Saveable): 0b
6	Reserved
5-0	Page Code: 01h

1 Page Length: 0Ah

2

Bit Description

7-6 Reserved

5 TB (Transfer Block): 1b

4 Reserved

3 EER (Enable Early Recovery): 1b

2 PER (Post Error): 0b

Value Description

0b The device does not create CHECK CONDITION status for recovered errors except for non-deferred sense data of:

— 1/0017 (Recovered Error, Drive Needs Cleaning) for a Load Unload command

— 1/3700 (Recovered Error, Rounded Parameter) for a Mode Select command, and

— 1/8383 (Recovered Error, Drive Has Been Cleaned) for a Load Unload command.

For reporting of Housekeeping errors, see *"MP 25h: Read/Write Control" on page 332*.

1b The device will report a CHECK CONDITION status for all recovered data and non-data errors with a sense key of 1 in non-deferred sense data as well as deferred sense data.

1 DTE (Disable Transfer on Error): 0b (changeable-ignored)

0 DCR (Disable Correction): 0b

3 Read Retry Limit: FFh (approximate maximum read recovery limit in seconds) (changeable)

Value	**Description**
05h	Limited error recovery; < 5 seconds.
FFh	Full Recovery Routines allowed (no time limit).
XXh	All other values may be rounded (to non-FFh).

4-7 Reserved

8 Write Retry Limit: FFh (approximate maximum write recovery limit in seconds) (changeable)

Value	**Description**
02h	Limited error recovery; < 2 seconds.
05h	Limited error recovery; < 5 seconds.
FFh	Full Recovery Routines allowed (no time limit).
XXh	All other values may be rounded (to non-FFh).

9-11 Reserved

6.4.6 MP 02h: Disconnect-Reconnect

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

There is one copy of this page for each initiator.

Byte	Description
0	
	Bit / **Description**
	7: PS: 0b
	6: Reserved
	5-0: Page Code: 02h
1	Page Length: 0Eh
2	Buffer Full Ratio: 00h
3	Buffer Empty Ratio: 00h
4-5	Bus Inactivity Limit: 0000h (no limit)
6-7	Disconnect Time Limit: 0000h (no limit)
8-9	Connect Time Limit: 0000h (no limit)
10-11	Maximum Burst Size: SCSI - 0000h (no limit)
12	
	Bit / **Description**
	7: EMDP (Enable Modify Data Pointers): 0b
	6: FARd (Fair Arbitration Read): 0b
	5: FAWrt (Fair Arbitration Write): 0b
	4: FAStat (Fair Arbitration Status): 0b
	3: Dimm (Disconnect Immediate): 0b
	2-0: DTDC (Data Transfer Disconnect Word): 000b
13	Reserved
14-15	First Burst Size: 0000h

6.4.7 MP 0Ah: Control Mode

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

There is one copy of this page for each initiator.

Byte **Description**

0

Bit	**Description**
7	PS: 0b
6	Reserved
5-0	Page Code: 0Ah

1 Page Length: 0Ah

2

Bit	**Description**
7-5	TST (Task Set Type): 000b
4-2	Reserved
1	GLTSD (Global Logging Target Save Disable): 0b
0	RLEC (Report Log Exception Condition): 0b

3

Bit	**Description**
7-4	Queue Algorithm Modifier: 0000b
3-2	Reserved
1	QErr (Queue Error): 0b
0	DQue (Disable Queuing): 1b

4

Bit	**Description**
7	Reserved
6	RAC (Report A Check): 0b
5-3	Reserved
2	RAERP (Ready Asynchronous Event Reporting): 0b
1	UAAERP (Unit Attention Asynchronous Event Reporting): 0b
0	EAERP (Error Asynchronous Event Reporting): 0b

5 Reserved

6-7 Ready AEN Holdoff Period: 0000h
If AEN is disabled (Byte 4 bit 2 = 0b), this field is not meaningful.

8-9 Busy time-out period: FFFFh

10 Reserved

11 Reserved

6.4.8 MP 0Ah[F0h]: Control Data Protection

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Control Data Protection mode page provides controls that allow selective use of logical block protection. Logical block protection (see 4.4 on page 80) describes how this page is used to control logical block protection.

The mode page policy of this page is Per I_T nexus.

Table 135 — Control Data Protection mode page format

Byte	Bit 7	6	5	4	3	2	1	0
0	PS	SPF(1b)	PAGE CODE (0Ah)					
1	SUBPAGE CODE (F0h)							
2	(MSB)	PAGE LENGTH (28)						
3								(LSB)
4	LOGICAL BLOCK PROTECTION METHOD							
5	Reserved		LOGICAL BLOCK PROTECTION INFORMATION LENGTH					
6	LBP_W	LBP_R	RBDP	Reserved				
7	Reserved							
8 - 31	Reserved							

Byte Description

0

Bit	Description
7	PS:
	Value / **Description**
	0b — Required in a MODE SELECT command.
	1b — Returned in a MODE SENSE command.
6	SPF: 1b
5-0	PAGE CODE: 28h

1 SUBPAGE CODE: 01h

2-3 PAGE LENGTH: 1Ch

4 LOGICAL BLOCK PROTECTION METHOD:

Value	Description
00h	Do not use logical block protection
01h	Use the Reed-Solomon CRC as defined in ECMA-319 as the logical block protection information.
others	Reserved.

5

Bit	Description
7-6	Reserved
5-0	LOGICAL BLOCK PROTECTION INFORMATION LENGTH: 04h.

6

Bit **Description**

7 LBP_W (logical blocks protected during write): 0 (changeable)

Shall be set to zero if the LOGICAL BLOCK PROTECTION METHOD field is set to zero.

Value	Description
0	Protection information is not included with logical blocks transferred when writing.
1b	Protection information is included with logical blocks transferred during commands specified in Protecting logical blocks transferred during writes (see 4.4.5 on page 86).

6 LBP_R (logical block protected during read): 0 (changeable)

Shall be set to zero if the LOGICAL BLOCK PROTECTION METHOD field is set to zero.

Value	Description
0	Protection information is not included with logical blocks transferred when reading.
1b	Protection information is included with logical blocks transferred during commands specified in Protecting logical blocks transferred during reads (see 4.4.6 on page 86).

5 RBDP (recover buffered data protected): 0b (changeable)

4-0 Reserved

7-31 Reserved

6.4.9 MP 0Fh: Data Compression

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

This page is defined as common to all initiators.

Byte Description

0

Bit	Description
7	PS: 0b
6	Reserved
5-0	Page Code: 0Fh

1 Page Length: 0Eh

2

Bit	Description
7	DCE (Data Compression Enabled): 1b

Value	Description
0	Data compression is not enabled
1	Data compression is enabled

NOTE 82 - The only advantage to disabling data compression is predictable full tape capacity (see 3.1.6 on page 74)

Bit	Description
6	DCC (Data Compression Capable): 1b
5-0	Reserved

3

Bit	Description
7	DDE: 1b
6-5	RED (Report Exception on Decompression): 00b
4-0	Reserved

Byte	Description
4-7	Compression Algorithm: 000000FFh (Unregistered algorithm)
8-11	Decompression Algorithm: 000000FFh (Unregistered algorithm)
12	Reserved
13	Reserved
14	Reserved
15	Reserved

6.4.10 MP 10h: Device Configuration

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

This page is defined as common to all initiators.

Table 136 — Device Configuration mode page

Bit / **Byte**	7	6	5	4	3	2	1	0
0	PS	SPF(0b)	PAGE CODE (10h)					
1	PAGE LENGTH (0Eh)							
2	Rsvd	Obsolete	CAF(0b)	ACTIVE FORMAT (00h)				
3	ACTIVE PARTITION							
4	WRITE OBJECT BUFFER FULL RATIO (00h)							
5	READ OBJECT BUFFER EMPTY RATIO (00h)							
6	(MSB)	WRITE DELAY TIME						
7								(LSB)
8	OBR (1)	LOIS (1)	Obsolete	AVC (0)	SOCF (0)		ROBO	REW (0)
9	Obsolete							
10	EOD DEFINED (0h)			EEG (1)	SEW (1)	SWP (0)	BAML(0)	BAM(0)
11	(MSB)	OBJECT BUFFER SIZE AT EARLY WARNING (000000h)						
12								
13								(LSB)
14	SELECT DATA COMPRESSION ALGORITHM							
15	WTRE		OIR	REWIND ON RESET (10b)		ASOCWP(0)	PERSWP(0)	PRMWP(0)

Byte **Description**

0

- **Bit** **Description**
- 7 PS: 1b The PS bit is set to one on MODE SENSE and ignored on MODE SELECT
- 6 Reserved
- 5-0 Page Code: 10h

1 Page Length: 0Eh

2

- **Bit** **Description**
- 7 Reserved
- 6 CAP (Change Active Partition): 0b
  - **Value** **Description**
  - 0 No partition change is specified.
  - 1 Change logical partition to the partition specified by Active Partition.
- 5 CAF (Change Active Format): 0b
- 4-0 Active Format: 00000b

3 Active Partition (non-changeable)

For Mode Select this field is ignored.

For Mode Sense this field specifies the current logical partition number in use on the volume.

4 Write Buffer Full Ratio: 00h (value not specified)

5 Read Buffer Empty Ratio: 00h (value not specified)

6-7 Write Delay Time: 0014h (about 2 sec)

8

Bit	Description
7	DBR (Data Buffer Recovery): 1b
6	BIS (Block Identifier Supported): 1b
5	RSmk (Report Setmarks): 0b
4	AVC (Automatic Velocity Control): 0b
3-2	SOCF (Stop on Consecutive Filemarks): 00b 00 (read ahead to fill buffer, without regard for filemarks)
1	RBO (Recover Buffer Order): 0b
0	REW (Report Early Warning): 0b

RBO values:

Value	Description
0	FIFO
1	LIFO

9 Gap Size: 00h

10

Bit	Description
7-5	EOD Defined (End Of Data Defined): 000b
4	EEG (Enable EOD Generation): 1b
3	SEW (Synchronize at Early-Warning): 1b
2	SWP (Soft Write Protect): 0b
1-0	Reserved

11-13 Buffer Size at Early Warning: 000000h

14 Select Data Compression Algorithm: 01h

Value	Description
00h	No compression used
01	Use default compression algorithm (ELDC)

NOTE 83 - The only advantage to disabling data compression is predictable full tape capacity (see 3.1.6 on page 74)

NOTE 84 - On a Mode Sense, the value of byte 14 will always be consistent with what is found on Mode Page 0F, Byte 2, Bit 7. If this byte alone is updated on a Mode Select, and Mode Page 0F is not sent, then Mode Page 0F, Byte 2, Bit 7 is updated to according to this field. If both Page 10 and Page 0F are sent, then what is in Page 0F is used to update both fields and any legal value in byte 14 is ignored.

15

Bit	Description
7-6	Reserved
5	OIR (Only If Reserved) 0b (changeable) (not changeable on earlier code levels) (saveable) This field dictates the behavior of commands other than RESERVE, RELEASE, PERSISTENT RESERVE IN, and PERSISTENT RESERVE OUT.

Value	Description
0b	Commands are processed per RVC column of Table 1. Drive Commands. No reservation is required to process the commands.
1b	Commands listed with a ‘Y’ in the RVC column of Table 1. Drive Commands are rejected with ILLEGAL REQUEST, NOT RESERVED if received and no reservation is present in the drive. If a reservation is present in the drive, the

commands are processed only if a reservation exists that allows access via the I_T nexus from which the command was received.

4-3 Reserved

2 ASOCWP (Associated Write Protect): 0b (changeable)

Value	Description
0	No soft write protect is in effect
1	No write type commands will be allowed for the current mount

1 PERSWP (Persistent Write Protect) 0b (from media) (changeable)

Value	Description
0	Persistent Write Protect not in effect
1	No write type commands will be allowed on this tape.

0 PRMWP (Permanent Write Protect): 0b (from media) (settable)

Value	Description
0	No soft write protect is in effect
1	No write type commands will ever be allowed for the mounted tape. This is permanent and cannot be reset. The media will be unwriteable after this operation is completed. Unlike Persistent Write Protect, <u>**Permanent Write Protect can never be reset except by degaussing. The media has factory written servo formatting and is unusable if degaussed.**</u>

Identical functions are provided by the write protect bits in vendor unique Mode Page 23. On a Mode Sense, the values in byte 15 will always match up with what is found on vendor unique Mode Page 23, Byte 10. If this byte alone is updated on a Mode Select, and Mode Page 23 is not sent, then Mode Page 23, Byte 10 is updated to match what was set in this field. If both Page 10 and Page 23 are sent, then what is in Page 10, byte 15 is used to update both fields and any legal value in Mode Page 23, Byte 10 is ignored.

6.4.11 MP 10h[01h]: Device Configuration Extension

The Device Configuration Extension mode page (see *table 137*), a subpage of the Device Configuration mode page (see 6.4.9), provides control of the SCSI features specific to sequential-access devices and is supported on device models 3592 E07 and later. The Device Configuration Extension mode page uses the shared mode page policy.

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

Table 137 — Device Configuration Extension mode page

Byte \ Bit	7	6	5	4	3	2	1	0
0	PS	SPF(1b)	PAGE CODE (10h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (1Ch)						
3								(LSB)
4	Reserved				TARPF (0)	TASER(0)	TARPC(0)	TAPLSD(0)
5	WRITE MODE				SHORT ERASE MODE (2h)			
6	(MSB)	PEWS						
7								(LSB)
8	Reserved							VCELBRE
9 - 31	Reserved							

Byte Description

0

Bit	Description
7	PS: 1b Set to 1b in MODE SENSE command indicating that the changeable parameters in the mode page are saveable by issuing a MODE SELECT command with the SP bit set to one.
6	SPF: 1b
5-0	PAGE CODE: 10h

1 SUBPAGE CODE: 01h

2-3 PAGE LENGTH: 1Ch

4

Bit	Description
7-4	Reserved
3	TARPF: 0b
2	TASER: 0b
1	TARPC: 0b
0	TAPLSD: 0b

5

Bit	Description
7-4	WRITE MODE: (0h) (changeable) The WRITE MODE field specifies the write mode (see 4.13 on page 108) in which to place the device server. Enablement is allowed when no volume is loaded or when positioned at BOP 0.

Disablement is allowed when no volume is loaded. The command is rejected with ILLEGAL REQUEST, INVALID FIELD IN PARAMETER LIST if a volume is loaded and:

a) an attempt is made to change the WRITE MODE from 1h (i.e., append-only) to 0h (i.e., write-anywhere); or
b) the logical position of the volume is not at BOP 0 and an attempt is made to change the WRITE MODE from 0h (i.e., write-anywhere) to 1h (i.e., append-only).

The values supported are:

Value	Description
0h	write-anywhere mode (see 4.13.2 on page 108).
1h	append-only mode (see 4.13.3 on page 108).

NOTE 85 - Support for a value of 1h was added after GA. Support may be discovered by examining the changeable bit mask returned in MODE SENSE.

3-0 SHORT ERASE MODE: (2h)

The device server, when performing a short erase records an EOD indication at the specified location on the medium.

6-7 PEWS (programmable early warning size)

The programmable early warning size (PEWS) field specifies the number of megabytes (i.e., 10^6) native capacity to use in establishing a PEWZ. See Programmable early warning (see 4.3 on page 79) for a description of programmable early warning. Device models 3592 E07 and later support the PEWS field set to any value and does not round the value (e.g., due to volume capacity). The default value is 0000h indicating that there is no PEWZ.

NOTE 86 - It is possible that a partition is set to a capacity less than the size that can be represented by the PEWS field. In this case the first write will get the programmable early warning indication.

NOTE 87 - PEWZ will be created using the amount of medium required to fit PEWS megabytes assuming one-to-one compression (e.g., compression disabled) and the medium is in good condition.

NOTE 88 - The drive employs a design to protect against the number of blocks on medium exceeding a value that can be represented in a 4-byte field. To ensure the programmable early warning indication is reported to an application during this scenario, the drive also uses the number of blocks on medium as a determination of entering PEWZ. The drive calculates how many blocks it will take to fill PEWZ assuming a modest block size of 64k (i.e., PEWS/10000h = number_of_blocks_to_make_PEWZ) and reports programmable early warning when the number of blocks on medium reaches PEWZ (i.e., FFFF FF00h - number_of_blocks_to_make_PEWZ).

8

Bit	Description
7-1	Reserved
0	VCELBRE (volume containing encrypted logical blocks requires encryption)

If the volume containing encrypted logical blocks requires encryption (VCELBRE) bit is set to one and the VCELB bit in the Data Encryption Status page is set to one, then the device server requires that any logical blocks written to the medium are encrypted. If the VCELBRE bit is set to zero, then the device server does not use the VCELB bit in the Data Encryption Status page to determine if encryption is required for writing logical blocks. The encryption mode (see 4.10) setting determines the behavior of the VCELBRE bit. This interaction is described in *table 138*.

Table 138 — VCELBRE behavior related to encryption modes

Encryption mode	VCELBRE is	
	Set to	Changeable on LUN 0
AME [1]	0b	Yes
Transparent Encryption - IBM (e.g., LME) [2]	1b	No
ADC Controlled [3]	1b	Yes

1 AME — Application Managed Encryption using in-band methods of controlling encryption (e.g., Logical block encryption described in SSC-3; method used by TSM).
2 Transparent Encryption - IBM — Application transparent encryption using a proxy to the IBM EKM or TKLM (e.g., LME; SME).
3 ADC Controlled — ADC tape data encryption (see ADC-3) using External data encryption control (see SSC-3).

9-31 Reserved

6.4.12 MP 11h: Medium Partition Page

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

This page is only supported on drives that support partitioning (i.e., 3592 E07 and later)

This page is defined as common to all initiators.

The Medium Partition mode page (see *table 139*) is used to specify the group of medium partitions. Fields in the Medium Partition mode page indicating the current state of the partitions for the medium are changed by the device server to the current medium state on a not ready to ready transition when the medium state changes from demounted to mounted.

The partitioning of the mounted volume is not changed until a subsequent FORMAT MEDIUM command is issued while the volume is mounted.

WARNING WARNING

The fields in this page do not follow normal mode parameter rules. Some fields always return values depending on the mounted volume even after a MODE SELECT command changes them. Other fields return pending values set by a MODE SELECT command instead of values dictated by the mounted volume. Check each field description to understand this behaior.

WARNING WARNING

The device ensures consistency of the partitioning values set in this mode page by causing a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PARAMETER VALUE INVALID to be returned to a subsequent FORMAT MEDIUM command attempting to use this mode page if values in this page become inconsistent between when they were set and when the FORMAT MEDIUM command is received. The invalidation of the values in this page is accomplished by setting the FDP, SDP, and IDP bits to zero and the other values in this page to:

a) the values dictated by the format of the currently mounted volume, if a volume is mounted; or
b) the default values present after power-on, if no volume is mounted.

The invalidation of values in this page occurs if:

a) the PENDING WRITE DENSITY AT BOP 0 field of MP 25h: Read/Write Control (see 6.4.20 on page 332) is modified;
b) the volume is capacity scaled (see MP 23h: Medium Sense (see 6.4.18 on page 320)); or
c) other events that are determined to make the values in this page inconsistent.

There is an overhead associated with each additional partition, regardless of the size of the partition, that subtracts from the customer data space on the volume. The larger the number of possible partitions, the more overhead is consumed when the volume is partitioned.

See Partitioning and reformatting (see 4.14.5 on page 118) for restrictions on partitioning scaled volumes.

Table 139 — Medium Partition mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS(0b)	SPF(0b)	PAGE CODE (11h)					
1	PAGE LENGTH (n-1)							
2	MAXIMUM ADDITIONAL PARTITIONS							
3	ADDITIONAL PARTITIONS DEFINED							
4	FDP	SDP	IDP	PSUM (11b)		POFM (1b))	CLEAR (0b)	ADDP(0b)
5	MEDIUM FORMAT RECOGNITION (03h)							
6	PARTITIONING TYPE				PARTITION UNITS			
7	Reserved							
Partition size descriptor(s)								
8	(MSB)	PARTITION SIZE (first)						
9								(LSB)
n-1	(MSB)	PARTITION SIZE (last)						
n								(LSB)

Byte **Description**

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 11h

1 PAGE LENGTH:

In a MODE SENSE command: 0Eh (14).

In a MODE SELECT command:

Condition	Description
FDP=1	6 + 2 * k; where 0 <= k <= 4
SDP=1	6 + 2 * k; where 0 <= k <= 4
IDP=1	6 + 2 * k; where (ADDITIONAL PARTITIONS DEFINED + 1) <= k <= 4.

2 MAXIMUM ADDITIONAL PARTITIONS: (non-changeable)

This field specifies the maximum number of additional partitions supported on the loaded volume at the PENDING WRITE DENSITY AT BOP 0. It can be thought of as the value N-1 where N is the maximum number of partitions allowed. In a MODE SENSE command the MAXIMUM ADDITIONAL PARTITIONS field is set to the value indicated by the loaded volume at the PENDING WRITE DENSITY AT BOP 0, or the value reported for the previously loaded volume if there is no volume loaded. If there has been no volume loaded since power-on or the mounted volume does not support partitioning (see 4.14 on page 112), then the MAXIMUM ADDITIONAL PARTITIONS field is set to 00h.

This value may be changed by the device if:

a) a volume is loaded; or
b) other unspecified events occur.

3 ADDITIONAL PARTITIONS DEFINED: 0h (changeable)

This field specifies the number of additional partitions on the mounted volume (in addition to partition 0). It can be thought of as the value N-1 where N is the total number of partitions.

The values for this field may be 00h, 01h, 02h, or 03h for SDP or IDP.

This field is ignored when FDP is set to one (i.e., any value is allowed and ignored).

