To: Membership T10

From: R.K. Roberts

Subject: Proposed Features and Profile definitions for SCSI devices

0.1. Features

Features are sets of commands, mode pages, parameters, and behaviors or operations specified for a logical unit. Each feature must be implemented entirely to its standard description in order to claim compliance with the feature. Except as explicitly identified, all commands, mode pages, parameters, and behaviors within a feature are mandatory.

Features were designed primarily to support multi-function devices that could only function as one device at a time, e.g. CD-R drives act as either a CD-R or CD-ROM depending on the medium. Virtually all removable medium devices are in effect multi-function devices: they can use their medium when present, but cannot perform any media operations when no medium is present.

Mode pages described and required by features shall always be present if the Feature is reported by the Logical Unit, regardless of whether or not the Feature is current. For example, the CD Audio parameters page shall be available for reading and writing if the CD Audio feature is supported by the device, even if no audio media is present. The current values and changeable masks shall not change, even across morphing. Default values may change when morphing occurs. De-fault values shall always reflect a usable set of values for the loaded medium. Changes to the default values shall not generate a Unit Attention condition.

The use of features allows generic drivers to use logical units that have among their many features some core functionality. For example, the Random Readable feature may be reported by a very large variety of devices: magnetic disk, CD, DVD, or Magneto-Optical. A common driver to read data would be usable with all of these devices; special code would be needed only to manage extensions unique to each technology.

Features implemented by a logical unit are reported to the host via the GET CONFIGURATION command. This command should be used to identify all possible features, and those features that are current. A feature shall not be current if any of its mandatory commands or behaviors are not available. For example, a logical unit with writable media loaded and a mechanical write protect active shall not report any writable features as available. A DVD-ROM logical unit with a non-protected DVD-ROM loaded shall not report the DVD-CSS feature as being available. A logical unit with removable medium shall have no read or write or other medium dependent features active. Commands within a feature that is not current may still operate normally, especially when those commands are described in more than one feature.

The introduction of features are not intended to change device behavior. The use of commands that are not current will generate the same errors as legacy devices. Features simply provide a method for avoiding errors and avoids using errors to convey state information. When features are used properly by the host, the host should see only true medium errors and not need to do any informational discovery through error codes.

This standard also specifies techniques for the logical unit to notify the host of changes in the list of current features. In addition, a technique for preventing changes until host approval is granted is defined. The GET EVENT/STATUS NOTIFICATION command is used for notification of changes or change requests; the Persistent Prevent and Send Event commands are used to notify the logical unit of a host control request and for the host to notify the logical unit of permission to change.

For a Feature to be considered current, all commands and behaviors described by that Feature should be available to the host. Even if a Feature is not current, its components should function if appropriate for the logical unit's state. Commands received by a logical unit that are a member of a supported Feature that is not current shall either execute normally or return an appropriate error (i.e. incompatible medium, medium not present, etc.). Logical Units shall not terminate any Command that is a member of any supported Feature with CHECK CONDITION status, ILLEGAL REQUEST, IN-VALID COMMAND OPERATION CODE. For example, if the Formattable Feature is implemented, the READ FORMAT CAPACITIES command should return valid data regardless of whether or not the Formattable Feature is Current.

An attempt to format a medium that cannot be formatted by the logical unit may return CHECK CONDITION status, ILLEGAL REQUEST, INCOMPATIBLE MEDIUM INSTALLED.

Features shall be identified by a feature code, see . The maximum number of feature sets is 65,536 and feature code 0 is reserved to provide a list of profiles supported by a logical unit. Each Feature Descriptor may contain information specific to that feature. The Feature specific information in the Feature Descriptor may not be valid if the Feature is not current.

Commands, pages, and behavior not described by a Feature may exist in the Logical Unit.

Each of the following sub-clauses describes one Feature.

0.1.1. Profile List

The Profile List Feature is a list of all profiles supported by a device. This Feature is always current. The only change allowed in the Profile List during morphing is the setting of the CurrentP bits for each profile. Logical units that support re-movable medium shall not have any current profiles listed. Profile 0 shall not be reported in the Profile List, but may be reported in the Current Profile field of the GET CONFIGURATION header to indicate compliance to no profile.

Profiles provide a quick method for identifying the basic functionality of Logical Units. Logical Units may conform to more than one profile at a time. For example, a DVD-RAM drive with DVD-RAM media loaded may report both the Removable Disk and DVD-RAM profiles. This allows generic removable disk drivers to work with DVD-RAM media while also reporting the additional capabilities required by the DVD-RAM profile.

0.1.2. Core

This feature describes basic logical unit functionality. This Feature shall always be current. All commands (Table 1) and functions described shall always function normally.

Table 1 - Commands for Core Feature

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION	
12h	Inquiry	
46h	Get Configuration	
55h	Mode Select (10)	
5Ah	Mode Sense (10)	
03h	Request Sense	
00h	Test Unit Ready	

The INQUIRY command (see) shall be supported. The INQUIRY command shall always complete without an error if the Command Packet is valid.

Logical Units shall be able to report sense to the host. For physical interfaces that report automatic delivery of Logical Unit Sense Information to the host shall use the transport's mechanism. For other physical interfaces, the REQUEST SENSE command shall be supported. The REQUEST SENSE command shall not generate any new sense information unless the Command Packet is invalid.