This field is not allowed to change when the drive is not ready.

The partitioning of the mounted volume is not changed until a subsequent Format Medium command is issued while the volume is mounted. If the logical unit is not ready, the ADDITIONAL PARTITIONS DEFINED field is undefined.

> NOTE 89 - If a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command, then the ADDITIONAL PARTITIONS DEFINED value returned is the value sent in the MODE SELECT command.

4

Bit **Description**

7 FDP (Fixed Data Partitions): 0b (changeable)

A FDP bit of one in a MODE SELECT command specifies the logical unit shall partition the medium based on its fixed definition of partitions. Setting this bit to one is mutually exclusive with the SDP and IDP bits. The ADDITIONAL PARTITIONS DEFINED field, the PARTITIONING TYPE field, and the partition size descriptors are ignored by the MODE SELECT command when the FDP bit is set to one. The drive creates two partitions on the volume and assigns one partition as the minimum sized partition and one partition as the remaining available size.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the FDP bit returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the FDP bit is set to zero.

> NOTE 90 - The partition size descriptors are present in MODE SENSE data regardless of the settings of the FDP, SDP or IDP fields to give an estimate of the size of each partition.

6 SDP (Select Data Partitions): 0b (changeable)

For Mode Select, either value is allowed

Value	Description
0b	The SDP functionality is not used.
1b	The volume is partitioned into the number of partitions as specified by the ADDITIONAL PARTITIONS DEFINED field (n) using partitions as close to equal size as possible. If rounding is required to meet format requirements, partitions will be rounded up from the equal size and the last partition (i.e., n + 1) will use the remaining capacity. The drive partitions the volume into n+1 partitions numbered 0 through n. Setting this bit to one is mutually exclusive with the FDP and IDP fields. The partition size descriptors are ignored by the MODE SELECT command when the SDP bit is set to one.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT command the SDP bit returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the SDP bit is set to zero.

5 IDP (Initiator Defined Partitions): 0b (changeable)

For Mode Select, either value is allowed

Value	Description
0b	The IDP functionality is not used.
1b	The volume is partitioned as specified by the ADDITIONAL PARTITIONS DEFINED field and the partition size descriptors. Setting this bit to one is mutually exclusive with the FDP and SDP fields. The number of non-zero partition size descriptors received

in the Medium Partition mode page shall be one more than the ADDITIONAL PARTITIONS DEFINED value. The size of partition 0 shall be non-zero.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the IDP bit returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the IDP bit is set to one.

4-3 PSUM (Partition Size Unit of Measure): 11b ($10^{(\text{PARTITION UNITS})}$ bytes) (non-changeable)

2 POFM (Partition on Format Medium): 1b (non-changeable)

This bit indicates that the Mode Select command will not cause changes to the partition sizes or user data, either recorded or buffered. Actual media partitioning occurs with a subsequent Format Medium command using the mode data for this page. Field values specified by a Mode Select command for this page will not be changed by the drive before the volume is unloaded or the drive is reset. Some field checking may be performed by the MODE SELECT command. However, there is no guarantee that any subsequent partitioning during a FORMAT MEDIUM command will complete with no errors.

1 CLEAR (Partition clearing): 0b (non-changeable)

0 ADDP (Adding Partitions): 0b (non-changeable)

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the values returned in the fields in byte 4 are the values that were set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page, then the values returned in the fields in byte 4 depend on the mounted volume.

See Volume partitioning (see 4.14 on page 112) for a detailed description of how to select partition sizes.

5 MEDIUM FORMAT RECOGNITION: 03h (Capable of format and partition recognition)

6

Bit **Description**

7-4 PARTITIONING TYPE: 0h (changeable)

This field is ignored if the FDP bit is set to one.

In the future, this device may support more than one type of partitioning. The PARTITIONING TYPE field specifies the criteria used to describe the partitions.

Value **Description**

0h The type of partitioning is unknown

The drive sets the PARTITIONING TYPE field to a value of 1h when a 0h is received in a MODE SELECT command.

If the volume is not partitioned, then a MODE SENSE command returns this value unless there is a pending action from a MODE SELECT

1h The type of partitioning is optimized for streaming performance (i.e., wrap-wise partitioning).

When this value is selected there may be a maximum of four partitions. See Wrap-wise Partitioning (see 4.14.2 on page 112) for a detailed description of how to select partition sizes.

2h The type of partitioning is optimized for random access performance (i.e., longitudinal partitioning).

When this value is selected there may be a maximum of two partitions. See Longitudinal Partitioning (see 4.14.3 on page 116) for a detailed description of how to select partition sizes.

Longitudinal partitioning support may be added in the future. A volume that is partitioned with longitudinal partitioning may be detected in a device that has a firmware level that does not support longitudinal partitioning. If a device operating a firmware level that does not support longitudinal partitioning detects that a volume is partitioned with longitudinal partitioning, then the volume is rejected as an unsupported format.

3h-Eh Reserved

Fh For a MODE SENSE command, this value is not returned because this device does not support multiple types of partitioning on the same volume. For a MODE SELECT command this value is reserved.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the PARTITIONING TYPE field returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the PARTITIONING TYPE field is set depending on how the volume is currently partitioned.

3-0 PARTITION UNITS:

The PARTITION UNITS is used in a MODE SELECT to define the value of the PARTITION SIZE descriptors.When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the PARTITION UNITS field returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page, then the PARTITION UNITS field is set depending on how the volume is currently partitioned.

7 Reserved

8-n PARTITION SIZE descriptors: (n=9, 11, 13, or 15) (changeable)

Each PARTITION SIZE descriptor specifies the size of a partition in $10^{\text{PARTITION UNITS}}$ bytes. The device rounds, any value received in a PARTITION SIZE descriptor to the nearest valid partition size. Volume partitioning (see 4.14 on page 112) provides a detailed description of how to select values for each PARTITION SIZE descriptor.

Byte Description

8-9 PARTITION SIZE descriptor for partition 00h

This shall exist and shall be non-zero.

10-11 PARTITION SIZE descriptor for partition 01h, if sent

This descriptor shall be present and non-zero if the ADDITIONAL PARTITIONS DEFINED field is 01h or greater. This descriptor may be present and set to zero if the ADDITIONAL PARTITIONS DEFINED field is 00h.

12-13 PARTITION SIZE descriptor for partition 02h, if sent

This descriptor shall be present and non-zero if the ADDITIONAL PARTITIONS DEFINED field is 02h or greater. This descriptor may be present and set to zero if the ADDITIONAL PARTITIONS DEFINED field is less than 02h.

14-15 PARTITION SIZE descriptor for partition 03h, if sent

This descriptor shall be present and non-zero if the ADDITIONAL PARTITIONS DEFINED field is 03h. This descriptor may be present and set to zero if the ADDITIONAL PARTITIONS DEFINED field is less than 03h.

NOTE 91 - Summing the partition sizes provides a standardized mechanism for an initiator to calculate the volume capacity with MODE SENSE.

In a MODE SELECT command:

a) a value of FFFFh received in a PARTITION SIZE descriptor, requests that the logical unit allocate all remaining partition space to that partition;
b) if the FDP bit is set to one any values are allowed in the PARTITION SIZE descriptors and ignored;
c) if the SDP bit is set to one any values are allowed in the PARTITION SIZE descriptors and ignored. The PARTITION SIZE descriptors are updated by the drive when an initiator specifies a new number of partitions; and
d) the device server returns CHECK CONDITION status with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST if:
   A) insufficient space exists on the volume for the requested partition sizes; or

B) multiple partition size descriptors are set to FFFFh.

In a MODE SENSE command:

a) All four PARTITION SIZE descriptors are always returned in a MODE SENSE command.
b) a value of FFFFh returned in a PARTITION SIZE descriptor, indicates the partition size, in units indicated by PSUM and PARTITION UNITS, is greater than or equal to FFFFh;
c) if the logical unit is not ready, then the PARTITION SIZE descriptors are undefined;
d) if a MODE SELECT command has modified values in this page but a FORMAT MEDIUM command has not yet been processed, then the values in the PARTITION SIZE fields are the values set by the MODE SELECT command rounded to a valid partition size as described in Volume partitioning (see 4.14 on page 112); and
e) if the logical unit is ready and there is no pending change related to a MODE SELECT command for this page, then the PARTITION SIZE fields reflect the size on the volume of the related partition.

NOTE 92 - When more than one partition is defined, the sum of the partition sizes may be less than when only a single partition is defined. Each partition requires a certain amount of overhead space on a volume, which reduces the usable customer data space.

6.4.13 MP 18h: Fibre Channel Logical Unit Control

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

There is one copy of this page for each initiator. This page is defined for Fibre Channel attached devices only.

Byte	Description
0	**Bit** / **Description** 7 PS (Page Save): 0b 6 Reserved 5-0 Page Code: 18h
1	Page Length: 06h
2	Reserved
3	**Bit** / **Description** 7-1 Reserved 0 EPDC (Enable Precise Delivery Control): 1b
4-7	Reserved

6.4.14 MP 19h: Fibre Channel Port Control

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

There is one copy of this page per Fibre Channel port. This page is defined for Fibre Channel attached devices only.

Byte Description

0

Bit	**Description**
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 19h

1 Page Length: 06h

NOTE 93 - A Page Length of 0Eh is allowed on Mode Select for backwards compatibility with older devices and levels of the standard. Any fields beyond byte 7 below are ignored.

2 Reserved

3

Bit	**Description**
7	DTFD (Disable Target Fabric Discovery): 0b
6	PLPB (Prevent Loop Port Bypass): 0b
5	DDIS (Disable Discovery): 0b
4	DLM (Disable Loop Master): 0b
3	RHA (Require Hard Address): 0b
2	ALWI (Allow Login without Loop Initialization): 0b
1	DTIPE (Disable Target Initiated Port Enable): 0b
0	DTOLI (Disable Target Originated Loop Initialization): 0b

4-5 Reserved

6

Bit	**Description**
7-3	Reserved
2-0	RR_TOV Units (changeable)

Value	**Description**
000b	No timer is specified
001b	Timer is specified in.001 second units
011b	Timer is specified in.1 second units
101b	Timer is specified in 10 second units

7 RR_TOV (Resource Recovery Time Out Value): (changeable)

NOTE 94 - The default RR_TOV value is 25 seconds.

6.4.15 MP 1Ch: Informational Exceptions Control

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

There is one copy of this page for each initiator.

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 1Ch

1 Page Length: 0Ah

2

Bit	Description
7	Perf: 0b
6-4	Reserved
3	DExcpt: 1b

Value	Description
0b	Exception Reporting is enabled
1b	Exception Reporting is disabled

Bit	Description
2	Test: 0b

Value	Description
0b	The next command is processed normally (always on Mode Sense)
1b	The next command will fail with a 1/5DFF (Recovered Error, Failure Prediction Threshold Exceeded-FALSE).

Bit	Description
1	Reserved
0	Logerr: 0b

3

Bit	Description
7-4	Reserved
3-0	MRIE: 3h

The MRIE field must be 3h. If an exception occurs, the next command will return 1/5D00 (Recovered Error, Failure Prediction Threshold Exceeded).

4-7 Interval Timer: 00000000h

8-11 Report Count: 00000000h

6.4.16 MP 21h: TOD Control

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

The TOD (Time-of-Day) control is used to provide the device with an estimate of the correct time. The device adds the current TOD clock to every block transferred to media. These time traces can then be used by engineering for analysis of medium at a later time. It is strongly recommended to device driver writers with access to system or network clocks to use this mode page to enable system time based device tracing.

The Time-of-Day clock is a binary counter with a 64-bit format: bit 63 being the highest value; bit 0 being the lowest. Bit 32 represents a 1 second clock; that is, the TOD is incremented by 1 in bit position 32, once every second. This gives the TOD clock a cycle time of approximately 136 years. Setting the high order byte to any number greater than F0 will result in parameter rounding down to F0 with CHECK CONDITION status and associated sense data of 1/3700 (Recovered Error, Rounded Parameter). The time of day may be set at any time. Page Code 21 is designed to provide the time-of-day clock setting to the device for 3592 format data.

This page is defined as common to all initiators.

> The Time-of-Day clock may be set by the library in which the drive resides. If a library sets the Time-of-Day clock the value set by the library will be used. An initiator may still issue a Mode Select with this page and attempt to set the Time-of-Day clock and will get a GOOD status returned. However, the value set by the library will still be the value used.

Byte Description

0

Bit	**Description**
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 21h

1 Page Length: 0Ah

2-9 Time of Day: (changeable)

The default time setting at power on is 0000 0000 0000 0000h. The time setting may be preserved across certain reset conditions. The Time of Day (TOD) clock begins counting relative time from that point.

When sensed, the TOD field returns the current drive time. If the TOD field has never been set, the TOD field contains the elapsed power on time from the default value of 0000 0000 0000 0000h, which corresponds to a time of January 1, 1970, 0:00 AM, Greenwich Mean Time (GMT).

10 Time-of-Day Flags

Bit	**Description**
7-3	Vendor-Reserved
2	TOD Reset Valid: 0b (changeable)

Value	**Description**
0b	The TOD clock will not be changed (always on Mode Sense)
1b	The TOD clock will be set to Time of Day (Mode Select only)

1 SysSet TOD:

Value	**Description**
0b	The TOD was not set by an initiator
1b	The TOD was set by an initiator

0 Relative TOD:

Value	**Description**
0b	The TOD was not set by the device
1b	The TOD was set by the device

6.4.17 MP 22h: Language

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

NOTE 95 - Operator languages other than English are not supported for this device. This mode page is supported for backwards compatibility only.

Byte	Description
0	
	Bit **Description**
	7 PS (Page Save): 0b
	6 Reserved
	5-0 Page Code: 22h
1	Page Length: 02h
2	Current Language When sensed, this field indicates the current language. The following languages are supported: **Value** **Language** 00h U.S. English
3	Requested Language: (changeable-ignored)

6.4.18 MP 23h: Medium Sense

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

The Medium Sense page provides information about the state of the medium currently associated with the device, if any.

This page is defined as common to all initiators.

NOTE 96 - Issuing a Mode Sense for current values before a Mode Select is generally recommended to avoid accidentally attempting to set fields that cannot be changed by the initiator. *Not all fields in this page can be set by users. All fields other than those explicitly indicated that can be set by users are read-only.*

Byte Description

0

Bit	**Description**
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 23h

1 Page Length: 3Ah

2-3 Vendor-Reserved

4-5 Medium Identifier:

When there is an associated medium, this field contains the medium identifier of the associated medium.

Value	**Description**
0000h	No medium present or type is invalid or unknown
0141h	Medium present is 3592 Enterprise Tape — Standard Cartridge (JA)
0142h	Medium present is 3592 Enterprise Tape — Extended Cartridge (JB)
0143h	Medium present is 3592 Enterprise Tape— Advanced Cartridge (JC)
0151h	Medium present is 3592 Enterprise Tape — ECONOMY Cartridge (JJ)
0152h	Medium present is 3592 Enterprise Tape — Advanced Economy Cartridge (JK)
0241h	Medium present is 3592 Enterprise Tape — Standard WORM Cartridge (JW)
0242h	Medium present is 3592 Enterprise Tape — Extended WORM Cartridge (JX)
0243h	Medium present is 3592 Enterprise Tape — Advanced WORM Cartridge (JY)
0251h	Medium present is 3592 Enterprise Tape - ECONOMY WORM Cartridge (JR)

6 Format Identifier:

When there is an associated medium, this field contains the format identifier of the associated medium.

Value	**Description**
00	No medium present of format is invalid or unknown
05	FMR cartridge (any format)
31	Medium present (only JA/JW; JJ/JR medium) is written in J1A format and is: • (JJ/JR) 3592 Enterprise Tape Cartridge ECONOMY with 60GB native capacity • (JA/JW) 3592 Enterprise Tape Cartridge with 300GB native capacity
32	Medium present (only JA/JW; JJ/JR medium) is written in E05 format and is: • (JJ/JR) 3592 Enterprise Tape Cartridge -- ECONOMY with 100GB native capacity • (JA/JW) 3592 Enterprise Tape Cartridge with 500GB native capacity • (JB/JX) 3592 Enterprise Extended Tape Cartridge with 700GB native capacity
33	Medium present (only JA/JW; JJ/JR; JB/JX medium) is written in E06 format and is: • (JJ/JR) 3592 Enterprise Tape Cartridge -- ECONOMY with 128GB native capacity • (JA/JW) 3592 Enterprise Tape Cartridge with 640GB native capacity

- (JB/JX) 3592 Enterprise Extended Tape Cartridge with 1000GB native capacity

34 Medium present (only JB/JX; JC/JY/JK medium) is written in E07 format and is:
- (JB/JX) 3592 Enterprise Extended Tape Cartridge with 1600GB native capacity
- (JK) 3592 Enterprise Tape — Advanced Economy with 500GB native capacity
- (JC/JY) 3592 Enterprise Tape — Advanced with 4000GB native capacity

71 Medium present (only JA/JW; JJ/JR medium) is written encrypted in J1A format and is:
- (JJ/JR) 3592 Enterprise Tape Cartridge -- ECONOMY with 60GB native capacity
- (JA/JW) 3592 Enterprise Tape Cartridge with 300GB native capacity

72 Medium present (only JA/JW; JJ/JR; JB/JX medium) is written encrypted in E05 format and is:
- (JJ/JR) 3592 Enterprise Tape Cartridge -- ECONOMY with 100GB native capacity
- (JA/JW) 3592 Enterprise Tape Cartridge with 500GB native capacity
- (JB/JX) 3592 Enterprise Extended Tape Cartridge with 700GB native capacity

73 Medium present (only JA/JW; JJ/JR; JB/JX medium) is written encrypted in E06 format and is:
- (JJ/JR) 3592 Enterprise Tape Cartridge -- ECONOMY with 128GB native capacity
- (JA/JW) 3592 Enterprise Tape Cartridge with 640GB native capacity
- (JB/JX) 3592 Enterprise Extended Tape Cartridge with 1000GB native capacity

74 Medium present (only JB/JX; JC/JY/JK medium) is written encrypted in E07 format and is:
- (JB/JX) 3592 Enterprise Extended Tape Cartridge with 1600GB native capacity
- (JK) 3592 Enterprise Tape — Advanced Economy with 500GB native capacity
- (JC/JY) 3592 Enterprise Tape — Advanced with 4000GB native capacity

7 Partition Information (non-changeable)

Bit	Description
7-4	PARTITIONING TYPE - The type of partitioning currently in use on the volume (see 6.4.12 on page 308)
3-0	Reserved

8 ACTIVE PARTITION - The partition number of the current logical position.

9 WORM Control

Bits	Description
7–5	Reserved
4	Vendor-Reserved (changeable) (unsupported)
3–0	WORM Mode (changeable)

Value	Description
0h	None
2h	Relabel/Reappend (Allow overwrite of working construct)

10 Write Protect Flags

There are two forms of write protect: logical and physical, and three types of logical write protect. Each performs essentially the same function: each protects the customers data from change. Each write protect method performs that function; the only difference is the permanence of the effect (but note the differences with respect to CM validity for Associated Write Protection).

Bits **Description**

7 Physical Write Protect:

This field is also found in *"Request Sense - 03h" on page 193* (byte 24, bit 1).

This field indicates the state of the physical Write Protect switch located on the cartridge. This switch is controlled by the user. When the switch is set to 1, the entire physical volume is set to the write protected state; when the switch is set to 0, the volume is physically write enabled.

Value	Description
0b	The cartridge write protect switch is set to write enabled.
1b	The cartridge write protect switch is set to write protected state.

This field may be changed only by physically changing the state of the switch on the cartridge. After the cartridge is loaded into the device, the write protect switch is not available to the user, and, therefore, does not change states while mounted.

6 Associated Write Protect:

An OR condition of the three forms of logical write protect may be found in *"Request Sense - 03h" on page 193* (byte 24, bit 0).

This field allows an initiator to set the logical volume to the Associated Write Protected state. Associated Write Protect protects a volume only while the logical volume is associated with (mounted on) the device.

For a Mode Select command, this field has the following meaning:

Value	Description
0b	Do not change the Associated Write Protect state.
1b	Set this logical volume to the Associated Write Protect state.

For a Mode Sense command, this field has the following meaning:

Value	Description
0b	This logical volume is not set to the Associated Write Protect state.
1b	This logical volume is set to the Associated Write Protect state.

The logical volume can be set to Associated Write Protect at any time. The medium need not be positioned to Beginning of Partition (BOP).

When the initiator accepts the GOOD status from the Mode Select command, the logical volume is write protected. Buffered write data is not necessarily transferred to the medium prior to the completion of the Mode Select command. It is transferred at such time as it would have been had no further writes been issued (in any case prior to cartridge unload).

The Associated Write Protect state remains only as long as the medium is associated with (mounted on) the device. Both Unload and Power Off return the logical volume to the default state of write enabled. The initiator can also write enable the logical volume by issuing the Mode Select command with the Reset Associated Write Protect field set to 1b.

While in the Associated Write Protect state, any attempt to repartition, reformat, or write results in CHECK CONDITION status with associated sense data of 7/2700 (Data Protect, Write Protected).

NOTE 97 - For models with a CE service panel, the write protect icon will appear on the status screen when the medium is physically or logically write protected. Except for the time span covered by cartridge loading and cartridge unloading, the icon will remain on until the initiator requests the write protection status to change or unload or power-off occurs, which reset the status by default. During load and unload the icon will revert to the unprotected indicator. This is due to updates to the tape Housekeeping region, which requires writing. Unlike Physical Write Protection, Persistent Write Protection, or Permanent Write Protection, the CM is subject to change when under Associated Write Protection. This means that unexpected power-offs during the load or unload process while Associated Write Protection is set may result in the CM being in an invalid state, just as is possible when no write protection is active. Subsequent locate and space operations to the volume will automatically rebuild the tape directory.