The MODE SENSE (10) command (see) shall be supported. Logical Units may not return Block Descriptors. PC field values of 00b, 01b, and 10b shall be implemented for all supported mode pages. Logical Units shall be able to report mode pages whether or not appropriate media is loaded.

The MODE SELECT (10) command (see) shall be supported. The SP bit may not be supported. Logical Units shall be able to accept mode pages whether or not appropriate media is loaded.

The GET CONFIGURATION command (see) shall be supported.

Unit Attention conditions shall not be reported to the GET CONFIGURATION command.

The TEST UNIT READY command (see) shall be supported.

TEST UNIT READY is a legacy command used to check for the existence of media and to discover Unit Attention conditions.

The GET CONFIGURATION or GET EVENT/STATUS NOTIFICATION commands should be used instead to determine media status. Unit Attention conditions can be prevented if the Morphing feature is present and is used. The GET EVENT/STATUS NOTIFICATION command (see) shall be supported. The host should determine supported events by issuing a GET EVENT/STATUS NOTIFICATION command with the Immed bit set. Zero or more event classes may be supported.

0.1.3. Morphing

The Morphing Feature provides a method for identifying changes in logical unit behavior, and to some extent, preventing changes in logical unit behavior without host involvement. The Feature includes a mechanism for notifying the host about events that have occurred and requests for operational changes, a mechanism for identifying the logical unit's current behavior, and a mechanism for allowing the logical unit to change its behavior. This feature, if implemented, shall always be current.

0.1.3.1. Morphing commands and functionality

Table 2 list the commands required for implementing the Morphing feature.

Table 2 - Commands for Morphing Feature

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION (GESN)	
46h	GET CONFIGURATION	
1Eh	PREVENT/ALLOW and Persistent bit	
A2h	SEND EVENT	

The GET CONFIGURATION command is used to discover a logical unit's behavior. The result data of the GET CONFIGURATION command may be dynamic. A Morph occurs whenever the data that would be returned to a GET CONFIGURATION command changes.

The GET EVENT/STATUS NOTIFICATION command shall be supported. Asynchronous GESN operation may be supported. If supported, the Async bit in the Feature Descriptor shall be set to one, otherwise the Async bit shall be set to zero.

The PREVENT/ALLOW command and the Persistent Prevent bit shall be supported. When a persistent prevent is in place, the Logical Unit shall not allow, to the limit of its design, non-host events to change the operational behavior of the device. Devices with a mechanical eject may not be able to prevent ejecting the media. When a persistent prevent is in place, events are reported to the host via the Get Event/Status Notification command instead of causing action within the logical unit. For example, if the user presses the eject button while a persistent prevent is in effect, the only action is to report the button press to the host. The logical unit shall behave as shown in "Figure 52 - Morphing States" on page 142.

The SEND EVENT command shall be supported for any GESN class 1 events that the device may generate. This command is used to tell the logical unit to perform an action that was previously requested by the drive via a Class 1 GESN response. The host, after receiving a Class 1 notification, prepares for a possible logical unit change by notifying its drivers and flushing buffers as needed. After the host is prepared for a possible device change, it sends the Class 1 event descriptor back to the logical unit for processing.

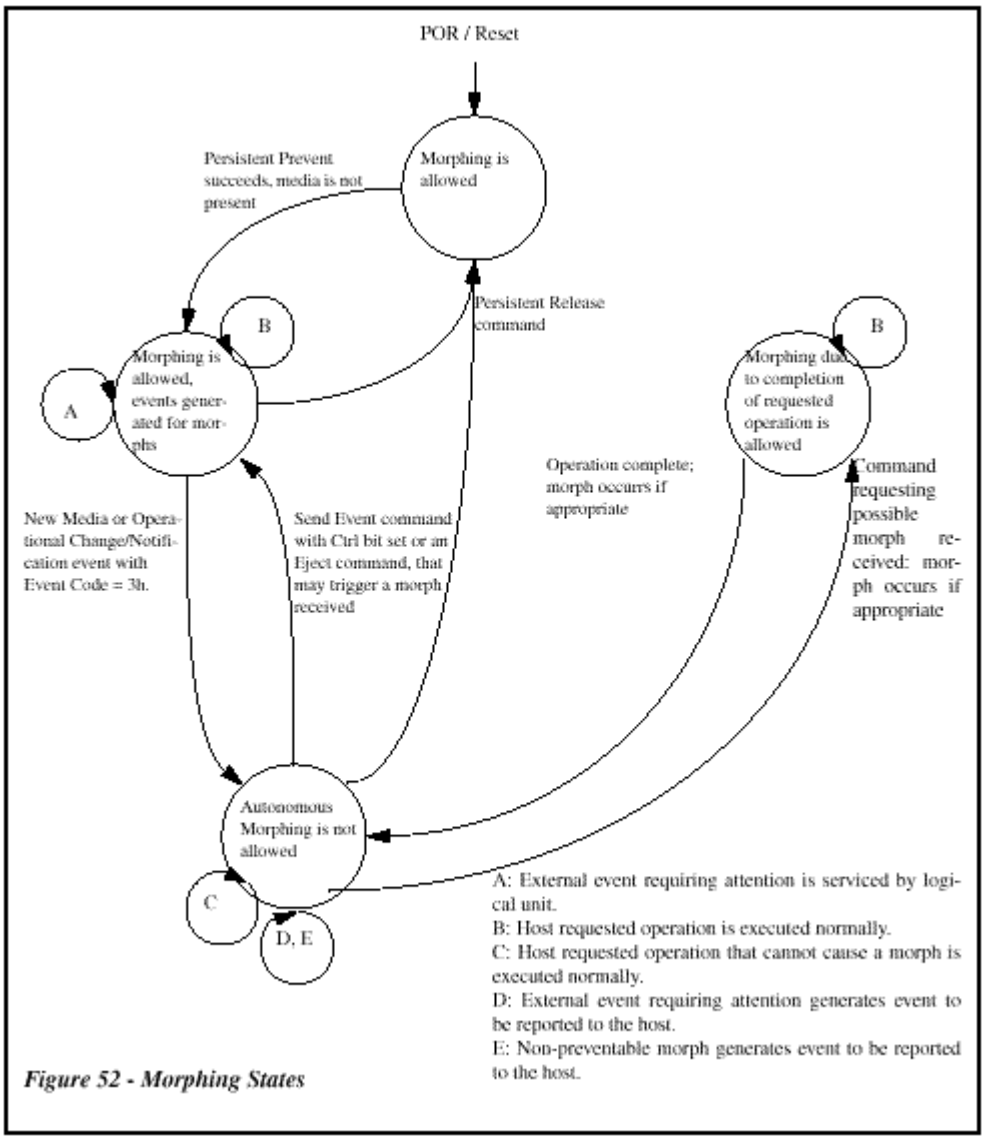

Figure 52 - Morphing States

0.1.4. Operation

The host may issue a PREVENT/ALLOW command with the Persistent Prevent bit set to indicate to the logical unit that it shall not change its behavior without host notification for any preventable action. This will, for example, prevent any front panel buttons from causing an eject, play, or other operation that affects device operation.

When the Persistent Prevent state is entered, the media shall remain locked in the Logical Unit and the Logical Unit shall not change its behavior, until the host issues an eject request, or a power on or hard reset condition occurs. The Persistent Prevent state shall be maintained after the eject request. New media that is inserted into the Logical Unit shall be locked in the Logical Unit after the logical unit reports the NEW MEDIA event. Prior to reporting the NEW MEDIA event, the logical unit may eject media without an explicit eject command from the host. This allows the user to remove incorrectly inserted media without having to wait for host intervention.

While in the Persistent prevent state, the logical unit shall generate Events upon receipt of a User Eject request. The logical unit shall not eject the media on receipt of these requests, if the logical unit has already reported a NEW MEDIA event for this media. When the host receives the Eject Request, and determines that it is safe to eject the medium, an

START/STOP UNIT command with the LoEj bit set will be issued, at which time the logical unit shall eject the medium.

The Persistent Prevent state shall be retained.

The logical unit shall only generate MSEN (EJECT REQUEST) events after reporting a MSEN (NEW MEDIA) event, and prior to reporting a MSEN (MEDIA REMOVAL) event for the given media.

In the Polling Mode of Event Notification, the host shall repeatedly issue GESN commands with an immediate bit of 1. The interval should be sufficiently short to provide quick user feedback but long enough to avoid performance impacts within the system. The logical unit shall complete these commands upon receipt, supplying the host with information on the most recent event occurrences, as described in the GESN command. If an event occurrence of the class(es) requested is not in the logical unit event queue, the Logical Unit shall complete the GESN command, and shall set the NEA bit to 1. This shall not be deemed an error.

If command queuing is supported, the host may issue a GESN command with an immediate bit of 0. The command shall not complete until an event occurrence of the class(es) requested is either in the event queue, or occurs.

The logical unit shall maintain a separate queue for each class of Event Notification(s) supported. Events that are generated shall be placed at the tail of the event queue. The depth of the queue(s) is vendor specific, although it shall be at least one. If an overflow occurs, the logical unit shall maintain the most recent Events in the queue.

Each GESN command shall report only one event. If multiple Event Classes are requested and multiple events are available, the logical unit shall report the Event in the Event Class with the lowest Notification Class ordinal.

0.1.5. Compatibility Considerations

To maintain compatibility with existing BIOS implementations and operating systems, the logical unit shall default to Persistent Prevent disabled. When the host enables the support using the PREVENT/ALLOW command, the logical unit shall respond as described in this specification. When the host disables this feature, the logical unit must default to normal operating modes. A power on or hard reset shall cause the logical unit to the default Persistent Prevent state.

If the Logical Unit is unable to maintain media status information across a reset or power cycle, the Logical Unit shall generate a NEW MEDIA event.

Commands must be processed exactly the same as they would be if Persistent Prevent was not enabled. For compatibility reasons, UNIT ATTENTION status conditions must still be returned. However, the logical unit shall not return the UNIT ATTENTION status on a GESN command. For example, if the user inserts a new medium and the logical unit is accessed with a command, the CHECK CONDITION with UNIT ATTENTION shall be reported, but the logical unit shall also report the NEW MEDIA Event with the next available GESN (Media Status) command. If the GESN command is received after a Unit Attention condition is generated, and before it is reported to the host, the GESN command shall report the event and clear the Unit Attention state.

0.1.6. Removable Medium

This feature shall indicate that the device has removable media. Media shall be considered removable if it can be removed from the loaded position, i.e. a single mechanism changer, even if the media is captive to the changer. The Feature Descriptor contains information about the logical unit and the loading of media. In particular, the Lock bit indicates the ability of the device to honor at least one aspect of Persistent Prevent. Table 3 list the command required to implement this feature.