5 Reset Associated Write Protect (changeable)

A 1h in this field causes the Associated Write Protect state to be reset; that is, to change the state of the logical volume from write protected to write enabled. After being reset, the logical volume again accepts write commands.

For a Mode Select command, this field has the following meaning:

Value	**Description**
0b	Do not change the Associated Write Protect state.
1b	Reset the Associated Write Protect state for this logical volume.

For a Mode Sense command, this field is 0b.

When the device successfully executes a Reset Associated Write Protect, the device immediately resets the write protected state to the write enabled state and allows write commands from that point.

4 Persistent Write Protect (changeable)

An OR condition of the three forms of logical write protect may be found in *“Request Sense - 03h” on page 193* (byte 24, bit 0).

This field allows an initiator to set the logical volume to the write protected state. Unlike the Associated Write Protect, Persistent Write Protect persists across mount cycles because the state is written in the housekeeping area of the volume.

For a Mode Select command, this field has the following meaning:

Value	**Description**
0b	Do not change the Persistent Write Protect state.
1b	Set this logical volume to the Persistent Write Protect state.

For a Mode Sense command, this field has the following meaning:

Value	**Description**
0b	This logical volume is not set to the Persistent Write Protect state.
1b	This logical volume is set to the Persistent Write Protect state.

The volume can be set to Persistent Write Protect only when the medium is positioned to Beginning of Partition 0 (BOP 0). The device writes the Persistent Write Protect field in the CM and presents status to the initiator. If the command fails, persistent write protection cannot be guaranteed.

Unlike Permanent Write Protect (see below), the volume may be write enabled by issuing a Mode Select with the Reset Persistent Write Protect field set to 1b. Similar to Permanent Write Protect, if a partition is set to Persistent Write Protect, the physical volume may not be repartitioned unless all partitions on the volume are write enabled. Any attempt to repartition, reformat, or write results in CHECK CONDITION status with associated sense data of 7/2700 (Data Protect, Write Protected).

3 Reset Persistent Write Protect

A 1b in this field causes the Persistent Write Protect field to be reset; that is, to change the state of the logical volume from write protected to write enabled. After being reset, the logical volume again accepts write commands.

For a Mode Select command, this field has the following meaning:

Value	Description
0b	Do not change the Persistent Write Protect state.
1b	Reset the Persistent Write Protect state for this logical volume.

For a Mode Sense command, this field is 0b.

The device must be at BOP 0 to accept Reset Persistent Write Protect.

2-1 Vendor-Reserved

0 Permanent Write Protect (settable)

An OR condition of the three forms of logical write protect may be found in *“Request Sense - 03h” on page 193* (byte 24, bit 0).

This field allows an initiator to set the logical volume to a permanently write protected state. Similar to the Persistent Write Protect, Permanent Write Protect persists across mount cycle because the state is written in the CM of the physical volume. Unlike Persistent Write Protect, Permanent Write Protect can never be reset except by degaussing. The media has factory written servo formatting and is unusable if degaussed.

For a Mode Select command, this field has the following meaning:

Value	Description
0b	Do not change the Permanent Write Protect state.
1b	Set this logical volume to the Permanent Write Protect state. After being set, THIS LOGICAL VOLUME CAN NEVER BE WRITTEN ON AGAIN!

For a Mode Sense command, this field has the following meaning:

Value	Description
0b	This logical volume is not set to the Permanent Write Protect state.
1b	This logical volume is set to the Permanent Write Protect state.

The volume can be set to the Permanent Write Protect state only when the medium is positioned to Beginning of Partition 0 (BOP 0). The device writes the Permanent Write Protect field in the CM and presents status to the initiator. Any attempt to repartition, reformat, or write results in CHECK CONDITION status with associated sense data of 7/2700 (Data Protect, Write Protected).

11 Capacity Scaling Control

Bits	Description
7-2	Vendor-Reserved
1	SegScalV (Performance Segment Scaling Valid): 0b

Value	Description
0b	Indicates that the device should not segment the medium in accordance with the value in the Segment Scaling field (always on Mode Sense).
1b	Indicates that the device should segment the medium in accordance with the value in the Performance Segment Scaling field.

NOTE 98 - Explicit Performance Segment Scaling of a volume is not currently supported, but may be in the future.

0 CapScalV (Capacity Scaling Valid): 0b

Value	**Description**
0b	Indicates that the device should not scale the medium in accordance with the value in the Capacity Scaling field (always on Mode Sense).
1b	Indicates that the device should scale the medium in accordance with the value in the Capacity Scaling field.

Capacity or Performance Segment Scaling is accepted only at Beginning of Partition 0 (BOP 0). A valid Scaling request causes all data on the entire physical volume to be lost. If this command is received at other than BOP 0, the command is presented CHECK CONDITION status with associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

Capacity or Performance Scaling of a volume is not supported for ECONOMY or WORM medium types. See the Support Flags field in this mode page for information on medium which supports scaling. If an attempt is made to perform scaling on medium types which disallow scaling, the command is presented CHECK CONDITION status with associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

NOTE 99 - On devices that support partitioning, if the volume is scaled, the values in *MP 11h: Medium Partition Page (see 6.4.12 on page 308)* are invalidated (e.g., the FDP, SDP, and IDP bits are set to 0b).

12 Capacity Scaling: 00h (from media) (changeable)

This field allows an initiator to logically change the size of partition 0. One effect is faster access to data at the expense of data capacity. This byte indicates or sets the currently formatted medium capacity in relationship to the maximum medium capacity. Maximum medium capacity in this context refers to the amount of data that can be potentially written on the medium, independent of the amount that is currently written or available. The capacity is reduced to a value of n/256*100 percent of this maximum capacity where n is the value in the Capacity Scaling field and ranges between 1 and 256 (01h - FFh, 00h). (The value 00 represents 256, or 100% of capacity.) For example, a Capacity Scaling value of 128 (80h) reduces the capacity of a single partition volume to 50% of its maximum value, but also reduces the average access time to any given data.

This medium is changed as indicated by this field only if the CapScalV bit is set to 1b.

Only certain values are supported. All other values are rounded up to the next supported value. If a value is rounded, the device responds to the Mode Select command with CHECK CONDITION status and associated sense data of 1/3700 (Recovered Error, Rounded Parameter). A Mode Sense command may be used to determine the actual value used. It is recommended that only non-rounding values be used as additional values may be supported in the future and may produce differing results.

Table 140 — Supported Capacity Scaling Values

Requested Capacity Scaling (byte 12)[3]	Actual Capacity Scaling (byte 12)[2]	Implicit[1] Performance Segment Scaling (byte 19)	FastSync (i.e., Virtual Backhitch) Supported to LEOP
F1h-FFh,00h	00h	00h	N
EC-F0	F0h	00h	Y
E1h-EBh	E1h-EBh	Y	N
4Bh-E0h	4Bh-E0h	Y	Y
1Dh-4Ah	1Dh-4Ah	00h	Y
16h-1Ch	16h-1Ch	00h	Y
01h-16h	16h	00h	Y

1 Performance Segment Scaling is automatically selected for Capacity Scaled medium at certain scaling values. When this value is non-zero the Performance Segment size is implicitly set to a fixed size of about the values:

Format:	J4C	J4B	J3B	J3A	J2B	J2A	J1A
Value:	720GB	227GB	155GB	135GB	100GB	100GB	60GB.

2 Medium Capacity is calculated as a fraction of nominal maximum capacity. Scaled medium capacity is approximately equal to the nominal unscaled medium capacity times this value divided by 256. The nominal capacity for 300 GB medium is 292, 968,750 (300GB/1024) and 500 GB medium is 488, 281, 250 (500GB/1024).

3 Recommended values are 00h (unscaled), F0h (FastSync optimized), EBh (performance segmented), E0h (performance segmented and FastSync optimized), and 35h to acheive:

Format:	J4C	J4B	J3B	J3A	J2B	J2A	J1A
Value:	820GB	330GB	200GB	130GB	140GB	100GB	60GB.

This command is accepted only at Beginning of Partition 0 (BOP 0). A valid Capacity Scaling command causes all data on the entire physical volume to be lost and only partition 0 to remain at some size. If this command is received at other than BOP 0, the command is presented CHECK CONDITION status with associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

NOTE 100 - On devices that support partitioning, if the volume is scaled, the values in *MP 11h: Medium Partition Page (see 6.4.12 on page 308)* are invalidated (e.g., the FDP, SDP, and IDP bits are set to 0b).

13-16 Medium Capacity

This field specifies the nominal capacity, in kilobytes, of the program accessible portion of the medium indicated by the Medium Identifier in bytes 4-5. If capacity scaling is in effect, this field reflects the capacity after scaling. If the medium is currently partitioned, the nominal capacity of the medium is the sum of the nominal capacity of all partitions. The value in the field multiplied by 1024 yields the approximate capacity in bytes. The field is set to 0 if the capacity is unknown. *This field is not changeable.* It is for reporting only.

17 Obsolete (never used)

18 Vendor-Reserved

19 Performance Segment Scaling: 00h (from media) (changeable)

NOTE 101 - Explicit Performance Segment Scaling of a volume is not currently supported, but may be in the future.

This field allows an initiator to logically change the size of the Performance Segment. This may affect the data capacity of the medium, and does affect the physical layout of data on medium. The logical layout is not affected. The primary effect is faster access to data located logically near BOT. A secondary effect is a possible improvement in pseudo-random access to data located within the same segment. This byte indicates or sets the currently formatted performance segment capacity in relationship to the currently scaled medium capacity. Currently scaled medium capacity in this context refers to the amount of data that can be potentially written on the currently capacity scaled medium (or the entire medium if not scaled), independent of the amount that is currently written or available. The performance segment capacity is set to a value of n/256*100 percent of this maximum capacity where n is the value in the Performance Segment Scaling field and ranges between 1 and 256 (01h - FFh, 00h). (The value 00h represents 256, or 100% of capacity.) For example, a Segment Scaling value of 128 (80h) set the performance segment capacity to 50% of the writeable medium capacity, but also reduces the average access time to any given data written in that area of media.

This medium is changed as indicated by this field only if the SegScalV bit is set to 1b.

NOTE 102 - On devices that support partitioning, if the volume is scaled, the values in *MP 11h: Medium Partition Page (see 6.4.12 on page 308)* are invalidated (e.g., the FDP, SDP, and IDP bits are set to 0b).

20 Support Flags

Bit **Description**

7 Medium Supports Partitioning: 0b

Value	**Description**
0b	The medium does not support partitioning.
1b	The medium supports partitioning (see 4.14.4 on page 118).

6 Medium Supports Performance Segment Scaling: 0b

5 Medium Supports Capacity Scaling:

Value	**Description**
0b	The medium does not support Capacity Scaling.
1b	The medium supports Capacity Scaling.

NOTE 103 - The only medium type which currently supports scaling is DATA. The ECONOMY, ECONOMY WORM, and WORM types do not support scaling.

4 Device supports WORM

Value	**Description**
0b	Medium is not WORM
1b	Medium is WORM

NOTE 104 - For WORM usage implications, see *“WORM Behavior” on page 102*

3 Medium Supports Encryption (Changeable-Ignored)

Value	**Description**
0b	Medium does not support encryption
1b	Medium supports encryption (device must also support encryption for this to be set)

2-1 Vendor-Reserved

0 Vendor-Reserved (Edge Track): 0b

21 Internal-VOLID Flags

Bits	Description
7	Internal-VOLID Valid

Value	Description
0b	Indicates that the fields are not valid.
1b	Indicates that the internal volume-identifier field and the remainder of the internal-VOLID flags field are valid.

6 Tape Directory Valid

Value	Description
0b	Indicates that the tape directory is not valid.
1b	Indicates that the tape directory is valid.

5 Vendor-Reserved

4 Internal Volid is EBCDIC

Value	Description
0b	Volume label is ASCII
1b	Volume label is EBCDIC

3 Vendor-Reserved

2-0 Internal-VOLID Information Source

Value	Description
000b	Internal-VOLID from external source, that is, a library manager.
001b	Internal VOLID from medium, namely the VOL1 record.
010b-111b	Vendor-Reserved

22-27 Internal-Volume Identifier

If available, this field contains the volume identifier, which is recorded on the medium. The field is left-justified and padded with ASCII or EBCDIC blanks. If the Volume Identifier is not valid, it is set to 0000 0000 0000h.

28-31 Partition Capacity

This field specifies the nominal capacity, in kilobytes, of the program accessible portion of the currently active partition. The value in the field multiplied by 1024 yields the number of bytes in the partition. The field is set to 0 if the capacity is unknown. This field is not changeable but does reflect changes by other activity. It is for reporting only.

32-35 Kilobytes Traversed

This field specifies the current position on the tape measured in kilobytes (1024 bytes) traversed (user data only). The value at the logical end of tape should equal the nominal capacity of the tape. All values are rounded down to the nearest kilobyte.

36-47 Vendor-Reserved

48–59 World Wide Unique Cartridge Identifier

The World Wide Unique identifier used by the WORM cartridge in hexidecimal numbers. If the cartridge is not a WORM cartridge this value may be all zeros.

NOTE 105 - This field should not be used to determine whether the current medium is a WORM cartridge.

NOTE 106 - Byte 8 (byte 56 of this page), bits 7 and 6 are used to indicate special test cartridges. For production WORM media bit 7 is set to b'0' and bit 6 is set to b'1'. To insure the most comprehensive WORM integrity protection, applications should check these bits as part of their medium management strategy for use with production data.

6.4.19 MP 24h: Initiator-Specific Extensions

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

The Initiator-Specific Extensions page provides controls that allow selective use of CRC protection and permit program control of key synchronous data transfer parameters.

There is one copy of this page for each initiator, except for fields common to all initiators as noted below.

Byte **Description**

0

- **Bit** **Description**
- 7 PS (Page Save): 0b
- 6 Reserved
- 5-0 Page Code: 24h

1 Page Length: 16h

2 CRC Target Support (checking across host interface)

This field cannot be changed by the initiator.

- **Bits** **Description**
- 7 IEEE CRC Support: 0b
  - **Value** **Description**
  - 0b IEEE CRC is not supported
  - 1b IEEE CRC is supported
- 6 Device-specific CRC Support: 1b
  - **Value** **Description**
  - 0b Device-specific CRC is not supported
  - 1b Device-specific CRC is supported
- 5-0 Vendor-Reserved

3 CRC Target Enablement (across host interface)

This field can be changed by the initiator.

- **Value** **Description**
- 00h CRC checking disabled (default setting)
- 01h IEEE CRC checking enabled (unsupported)
- 02h Device-specific CRC checking enabled

4 CRC (1) Placement and Length

- **Bits** **Description**
- 7-6 CRC Placement
  - **Value** **Description**
  - 00b CRC appended to data
  - 01b CRC prefixed to data
- 5-0 CRC Length (0-63 bytes): 04h

5 CRC (1) Scope

- **Bits** **Description**
- 7 Read data checked: 1b
- 6 Write data checked: 1b
- 5 Parameter read data checked: 0b
- 4 Parameter write data checked: 0b
- 3 CDB checked: 0b
- 2 RBD data checked: 1b
- 1-0 Vendor-Reserved

6 Other CRC (1) Characteristics

Bits	Description
7	CDB Transfer Length: 1b

Value	Description
0b	CDB Transfer Length does not include CRC.
1b	CDB Transfer length includes CRC.

6 CRC Endian: 0b

Value	Description
0b	CRC is Little Endian.
1b	CRC is Big Endian.

5 Read CRC Reporting: 1b

Value	Description
0b	Check One on Read CRC Miscompare
1b	Check Condition on Read CRC Miscompare

4 Write CRC Reporting: 1b

Value	Description
0b	Check One on Write CRC Miscompare
1b	Check Condition on Write CRC Miscompare

3 Write CRC Check Condition: 0b

Value	Description
0b	Deferred Check Condition on Write CRC Miscompare
1b	Immediate Check Condition on Write CRC Miscompare

2-0 Vendor-Reserved

7 Support Flags

Bit	Description
7	Device Supports Partitioning: 0b
6	Device Supports Performance Segment Scaling: 0b
5	Device Supports Capacity Scaling: 1b
4	Device Supports WORM

Value	Description
0b	WORM medium is not supported, and will not fully load and come ready.
1b	WORM medium is supported.

3 Device Supports Encryption - Enabled (Changeable-Ignored)

Value	Description
0b	Device does not support encryption
1b	Device supports encryption (encryption interface(s) are enabled)

2-1 Vendor-Reserved

0 Device Supports Encryption- Capable (Changeable-Ignored)

Value	Description
0b	Device does not support encryption (does not have encryption hardware)
1b	Device supports encryption (encryption interface(s) are not necessarily enabled)

8-12 Vendor-Reserved

13 Vendor-Reserved (Transfer Period): FFh

14 Vendor-Reserved (REQ/ACK Offset): FFh

15 Buffer Association Enablement (DDR Support)

NOTE 107 - This is persistent across host resets and is common to all initiators.

Bits	Description
7	Manual unload Association: 0b (changeable)

Value	Description
0b	Association Disabled (RBD must be performed prior to unload)
1b	Association Enabled (RBD may be performed before or after unload)

NOTE 108 - The associated date will be lost if a Rewind or Load command is executed.

6 Manual Rewind Association: 0b

Value	Description
0b	Association Disabled
1b	Association Enabled

5 Unload with Write error Association: 0b (changeable)

Value	Description
0b	Association Disabled (RBD must be performed prior to unload)
1b	Association Enabled (RBD may be performed before or after unload)

NOTE 109 - The associated date will be lost if a Rewind or Load command is executed.

4-0 Vendor-Reserved

16-23 Vendor-Reserved

6.4.20 MP 25h: Read/Write Control

See *Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153)* for how to set these parameters and *Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155)* for how to read these parameters.

This page is defined as common to all initiators.

Byte Description

0

Bit	**Description**
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 25h

1 Page Length: 1Eh

2 Ignore Sequence Checks

Bit	**Description**
7-3	Vendor-Reserved
2	Locate command: 0b (changeable)

Value	**Description**
0b	Do not ignore sequence checks
1b	Ignore sequence checks

1 Space command for blocks: 0b (changeable)

Value	**Description**
0b	Do not ignore sequence checks
1b	Ignore sequence checks

0 Space command for filemarks: 0 (changeable)

Value	**Description**
0b	Do not ignore sequence checks
1b	Ignore sequence checks

3 Ignore Data Checks

Bit	**Description**
7-3	Vendor-Reserved
2	Locate command: 1b (changeable)

Value	**Description**
0b	Do not ignore data checks
1b	Ignore data checks

1 Space command for blocks: 1b (changeable)

Value	**Description**
0b	Do not ignore data checks
1b	Ignore data checks

0 Space command for filemarks: 1b (changeable)

Value	**Description**
0b	Do not ignore data checks
1b	Ignore data checks

4 Vendor-Reserved

5 Logical End of Partition Method: 00h (changeable)

Value	**Description**
00h	LEOP is determined by density code where: • density code 51h or 71h uses maximum medium capacity • density codes other than 51h or 71h use constant medium capacity
01h	LEOP is determined to maximize medium capacity
02h	LEOP is determined to provide constant medium capacity

6-7 Logical End of Partition: 0000 — Early Warning (LEOP-EW)

This field provides a vehicle for the initiator to enable an early warning indication of the approach of the Logical End of Partition (LEOP). This warning may be used by the initiator to ensure it has sufficient remaining space on the current tape partition to commit all of its internal write buffers. The early warning is provided in the form of a deferred CHECK CONDITION status with associated sense data of 6/0002 (Unit Attention, End-of-Partition/Medium Detected). This CHECK CONDITION status is returned when the first device block is committed to the medium which comes within the specified number of megabytes of the LEOP. The normal initiator response may be to stop further writes and flush all initiator buffered data to the drive.

This field is specified in megabytes. The maximum allowed value is 1000h. A value of 0000h results in no warning being given. Any other value specifies the number of megabytes prior to the LEOP that the warning will occur. Non-zero values less than 008Ch are rounded to 008Ch and report 1/3700 Rounded Parameter. The device makes worst case compression assumption.

8

Bit **Description**

7 Disable FastSync (i.e., Virtual Backhitch): 0b (changeable)

Value	**Description**
0b	FastSync operation is enabled.
1b	FastSync operation is disabled.

6 Disable SkipSync: 0b (changeable)

0b	SkipSync operation is enabled.
1b	SkipSync operation is disabled.

5-4 Vendor-Reserved

3 Disable Crossing EOD: 0b (changeable)

Value	**Description**
0b	Crossing EOD is enabled. (See *“General Read-Type Handling” on page 91*)
1b	Crossing EOD is disabled.

2 Disable Crossing Permanent Errors: 0b (changeable)

Value	**Description**
0b	Crossing permanent errors is enabled. (See *“General Read-Type Handling” on page 91*)
1b	Crossing permanent errors is disabled.

1 Report Segment Early Warning: 0b

0 Report Housekeeping Errors: 0b (changeable)

Value	**Description**
0b	If the Mode Page 01h PER bit is set to 0b, do not report Housekeeping errors.
1b	Report CHECK CONDITION status and deferred sense data of 1/0000 (Recovered Error, No Additional Sense Information) for permanent read/write housekeeping errors including Tape Directory invalid.

9 Default Write Density at BOP 0: X’00’ (changeable [not model J1A]) (from VPD)

NOTE 110 - Note: If medium that does not support the specifically selected density is loaded, the nearest supported density will be used and reflected in the Pending Active Write Density at BOP field.