Table 3 - Commands for Removable Medium Feature

Op Code	Command Description	Clause
BDh	MECHANISM STATUS	
1Eh	PREVENT/ALLOW	
51H	READ DISC INFORMATION	
52H	READ TRACK/RZONE INFORMATION	
1Bh	START/STOP UNIT and load eject (LOEJ) bit	

The READ DISC INFORMATION command shall be supported. Logical Units that do not have logical Tracks/Rzones or logical Sessions shall identify the media as having one session and one Track/RZone, numbered as Track/RZone 1. Fields that do not apply to the loaded media shall be marked as invalid or set to zero, as appropriate.

The READ TRACK/RZONE INFORMATION command shall be supported. Logical Units that do not have logical Tracks/RZones shall report information as if the medium contains one Track/RZone encompassing all logical blocks on the medium.

The START/STOP UNIT command shall be supported. The Immed, Start bits shall be supported. The LoEj bit shall be supported if the Eject bit in the Removable Medium Feature descriptor is set to one. A Power Condition value of 0 shall be supported.

The MECHANISM STATUS command shall be supported. Devices with removable media and no other slots shall report information to this command as if they are a one disc changer (single sided) or a two disc changer (logical unit can switch sides).

0.1.7. Random Readable

The Random Readable feature is for basic sector reading ability found on most storage class devices for which data are recorded in independently addressable logical blocks which are readable in any order. The number of blocks on the medium cannot be determined via commands in this Feature. If this information is desired, either the Removable Medium Feature or the Random Writable Feature must be implemented. This feature shall be current only if randomly readable media is present. Table 4 list the commands required to implement this feature.

Table 4 - Commands for Random Readable Feature

Op Code	Command Description	Clause
28h	Read (10)	
35h	Flush Cache	

The READ (10) command shall be supported for any recorded sector. The FUA bit shall be supported when writable media is loaded. The operation of the read command is modified by the Read/Write Error Recovery page settings.

The Block Size shall be reported in the Feature Descriptor. The block size for a medium may change for the entire medium after a format operation.

The Blocking field reported in the Feature Descriptor is for performance optimization only. Reads of any sector or sector count shall be allowed

If the PP bit in the Feature Descriptor is set, the TB, RC, PER, DTE, and DCR bits of the Read/Write Error Recovery page shall be supported. An Error Recovery Parameter field of 0 in the Read/Write Error Recovery page shall be supported.

Support for other bits and values in the page is optional. This page shall not change due to medium removal or changes. The changeable fields mask shall not change due to medium removal or changes. The host shall be able to change changeable values whether or not media is loaded.

0.1.8. MultiRead

This feature shall indicate that the device is capable of reading CD Media including CD-ROM, CD-R and CD-RW, with logical formats including fixed and variable packets. When reading fixed packets, the drive shall perform Method 2 address translation. Reading of digital audio via the Read CD command shall be supported. The reading of Audio Data shall be aligned such that contiguous Read CD commands return contiguous information, even if buffer overruns or underruns occur. As this feature indicates a capability, if present, shall have the current and persistent bits in the feature descriptor set to one.

0.1.9. CD Read

This feature shall indicate support for reading structures specific to CD. This feature shall be current only if CD specific structures are available for reading. Table 5 list the commands required to implement this feature.

Table 5 - Commands for CD READ Feature

Op Code	Command Description	Clause
28h	Read (10)	
BEh	READ CD	
51h	READ DISC INFOROMATION	
43h	READ TOC/PMA/ATIP	
52h	READ TRACK/RZONE INFORMATION	

The READ TOC command with format codes of 0h, 1h, and 2h shall be supported.

The READ DISC INFORMATION command shall be supported. If reading of open sessions is not supported, the logical unit shall report information about the last complete session and indicate that the last complete session is the last session on the disc.

The READ TRACK/RZONE INFORMATION command shall be supported. If reading of open sessions is not supported, the last track identified shall be the last track in the last complete session.

The READ CD command shall be supported. All data forms shaded in "Table 203 - Number of Bytes Returned Based on Data Selection Field" on page 277 shall be supported; non-shaded forms are optional. If the Method2 bit in the Feature Descriptor is set, the logical unit shall perform method 2 address translation for fixed packet tracks.

0.1.10. DVD Read

This feature shall indicate support for reading DVD specific structures. This feature shall be current only if DVD specific structures are available for reading. Table 6 list the commands required to implement this feature.

Table 6 - Commands for DVD READ Feature

Op Code	Command Description	Clause
28h	Read (10)	
A8h	READ(12)	
51h	READ DISC INFOROMATION	
ADh	READ DVD STRUCTURE	
52h	READ TRACK/RZONE INFORMATION	

The READ DVD structure command shall be supported. Format codes of 00h-05h, 08h, and 0Ch shall be supported.

The READ (12) command shall be supported.

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

0.1.11. Random Writable

This feature identifies a logical unit that can write data to logical blocks specified by a Write command. There is no requirement that the addresses in sequences of writes occur in any particular order. This feature shall be present only if writable media is present. Write protected media shall not be considered writable.

The Random Readable feature shall be current when this Feature is current. The Logical Block Size and Blocking fields of the Random Readable Feature are required by operations supported by the Random Writable Feature. Table 7 list the commands required to implement this feature.

Table 7 - Commands for Random Writable Feature

Op Code	Command Description	Clause
2Ah	Write (10)	
2Eh	Write and Verify (10)	
35h	Flush Cache	

The WRITE (10) command shall be supported.

The FLUSH CACHE command shall be supported. The Immediate bit shall be supported.

If the PP bit in the Random Readable feature is set to one, all fields in the Read/Write error recovery page shall be supported.

0.1.12. Incremental Streaming Writable

This feature shall indicate support for sequential recording, such as CD Packet, and DVD Incremental recording to write once or rewritable media. If this feature is current, the Random Readable feature shall also be current. This feature shall become not current after a final fixation is performed. Table 8 list the commands required to implement this feature.

Table 8 - Commands for Incremental Streaming Writable Feature

Op Code	Command Description	Clause
5Bh	Close Track/Session/RZONE	
53h	Reserve Track/RZONE	
2Ah	WRITE(10)	

The WRITE (10) command shall be implemented. Writing may be limited to locations identified by the READ DISC IN-FORMATION and READ TRACK/RZONE commands. If sequential write commands occur to contiguous locations at a sufficient rate, the logical unit shall stream the data to the medium without interruption or link generation occurring. If the writing is interrupted due to insufficient data (underrun) or is forced by a FLUSH CACHE or other command, a link shall be generated. The nominal size of the link shall be that specified by the Write Parameters mode page. The number of padding and link blocks actually recorded may also depend on blocking: the data from the host may first be padded to fill a Blocking unit and then a link shall be appended.

While a streaming write is in progress (data are in the logical unit's buffer but not committed to the medium), the commands in Table 9 shall execute normally without interrupting the writing. All other commands shall execute normally, but may interrupt recording. All other commands may force a flush cache before execution. Logical Units should execute all other commands without flushing the write buffer. This is possible if writing to the medium has not yet started. Normal execution is defined as the behavior the command would have if no data were in the write buffer.

The FLUSH CACHE command shall be implemented. The FLUSH CACHE command shall force the underrun condition regardless of the state of the immediate bit.

The Write Parameters page shall be supported. If CD media is present, the Packet recording write type shall be available.

If DVD media is present, the Incremental recording write method shall be available. The Write Parameters page may contain or be actively set to settings that are incompatible with the current medium, or be set when no medium is present. If writing is attempted when the Write Parameters page is not compatible with the current track, RZone, or medium, the logical unit shall return a CHECK CONDITION status, ILLEGAL REQUEST, WRITE PARAMETERS

IN-COMPATIBLE WITH TRACK/RZONE, and the sense key specific information set to the byte and field of the incompatible parameter in the mode page.

The CLOSE TRACK/RZONE command shall be supported.

The RESERVE TRACK/RZONE command shall be supported.

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

If the erasable flag in the READ DISC INFORMATION command is set to one, the BLANK command shall be supported with Blanking Types of 000b, 001b, and 100b.

If OPC information is ever returned via READ DISC INFORMATION, the SEND OPC command shall be supported.

Table 9 - Commands that shall not interrupt streaming writing

Command	Comment
TEST UNIT READY	
READ TRACK/RZONE INFORMATION	Required only for current Track/RZone
GET EVENT/STATUS NOTIFICATION	
GET CONFIGURATION	
REQUEST SENSE	
INQUIRY	
READ BUFFER CAPACITY	Please see T10/1048D for a description of this command
WRITE (10)	For NWA in current Track/RZone

0.1.13. Sector erasable

This feature shall identify a system in which sectors must be erased before overwriting. The default operation of the logical unit is to perform an erase pass before writing. If this feature is current, the Random Readable Feature shall be current, and the Random Writable Feature shall also be current.

The logical unit shall generate a CHECK CONDITION status, ILLEGAL REQUEST, BLANK CHECK if the host attempts to read an erased logical block.

The EBP bit in the WRITE command shall be supported. If the EBP bit is set to one, the host is indicating to the device that the block(s) addressed are known to be erased and therefore don't require erasure before recording. If the EBP bit is set to zero, the logical unit shall perform an erase pass before recording The ERASE command shall be supported.

The BlkVfy bit of the VERIFY command shall be supported.

0.1.14. Formattable

This feature shall identify media that can be formatted. The type of formatting that may be performed is defined in the FORMAT UNIT command (see). Table 10 list the commands that are required to implement this feature.

Table 10 - Commands for Formattable Feature

Op Code	Command Description	Clause
04h	Format Unit	
23h	READ FORMATED CAPACITies	
2Fh	VERIFY	

The FORMAT UNIT command with a format code of 001b shall be supported.

The READ FORMAT CAPACITIES command shall be supported. All descriptors returned shall be valid for the current medium.

0.1.15. Defect Management

The logical unit shall be able to perform defect management to provide the host with an apparently defect-free contiguous address space. Table 11 list the mode page required for this feature. This feature shall be current only if media with defect management capability is present.

If the Read/Write Error Recovery page is implemented, the AWRE and ARRE bits shall be supported.

Table 11 - Mode Page for Defect Management Feature

Page Code	Page Description	Clause
01h	READ/write error RECOVERY Page	

0.1.16. Write Once

This feature identifies a logical unit that can write data to randomly addressed logical blocks specified by a WRITE command.

There is no requirement that the addresses in sequences of writes occur in any particular order. This feature shall be present only if write once media is present. Write protected media shall not be considered writable. After being written once, the logical unit cannot record the same block again. If the logical unit detects that all logical blocks are recorded, this feature shall become not current.