NOTE 111 - If an attempt is made to set the value to an value unknown by the device including a value for a later generation product (e.g., the device is an E05 drive and the attempted value is for an E06) the Mode Select will be rejected

Value	**Description**
00h	Use default density code (highest supported) (on unload)
51h	Use J1A format density (only JA/JW; JJ/JR medium) (on unload)
52h	Use E05 format density (only JA/JW; JJ/JR; JB/JX medium) (on unload)
53h	Use E06 format density (only JA/JW; JJ/JR; JB/JX medium) (on unload)
54h	Use E07 format density (only JB/JX; JC/JY/JK medium)(on unload)
7Fh	No change to density (including pending density) (on load, use default for uninitialized medium)
FFh	Use currently recorded density (on load use default for uninitialized medium)

10 PENDING WRITE DENSITY AT BOP 0 (changeable [not model J1A])

The medium is reformatted to this density on the next qualified write operation (write, write filemarks, format, etc.) at logical block 0. This field may be indirectly altered when the Default Write Density field above is changed, when the Mode Select Block Descriptor Density Code field is changed, or according to the Default Write Density field value when medium is unloaded or loaded.

NOTE 112 - This field will be read as explicit density values only.

Value	Description
00h	Use default density code (highest supported) (mode select only)
51h	Use J1A format density (only JA/JW; JJ/JR medium)
52h	Use E05 format density (only JA/JW; JJ/JR; JB/JX medium)
53h	Use E06 format density (only JA/JW; JJ/JR; JB/JX medium)
54h	Use E07 format density (only JB/JX; JC/JY/JK medium)
7Fh	No change to pending density (this value is a no-op) (mode select only)
FFh	Use currently recorded density (on load, use default for uninitialized medium; mode select only)

NOTE 113 - It is illegal for PENDING WRITE DENSITY AT BOP 0 to change from the value reported in Mode Sense if the Density Code field in the Block Descriptor is changed to a value different than either the value returned in Mode Sense, the value X'7F' or the changed value specified for PENDING WRITE DENSITY AT BOP 0. For such an illegal attempt, the device responds with CHECK CONDITION status and associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

NOTE 114 - On devices which support encryption, secondary encryption density codes may be selected but are interchangeable and identical to primary density codes and are remapped by the device. Use of any density codes has no effect on the encrypted state of medium and cannot be used to control encryption.

NOTE 115 - On devices that support partitioning, if the value of the PENDING WRITE DENSITY AT BOP 0 changes, the values in *MP 11h: Medium Partition Page (see 6.4.12 on page 308)* are invalidated (e.g., the FDP, SDP, and IDP bits are set to 0b).

11-15 Reserved

16-27 Vendor-Reserved

28-31 Reserved

6.4.20.1 Encryption Parameters - IBM Proprietary Protocol (IPP)

This clause, its subclauses, and its sister clauses contain parameters used in the IBM Proprietary Protocol (IPP) related to encryption. These are used in Library Managed Encryption (LME), System Managed Encryption (SME), and Application Managed Encryption - IBM (AME-IBM). These are not used in the standards defined encryption methodology defined in T10 (AME-T10). To find the encryption information related to the standards defined methodology (AME-T10) see the Security Protocol Out command *(see 5.2.31 on page 212)*, the Security Protocol In command *(see 5.2.30 on page 211)*, and the Security Protocol Parameters *(see 6.5 on page 367)*.

See IBM for the contents of this clause.

6.4.21 MP 30h: Device Attribute Settings

The device attribute settings page and the related subpages are used to query and configure settings used by the drive to control its behavior and configuration in a specified environment. The page_0 mode page 30h is the directory listing of supported subpages. Each subpage is for the query and/or setting of device attributes for a specific function. The persistence of parameters and statement of which parameters are settable or only readable is stated in the section describing each subpage.

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

6.4.21.1 MP 30h: Directory Listing - Device Attribute Settings

The directory listing - device attribute settings mode page is used to report the list of supported subpages in the device attribute settings mode page and subpages. The page is valid only for a Mode Sense command.

This page is defined as common to all initiators.

Table 141 — MP 30h: Directory Listing - Device Attribute Settings mode page format

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td>PS</td><td>SPF(0)</td><td colspan="6">PAGE CODE (30h)</td></tr>
<tr><td>1</td><td colspan="8">PAGE LENGTH (n-1)</td></tr>
<tr><td colspan="9">Supported subpage list</td></tr>
<tr><td>2</td><td colspan="8">Supported subpage [first]</td></tr>
<tr><td colspan="9">⋮</td></tr>
<tr><td>n</td><td colspan="8">Supported subpage [last]</td></tr>
</table>

The supported subpage list is a list of supported subpages listed in ascending order. Since the list of supported subpages is anticipated to differ between code levels (i.e., newer code levels may add subpages) the complete list is not described here. A user should read this page to determine which subpages may be used.

The following parameters apply:

Byte Description

0

Bit	**Description**
7	PS (Page Save):
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 30h

1 PAGE LENGTH:

2-n Supported subpage list: Supported subpage list - Device Attribute Settings (see 6.4.21.2 on page 339) describes the subpages that were implemented or planned at the time this document was published.

6.4.21.2 Supported subpage list - Device Attribute Settings

The supported subpage list returns the list of supported subpages. These subpages are organized in logical groupings by function.

Range	Description
01h-03h	MP 30h[01h-03h]: Ethernet attributes - Device attribute settings (see 6.4.21.3 on page 340).
04h-1Fh	Reserved
20h	MP 30h[20h-(20h)]: Encryption Attributes - Device Attribute Settings (see 6.4.21.4 on page 347).
21h-3Fh	Reserved
40h-42h	MP 30h[40h-42h]: Data processing attributes - Device attribute settings (see 6.4.21.5 on page 349)
43h-FEh	Reserved

The list of subpages that were implemented or planned at the time this document was published follows:

MP 30h[01h]: Drive MAC address - Device attribute settings (see 6.4.21.3.2 on page 342)
MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings (see 6.4.21.3.3 on page 343)
MP 30h[20h]: Encryption mode - Device Attribute Settings (see 6.4.21.4.1 on page 347)
MP 30h[40h]: SkipSync - Device attribute settings (see 6.4.21.5.1 on page 349)
MP 30h[42h]: End of partition behavior control - Device attribute settings (see 6.4.21.5.2 on page 352)

Byte	Description
2	First subpage: 01h
3	Second subpage: 02h
4	Third subpage: 03h
5	Fourth subpage: 20h
6	Fifth subpage: 40h
7	Sixth subpage: 41h
8	Seventh subpage: 42h

6.4.21.3 MP 30h[01h-03h]: Ethernet attributes - Device attribute settings

6.4.21.3.1 Ethernet attributes overview

The Ethernet attributes subpages of the device attribute mode page describe information related to the drives Ethernet interface. The subclauses to this subclause list structures used by the Ethernet attribute subpages that are described in the subclauses that are at a peer level to this subclause.

6.4.21.3.1.1 Ethernet socket address descriptor

The IP address and subnet mask is defined in table 142..

Table 142 — Ethernet socket address descriptor

Byte	Bit 7	6	5	4	3	2	1	0
0	MSB	ethernet socket address descriptor length (22h)						
1								LSB
2	MSB	relative socket address identifier						
3								LSB
4 - 31	sockaddr							
32	subnet mask length							
33 - 35	Reserved							

The following parameters apply:

Byte Description

0-1 ETHERNET SOCKET ADDRESS DESCRIPTOR LENGTH - The number of bytes to follow in the Ethernet socket address descriptor.

2-3 RELATIVE SOCKET ADDRESS IDENTIFIER - A unique identifier for this Ethernet socket address.

4-31 SOCKADDR - defined by type of IP address

Type	Description
IPv4	*6.4.21.3.1.1.1*
IPv6	*6.4.21.3.1.1.2*

32 SUBNET MASK LENGTH - The number of bits set to one in the subnet mask.

33-35 Reserved

6.4.21.3.1.1.1 Sockaddr for an IPv4 IP address

The sockaddr for an IPv4 IP address is defined in table 143.

Table 143 — Sockaddr format for IPv4

Byte	Bit 7	6	5	4	3	2	1	0
0	address length							
1	address family							
2	MSB			port				
3								LSB
4	MSB			internet address				
7								LSB
8				Pad bytes				
27								

The following parameters apply:

Byte	Description
0	ADDRESS LENGTH (10h)
1	ADDRESS FAMILY (02h)
2-3	PORT - The TCP port number, if any. Zero if there is no TCP port number.
4-7	INTERNET ADDRESS - The IP Address.
8-27	Pad bytes - All bytes set to zero.

6.4.21.3.1.1.2 Sockaddr for an IPv6 address

The sockaddr for an IPv6 IP address is defined in table 144.

Table 144 — Sockaddr format for IPv6

Byte	Bit 7	6	5	4	3	2	1	0
0	address length							
1	address family							
2	MSB			port				
3								LSB
4				flow info				
7								
8	MSB			internet address				
23								LSB
24				scope id				
27								

The following parameters apply:

Byte Description

0 ADDRESS LENGTH (1Ch)
1 ADDRESS FAMILY (0Ah)
2-3 PORT - The TCP port number, if any. Zero if there is no TCP port number.
4-7 FLOW INFO - (0000 0000h)
8-23 INTERNET ADDRESS - The IP Address.
24-27 SCOPE ID - (0000 0000h)

6.4.21.3.2 MP 30h[01h]: Drive MAC address - Device attribute settings

The drive MAC address is read only and is defined in table 145.

Table 145 — Drive MAC address

Byte	Bit 7	6	5	4	3	2	1	0
0	ps (0b)	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	number of drive port mac address descriptors							
8 - 15	Drive port MAC address descriptor [first]							
	⋮							
n-7 - n	Drive port MAC address descriptor [last]							

The following parameters apply:

Byte Description

0

Bit	Description
7	PS (0b)
6	SPF (1b)
5-0	PAGE CODE (30h)

1 SUBPAGE CODE (01h)
2-3 PAGE LENGTH
4-6 Reserved
7 NUMBER OF DRIVE PORT MAC ADDRESS DESCRIPTORS - The number of descriptors to follow

8-n Drive port MAC address descriptors.
The Drive port MAC address descriptors are listed in ascending order by RELATIVE TARGET PORT IDENTIFIER. The Drive port MAC address descriptor is defined in table 146.

Table 146 — Drive port MAC address descriptor

Byte	Bit 7	6	5	4	3	2	1	0
0	MSB	relative target port identifier						
1								LSB
2	mac address							
7								

Byte Description

0-1 RELATIVE TARGET PORT IDENTIFIER - The relative port value for the Ethernet port.
2-7 MAC ADDRESS - The binary representation of the MAC address for that port.

6.4.21.3.3 MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings

The drive IP address and subnet mask subpage is defined in table 147. When sending the drive IP address and subnet mask subpage in a Mode Select command the SP bit shall be set to one. If the SP bit is set to zero, then the drive rejects the command with a CHECK CONDITION and sets the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN CDB.

Table 147 — Drive IP address and subnet mask subpage

Byte	Bit 7	6	5	4	3	2	1	0
0	ps	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (02h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	number of drive ethernet port descriptors							
8	Drive Ethernet port descriptor [first]							
m								
	⋮							
n-k	Drive Ethernet port descriptor [last]							
n								

The following parameters apply:

Byte Description

0

Bit Description

7 PS - The PS bit is set to one on Mode Sense and reserved on Mode Select.

6 SPF (1b)

5-0 PAGE CODE (30h)

1 SUBPAGE CODE (02h)

2-3 PAGE LENGTH

4-6 Reserved

7 NUMBER OF DRIVE PORT DESCRIPTORS - May be set to any number between one and the number of drive Ethernet ports inclusive. Changes will only affect the ports for which a drive Ethernet port descriptor is sent.

8-n Drive Ethernet port descriptors.

The drive Ethernet port descriptors shall be sent in ascending order by RELATIVE TARGET PORT IDENTIFIER *(see table 148)*. The drive Ethernet port descriptor is defined in table 148.

Table 148 — Drive Ethernet port descriptor

Byte	Bit 7	6	5	4	3	2	1	0
0	MSB	drive ethernet port descriptor length (n-1)						
1								LSB
2	MSB	relative target port identifier						
3								LSB
4	Reserved							
5								
6	Reserved							dhcp_v4
7	number of ethernet socket address descriptors							
8	Ethernet socket address descriptor [first]							
x								
	⋮							
y	Ethernet socket address descriptor [last]							
n								

Byte Description

0-1 DRIVE ETHERNET PORT DESCRIPTOR LENGTH - The number of bytes to follow in the drive Ethernet port descriptor.

2-3 RELATIVE TARGET PORT IDENTIFIER - The relative port identifier of the Ethernet port.

4-5 Reserved

6

Bit Description

7-1 Reserved

0 DHCP_V4

Value Description

1b DHCP shall be used to obtain an additional IPv4 address.

0b DHCP shall not be used to obtain an additional IPv4 address.

7 NUMBER OF ETHERNET SOCKET ADDRESS DESCRIPTORS - Shall be set to 01h or 02h.

8-n Ethernet socket address descriptors. The Ethernet socket address descriptor is defined in *6.4.21.3.1.1 on page 340*.

In each Ethernet socket address descriptor the PORT field of the SOCKADDR (see table 143 and table 144) is reserved and shall be set to zero.

In each Ethernet socket address descriptor the FLOW INFO field of the SOCKADDR *(see table 144)*, if any, is reserved and shall be set to zero.

In each Ethernet socket address descriptor the SCOPE ID field of the SOCKADDR *(see table 144)*, if any, is reserved and shall be set to zero.

6.4.21.4 MP 30h[20h-(20h)]: Encryption Attributes - Device Attribute Settings

6.4.21.4.1 MP 30h[20h]: Encryption mode - Device Attribute Settings

The Encryption mode - Device attribute settings mode page allows an application client to query the encryption settings in the drive. If the drive receives an Encryption mode - device attribute settings mode page in a MODE SELECT command it is rejected with an ILLEGAL REQUEST, INVALID FIELD IN PARAMETER LIST.

The Encryption mode - Device attribute settings mode page may be used in a Mode Sense command to query the current Encryption settings. Some of the settings likely to be reported are listed in table 151.

Table 149 — Expected Encryption settings

Encryption setting	Method (byte 5)	Key Path (byte 6)	Default Encryption State (byte 7)	Density Reporting (byte 8)
No Encryption	01h	01h	01h	00h
AME (Application Managed Encryption)	03h	01h	01h	00h
LME (Library Managed Encryption) - Barcode policy	04h	01h	03h	00h
LME - Internal label (selects) policy	04h	01h	06h	00h
LME - Internal label (all) policy	04h	01h	07h	00h
LME - Encrypt Always policy	04h	01h	02h	00h
Custom	combinations not listed above			

The Encryption mode - Device attribute settings mode page is defined in table 152.

Table 150 — Encryption mode mode page

Byte	Bit 7	6	5	4	3	2	1	0
0	PS	SPF(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (20h)							
2	(MSB)	PAGE LENGTH (0005h)						
3								(LSB)
4	Reserved							
5	METHOD							
6	KEY PATH							
7	DEFAULT ENCRYPTION STATE							
8	DENSITY REPORTING							

Byte **Description**

0

Bit **Description**

7 PS (parameters saveable): 0b

Parameters are not saveable via a MODE SELECT. Note that the parameters do change in response to configuration changes made via other paths (e.g., through the library).

6 SPF (subpage format): 1b

5-0 PAGE CODE: 30h

1 SUBPAGE CODE: 20h

2-3 PAGE LENGTH: 0005h

4	Reserved
5	METHOD: Encryption solution method.
6	KEY PATH: The path used for key management communications
7	DEFAULT ENCRYPTION STATE:
8	DENSITY REPORTING:

6.4.21.5 MP 30h[40h-42h]: Data processing attributes - Device attribute settings

6.4.21.5.1 MP 30h[40h]: SkipSync - Device attribute settings

See Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153) for how to set these parameters and Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155) for how to read these parameters.

This page is defined as common to all initiators.

The SkipSync mode page is defined in table 153. SkipSync is a feature that performs a trade-off between how much data can be written to a volume and how fast that data can be written when the data is a small file size. This mode page allows the feature to be enabled and disabled. It also provides information that describes certain aspects of this trade-off, such as the Target Minumum Capacity. This feature is only available for use on volumes that are not scaled and that are not partitioned.

Table 151 — SkipSync - Device attribute settings mode page format

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS</td><td>SPF(1b)</td><td colspan="6">PAGE CODE (30h)</td></tr>
<tr><td>1</td><td colspan="8">SUBPAGE CODE (40h)</td></tr>
<tr><td>2</td><td>(MSB)</td><td colspan="6" rowspan="2">Page Length 10h</td><td></td></tr>
<tr><td>3</td><td></td><td>(LSB)</td></tr>
<tr><td>4</td><td colspan="5">Reserved</td><td colspan="2">SV</td><td>ENABLE</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">SkipSync Policy</td></tr>
<tr><td>8</td><td>(MSB)</td><td colspan="6" rowspan="2">Target Minimum Capacity</td><td></td></tr>
<tr><td>11</td><td></td><td>(LSB)</td></tr>
<tr><td>12</td><td>(MSB)</td><td colspan="6" rowspan="2">Vendor-restricted</td><td></td></tr>
<tr><td>15</td><td></td><td>(LSB)</td></tr>
<tr><td>16</td><td>(MSB)</td><td colspan="6" rowspan="2">Vendor-restricted</td><td></td></tr>
<tr><td>19</td><td></td><td>(LSB)</td></tr>
</table>

Byte **Description**

0

Bit **Description**

7 PS (Parameter Saveable): 1b

It is recommended that users set the SP bit of the MODE SELECT command to one.

6 SPF (SubPage Format): 1b

5-0 PAGE CODE: 01h

1 SUBPAGE CODE: 40h

2-3 PAGE LENGTH: 10h

4

Bit	Description
7-3	Reserved
2-1	SV (SkipSync Validity):

Note that mounting a volume that modifies the value of this field does not establish a unit attention condition.

Value	Description
00b	There is no volume mounted, or SkipSync is not valid for mounted volume.
01b	SkipSync valid for mounted volume but SKIPSYNC POLICY field not supported
10b	SkipSync valid for mounted volume and SKIPSYNC POLICY field is supported
11b	Reserved

0 ENABLE: 1b (changeable)

Value	Description
0b	The SkipSync function is disabled. If this bit is changed from 1b to 0b, then the DISABLE SKIPSYNC bit in MP 25h: Read/Write Control (see 6.4.20 on page 332) is implicitly set to 1b
1b	The SkipSync function is enabled. The drive operates in a manner to increase performance and reduce backhitches while still performing synchronizations on small file writes. If this bit is changed from 0b to 1b, then the DISABLE SKIPSYNC bit in MP 25h: Read/Write Control (see 6.4.20 on page 332) is implicitly set to 0b

5-6 Reserved

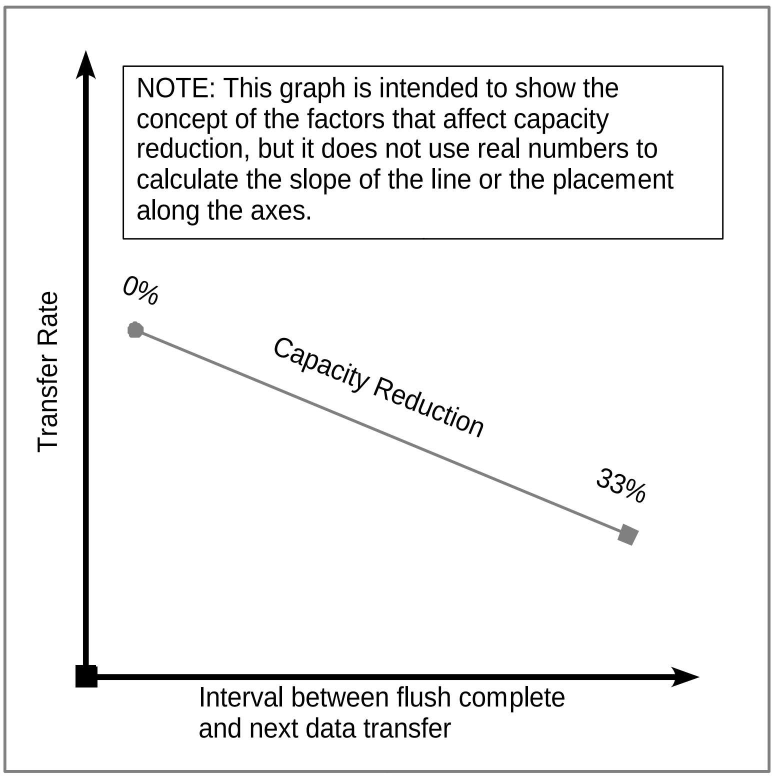
7 SKIPSYNC POLICY:

The SkipSync Policy field indicates the algorithm used in performing the SkipSync operations.

If no volume is mounted or if a volume is mounted and the SV field is set to 10b, then this field is changeable.

If a volume is mounted and the SV field is set to 00b or 01b and an attempt to change the value of this field is made, then the MODE SELECT command is rejected with ILLEGAL REQUEST, INVALID FIELD IN PARAMETER DATA.

Value	Description
00h	Drive Default SkipSync Policy (Not returned on MODE SENSE if SV = 10b)
10h	Sync performance with no capacity reduction
20h	Sync performance allowing capacity reduction (a MODE SENSE command may be used to report in other fields the limits that are established by this setting; e.g., TARGET MINIMUM CAPACITY) When this option is selected, the overall capacity may be reduced by up to 33% depending on the transfer characteristics (e.g., transfer rate and the interval between the sync completion and the next data transfer).