The Random Readable feature shall be current when this feature is current.

The WRITE (10) command shall be supported. Writing may occur to any previously unrecorded logical block. If recording is attempted to any recorded logical block, the logical unit shall generate CHECK CONDITION status, ILLEGAL REQUEST, BLANK CHECK.

The FLUSH CACHE command shall be supported. The Immediate bit shall be supported.

The Read/Write error recovery page shall be supported.

0.1.17. Restricted Overwrite

The Restricted Overwrite Feature shall indicate the ability to perform writing only on Blocking boundaries. This feature replaces Random Writable for devices that do not perform read-modify-write operations on write requests smaller than Blocking. This feature shall not be current if the Random Writable Feature is current. This feature may be present only when Restricted Overwritable media, such as CD-RW with a single track containing fixed packets, is loaded. Logical Units with write protected media shall not have this feature current. If this Feature is current, the Random Writable Feature shall not be current. If this feature is current, the Random Readable Feature shall also be current.

On CD-RW, this feature should be current only if the first track on the media is formatted for fixed packets and is complete. Table 12 list the commands required for this feature.

Table 12 - Commands for RESTRICTED OVERWRITE Feature

Op Code	Command Description	Clause
A1h	BLANK	
	READ TRACK/RZONE INFORMATION	
	WRITE (10)	

The Blocking field in the Random Readable Feature shall be equal to the packet size. The Last Addressable Block shall be the last addressable block in the first track. If more than one track is present on the media, the host must use READ TRACK/RZONE INFORMATION Command to obtain a description of the medium.

Writing from the host into the first track shall be in units of Blocking. Writing shall begin at Blocking boundaries. The writable units may be sent via multiple Write (10) commands. If the logical unit receives a Write that does not begin on a Blocking boundary and is not contiguous with a previous Write that did begin on a Blocking boundary shall return

CHECK CONDITION STATUS, ILLEGAL REQUEST, ILLEGAL ADDRESS FOR WRITE. If an incomplete set of blocks is received and the logical unit is required to flush its cache via Flush Cache or other implied causes, the logical unit shall generate CHECK CONDITION status, RECOVERED ERROR, PADDING BLOCKS ADDED.

The WRITE (10) command shall be supported.

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

0.1.18. CD Track at Once

This feature shall indicate support for sequential Track at Once recording to write once or rewritable media. This Feature shall become not current after a final fixation is performed. Logical units that may record C/D-R/RW media with sequential Track at Once behavior shall implement the commands specified in Table 13 and the mode parameters specified in Table 14.

Table 13 - Commands for CD TRACK AT ONCE Feature

Op Code	Command Description	Clause
35h	FLUSH CACHE	
53h	Reserve Track/RZONE	
51h	READ DISC INFOROMATION	
52h	READ TRACK/RZONE INFORMATION	
2Ah	WRITE(10)	

Table 14 - Mode Parameters for CD TRACK AT ONCE Feature

Page Code	Page Description	Clause
05h	WRITE PARAMETERS Page and Track at Once recording	

The WRITE (10) command shall be implemented. Writing may be limited to locations identified by the READ DISC IN-FORMATION and READ TRACK/RZONE commands. If sequential write commands occur to contiguous locations at a sufficient rate, the logical unit shall stream the data to the medium without interruption or link generation occurring. If the writing is interrupted due to insufficient data (“underrun”) or is forced by a flush cache or other command, run-out and link shall be generated after padding. Padding shall consist of (1) sufficient blocks of zeros to make the track the minimum length and (2) padded to fill an existing reservation for the track. If the track is of minimum length and is not reserved, no padding blocks shall be added.

While a Track at Once write is in progress (data are in the logical unit’s buffer but not committed to the medium), the commands in "Table 46 - Commands that shall not interrupt streaming writing" on page 146 shall execute normally without interrupting the writing. All other commands shall execute normally, but may interrupt recording. All other commands may force a flush cache before execution. Logical Units should execute all other commands without flushing the write buffer. This is possible if writing to the medium has not yet started. Normal execution is defined as the behavior the command would have if no data were in the write buffer.

The FLUSH CACHE command shall be implemented. The flush cache command shall force the underrun condition regardless of the state of the immediate bit.

The Write Parameters page shall be supported. If CD media is present, the Track at Once recording write type shall be available. The Write Parameters page may contain or be actively set to settings that are incompatible with the current medium, or be set when no medium is present. If writing is attempted when the Write Parameters page is not compatible with the current Track/RZone, or medium, the logical unit shall return a CHECK CONDITION status, ILLEGAL REQUEST, ILLEGAL MODE FOR THIS TRACK OR INCOMPATIBLE MEDIUM, and the sense key specific information set to the byte and field of the incompatible parameter in the mode page.

The RESERVE TRACK/RZONE command shall be supported.

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

If the CD-RW flag is set in the CD Track at Once Feature Descriptor is set, the Erasable bit in the READ DISC INFORMATION command shall be set to one and the BLANK command shall be supported. Blanking types 000b, 001b shall be supported. Overwriting of previously recorded tracks shall be allowed. Overwriting of previously recorded tracks is performed as if the track had been reserved and not recorded (the PMA entry is unchanged).

If OPC information is ever returned via Read Disc Information, the SEND OPC command shall be supported.

0.1.19. CD Mastering

Two fundamental types of CD mastering are possible - raw and session at once. A logical unit with this Feature shall support at least one of Raw or Session at Once recording. The type of recording is identified in the Feature Descriptor.

This feature shall be current only if the last session status is empty.

> Note: the raw mode offers additional control but by-passes logical unit data checking and has larger data transfer size. The session at once mode offers logical unit control and supervision but has greater logical unit complexity.

The Write Parameters page is mandatory.

The Raw bit shall indicate that the logical unit can record using the raw write type. The Session at Once bit shall indicate that the logical unit can record using the Session at Once write type. Each write type is described in the following sections.

Table 15 - Commands that shall not interrupt Track at Once writing

Command	Comment
TEST UNIT READY	
READ TRACK/RZONE INFORMATION	Required only for current Track/RZone
GET EVENT/STATUS NOTIFICATION	
GET CONFIGURATION	
REQUEST SENSE	
INQUIRY	
READ BUFFER CAPACITY	Please see T10/1048D for a description of this command
WRITE (10)	For NWA in current Track/RZone

The Test Write bit shall indicate that the logical unit can perform test writes. In test write mode, the logical unit shall be-have as if data were committed to the medium, but writing to the medium shall not occur.

If OPC information is ever returned via Read Disc Information, the Send OPC command shall be supported.

0.1.20. CD Mastering - Raw

Logical units that may record C/D-R/RW media with CD Mastering - Raw behavior shall implement the commands specified in Table 16 and the mode parameters specified in Table 17.

Table 16 - Commands for CD MASTERING - RAW Feature

Op Code	Command Description	Clause
51h	READ DISC INFOROMATION	
52h	READ TRACK/RZONE INFORMATION	
2Ah	WRITE(10)	

Table 17 - Mode Parameters for CD MASTERING – RAW Feature

Page Code	Page Description	Clause
05h	WRITE PARAMETERS Page and Raw, Data Block Type 1	

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

The Raw write type in the Write Parameters page shall be supported. Data Block Type 1 shall be supported. If the R-W bit in the Feature Descriptor is set, then Data Block Types 2 and 3 shall also be supported.

The WRITE (10) command shall be supported. The host shall send all data, from the beginning of lead-in to the end of lead-out. The number of bytes per block is determined by the Data Block Type in the Write Parameters mode page. The Writes shall occur to a contiguous sequence of addresses. When an underrun occurs, the logical unit shall write the last block sent from the host as a link. If the Raw MS bit is set, the logical unit shall also generate valid PMA entries for the information sent by the host. The logical unit may use the TOC and approximations, or TOC and scanning to determine PMA parameters.

0.1.21. CD Mastering - Session at Once

The SAO bit shall indicate that the logical unit can record using the Session at Once write type. Logical units that may record C/D-R/RW media with CD Mastering – Session at Once behavior shall implement the commands specified in Table 18 and the mode parameters specified in Table 19.

Table 18 - Commands for CD MASTERING – Session at Once Feature

Op Code	Command Description	Clause
51h	READ DISC INFOROMATION	
52h	READ TRACK/RZONE INFORMATION	
5Dh	SEND QUE SHEET	
2Ah	WRITE(10)	

Table 19 - Mode Parameters for CD MASTERING – Session at Once Feature

Page Code	Page Description	Clause
05h	WRITE PARAMETERS Page and SAO	

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

The SAO write type in the Write Parameters page shall be supported. The Data Block Type field is ignored; the data block type changes dynamically according to the cue sheet.

The WRITE (10) command shall be supported. The number of bytes per block is determined by the cue sheet. Writes must be issued for every user data block, even if the cue sheet indicates that those blocks require no data be sent from the host. In that case, the number of bytes transferred is zero. WRITE (10) commands shall be issued by the host with an ascending sequence of Logical Block Addresses. The number of blocks per write may change over the course of recording. If an underrun occurs, the logical unit may pad the rest of the session or abort the recording. Underruns may be detected by the host at the next write, which will not be a valid address for writing due to the underrun.

The SEND CUE SHEET command shall be supported. The logical unit shall accept cue sheets up to the size specified in the Maximum Cue Sheet Size field.

0.1.22. DVD-R Write

This feature indicates the ability to master a DVD disc on write once media. Logical units that may write DVD-R media shall implement the commands specified in Table 20 and the mode parameters specified in Table 21.

Table 20 - Commands for DVD-R Write Feature

Op Code	Command Description	Clause
51h	READ DISC INFOROMATION	
52h	READ TRACK/RZONE INFORMATION	
ADh	SEND DVD STRUCTURE	
2Ah	WRITE(10)	

Table 21 - Mode Parameters for DVD-R Feature

Page Code	Page Description	Clause
05h	WRITE PARAMETERS Page and Type of Session at Once	

The Write Parameters mode page shall be supported. A Write Type of Session at Once shall be supported.

The READ DISC INFORMATION command shall be supported.

The READ TRACK/RZONE INFORMATION command shall be supported.

The WRITE (10) command shall be supported. The number of bytes per block is determined by the block size in the Random Read Feature. Writes must be issued for every user data block. WRITE (10) commands shall be issued by the host with a contiguous sequence of Logical Block Addresses. The number of blocks per write may change over the course of recording. If an underrun occurs, the logical unit may pad the rest of the disc or abort the recording. Underruns may be detected by the host at the next write, which will not be a valid address for writing due to the underrun.

The SEND DVD STRUCTURE command shall be supported.