8-11 TARGET MINIMUM CAPACITY (MiB): (non-changeable) (ignored on MODE SELECT)

This field indicates the target capacity in mebibytes (2^{20}) to which the capacity of the current partition when full may be decreased in order to perform SkipSync operations. The total capacity may be smaller than TARGET MINIMUM CAPACITY if the average of transaction sizes is very small. If the mounted volume is not capable of supporting skipsync this field is set to zero. This field reflects the setting of the SKIPSYNC POLICY field.

NOTE 116 - Mebibyte is equal to 1 048 576 bytes. As an example, a value of E 8D4Ah in the Target Minimum Capacity field is equal to 953 674 megabytes, which is equal to 976 562 176 bytes. This is actually in mebibytes (MiB).

12-15 Vendor-restricted

16-19 Vendor-restricted

6.4.21.5.2 MP 30h[42h]: End of partition behavior control - Device attribute settings

The End of partition behavior control - Device attribute settings mode page is defined in table 145.

Table 152 — End of partition behavior control - Device attribute settings mode page format

Byte	Bit 7	6	5	4	3	2	1	0
0	ps	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (42h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	leop method							

The following parameters apply:

Byte Description

0 Byte zero

Bit Description

7 PS - parameters saveable

When using the MODE SENSE command the parameters saveable (PS) bit is set to one indicating that the mode page may be saved.

When using the MODE SELECT command, the PS bit is reserved.

6 SPF (1b)

5-0 PAGE CODE: 30h

1 SUBPAGE CODE (42h)

2-3 PAGE LENGTH

4 LEOP METHOD - Logical end of partition (LEOP) method: 00h (changeable)

Value Description

00h LEOP is determined by density code

Value	Description
51h	Maximize medium capacity
71h	Maximize medium capacity
others	Constant medium capacity

01h Maximize medium capacity - LEOP is based on the amount of physical medium available. Early warning is based on the drive's buffer size, the nominal physical dataset length, and some margin (i.e., the drive will accept write request before LEOP if there is tape available).

02h Constant medium capacity - LEOP is determined to provide constant medium capacity. Early warning is based on the user's logical data capacity already written to the tape (i.e constant capacity). If the medium condition or drive condition is degraded enough to reach a predetermined LPOS tape region, then LEOP may be reached prior to the constant capacity.

others Reserved

6.4.22 MP 37h: String Search (not J1A)

See Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153) for how to set these parameters and Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155) for how to read these parameters.

This page is used to setup search criteria and query summary status. See *4.17 on page 122* for additional information on string searches.

This page is defined as common to all initiators. Some fields in this page may be reset under special conditions as noted below.

This page or related subpage(s) exceeds the maximum page length supported by Mode Sense (6) and Mode Select (6) and cannot be queried or altered with these commands. The Mode Sense (10) and Mode Select (10) must be used with this mode page. This page is not returned in mode page 3Fh (all pages).

Mode Page 37h and Mode Page 37h[01h] should be set under separate Mode Select commands to insure the proper operating setup is used. To do this, the criteria should be setup with Mode Page 37h[01h] before the base page (i.e., Mode Page 37h) enables searching, etc.

6.4.22.1 String Search Control/Status

Byte **Description**

0

Bit	**Description**
7	PS (Page Save): 0b
6	Reserved
5-0	Page Code: 37h

1 Page Length: 3Eh

2 Search Control

Bit	**Description**
7	Extended Search Enable: 0b (unsupported)
6	Snoop Search Enable:0b (reset when a cartridge is unloaded)

NOTE 117 - Read and write performance may be affected if Snoop Search Enable is 1b and Match Buffer is also 1b.

NOTE 118 - Snoop operations may require a flush (Write Filemarks 0) operation to insure the results are correct due to posting latencies.

Bit	**Description**
5	Snoop Read: 1b
4	Snoop Write: 1b
3-0	Vendor-Reserved

3-4 Vendor-Reserved

5 Search Reporting

Bit	**Description**
7	Vendor-Reserved
6	Deferred Sense Key 1: 0b (unsupported)
5	Read Sense Key 1: 0b (unsupported)

Value	**Description**
1b	Generate a sense with 1/8501 (Recovered Error, Search Snoop Match Found)

Bit	**Description**
4	Write Sense Key 1: 0b (unsupported)
3-0	Vendor-Reserved

6 Match List Control

Bit	**Description**
7	Match Buffer: 0b (changeable)

Value	**Description**
0b	Do not generate match list buffer for snoop/implicit operations
1b	Generate match list buffer for snoop/implicit operations

NOTE 119 - Read and write performance will be affected if Snoop Search Enable is 1b and Match Buffer is also 1b.

Bit	**Description**
6	Match Overflow: 0b (changeable)

Value	**Description**
0b	Match List overwrites oldest entries when list is full
1b	Match List discards new entries when list is full

Bit	**Description**
5-0	Vendor-Reserved

7 Match List Entry Type: 01h (type of match list entry to generate) (changeable)

Value	**Description**
00h	No match list
01h	Use four (4) byte Logical Block Numbers
02h	Use four (4) byte Logical Block Numbers and four (4) byte File Number pairs
03h	Use eight (8) byte Logical Block Numbers
04h	Use eight (8) byte Logical Block Numbers and eight (8) byte File Number pairs

8-9 Search Time: 0000h. The maximum time allowed for a search operation in seconds. If 0000h then there is no search time limit.

NOTE 120 - Device read error recovery actions may cause this time to be exceeded. The device stops the search command when this time has elapsed and only after any record (not necessarily a matching record) has been fully processed.

10 Vendor-Reserved

11 Search Method (Active SubPage): 01h

12 Search Status

Bit **Description**

7 Explicit Results

Value	**Description**
0b	Search Results and Match List reflect implicit (snoop) searches
1b	Search Results and Match List reflect the last explicit search (if Valid Results is 1b)

6-2 Vendor-Reserved

1 Valid Criteria (resettable)

Value	**Description**
0b	Search Criteria has not been setup
1b	Search Criteria has been setup (valid criteria and at least one possible match condition)

0 Valid Results (resettable)

Value	**Description**
0b	Current results are not valid (this will cause the Match Buffer to be cleared)
1b	Current results are valid

13 String Criteria Setup (changeable-ignored)

Bit	**Description**
7	1b: String 1 has valid criteria
6	1b: String 2 has valid criteria
5	1b: String 3 has valid criteria
4	1b: String 4 has valid criteria
3	1b: String 5 has valid criteria
2	1b: String 6 has valid criteria
1	1b: String 7 has valid criteria
0	1b: String 8 has valid criteria

14 Vendor-Reserved (Hardware Match Status Last Record) (changeable-ignored)

15 Vendor-Reserved (Hardware Match Status Last Dataset) (changeable-ignored)

16-23 First Match Logical Block Address (if Valid Results is 1b) (changeable-ignored)

24-31 First Match File Number (if Valid Results is 1b) (changeable-ignored)

32-39 Final Match Logical Block Address (if Valid Results is 1b) (changeable-ignored)

40-47 Final Match File Number (if Valid Results is 1b) (changeable-ignored)

48-55 Match Count (if Valid Results is 1b) (changeable-ignored)

NOTE 121 - It is possible for the Match Count to be larger than the number of Match List Entries

56-63 Check Count (if Valid Results is 1b) (changeable-ignored)

6.4.22.2 MP 37h[01h]: String Search Criteria

This subpage applies to Search Method 01h.

NOTE 122 - This page is specified in the manner that it is returned in Mode Sense (full fields and descriptors are always returned). For Mode Select any of the various Descriptors listed may be omitted, the number of elements in each descriptor may be reduced, or a shorted string length (m) may be used. When this subpage is altered, usage and order sensitive default values will be used for all unspecified/unchanged fields. Given this unique descriptor and default behavior, it may be simpler for the initiator to explicitly generate this subpage and use Mode Select only (without Mode Sense), rather than using the normally recommended standard method of reading the data with Mode Sense, modifying it, and using Mode Select. If the page is explicitly built, care should be taken to insure that the mode headers are not unintentionally altered. Additionally, in order to support a similar simplified method of defaulting descriptors when using the normally recommended standard Mode Sense, alter fields, Mode Select sequence, an “Apply” field is present in each descriptor. The Apply field must be set to 1b when any changes are intended for that descriptor. If changes to a descriptor are detected without the Apply bit set, the device responds with a CHECK CONDITION status and associated sense data of 5/2600 (Illegal Request, Invalid Field in Parameter List).

NOTE 123 - Descriptors are processed in order within the Mode Select. The last descriptor which affects (either by defaulting or explicitly) a given field or set of fields has precedence. The descriptors have been ordered to facilitate the most common behaviors and allow easy explicit overrides with a single Mode Select.

NOTE 124 - Mode Page 37h and Mode Page 37h[01h] should be set under separate Mode Select commands to insure the proper operating setup is used. To do this, the criteria should be setup with Mode Page 37h[01h] before the base page (i.e., Mode Page 37h) enables searching, etc.

NOTE 125 - Model E05 only supports eight (8) strings of sixteen (16) bytes. Strings longer than this may be specified, but the match criteria is only significant up to the first sixteen (16) bytes for each string.

Byte Description

0

Bit	**Description**
7	PS (Page Save): 0b
6	SPF (SubPage Format): 1b
5-0	Page Code: 37h

1 SubPage Code: 01h

2-3 Page Length: (sum of descriptors)
On Mode Sense: 03B4h

The following descriptors are sent in the order listed.

6.4.22.2.1 Search Criteria 01h - Features Descriptor 00h

This descriptor is normally sent on Mode Selects.

Table 153 — Search Criteria 01h - Features Descriptor 00h

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Descriptor Code: 00h							
	Apply	Vendor-Reserved						
2	MSB	Descriptor Length: 0008h						
3								LSB
4	Span: 0b	Vendor-Reserved						
5	Vendor-Reserved							
11								

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see *note 122*).
- Span: 0b (unsupported)

Value	Description
0b	match does not span record boundaries (all strings must be found in a single logical block)
1b	match may span record boundaries (unsupported)

  NOTE 126 - A given spanned match may only be contained in two successive records. If the string is longer than the record length and spans three or more records, it will not be found.

  NOTE 127 - Until span support is available, a single sufficiently long string may be split into two strings and ANY (OR) match logic can be used. This may result in more candidate searches, but will allow a search to find simple strings which span records.

6.4.22.2.2 Search Criteria 01h - String Descriptor 10h

This descriptor is normally sent on Mode Selects.

NOTE 128 - Strings specified will generate implicit default search criteria and setup bit masks and byte methods according to the Case, Wild, Any and Not fields corresponding to the values of all specified bytes. These defaults may be overridden by other descriptors with the Apply bit set. Strings are considered valid and will setup default behavior up to the last non-00h character of each string. Strings with one or more byte(s) with the most significant bit (7) set (80h) are considered EBCDIC with respect to Wild and Case. To specify matches of strings with trailing 00h characters the Byte Mask must be explicitly specified. Unspecified strings and partial strings will be non-criteria (byte mask methods of 00b).

Table 154 — Search Criteria 01h - String Descriptor 10h

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7 msb</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0 lsb</th></tr>
<tr><td>0</td><td colspan="8">Descriptor Code: 10h</td></tr>
<tr><td>1</td><td>Apply</td><td colspan="7">Vendor-Reserved</td></tr>
<tr><td>2</td><td>MSB</td><td colspan="6" rowspan="2">Additional Descriptor Length (n-3)</td><td></td></tr>
<tr><td>3</td><td></td><td>LSB</td></tr>
<tr><td>4</td><td colspan="5">Vendor-Reserved</td><td>Case</td><td>Wild</td><td>Any</td></tr>
<tr><td>5</td><td>Not 1</td><td>Not 2</td><td>Not 3</td><td>Not 4</td><td>Not 5</td><td>Not 6</td><td>Not 7</td><td>Not 8</td></tr>
<tr><td>6</td><td colspan="8">Vendor-Reserved</td></tr>
<tr><td>7</td><td colspan="8">String Length: (m; where m <= 20h)</td></tr>
<tr><td>8</td><td>MSB</td><td colspan="6" rowspan="2">String (k) (changeable) (where k = 1)</td><td></td></tr>
<tr><td>7+m</td><td></td><td>LSB</td></tr>
<tr><td colspan="9">.
.
.</td></tr>
<tr><td>n-m-1</td><td>MSB</td><td colspan="6" rowspan="2">String (k) (changeable) (where k <= 8)</td><td></td></tr>
<tr><td>n</td><td></td><td>LSB</td></tr>
</table>

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).
- Case: Always reads 0b (changeable)

  This applies to all of the following strings in String (k)

Value	Description
0b	use exact match Byte Mask method
1b	use case insensitive Byte Mask method (for ASCII or EBCDIC characters between A-Z and a-z)

- Wild: Always reads 0b (changeable)

  This applies to all of the following strings in String (k)

Value	Description
0b	do not use wildcard character
1b	use “?” as a wildcard character (match any byte) for ASCII (3Fh) and EBCDIC (6Fh)

- Any: Always reads 0b (changeable)

Value	Description
0b	default Truth Table *(see 4.17.1 on page 122)* is built with AND conditions for all specified strings (ALL specified strings must be found)
1b	default Truth Table is built with OR conditions for all specified strings (ANY specified string may be found)

- Not (k): Always reads 0b (changeable)

k = [1,2,3,4,5,6,7,8]

Each Not (k) relates to the corresponding String (k) that follows.

Value	Description
0b	default Truth Table is built with specified AND/OR behavior
1b	default Truth Table is built with NOT conditions for the specified string (match cannot contain string) - only valid when Any is set to 0b

6.4.22.2.3 Search Criteria 01h - Bit Mask Descriptor 20h

Table 155 — Search Criteria 01h - Bit Mask Descriptor 20h

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Descriptor Code: 20h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length (n-3)						
3								LSB
4	Vendor-Reserved							
6								
7	String Bit Mask Length: (m; where m <= 20h)							
8	MSB	String Bit Mask (k) (changeable) (where k = 1)						
7+m								LSB
. . .								
n-m-1	MSB	String Bit Mask (k) (changeable) (where k <= 8)						
n								LSB

NOTE 129 - All Bytes in a String Bit Mask (k) must be set to the same value. Typical values which might be used are 11011111b or 10111111b for case independent matches of ASCII or EBCDIC strings respectively.

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).

6.4.22.2.4 Search Criteria 01h - Byte Mask Descriptor 30h

Table 156 — Search Criteria 01h - Byte Mask Descriptor 30h

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Descriptor Code: 30h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length (n-3)						
3								LSB
4	Vendor-Reserved							
6								
7	Byte Mask Element Length: (m; where m <= 20h)							
8	MSB	Byte Mask Element (k) (changeable) (where k = 1)						
7+m								LSB
. . .								
n-m-1	MSB	Byte Mask Element (k) (changeable) (where k <= 8)						
n								LSB

- Apply: Always reads as 0n, must be set to 1b if descriptor changes were made or values should be used (see note 114).

6.4.22.2.4.1 Search Criteria 01h - Descriptor 30h - Byte Mask Element

Table 157 — Search Criteria 01h - Descriptor 30h - Byte Mask Element

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Byte Method		Vendor-Reserved					
. . .								
m	Byte Method		Vendor-Reserved					

- Byte Method:

Value	Description
00b	No valid byte in this location (this terminates the string allowing strings of less than 16 bytes)
01b	A byte must exist in this location, but its value is not checked (this may also be accomplished with Byte Method 10b and a String Bit Mask of 00h
10b	Match byte, but only check String bits which have corresponding bits in the String Bit Mask field set to 1b.
11b	Match byte exactly, bit for bit (do not use String Bit Mask field).

NOTE 130 - If a string is not to be searched for, set 00b in the mask for byte 0. A string will be searched starting at byte 0 and continuing until the first byte mask that is 00b or the end of the string.

6.4.22.2.5 Search Criteria 01h - Minimum Record Offset Descriptor 40h

Table 158 — Search Criteria 01h - Minimum Record Offset Descriptor 40h

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Descriptor Code: 40h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length (n-3)						
3								LSB
4	Vendor-Reserved							
6								
7	String (k) Minimum Byte Offset Length: (04h)							
8	MSB	String (k) Minimum Byte Offset: (where k = 1)						
11								LSB
. . .								
n-3	MSB	String (k) Minimum Byte Offset: (where k <= 8)						
n								LSB

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).
- Minimum Byte Offset:

  Value **Description**
  00000000h Beginning of a string

6.4.22.2.6 Search Criteria 01h - Maximum Record Offset Descriptor 50h

Table 159 — Search Criteria 01h - Maximum Record Offset Descriptor 50h

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Descriptor Code: 50h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length (n-3)						
3								LSB
4	Vendor-Reserved							
6								
7	String (k) Maximum Byte Offset Length: (04h)							
8	MSB	String (k) Maximum Byte Offset: FFFF FFFFh (where k = 1)						
11								LSB
. . .								
n-3	MSB	String (k) Maximum Byte Offset: FFFF FFFFh (where k <= 8)						
n								LSB

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).

6.4.22.2.7 Search Criteria 01h - Match Truth Table Descriptor F0h

Table 160 — Search Criteria 01h - Match Truth Table Descriptor F0h

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	Descriptor Code: F0h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length: 0024h						
3								LSB
4	Vendor-Reserved							
6								
7	Element Length: 20h							
8	Truth Table (changeable) *(see 4.17.1 on page 122)*							
39								

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).

NOTE 131 - If a Truth Table is not specified (descriptor not present or Apply is 0b), then a table will be generated according to the Any field in descriptor 10h and/or by descriptor F1h. See *"String Search Function (not J1A)" on page 122* for additional information on the Truth Table.

6.4.22.2.8 Search Criteria 01h - Match String Helper Descriptor F1h

NOTE 132 - This helper descriptor is provided to simplify the generation of the Truth Table *(see 4.17 on page 122)*. Any number of elements can be used. All bits in each entry specify an AND and AND NOT match criteria. Each entry in the list is an OR match criteria. This table is used for Mode Select only, and it affects other fields and does not retain any values itself (always reads defaults).

Table 161 — Search Criteria 01h - Match String Helper Descriptor F1h

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Descriptor Code: F1h							
1	Apply	Vendor-Reserved						
2	MSB	Additional Descriptor Length: n-3						
3								LSB
4	Vendor-Reserved						Delete	Modify
5	Vendor-Reserved							
6								
7	Element Length: 02h							
AND Match Condition(s) (Element) (2 bytes - repeating) (changeable) (bits as below)								
8	Find 1	Find 2	Find 3	Find 4	Find 5	Find 6	Find 7	Find 8
9	Not 1	Not 2	Not 3	Not 4	Not 5	Not 6	Not 7	Not 8
. . .								
n-1	Find 1	Find 2	Find 3	Find 4	Find 5	Find 6	Find 7	Find 8
n	Not 1	Not 2	Not 3	Not 4	Not 5	Not 6	Not 7	Not 8

- Apply: Always reads as 0b, must be set to 1b if descriptor changes were made or values should be used (see note 114).
- Modify: Always read as 0b (changeable)

Value	**Description**
0b	Use AND Match Condition(s) to generate entire Truth Table (clear prior)
1b	Use AND Match Condition(s) to modify existing Truth Table

- Delete: Always read as 0b (changeable)

Value	**Description**
0b	Add AND Match Condition(s) to Truth Table
1b	Remove AND Match Condition(s) from Truth Table. The Modify field must be set to 1b when Delete is 1b.

- Find (k): Always read as 0b (changeable)

  k = [1,2,3,4,5,6,7,8]

Value	**Description**
0b	string is a don't care state (if Not is also 0b)
1b	Truth Table is built with AND conditions for the specified string (match must contain string)

- Not (k): Always read as 0b (changeable) k = [1,2,3,4,5,6,7,8]

Value	Description
0b	string is a don't care state (if And is also 0b)
1b	Truth Table is built with NOT conditions for the specified string (match cannot contain string)

NOTE 133 - It is illegal for corresponding Find and Not bits to both be set to 1b on any given match condition element.

NOTE 134 - More than one F1h descriptor may be sent. If more than one F1h descriptor is sent, each descriptor is processed before the next descriptor is processed (i.e., they are processed in the order they appear).

6.4.23 MP 3Eh: Engineering Support

See Mode Select (6/10) - 15h/55h (see 5.2.9 on page 153) for how to set these parameters and Mode Sense (6/10) - 1Ah/5Ah (see 5.2.10 on page 155) for how to read these parameters.

The initiator behavior for this page is not defined, and may contain elements which are common to all initiators, as well as elements which are initiator unique.

NOTE 135 - As this page is not for normal application use, it is not returned in mode page 3Fh (all pages). Consequently, this page must be specifically queried and set.

NOTE 136 - For more information on special needs and the usage of this page contact IBM.

Byte	Description
0	
	Bit **Description**
	7 PS (Page Save): 0b
	6 Reserved
	5-0 Page Code: 3Eh
1	Page Length: 7Eh
2-95	Vendor-Reserved

6.5 Security Protocol Parameters (SPP)

Security Protocol parameters are used by the SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140)command and by the SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) command.

The following terms are used in this clause:

Term	Description
SPIN	Security Protocol In
SPOUT	Security Protocol Out

6.5.1 SPIN Pages (00h - Security Protocol Information)

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The Security Protocol Specific field of the SPIN CDB is defined by *Table 164*

Table 164 — Security Protocol Specific Definitions for Security Protocol 00h

Code	Description	Reference
0000h	Supported security protocol list	see *page 367*
0001h	Certificate data	see *page 367*
0002h - FFFFh	Reserved	

6.5.1.1 SPIN (00h[0000h]) - Supported Security Protocols List

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. If the SECURITY PROTOCOL field is set to 00h and the SECURITY PROTOCOL SPECIFIC field is set to 0000h in a SECURITY PROTOCOL IN command, the parameter data shall have the format shown in *Table 165*.

Table 165 — Supported Security Protocols List Structure

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0 - 5	Reserved							
6	(MSB)	SUPPORTED SECURITY PROTOCOL LIST LENGTH (m-7)						
7								(LSB)
8	Supported Security Protocol (first)							
	⋮							
m	Supported Security Protocol (last)							

The Supported Security Protocol list contains the following supported security protocols:

Value	Description
00h	Security protocol information *(see 6.5.1 on page 367)*.
20h	Tape Data Encryption *(see 6.5.2 on page 369)*.

6.5.1.2 SPIN (00h[0001h]) - Certificate Data

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The drive certificate (if present) is provided in X.509 format via this interface (see SPC-4).

If the Security Protocol field is set to 00h and the Security Protocol Specific field is set to 0001h in a Security Protocol In command, the parameter data shall have the format shown in *Table 166*.

Table 166 — 0001h - Certificate Data Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0 - 1	Reserved							
2 - 3	(MSB) CERTIFICATE LENGTH (m-3) (LSB)							
4 - m	CERTIFICATE							

The following parameters apply:

- Certificate Length - The total length, in bytes, of the certificate that follows.
- Certificate - The drive certificate set during manufacturing is returned.

6.5.2 SPIN Pages (20h - Tape Data Encryption)

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The SECURITY PROTOCOL SPECIFIC field specifies the type of report that the application client is requesting. *Table 167* shows supported SECURITY PROTOCOL SPECIFIC field values.

Table 167 — Security Protocol Specific Definitions for Security Protocol 20h

Page Code	Description	Reference
0000h	Tape Data Encryption In Support Pages	see *page 369*
0001h	Tape Data Encryption Out Support Pages	see *page 370*
0010h	Data Encryption Capabilities	see *page 371*
0011h	Supported Key Formats	see *page 376*
0012h	Data Encryption Management Capabilities	see *page 376*
0020h	Data Encryption Status	see *page 377*
0021h	Next Block Encryption Status	see *page 380*
0030h	Random Number page	see *page 383*

6.5.2.1 SPIN (20h[0000h]) - Tape Data Encryption In Support Pages page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Supported protocol specific in pages for protocol 20h are indicated above (see SSC-3).

Table 168 — 0000h - Tape Data Encryption In Support Pages Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0000h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
Tape Data Encryption In Support page code list								
4	(MSB)	Tape Data Encryption In Support page code (first)						
5								(LSB)
	⋮							
n-1	(MSB)	Tape Data Encryption In Support page code (last)						
n								(LSB)

Table 169 on page 369 show which Tape Data Encryption In page codes are supported:

Table 169 — Tape Data Encryption In page codes

Page Code	Description	Reference
0000h	Tape Data Encryption In Support Pages	see *page 369*
0001h	Tape Data Encryption Out Support Pages	see *page 370*
0010h	Data Encryption Capabilities	see *page 371*

Table 169 — Tape Data Encryption In page codes

Page Code	Description	Reference
0011h	Supported Key Formats	see *page 376*
0012h	Data Encryption Management Capabilities	see *page 376*
0020h	Data Encryption Status	see *page 377*
0021h	Next Block Encryption Status	see *page 380*

6.5.2.2 SPIN (20h[0001h]) - Tape Data Encryption Out Support Pages page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Supported protocol specific out pages for protocol 20h are indicated above (see SSC-3).

Table 170 — 0001h - Tape Data Encryption Out Support Pages Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	Page Code (0001h)						
1								(LSB)
2	(MSB)	Page Length (n-3)						
3								(LSB)
Tape Data Encryption Out Support page code list								
4	(MSB)	Tape Data Encryption Out Support page code (first)						
5								(LSB)
	⋮							
n-1	(MSB)	Tape Data Encryption Out Support page code (last)						
n								(LSB)

Table 171 on page 370 show which Tape Data Encryption Out page codes are supported:

Table 171 — Tape Data Encryption Out page codes

Page Code	Description	Reference
0010h	Set Data Encryption	*6.5.3.1 on page 385*

6.5.2.3 SPIN (20h[0010h]) - Data Encryption Capabilities page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Table 97 specifies the format of the Data Encryption Capabilities page.

Table 172 — 0010h - Data Encryption Capabilities page

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0010h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Reserved				EXTDECC		CFG_P	
5	Reserved							
19								
	Data Encryption Algorithm descriptor list							
20	Data Encryption Algorithm descriptor (first)							
	⋮							
n	Data Encryption Algorithm descriptor (last)							

The external data encryption control capable (EXTDECC) field specifies the external data encryption control capability of the device entity. The EXTDECC field values are specified in *table 173*.

Table 173 — EXTDECC field

Code	Description
00b	The external data encryption control capability is not reported.
01b	The device entity is not external data encryption control capable.
10b	The device entity is external data encryption control capable.
11b	Reserved

The configuration prevented (CFG_P) field specifies the logical block encryption parameters configuration capabilities for the algorithms reported in the logical block encryption algorithm descriptors. The CFG_P field values are specified in *table 174*.

Table 174 — CFG_P field

Code	Description
00b	The logical block encryption configuration capabilities are not reported.
01b	The device entity is configured to allow this device server to establish or change logical block encryption parameters.
10b	The device entity is configured to not allow this device server to establish or change logical block encryption parameters. In code levels that set this field, this value is reported when in LME mode.
11b	Reserved

6.5.2.3.1 Data Encryption Algorithm Descriptor - Standard Encryption

The Standard Encryption Algorithm Descriptor is shown in *Table 175 on page 372*

Table 175 — Data Encryption Algorithm Descriptor - Standard Encryption Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	ALGORITHM INDEX (01h)							
1	Reserved							
2	(MSB)	DESCRIPTOR LENGTH (0014h)						
3								(LSB)
4	AVFMV	SDK_C (0b)	MAC_C (1b)	DELB_C (1b)	DECRYPT_C (2h)		ENCRYPT_C (2h)	
5	AVFCLP		NONCE_C (3h)		KADF_C	VCELB_C (1b)	UKADF	AKADF
6	(MSB)	MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED DATA (U-KAD) BYTES (0000h)						
7								(LSB)
8	(MSB)	MAXIMUM AUTHENTICATED KEY-ASSOCIATED DATA (A-KAD) BYTES (000Ch)						
9								(LSB)
10	(MSB)	LOGICAL BLOCK ENCRYPTION KEY SIZE (0020h)						
11								(LSB)
12	DKAD_C		EEMC_C (2h)		RDMC_C (5h)			EARM (1b)
13	Reserved							
14		MSDK_COUNT (00000000h)						
15								
16		Reserved						
19								
20	(MSB)	SECURITY ALGROTIHM CODE (00010014h)						
23								(LSB)

The ALGORITHM INDEX field is used by the SECURITY PROTOCOL OUT command Set Data Encryption page to select this algorithm.

The algorithm valid for mounted volume (AVFMV) bit is set to one if there is a volume currently mounted and the encryption algorithm being described is valid for that volume. The AVFMV bit is set to zero if there is no volume mounted or the algorithm is not valid for the currently mounted volume.

The supplemental decryption key capable (SDK_C) bit is set to zero because the device entity is not capable of supporting supplemental decryption keys.

The message authentication code capable (MAC_C) bit is set to one to indicate the algorithm includes a message authentication code added to encrypted logical blocks.

The distinguish encrypted logical block capable (DELB_C) bit is set to one to indicate the device entity is capable of distinguishing encrypted logical blocks from unencrypted logical blocks when reading it from the medium.

The DECRYPT_C field *(see table 176)* specifies the decryption capabilities of the device entity.

Table 176 — DECRYPT_C field

Code	Name	Description
00b	No capability	The device entity has no logical block decryption capability using this algorithm. This value shall be returned if the specified algorithm is disabled.
01b	Software capable	Not Supported.
10b	Hardware capable	The device entity has the ability to decrypt logical blocks using this algorithm in hardware.
11b	Capable with external control	The device entity has the capability to decrypt logical blocks using this algorithm, but control of the logical block encryption parameters by this device server is prevented.

The ENCRYPT_C field *(see table 177)* specifies the encryption capabilities of the device entity.

Table 177 — ENCRYPT_C field

Code	Name	Description
00b	No capability	The device entity has no logical block encryption capability using this algorithm. This value shall be returned if the specified algorithm is disabled.
01b	Software capable	Not Supported.
10b	Hardware capable	The device entity has the ability to encrypt logical blocks using this algorithm in hardware.
11b	Capable with external control	The device entity has the capability to encrypt logical blocks using this algorithm, but control of the logical block encryption parameters by this device server is prevented.

The algorithm valid for current logical position (AVFCLP) field specifies if the encryption algorithm being specified is valid for writing to the mounted volume at the current logical position. *Table 178* specifies the values for the AVFCLP field.

Table 178 — AVFCLP field values

Code	Description
00b	Current logical position is not applicable to the encryption algorithm validity or no volume is loaded.
01b	The encryption algorithm being specified is not valid for writing to the mounted volume at the current logical position.
10b	The encryption algorithm being specified is valid for writing to the mounted volume at the current logical position.
11b	Reserved

Table 179 specifies the values for the NONCE_C field.

Table 179 — NONCE_C field

Code	Description
00b	Not Supported.
01b	Not Supported.
10b	Not Supported.
11b	The device entity supports all or part of the nonce value provided by the application client. If the Set Data Encryption page that enables encryption does not include a nonce value descriptor, the device entity generates the nonce value.

A KAD format capable (KADF_C) bit set to one indicates that the device server supports:

a) the ENCRYPTION PARAMETERS KAD FORMAT field in the Data Encryption Status page *(see 6.5.2.6 on page 377)*;
b) the NEXT BLOCK KAD FORMAT field in the Next Block Encryption Status page *(see 6.5.2.7 on page 380)*; and
c) the KAD FORMAT field in the Set Data Encryption page *(see 6.5.3.1 on page 385)*.

A KADF_C bit set to zero indicates that the device server does not support:

a) the ENCRYPTION PARAMETERS KAD FORMAT field in the Data Encryption Status page *(see 6.5.2.6 on page 377)*;
b) the NEXT BLOCK KAD FORMAT field in the Next Block Encryption Status page *(see 6.5.2.7 on page 380)*; or
c) the KAD FORMAT field in the Set Data Encryption page *(see 6.5.3.1 on page 385)*.

The volume contains encrypted logical blocks capable (VCELB_C) bit is set to one to indicate that the device server is capable of determining that a volume contains logical blocks encrypted using this algorithm when the volume is mounted.

The U-KAD fixed (UKADF) bit shall be set to one if the device server requires the length of U-KAD in the parameter data for a SECURITY PROTOCOL OUT command to equal the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field. If the UKADF bit is set to one, then the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field shall contain a non-zero value. If the UKADF bit is set to zero and the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field is non-zero, then the length of the U-KAD, if present in the parameter data for a SECURITY PROTOCOL OUT command, shall be a value between one and the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field.

The A-KAD fixed (AKADF) bit shall be set to one if the device server requires the length of A-KAD in the parameter data for a SECURITY PROTOCOL OUT command to equal the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field. If the AKADF bit is set to one, then the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field shall contain a non-zero value. If the AKADF bit is set to zero and the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field is non-zero, then the length of the A-KAD, if present in the parameter data for a SECURITY PROTOCOL OUT command, shall be a value between one and the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field.

The MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED DATA BYTES field indicates the maximum size of the unauthenticated key-associated data supported by the device server for this algorithm.

The MAXIMUM AUTHENTICATED KEY-ASSOCIATED DATA BYTES field indicates the maximum size of the authenticated key-associated data supported by the device server for this algorithm.

The LOGICAL BLOCK ENCRYPTION KEY SIZE field indicates the size in bytes of the logical block encryption key required by the algorithm.

Table 180 specifies the values for the decryption KAD capabilties (DKAD_C) field. The DKAD_C field indicates the decryption capabilities when the DECRYPTION MODE field of the Set Data Encryption page *(see 6.5.3.1 on page 385)* is set to DECRYPT or MIXED.

Table 180 — DKAD_C field

Code	Name	Description
00b	not specified	No capabilities are specified.
01b	KAD Required	Not Supported.
10b	KAD Not Allowed	Not Supported.
11b	KAD Capable	The device entity has the capability to accept a U-KAD or A-KAD to be provided by the application client with the Set Data Encryption page, but one is not required.

The external encryption mode control capabilities (EEMC_C) field indicates the capabilities the encryption algorithm provides to the application client to control write operations that transfer encrypted logical blocks while the encryption mode is set to EXTERNAL. *Table 181* defines the values for the EEMC_C field.

Table 181 — EEMC_C field

Code	Description
0h	No capabilities are specified.
1h	Not Supported.
2h	The encryption algorithm allows write operations in EXTERNAL encryption mode. The device server does act as a KCDLU *(see 4.2.22.5 on page 73)* for this encryption algorithm.
3h	Reserved

The raw decryption mode control capabilities (RDMC_C) field indicates the capabilities the encryption algorithm provides to the application client to control read operations that access encrypted logical blocks while the decryption mode is set to RAW. *Table 182* defines the values for the RDMC_C field.

Table 182 — RDMC_C field

Code	Description
0h	No capabilities are specified.
1h	Not Supported.
2h-3h	Reserved
4h	Not Supported.
5h	The encryption algorithm enables read operations in RAW mode by default and allows the application client to control RAW reads via the RDMC field in the Set Data Encryption page *(see 6.5.3.1 on page 385)*. The device server acts as a KCSLU *(see 4.2.22.5 on page 73)* for this encryption algorithm.
6h	Not Supported.
7h	Not Supported.

The encryption algorithm records encryption mode (EAREM) bit shall be set to one if the encryption mode is recorded with each encrypted logical block. The EAREM bit shall be set to zero if the encryption mode is not recorded with each encrypted logical block.

The maximum supplemental decryption key count (MSDK_COUNT) field contains the maximum number of supplemental decryption keys that the device server supports with this algorithm. If the SDK_C bit is set to one, then the MSDK_COUNT field shall be set to non-zero. If the SDK_C bit is set to zero, then the MSDK_COUNT field shall be set to zero.

The SECURITY ALGORITHM CODE field contains a security algorithm code (see SPC-4).

6.5.2.4 SPIN (20h[0011h]) - Supported Key Formats page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

The structure of the Supported Key Formats page is shown in *Table 183 on page 376*

Table 183 — 0011h - Supported Key Formats page Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0011h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
Supported Key Format list								
4	Supported Key Format [first]							
	⋮							
n	Supported Key Format [last]							

Table 184 — Supported Key Formats

Key Format	Description	Reference
00h	Plaintext Key Format	See *page 376*

6.5.2.4.1 Plaintext Key Format (00h)

The Plaintext Key Format structure is shown in *Table 185 on page 376*

Table 185 — 00h - Plaintext Key Format Structure

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	KEY							
n								

6.5.2.5 SPIN (20h[0012h]) - Data Encryption Management Capabilities

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

Table 186 on page 377 specifies the format of the Data Encryption Management Capabilities page.

Table 186 — 0012h - Data Encryption Management Capabilities page

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0012h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (000ch)						
3								(LSB)
4	Reserved							LOCK_C (1b)
5	Reserved					CKOD_C (1b)	CKORP_C (1b)	CKORL_C (1b)
6	Reserved							
7	Reserved					AITN_C (1b)	LOCAL_C (1b)	PUBLIC_C (1b)
8 - 15	Reserved							

6.5.2.6 SPIN (20h[0020h]) - Data Encryption Status page

Table 187 specifies the format of the Data Encryption Status page

This is a query of information which was set with Security Protocol Out 0010h - Set Data Encryption and does not reflect the actual state of the medium itself or of any data on medium..

Table 187 — 0020h - Data Encryption Status page

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0020h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	I_T NEXUS SCOPE			Reserved		LOGICAL BLOCK ENCRYPTION SCOPE		
5	ENCRYPTION MODE							
6	DECRYPTION MODE							
7	ALGORITHM INDEX							
8	(MSB)	KEY INSTANCE COUNTER						
11								(LSB)
12	Reserved	parameters control			VCELB	CEEMS		RDMD
13	ENCRYPTION PARAMETERS KAD FORMAT							
14	(MSB)	ASDK_COUNT (0000h)						
15								(LSB)
16	Reserved							
23								
Key-associated data descriptor list								
24	Key-associated data descriptor (first)							
	Key-associated data descriptor (last)							
n								

The I_T NEXUS SCOPE field shall contain the value from the logical block encryption scope saved for the I_T_L nexus through which this command was received.

The LOGICAL BLOCK ENCRYPTION SCOPE field shall contain the value from the logical block encryption scope in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The ENCRYPTION MODE field shall contain the value from the encryption mode in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The DECRYPTION MODE field shall contain the value from the decryption mode in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The ALGORITHM INDEX field shall contain the value from the algorithm index in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the value in the ALGORITHM INDEX field is undefined.

The KEY INSTANCE COUNTER field contains the value of the logical block encryption parameters key instance counter assigned to the logical block encryption key indicated by the LOGICAL BLOCK ENCRYPTION SCOPE field value.

The PARAMETERS CONTROL field specifies information on how the logical block encryption parameters are controlled. The PARAMETERS CONTROL field values are specified in *table 188*.

Table 188 — PARAMETERS CONTROL field

Code	Description
000b	Logical block encryption parameters control is not reported. This value is returned on Ultrium 4 devices
001b	Logical block encryption parameters are not exclusively controlled by external data encryption control. This value is returned when in AME encryption mode.
010b	Logical block encryption parameters are exclusively controlled by the sequential-access device server.
011b	Logical block encryption parameters are exclusively controlled by the automation/drive interface device server. This value is returned when in LME or ADC Controlled encryption mode.
100b	Not supported.
101b-111b	Reserved

A volume contains encrypted logical blocks (VCELB) bit set to one indicates that the mounted volume contains an encrypted logical block. A VCELB bit set to zero indicates that either:

a) the mounted volume does not contain any encrypted logical blocks;
b) there is no volume mounted; or
c) the VCELB_C bit in the Data Encryption Capabilities page is set to zero.

The raw decryption mode disabled (RDMD) bit shall be set to one if the device entity is configured to mark each encrypted record as disabled for raw read operations based on the RDMC_C value and the raw decryption mode disable parameter in the saved logical block encryption parameters currently associated with the I_T_L nexus on which the command was received.

The check external encryption mode status (CEEMS) field shall contain the value from the check external encryption mode parameter in the saved logical block encryption parameters currently associated with the I_T_L nexus on which the command was received.

The ENCRYPTION PARAMETERS KAD FORMAT field shall contain the value from the KAD_FORMAT in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. If the encryption algorithm specified in the ALGORITHM INDEX field reports a KADF_C bit set to zero, then the ENCRYPTION PARAMETERS KAD FORMAT field shall be set to zero.

The available supplemental decryption key count (ASDK_COUNT) field shall bet set to zero because the device server is not capable of supporting supplemental decryption keys.

If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the key-associated data descriptors list shall not be included in the page.

If either the ENCRYPTION MODE field or the DECRYPTION MODE field is set to a value other than DISABLE, the key-associated data descriptors list shall include Tape Data Encryption descriptors describing attributes assigned to the logical block encryption key defined by the I_T NEXUS SCOPE and LOGICAL BLOCK ENCRYPTION SCOPE fields at the time the logical block encryption key was established in the device entity (see *“Key-Associated Data (KAD) Descriptors” on page 388*). If more than one key-associated data descriptor is included, they shall be in increasing numeric order of the value in the KEY DESCRIPTOR TYPE field. Descriptors shall be included as defined by the following paragraphs.

An unauthenticated key-associated data descriptor shall be included if an unauthenticated key-associated data descriptor was included when the logical block encryption key was established in the device entity. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the logical block encryption key.

An authenticated key-associated data descriptor shall be included if an authenticated key-associated data descriptor was included when the logical block encryption key was established in the device entity. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the logical block encryption key.

A nonce value descriptor shall be included if a nonce value descriptor was included when the logical block encryption key was established in the device entity. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the nonce value associated with the logical block encryption key. A nonce value descriptor may be included if no nonce value descriptor was included when the logical block encryption key was established in the device entity. In this case, the KEY DESCRIPTOR field shall be set to the nonce value established by the device entity for use with the selected logical block encryption key.

A metadata key-associated data descriptor shall be included if the metadata key-associated data descriptor was included when the logical block encryption parameters were established. The KEY DESCRIPTOR field shall contain the M-KAD value associated with the logical block encryption key.

6.5.2.7 SPIN (20h[0021h]) - Next Block Encryption Status page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

NOTE 137 - Next block encryption status may not be available in all situations. When it is not known appropriate values are returned as per the standard. In most situations next block information is available during read operations when read ahead is being performed. This is automatically managed by the device.

Table 189 specifies the format of the Next Block Encryption Status page

Table 189 — 0021h - Next Block Encryption Status page

Byte	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0021h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	(MSB)	LOGICAL OBJECT NUMBER						
11								(LSB)
12	COMPRESSION STATUS (0h)				ENCRYPTION STATUS			
13	ALGORITHM INDEX							
14	Reserved						EMES	RDMDS
15	NEXT BLOCK KAD FORMAT							
	Key-associated data descriptor list							
16	Key-associated data descriptor [first]							
	Key-associated data descriptor [last]							
n								

The LOGICAL OBJECT NUMBER field contains the logical object identifier of the next logical object *(see 4.2.8.2 on page 42)*.

The COMPRESSION STATUS field values are specified in *table 190*.

Table 190 — COMPRESSION STATUS field

Code	Description
0h	The device entity is incapable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been compressed.
1h	Not Supported.
2h	Not Supported.
3h	Not Supported.
4h	Not Supported.
5h-Fh	Reserved

The ENCRYPTION STATUS field values are specified in *table 191*.

Table 191 — ENCRYPTION STATUS field

Code	Description
0h	The device entity is incapable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been encrypted.
1h	The device entity is capable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been encrypted, but is not able to at this time. Possible reasons are: the next logical block has not yet been read into the buffer; there was an error reading the next logical block; or there are no more logical blocks (i.e., end-of-data).
2h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is not a logical block.
3h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is not encrypted.
4h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is not supported by this device server. The values in the key-associated data descriptors list contain information pertaining to the encrypted logical block.
5h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is supported by this device server. The values in the ALGORITHM INDEX field and key-associated data descriptors list contain information pertaining to the encrypted logical block.
6h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is supported by this device server, but the device entity is either not enabled to decrypt or does not have the correct logical block encryption key or nonce value to decrypt the encrypted logical block.
7h-Fh	Reserved

The ALGORITHM INDEX field indicates which of the encryption algorithms reported by the SECURITY PROTOCOL IN command Data Encryption Capabilities page was used to encrypt the logical block. For values in the ENCRYPTION STATUS field *(see table 191)* that do not indicate the ALGORITHM INDEX field is valid, the algorithm index is undefined.

The encryption mode external status (EMES) bit shall be set to one if:

a) the ENCRYPTION STATUS field is set to either 5h or 6h;
b) the EAREM bit in the algorithm descriptor *(see 6.5.2.3 on page 371)* for the algorithm specified by the ALGORITHM INDEX field is set to one; and

c) the next logical block is marked as having been written to the medium while the encryption mode was set to EXTERNAL.

The EMES bit shall be set to zero if:

a) the ENCRYPTION STATUS field is set to a value other than 5h or 6h;
b) the EAREM bit in the algorithm descriptor *(see 6.5.2.3 on page 371)* for the algorithm specified by the ALGORITHM INDEX field is set to zero; or
c) the next logical block is marked as having been written to the medium while the encryption mode was set to ENCRYPT.

The raw decryption mode disabled status (RDMDS) bit shall be set to one if:

a) the device server supports raw decryption mode;
b) the ENCRYPTION STATUS field is set to either 5h or 6h; and
c) the next logical block is marked as disabled for raw decryption mode operations *(see 4.2.22 on page 71)*.

The RDMDS bit shall be set to zero if:

a) the device server does not support raw decryption mode;
b) the ENCRYPTION STATUS field is set to a value other than 5h or 6h; or
c) the next logical block is not marked as disabled for raw decryption mode operations.

If the value in the ENCRYPTION STATUS field indicates that the next logical block is encrypted by a supported algorithm, then the NEXT BLOCK KAD FORMAT field shall contain the KAD_FORMAT logical block encryption parameters associated with the encrypted logical block. If the value in the ENCRYPTION STATUS field does not indicate that the next logical object is an encrypted logical block, then the NEXT BLOCK KAD FORMAT field shall be ignored. If the encryption algorithm specified in the ALGORITHM INDEX field reports a KADF_C bit set to zero, then the NEXT BLOCK KAD FORMAT field shall be set to zero.

If the value in the ENCRYPTION STATUS field indicates that the next logical block is encrypted by a supported algorithm, then the device server shall include in the key-associated data descriptor list (see *"Key-Associated Data (KAD) Descriptors" on page 388*) all key-associated data that is associated with the encrypted logical block. If more than one key-associated data descriptor is included in the Next Block Encryption Status page, then they shall be in increasing numeric order of the value in the KEY DESCRIPTOR TYPE field.

An unauthenticated key-associated data descriptor *(see 6.5.3.2.1 on page 388)* shall be included if any unauthenticated key-associated data is associated with the next logical block. The AUTHENTICATED field shall be set to 1. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the encrypted logical block.

An authenticated key-associated data descriptor *(see 6.5.3.2.2 on page 389)* shall be included if any authenticated key-associated data is associated with the next logical block. The AUTHENTICATED field shall indicate the status of the authentication done by the device entity. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the encrypted logical block.

The Next Block Encryption Status page may include a nonce value descriptor *(see 6.5.3.2.3 on page 389)*. If a nonce value descriptor is included, then the AUTHENTICATED field shall indicate the status of the authentication done by the device entity. The KEY DESCRIPTOR field shall contain the nonce value associated with the encrypted logical block.

A metadata key-associated data descriptor (see *6.5.3.2.4*) shall be included if any M-KAD is associated with the next logical block and the decryption mode is set to RAW in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. The KEY DESCRIPTOR field shall contain the M-KAD value associated with the encrypted logical block.

The following table indicates valid combinations of record status, Decryption Mode and returned Key-Associated Descriptors reflecting the currently setup state of the device.

Table 192 — SPIN (20h[0021h]) - KAD Parameters by Mode

Record Information	Decryption Mode	Read Data	Status	Key-Associated Descriptors				Notes
				uKAD 00h	aKAD (DKi) 01h	Nonce 02h	Meta data 03h	
Unknown	any	?	1h	n/a	n/a	n/a	n/a	
Filemark	any	n/a	2h	n/a	n/a	n/a	n/a	may be unknown
EOD	any	n/a	2h	n/a	n/a	n/a	n/a	may be unknown
Error	any	n/a	1h	n/a	n/a	n/a	n/a	may be unknown
Cleartext	0h Disable	C	3h	n/a	n/a	n/a	n/a	
Cleartext	1h Raw	E	3h	n/a	n/a	n/a	n/a	not readable
Cleartext	2h Decrypt	E	3h	n/a	n/a	n/a	n/a	not readable
Cleartext	3h Mixed	C	3h	n/a	n/a	n/a	n/a	
Encrypted	0h Disable	E	4h 5h or 6h	N	Y	N	N	not readable
Encrypted	1h Raw	R		N	N	N	Y	
Encrypted	2h Decrypt	C[1]		N	Y	N	N	
Encrypted	3h Mixed	C[1]		N	Y	N	N	
Legend: Y: element is required O: element is optional N: element is not present n/a: not applicable (element is not present) C: cleartext (not encrypted) R: raw (compressed encoded/encrypted) E: error condition, record cannot be read				Notes: 1: Data is decrypted				

6.5.2.7.1 Key-Associated Data (KAD) Descriptors

See *“Key-Associated Data (KAD) Descriptors” on page 388*

6.5.2.8 SPIN (20h[0030h]) - Random Number page

Table 193 specifies the format of the Random Number page.

Table 193 — Random Number page

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PAGE CODE (0030h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (32)				
3								(LSB)
4	(MSB)			RANDOM NUMBER				
35								(LSB)

The RANDOM NUMBER field contains a secure random number, suitable for use as a random nonce, that is generated by the device server using a source of entropy available within the device. Each request for the Random Number page generates a new secure random number for the RANDOM NUMBER field.

6.5.3 SPOUT Pages (20h - Tape Data Encryption security protocol)

See SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) for a description of how to send this page.

The Security Protocol Specific field (see *Table 93, "SECURITY PROTOCOL OUT B5h CDB," on page 141*) specifies the type of page that the application client is sending. *Table 194* shows supported values.

Table 194 — Security Protocol Specific Definitions for Security Protocol 20h

Page Code	Description	Reference
0010h	Set Data Encryption	See *page 385*

6.5.3.1 SPOUT (20h[0010h]) - Set Data Encryption

See SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) for a description of how to send this page.

Table 195 specifies the format of the Set Data Encryption page.

Table 195 — 0010h - Set Data Encryption page

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0010h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (m-3)						
3								(LSB)
4	SCOPE			Reserved				LOCK
5	CEEM		RDMC		SDK (0b)	CKOD	CKORP	CKORL
6	ENCRYPTION MODE							
7	DECRYPTION MODE							
8	ALGORITHM INDEX							
9	LOGICAL BLOCK ENCRYPTION KEY FORMAT							
10	KAD FORMAT							
11	Reserved							
17								
18	(MSB)	LOGICAL BLOCK ENCRYPTION KEY LENGTH (n-19)						
19								(LSB)
20	LOGICAL BLOCK ENCRYPTION KEY							
n								
Key-associated data descriptor list								
n+1	Key-associated data descriptor [first]							
	Key-associated data descriptor [last]							
m								

The following parameters apply:

- SCOPE

Value	Description
0h	Public
1h	Local
2h	All I_T Nexus

- LOCK
- CEEM (check external encryption mode)

Value	Description
01b	Do not check the encryption mode that was in use when the logical block was written to the medium.
10b	On read and verify commands, check the encryption mode that was in use when the logical block was written to the medium. Report an error if the logical block was written in EXTERNAL mode
11b	On read and verify commands, check the encryption mode that was in use when the logical block was written to the medium. Report an error if the logical block was written in ENCRYPT mode

A CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA is returned if the CEEM field is set to either 10b or 11b, and:

a) the DECRYPTION MODE field is set to DISABLE; or
b) the EAREM bit in the algorithm descriptor *(see 6.5.2.3 on page 371)* for the algorithm specified by the ALGORITHM INDEX field is set to zero.

- RDMC (raw decryption mode control)

This field is ignored if the ENCRYPTION MODE field is not set to ENCRYPT.

Value	Description
00b	The device entity shall mark each encrypted logical block per the default setting for the algorithm.
10b	The device entity shall mark each encrypted logical block written to the medium as enabled for raw decryption mode operations.
11b	The device entity shall mark each encrypted logical block written to the medium as disabled for raw decryption mode operations.

A CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST and the additional sense key set to INVALID FIELD IN PARAMETER DATA is returned if:

a) the ENCRYPTION MODE field is set to ENCRYPT;
b) the RDMC field is set to 10b or 11b; and
c) the RDMC_C field in the algorithm descriptor for the encryption algorithm selected by the value in the ALGORITHM INDEX field is set to 1h, 6h, or 7h.

- CKOD (clear key on demount)
- CKORP (clear key on reservation preempt)
- CKORL (clear key on reservation loss)
- ENCRYPTION MODE

Value	Description
0h	Disable
1h	External
2h	Encrypt

- DECRYPTION MODE

Value	Description
0h	Disable
1h	Raw
2h	Decrypt
3h	Mixed

- LOGICAL BLOCK ENCRYPTION KEY FORMAT
- KAD FORMAT

A non-zero value is only allowed if the algorithm in the ALGORITHM INDEX field reports a KADF_C bit set to one.

Value	Description
0h	Unspecified
1h	Binary logical block encryption key name
2h	ASCII logical block encryption key name

If the KAD FORMAT value is non-zero, then:

a) a) only an A-KAD descriptor is provided and the authenticated key-associated data is the key name;
b) b) only a U-KAD descriptor is provided and the unauthenticated key-associated data is the key name; or
c) c) both an A-KAD descriptor and a U-KAD descriptor is provided and the key name is formed by the authenticated key-associated data followed by the unauthenticated key-associated data.

- LOGICAL BLOCK ENCRYPTION KEY LENGTH

Value	Description
0000h	When no Key is specified
0020h	When Key is specified using Key Format 00h

- LOGICAL BLOCK ENCRYPTION KEY
- Key-Associated Descriptors List (See *"Key-Associated Data (KAD) Descriptors" on page 388*)

The following table indicates valid combinations of Encryption Mode and Decryption Mode and mandatory, optional and prohibited Key and Key-Associated Descriptors.

Table 196 — SPOUT (20h[0010h]) - KAD Parameters by Mode

Encryption Mode	Decryption Mode	R/W Data	Key	Key-Associated Descriptors				Notes
				uKAD 00h	aKAD (DKi) 01h	Nonce 02h	Meta data 03h	
0h Disable	0h Disable	C/C	P	P	P	P	P	
0h Disable	1h Raw	R/C	P	P	P	P	P	not recommended
0h Disable	2h Decrypt	C^4/C	M [2]	P	P	P	P	not recommended
0h Disable	3h Mixed	C^6/C	M [2]	P	P	P	P	
1h External	0h Disable	C/R	P	P	P	P	M [1]	not recommended
1h External	1h Raw	R/R	P	P	P	P	M [1]	
1h External	2h Decrypt	C^4/R	M [2]	P	P	P	M [1]	not recommended
1h External	3h Mixed	C^6/R	M [2]	P	P	P	M [1]	not recommended
2h Encrypt	0h Disable	C/C^4	M [1]	P	O [1]	O [1,3]	P	
2h Encrypt	1h Raw	R/C^4	M [1]	P	O [1]	O [1,3]	P	not recommended
2h Encrypt	2h Decrypt	C^5/C^4	M	P	O [1]	O [1,3]	P	
2h Encrypt	3h Mixed	C^6/C^4	M	P	O [1]	O [1,3]	P	

Legend:
- M: element is mandatory (required)
- P: element prohibited (must not be present)
- O: element is optional (may be device generated)
- I: element is ignored (may be present)
- C: cleartext (not encrypted)
- R: raw (compressed encoded/encrypted)

Notes:
1: Only used for writing
2: Only used for reading
3: May be partially ignored
4: Data is encrypted
5: Data is decrypted
6: Data is decrypted (if needed)

6.5.3.2 Key-Associated Data (KAD) Descriptors

6.5.3.2.1 KAD 00h - UKAD (Unathenticated KAD)

The UKAD field is an optional field which is used when writing and is recorded with each record.

Table 197 — KAD 00h - UKAD (Unathenticated KAD)

Byte	Bit 7 msb	6	5	4	3	2	1	0 lsb
0	KEY DESCRIPTOR TYPE (00h)							
1	Reserved					AUTHENTICATED		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4	UNAUTHENTICATED DATA							
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out - 0010h)
1h	Not Covered by Authentication (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: Maximum size is determined by generation.
- UNATHENTICATED DATA

6.5.3.2.2 KAD 01h - DKi (Data Key Identifier)

The DKi KAD field is an optional field which is used when writing and is recorded with each record. This is the AKAD field.

Table 198 — KAD 01h - DKi (Data Key Identifier)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	KEY DESCRIPTOR TYPE (01h)							
1	Reserved					AUTHENTICATED		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4	DKi							
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out)
2h	No attempt has been made to authenticate (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: may be up to 000Ch bytes
- DKi

6.5.3.2.3 KAD 02h - Nonce

The Nonce/IV is not technically KAD. The Nonce may be set to provide the initial value for IV generation for write operations. This field is optional and the device is capable of generating high quality random IV values. When an application specifies nonce values, it is possible that a systemic cryptographic weakness may be introduced into the system. It is strongly recommended that nonce values are not supplied by the application.

> NOTE 138 - The Nonce KAD is only reported by the device in Security Protocol In X'0020' - Data Encryption Status, and the value returned is the exact value specified in X'0010' - Set Data Encryption. This may not reflect the actual nonce or IV used for writing encrypted data.

NOTE 139 - IV values are constructed using only part of the specified Nonce value and are altered for each write in a device dependent manner.

Table 199 — KAD 02h - Nonce

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Key Descriptor Type (02h)							
1	Reserved					Authenticated		
2	(MSB)	KEY DESCRIPTOR LENGTH (000Ch)						
3								(LSB)
4	NONCE/IV							
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out)
1h	Not Covered by Authentication (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: the only supported length is 000Ch
- NONCE/IV

6.5.3.2.4 KAD 03h - MKAD (Metadata)

The MKAD field is used for a keyless copy operation (i.e., RAW decryption mode and EXTERNAL encryption mode).

Table 200 — KAD 03h - MKAD (Metadata)

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	KEY DESCRIPTOR TYPE (00h)							
1	Reserved					AUTHENTICATED (2h)		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4	KEY DESCRIPTOR							
n								

The following parameters apply:

- KEY DESCRIPTOR LENGTH
- KEY DESCRIPTOR: Data required by the encryption algorithm for a keyless copy operation.

Annex A. Protocol Implementation Notes

This product is comprised of one or more SCSI-2 compliant devices with some important SCSI-3 extensions (deviations are noted). This appendix describes some of the specific implementation choices made within the SCSI architecture under the following headings:

- *"Supported SCSI Status Codes" on page 392*

Throughout this appendix, the drive is also called "target" and "device."

A.1 Supported SCSI Status Codes

The SCSI status codes are defined in the SCSI-2 standard. The 3592 drive does not use all available status codes. However, the 3592 complies with the SCSI standard for all status codes that it supports. The list of status codes and their use in the drive follows:

Status	Description
00h	GOOD Used on the last command of any nexus when the last command finishes correctly. Since command linking is not supported, there may only be one commands per nexus.
02h	CHECK CONDITION Used to report any error condition that generates a contingent allegiance for the command. The device prepares sense data for the event and reports Auto-Sense information with the CHECK CONDITION status. A REQUEST SENSE command is not required, and a contingent allegiance does not exist.
18h	RESERVATION CONFLICT Used when an initiator not holding a current reservation attempts to execute an unauthorized command while a reservation is in effect.
08h	BUSY Used when required by SCSI-2 (for example, contingent allegiance). The dual port nature of the drive makes the SCSI-3 behavior extend the BUSY status to a second port. No unnecessary BUSY status is presented. However, some BUSY status reports are required and are presented. BUSY status may be presented during the power-up sequence until the diagnostics are complete. Under ordinary circumstances, this is the most common reason for encountering BUSY status.
28h	TASK SET FULL This is used when the maximum number of commands are currently queued for execution. This should not generally be presented, but may be used when a large number of initiators are present, or multiple commands are issued from single initiators using the simple queueing model.

A.2 Features of the Fibre Channel Interface

The 3592 drive supports Fibre Channel Arbitrated Loop (FC-AL) protocol, and uses Class 3 Service frames. The drive supports operating as a public (switch-attached) or private device (that is, L-Port to FL-Port; or L-Port to L-Port). The 3592 drive can also attach using the point-to-point protocol (also known as an N-Port). When operating in the point-to-point protocol, the drive can attach in a Fabric topology (that is, N-Port to F-Port). The World Wide Node Name and Port Name that are used follow the format of the Institute of Electrical and Electronics Engineers (IEEE). The IBM 3592 Tape Drive is compliant with the FC-Tape Technical Report of the Accredited Standard Committee NCITS. IBM recommends that your server's device driver and host bus adapter (HBA) use the Class 3 Error Recovery procedures that are specified in the Fibre Channel Protocol for SCSI, Second Version (FCP-2).

Annex B. Error Sense Information

This annex lists all possible combinations of Sense Keys, Additional Sense Codes (ASC), and Additional Sense Code Qualifiers (ASCQ) that are reported by this device.

NOTE 140 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 141 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.1 Sense Key 0 (No Sense)

Table 201 — ASC, and ASCQ Summary for Sense Key 0 (No Sense)

ASC ASCQ	Description
00 00	No Additional Sense Information - (unsolicited, no CA/CC)
00 00	No Additional Sense Information - EOM=1b (Early Warning)
00 00	No Additional Sense Information - ILI=1b
00 00	No Additional Sense Information - FM=1b
00 01	Filemark Detected
00 02	End-of-Partition/Medium Detected, Early Warning
00 04	Beginning-of-Partition/Medium Detected
00 07	Programmable Early Warning Detected
00 16	Operation in Progress
14 01	Record Not Found (String Search)
2E 00	Insufficient Time For Operation (String Search)
EF 13	Encryption - Key Translate

NOTE 142 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 143 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.2 Sense Key 1 (Recovered Error)

Table 202 — ASC, and ASCQ Summary for Sense Key 1 (Recovered Error)

ASC ASCQ	Description
00 00	No Additional Sense Information
00 17	Drive Needs Cleaning
17 01	Recovered Data with Retries
18 00	Recovered Data with Error Correction Applied
37 00	Rounded Parameter
5B 02	Log Counter at Maximum
5D 00	Failure Prediction Threshold Exceeded
5D FF	Failure Prediction Threshold Exceeded (FALSE)
83 83	Drive Has Been Cleaned
85 00	Search Match List Limit (warning)
85 01	Search Snoop Match Found
Note — Many additional ASC ASCQ combinations are possible if recovered error reporting is enabled via Mode Select. Recovered Error Reporting Enabled is the default option with some of the 3592 device drivers.	

B.3 Sense Key 2 (Not Ready)

Table 203 — ASC, and ASCQ Summary for Sense Key 2 (Not Ready)

ASC ASCQ	Description
04 00	Logical Unit Not Ready, Cause Not Reportable
04 01	Logical Unit Is in Process of Becoming Ready
04 03	Logical Unit Not Ready, Manual Intervention Required
04 04	Logical Unit Not Ready, Format in Progress
04 07	Logical Unit Not Ready, Operation in Progress
30 03	Cleaning in Progress
3A 00	Medium Not Present
3A 04	Not Ready - Medium Auxiliary Memory Accessible
53 00	Media Load or Eject Failed

B.4 Sense Key 3 (Medium Error)

Table 204 — ASC, and ASCQ Summary for Sense Key 3 (Medium Error)

ASC ASCQ	Description
03 02	Excessive Write Errors
09 00	Track Following Error
0C 00	Write Error
11 00	Unrecovered Read Error
11 01	Read Retries Exhausted
11 08	Incomplete Block Read
14 00	Recorded Entity Not Found
14 01	Record Not Found
14 02	Filemark or Setmark Not Found
14 03	End-of-Data Not Found
14 04	Block Sequence Error
30 00	Incompatible Medium Installed
30 01	Cannot Read Medium, Unknown Format
30 02	Cannot Read Medium, Incompatible Format
30 0D	WORM Medium - Tampering Detected
31 00	Medium Format Corrupted
31 01	Format Command Failed
33 00	Tape Length Error
51 00	Erase Failure
53 04	Medium Thread or Unthread Failure
85 00	Write Protected Because of Tape or Drive Failure
85 01	Write Protected Because of Tape Failure
85 02	Write Protected Because of Drive Failure
EE 60	Encryption - Proxy Command Error
EE D0	Encryption - Data Read Decryption Failure
EE D1	Encryption - Data Read after Write Decryption Failure
EE E0	Encryption - Key Translation Failure
EE E1	Encryption - Key Translation Ambiguous
EE F0	Encryption - Decryption Fenced (Read)
EE F1	Encryption - Encryption Fenced (Write)

NOTE 144 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 145 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.5 Sense Key 4 (Hardware Error)

Table 205 — ASC, and ASCQ Summary for Sense Key 4 (Hardware Error)

ASC ASCQ	Description
09 00	Track Following Error
10 01	Logical Block Guard Check Failed
10 04	Logical Block Protection Error On Recover Buffered Data
15 01	Mechanical Positioning Error
3B 00	Sequential Positioning Error
3B 08	Reposition Error
40 00	Diagnostic Failure
44 00	Internal Target Failure Drive Needs Cleaning, Warning Threshold Exceeded
47 80	Read Internal CRC Error
47 81	Write Internal CRC Error
4C 00	Logical Unit Failed Self-Configuration
52 00	Cartridge Fault
53 00	Media Load or Eject Failed
53 01	Unload Tape Failure
EE 0E	Encryption - Key Service time-out
EE 0F	Encryption - Key Service Failure

NOTE 146 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 147 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.6 Sense Key 5 (Illegal Request)

Table 206 — ASC, and ASCQ Summary for Sense Key 5 (Illegal Request) (part 1 of 2)

ASC ASCQ	Description
0E 03	Invalid Field in Command Information Unit (e.g., FCP_DL error)
1A 00	Parameter List Length Error
20 00	Invalid Command Operation Code
20 0C	Illegal Command When Not In Append-only Mode *(see 4.13.3 on page 108)*
24 00	Invalid Field in CDB
25 00	Logical Unit Not Supported
26 00	Invalid Field in Parameter List
26 01	Parameter Not Supported
26 02	Parameter Value Invalid
26 03	Threshold Parameters Not Supported
26 04	Invalid Release of Persistent Reservation
26 11	Encryption - Incomplete Key-Associate Data Set
2C 00	Command Sequence Error
2C 0B	Not Reserved - The OIR bit of the Sequential Access Device page is set and the I_T nexus attempting to communicate with the drive does not hold a reservation.
30 05	Cannot Write Medium - Incompatible Format
39 00	Saving Parameters Not Supported
3B 00	Sequential Positioning Error
3D 00	Invalid Bits in Identify Message
49 00	Invalid Message Error (e.g., FCP CMD Fields Invalid)
53 02	Medium Removal Prevented
5B 03	Log List Codes Exhausted
80 00	CU Mode, Vendor-Unique
85 03	Write Protected Because of Current Tape Position
EE 00	Encryption - Key Service Not Enabled
EE 01	Encryption - Key Service Not Configured
EE 02	Encryption - Key Service Not Available
EE 10	Encryption - Key Required
EE 20	Encryption - Key Count Exceeded
EE 21	Encryption - Key Alias Exceeded
EE 22	Encryption - Key Reserved
EE 23	Encryption - Key Conflict

NOTE 148 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 149 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

Table 206 — ASC, and ASCQ Summary for Sense Key 5 (Illegal Request) (part 2 of 2)

ASC ASCQ	Description
EE 24	Encryption - Key Method Change
EE 25	Encryption - Key Format Not Supported
EE 26	Encryption - Unauthorized Request - dAK
EE 27	Encryption - Unauthorized Request - dSK
EE 28	Encryption - Unauthorized Request - eAK
EE 29	Encryption - Authentication Failure
EE 2A	Encryption - Invalid RDKi
EE 2B	Encryption - Key Incorrect
EE 2C	Encryption - Key Wrapping Failure
EE 2D	Encryption - Sequencing Failure
EE 2E	Encryption - Unsupported Type
EE 2F	Encryption - New Key Encrypted Write Pending
EE 30	Encryption - Prohibited Request
EE 31	Encryption - Key Unknown
EE 42	Encryption - EKM Challenge Pending
EE E2	Encryption - Key Translation Disallowed
EE FF	Encryption - Security Prohibited Function
EF 01	Encryption - Key Service Not Configured

NOTE 148 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 149 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.7 Sense Key 6 (Unit Attention)

Table 207 — ASC, and ASCQ Summary for Sense Key 6 (Unit Attention)

ASC ASCQ	Description
00 02	End-of-Partition/Medium Detected, Early Warning
28 00	Not Ready to Ready Transition, Medium May Have Changed
29 00	Power On, Reset, or Bus Device Reset Occurred
2A 01	Mode Parameters Changed
2A 02	Log Parameters Changed
2A 03	Reservations Preempted
2A 04	Reservations Released
2A 05	Registrations Preempted
2A 11	Encryption - Data Encryption Parameters Changed by Another I_T Nexus
2A 12	Encryption - Data Encryption Parameters Changed by Vendor Specific Event
2F 00	Commands Cleared by Another Initiator
30 00	Incompatible Medium Installed
3F 01	Microcode Has Been Changed
3F 02	Changed Operating Definition
3F 03	Inquiry Data Has Changed
5A 01	Operator Medium Removal Request
82 83	Drive Has Been Cleaned (older versions of microcode)
85 00	Search Match List Limit (alert)
EE 12	Encryption - Key Change Detected
EE 18	Encryption - Changed (Read)
EE 19	Encryption - Changed (Write)
EE 40	Encryption - EKM Identifier Changed
EE 41	Encryption - EKM Challenge Changed
EE 50	Encryption - Initiator Identifier Changed
EE 51	Encryption - Initiator Response Changed

NOTE 150 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 151 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.8 Sense Key 7 (Data Protect)

Table 208 — ASC, and ASCQ Summary for Sense Key 7 (Data Protect)

ASC ASCQ	Description
26 10	Encryption - Data Decryption Key Fail Limit
27 00	Write Protected
2A 13	Encryption - Data Encryption Key Instance Counter Has Changed
50 01	Write Append Position Error (WORM)
5A 02	Operator Selected Write Protect
74 00	Security Error
74 01	Encryption - Unable to Decrypt Data
74 02	Encryption - Unencrypted Data Encountered While Decrypting
74 03	Encryption - Incorrect Data Encryption Key
74 04	Encryption - Cryptographic Integrity Validation Failed
74 05	Encryption - Error Decrypting Data
EF 10	Encryption - Key Required
EF 11	Encryption - Key Generation
EF 13	Encryption - Key Translate
EF 1A	Encryption - Key Optional
EE 31	Encryption - Key Unknown
EF C0	Encryption - No Operation

NOTE 152 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 153 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.9 Sense Key 8 (Blank Check)

Table 209 — ASC, and ASCQ Summary for Sense Key 8 (Blank Check)

ASC ASCQ	Description
00 05	End-of-Data Detected
14 01	Record Not Found, Void Tape

B.10 Sense Key B (Aborted Command)

Table 210 — ASC, and ASCQ Summary for Sense Key B (Aborted Command)

ASC ASCQ	Description
14 00	Recorded Entity Not Found
14 01	Record Not Found
14 02	Filemark or Setmark Not Found
1B 00	Synchronous Data Transfer Error
43 00	Message Error
44 00	Internal Target Failure
45 00	Select or Reselect Failure
47 00	SCSI Parity Error
48 00	Initiator Detected Error Message Received
49 00	Invalid Message Error
4A 00	Command Phase Error
4B 00	Data Phase Error
4E 00	Overlapped Commands Attempted

B.11 Sense Key D (Volume Overflow)

Table 211 — ASC, and ASCQ Summary for Sense Key D (Volume Overflow)

ASC ASCQ	Description
00 02	End-of-Partition/Medium Detected

Annex C. Product Comparisons

This annex is provided to summarize key differences and features between this product and the IBM System Storage Tape System 3590 product, as well as the IBM System Storage Ultrium Tape Drive. As a summary, the following information is not intended to definitively detail all aspects and differences of each product family, but should be used in conjunction with this entire manual and various other documents for this and the other products.

NOTE 154 - All comparisons are made from the perspective of this device (i.e., statements of support or non-support pertain to the 3592 device).

C.1 Summary of New or Enhanced Product Features

This product is designed to be the best of breed enterprise tape drive, and has many new and enhanced features to achieve this. These items include:

- Reduced nominal power consumption
- Small form factor
- Hot-pluggable CE service panel
- Eight (8) character alphanumeric bezel message display
- Rugged automation compatible 3590 form-factor cartridge
- Cartridge Memory
- Resettable loader for maximum load/unload reliability
- Larger read/write buffer (128 MB on J1A, 512 MB on E05, 1 GB on E06)
- Speed matching
- Channel calibration
- Fibre Channel 2 Gbps interface (J1A), 4 Gbps interface (E05 and E06)
- Fibre Channel N-Port support (i.e., Fabric Topology)
- High linear density, for increased capacity
- High Resolution Tape Directory (HRTD) for optimal space/locate performance
- Improved small transaction performance
- WORM (Write Once, Read Many) media support
- Hardware String Search Function (not J1A)

C.2 Differences between 3592 Model E06 and Model E05

The third generation offering of the IBM System Storage Tape System 3592 is the E06 model. This model maintains maximum compatibility with the second generation E05 model, while adding additional features and capabilities. New features have been added with care to minimize impact to existing device drivers and applications.

NOTE 155 - All comparisons are made from the perspective of the E06 model (statements of new features or enhancements pertain to the E06 model).

C.2.1 Physical Differences

There are no external physical differences beyond device labeling.

Internal differences follow:

- Giant Magneto Resistive (GMR) technology used for the head

C.2.2 Functional Differences

- Support for additional speeds for matching
- Larger read/write buffer of 1 GB (2x larger than model E05)
- Increased high speed locate rate of 12 m/s
- Increased maximum native data rate of 160 MB/s in E06 format
- Improved virtual backhitch small file write synchronize handling
- Improved performance for large files with the new SkipSync feature
- Standby cooling management feature to reduce power and reduce the risk of unnecessary airborne debris contamination when idle

C.2.3 Command Differences

- None

C.2.4 Data Differences

- Log pages may contain additional counters
- Various density, capacity, and model changes (depending on mode and medium format)

C.3 Differences between 3592 Model E05 and Model J1A

The second generation offering of the IBM System Storage Tape System 3592 is the E05 model. This model maintains maximum compatibility with the first generation J1A model, while adding additional features and capabilities. New features have been added with care to minimize impact to existing device drivers and applications.

NOTE 156 - All comparisons are made from the perspective of the E05 model (statements of new features or enhancements pertain to the E05 model).

C.3.1 Physical Differences

There are no external physical differences beyond device labeling.

Internal differences follow:

- Improved tape mechanical tape guiding

C.3.2 Functional Differences

- Support for additional speeds for matching (speed 5 and 6) (2 more speeds than J1A)
- Larger read/write buffer of 512 MB (4x larger than model J1A)
- Increased high speed locate rate of 10 m/s
- Increased maximum read/write speed
- Increased maximum native data rate of 100 MB/s in E05 format
- Increased maximum native data rate of 50 MB/s in J1A format (J1A model is 40 MB/s)
- 4Gbps dual port fibre channel interfaces
- Support for Constant Capacity mode to insure tapes may always be copied and fit on other tapes
- Default to automatic up formatting of existing medium when written from BOT
- Hardware String Search function at full device native data rates

C.3.3 Command Differences

- New String Search command opcode E3h
- New String Search Send Diagnostic 3000h
- New Vendor-Unique String Search options for Read and Space
- New String Search Read Buffer ID 40h
- New String Search mode page 37h and subpage(s) support
- Reformat support using density code and/or Mode Page 25h
- New Log Page and Subpage support for Performance Characteristics (37h) for interfaces, device and medium

C.3.4 Data Differences

- Report Density supports medium reuse
- Log pages may contain additional counters
- Various density, capacity, and model changes (depending on mode and medium format)

C.4 Differences from IBM SystemStorage Tape System 3590

This product was designed to bring advanced technology features into the enterprise, while maintaining maximum compatibility with the proven high reliability of the IBM System Storage Tape System 3590. New features have been added with care to minimize impact to existing device drivers and applications.

NOTE 157 - All comparisons are made from the perspective of this device (i.e., statements of support or non-support pertain to the 3592 J1A model).

C.4.1 Physical Differences

- Smaller overall device form factor
- No pneumatic compressor
- Physically prevents loading of 3590 cartridge
- Loader is “hard” and requires code to move tray to mounting positions
- Leader pin cartridge design
- Cartridge memory
- Optimal non-expanding data compression
- 8 character alphanumeric bezel message display
- 2 Gbps dual-ported Fibre Channel interface
- No parallel SCSI interface

C.4.2 Command Differences

- Certain checks (Reservation conflicts, DCCs, UAs, Media format corrupt, After Check 1) are now checked and acted on when the command is queued (will immediately report these conditions). Checking is also repeated when the command is dequeued as condition(s) may have occurred.
- Command time-out changes
- Erase with Long 0b supported
- Host Early Warning on Mode Page 25h minimum is larger
- Load Unload with Load 1b supported in more environments
- Log Counters are not scaled as they are incremented (previously scaled counters are now more accurate and are only rounded when reported)
- Log Sense additional pages 2Eh, 30h, and 3Eh
- Read Buffer IDs 20h
- Read Buffer mode 2 supported
- Sense data for all ILI conditions may be only 18 bytes long (3590 only generated 18 bytes for underlength ILIs)
- Space and Locate at EOD will not attempt to cross into old data
- TapeAlert support (mode page 1Ch and log page 2Eh)
- Write Buffer ID 30h
- Write Buffer mode 2 and 4

C.4.3 Data Differences

- Inquiry page 83 reports port information
- Log pages may contain additional counters
- Mode page 21h TOD basis changed
- Sense data enhanced vendor-unique debug information
- Various density, capacity, and model changes
- Write sense Information field is command relative (SSC-2)

C.5 Differences from IBM SystemStorage LTO Ultrium Tape Drive

There are a large number of differences between this product and the LTO Ultrium product family, much of which centers on physical and command interfaces.

NOTE 158 - All comparisons are made from the perspective of this device (i.e., statements of support or non-support pertain to the 3592 J1A model).

C.5.1 Physical Differences

- 3590 automation-compatible rugged cartridge
- Larger overall device form factor
- 8 character alphanumeric bezel message display
- Resettable threader
- Dual-ported Fibre Channel interface
- No parallel SCSI interface

C.5.2 Command Differences

- Command time-out changes
- Control Units (CU) are supported
- Early warning is SK/ASC/Q 0/0000 EOM=1 (not 0/0002 EOM=1)
- Echo buffer not supported (SPC-3 for SPI parallel SCSI)
- Log pages and counters are different
- Log sense counters may be individually queried
- Maximum supported logical block size is 200000h
- Mode pages are different
- All fixed block record sizes are supported
- Read after encountering EOD will cross EOD into old data
- Read Attribute and Write Attribute are not supported
- Read Buffer and Write Buffer IDs are different
- Read Reverse is supported
- Recover Buffered Data is supported
- Send Diagnostic IDs are different
- Set Capacity command is not supported (see mode page 23)
- Space sequential filemarks is supported
- Test Unit Ready default does not report DCCs (vendor-unique bit)
- Write sense Information field is command relative (SSC-2)
- To use media for encryption, the media must be formated for encryption. This is done by being setup for encryption on write of LBA 0.

Annex D. Sample C program to generate Reed-Solomon CRC

The following is sample C code for generating the Reed-Solomon CRC defined in ECMA-319

```
/*-----------------------------------------------------------------------------
**  INPUTS:   crc   - initial crc (0 for fresh) (i.e., seed)
**            cnt   - the number of data bytes to compute CRC for
**           start - the starting address of the data bytes (e.g., data buffer)
**  OUTPUTS:  UINT32 - crc in big endian (MSB is first byte)
*/
UINT32 GenerateRSCRC(UINT32 crc, UINT32 cnt, const void *start)
{
 static const UINT32 crcTable[256]=
 { 0x00000000,0x38CF3801,0x70837002,0x484C4803,0xE01BE004,0xD8D4D805,
   0x90989006,0xA857A807,0xDD36DD08,0xE5F9E509,0xADB5AD0A,0x957A950B,
   0x3D2D3D0C,0x05E2050D,0x4DAE4D0E,0x7561750F,0xA76CA710,0x9FA39F11,
   0xD7EFD712,0xEF20EF13,0x47774714,0x7FB87F15,0x37F43716,0x0F3B0F17,
   0x7A5A7A18,0x42954219,0x0AD90A1A,0x3216321B,0x9A419A1C,0xA28EA21D,
   0xEAC2EA1E,0xD20DD21F,0x53D85320,0x6B176B21,0x235B2322,0x1B941B23,
   0xB3C3B324,0x8B0C8B25,0xC340C326,0xFB8FFB27,0x8EEE8E28,0xB621B629,
   0xFE6DFE2A,0xC6A2C62B,0x6EF56E2C,0x563A562D,0x1E761E2E,0x26B9262F,
   0xF4B4F430,0xCC7BCC31,0x84378432,0xBCF8BC33,0x14AF1434,0x2C602C35,
   0x642C6436,0x5CE35C37,0x29822938,0x114D1139,0x5901593A,0x61CE613B,
   0xC999C93C,0xF156F13D,0xB91AB93E,0x81D5813F,0xA6ADA640,0x9E629E41,
   0xD62ED642,0xEEE1EE43,0x46B64644,0x7E797E45,0x36353646,0x0EFA0E47,
   0x7B9B7B48,0x43544349,0x0B180B4A,0x33D7334B,0x9B809B4C,0xA34FA34D,
   0xEB03EB4E,0xD3CCD34F,0x01C10150,0x390E3951,0x71427152,0x498D4953,
   0xE1DAE154,0xD915D955,0x91599156,0xA996A957,0xDCF7DC58,0xE438E459,
   0xAC74AC5A,0x94BB945B,0x3CEC3C5C,0x0423045D,0x4C6F4C5E,0x74A0745F,
   0xF575F560,0xCDBACD61,0x85F68562,0xBD39BD63,0x156E1564,0x2DA12D65,
   0x65ED6566,0x5D225D67,0x28432868,0x108C1069,0x58C0586A,0x600F606B,
   0xC858C86C,0xF097F06D,0xB8DBB86E,0x8014806F,0x52195270,0x6AD66A71,
   0x229A2272,0x1A551A73,0xB202B274,0x8ACD8A75,0xC281C276,0xFA4EFA77,
   0x8F2F8F78,0xB7E0B779,0xFFACFF7A,0xC763C77B,0x6F346F7C,0x57FB577D,
   0x1FB71F7E,0x2778277F,0x51475180,0x69886981,0x21C42182,0x190B1983,
   0xB15CB184,0x89938985,0xC1DFC186,0xF910F987,0x8C718C88,0xB4BEB489,
   0xFCF2FC8A,0xC43DC48B,0x6C6A6C8C,0x54A5548D,0x1CE91C8E,0x2426248F,
   0xF62BF690,0xCEE4CE91,0x86A88692,0xBE67BE93,0x16301694,0x2EFF2E95,
   0x66B36696,0x5E7C5E97,0x2B1D2B98,0x13D21399,0x5B9E5B9A,0x6351639B,
   0xCB06CB9C,0xF3C9F39D,0xBB85BB9E,0x834A839F,0x029F02A0,0x3A503AA1,
   0x721C72A2,0x4AD34AA3,0xE284E2A4,0xDA4BDAA5,0x920792A6,0xAAC8AAA7,
   0xDFA9DFA8,0xE766E7A9,0xAF2AAFAA,0x97E597AB,0x3FB23FAC,0x077D07AD,
   0x4F314FAE,0x77FE77AF,0xA5F3A5B0,0x9D3C9DB1,0xD570D5B2,0xEDBFEDB3,
   0x45E845B4,0x7D277DB5,0x356B35B6,0x0DA40DB7,0x78C578B8,0x400A40B9,
   0x084608BA,0x308930BB,0x98DE98BC,0xA011A0BD,0xE85DE8BE,0xD092D0BF,
   0xF7EAF7C0,0xCF25CFC1,0x876987C2,0xBFA6BFC3,0x17F117C4,0x2F3E2FC5,
   0x677267C6,0x5FBD5FC7,0x2ADC2AC8,0x121312C9,0x5A5F5ACA,0x629062CB,
   0xCAC7CACC,0xF208F2CD,0xBA44BACE,0x828B82CF,0x508650D0,0x684968D1,
   0x200520D2,0x18CA18D3,0xB09DB0D4,0x885288D5,0xC01EC0D6,0xF8D1F8D7,
   0x8DB08DD8,0xB57FB5D9,0xFD33FDDA,0xC5FCC5DB,0x6DAB6DDC,0x556455DD,
   0x1D281DDE,0x25E725DF,0xA432A4E0,0x9CFD9CE1,0xD4B1D4E2,0xEC7EECE3,
   0x442944E4,0x7CE67CE5,0x34AA34E6,0x0C650CE7,0x790479E8,0x41CB41E9,
   0x098709EA,0x314831EB,0x991F99EC,0xA1D0A1ED,0xE99CE9EE,0xD153D1EF,
   0x035E03F0,0x3B913BF1,0x73DD73F2,0x4B124BF3,0xE345E3F4,0xDB8ADBF5,
   0x93C693F6,0xAB09ABF7,0xDE68DEF8,0xE6A7E6F9,0xAEEBAEFA,0x962496FB,
   0x3E733EFC,0x06BC06FD,0x4EF04EFE,0x763F76FF};
```

```
        UINT32  i;
  const UINT8*  d = start;

   for ( i=0; i<cnt; i++ )
   {
     crc = (crc << 8) ^ crcTable[*d ^ (crc >> 24)];
     d++;
   }
 return crc;
 }
```

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