0.1.23. Power Management

This feature identifies a logical unit that can perform host managed and host directed power management. The Power Conditions field of the START/STOP UNIT command shall be supported. Logical units that support power management shall implement the commands specified in Table 22 and the mode parameters specified in **Error! Reference source not found.**.

Table 22 - Commands for Power Management Feature

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION	
1Bh	START/STOP UNIT and the Power Conditions field	

Table 23 - Mode Parameters for Power Management Feature

Page Code	Page Description	Clause
1Ah	POWER CONDITION Page	

The Power Condition page shall be supported.

The Power Event class of the GET EVENT/STATUS NOTIFICATION Command shall be supported.

0.1.24. S.M.A.R.T.

S.M.A.R.T. capable Logical Units monitor a wealth of information internal to the Logical Unit to assess reliability and predict an impending Logical Unit or medium failure. Logical units that support Self Monitoring Analysis and Reporting shall support the mode pages specified in Table 24.

Table 24 - Mode Parameters for S.M.A.R.T. Feature

Page Code	Page Description	Clause
1Dh	FAULT/FAILURE REPORTING Page	

If the PP bit is set in the S.M.A.R.T Feature Descriptor, the Fault / Failure Reporting Control Page on page 239 shall be supported.

0.1.25. Embedded Changer

For more information on changers, see the description of the Changer Model. If this Feature is current, the Removable Medium Feature shall also be current. Logical units that support an embedded changer shall implement the commands specified in Table 25.

Table 25 - Commands for Embedded Changer Feature

Op Code	Command Description	Clause
A6h	Load/Unload C/DVD Medium	
BDh	Mechanism Status	

The LOAD/UNLOAD C/DVD command shall be supported.

0.1.26. CD Audio analog play

This Feature identifies C/DVD Logical Units that have an analog audio output port and that can play media that contain CD-DA tracks. If this feature is current, the CD Read Feature shall also be current. Logical units that have a CD-Audio analog output shall support the commands specified by Table 26 and the mode pages specified in

Table 27.

To allow for the legacy method for the Host Computer to determine if audio operations are supported, C/DVD Logical Units shall respond to a PLAY AUDIO command which has a transfer length of zero, with GOOD status, regardless of whether or not this feature is current.

Table 26 - Commands for CD-Audio Analog Feature

Op Code	Command Description	Clause
BDh	MECHANISM STATUS	
4Bh	PAUSE/RESUME	
45h	PLAY AUDIO (10)	
47h	PLAY AUDIO MSF	
42h	READ SUBCHANNEL	
4Eh	STOP PLAY/SCAN	

Table 27 - Mode Parameters for CD-Audio Analog Feature

Page Code	Page Description	Clause
0Eh	CD Audio Control Mode Page	

The PLAY AUDIO (10), and PLAY AUDIO MSF commands shall be supported.

The PAUSE/RESUME command shall be supported.

The STOP PLAY/SCAN command shall be supported.

The SEEK command shall be supported. The SEEK command shall halt the playing of audio and set the current position to the LBA specified in the command. This current position may be used by a future PLAY AUDIO or PLAY AUDIO MSF command.

The READ SUB-CHANNEL command shall be supported.

The CD Audio Control page shall be implemented. This page shall not be affected by the insertion or removal of CD Audio media.

0.1.27. Microcode Upgrade

This Feature identifies logical units that can upgrade their microcode via the logical interface. While the download technique is standard, the microcode data is vendor unique. Logical Units shall validate microcode data before making the microcode permanent. Logical units that support microcode upgrades shall implement the mode parameters specified in Table 28.

Table 28 – Mode Parameters for Microcode Upgrade Feature

Op Code	Command Description	Clause
3Bh	Write Buffer and Mode 101b (Download microcode and save)	

The WRITE BUFFER command, Download microcode with offsets and save mode (111b) shall be supported. Buffer 0 shall be usable for microcode upgrades. Please see SPC for a definition of these two commands.

0.1.28. Time-out

This Feature ()identifies the ability to complete commands within specified time limits. Logical units that support execution of commands with time constraints shall implement the mode parameters specified in Table 28.

Table 29 – Mode Parameters for Time-out Feature

Op Code	Command Description	Clause
1Dh	C/DVD Timeout and Protect Page	

The C/DVD Time-out & Protect Page shall be implemented. See on page 241.

Commands that cannot complete normal execution within their specified time limit shall complete within the specified time limit with a CHECK CONDITION status, UNIT ATTENTION, INSUFFICIENT TIME FOR OPERATION.

0.1.28.1. Time-out Model

ED NOTE: make this a feature set section---possible normative annex.

It is difficult for an operating system to determine a correct time-out value to use when issuing commands to a Logical Unit. Specifically, in instances of commands that may take a long time complete, but usually complete in a relatively short time. An example would be a read command after the Logical Unit has entered a low power state, and the media must spin up before completing the request. This model allows for a method for the Logical Unit to complete the request with an error that indicates to the host operating system that the request should be retried, but with a longer time-out.

The Logical Unit will specify two time-out parameters in the C/DVD Time-out & Protect Page. The first parameter is the minimum time-out that an operating system must use for all commands in Group 1. The second parameter is the minimum time-out that an operating system must use for all commands in Group 2.

For commands in Group 1, the Logical Unit shall start an internal timer when the command is received. If the command is unable to complete before the time specified in the Group 1 Time-out field C/DVD Time-out & Protect Page, bytes 6 and 7), the Logical Unit may terminate the command, at any time before the Group 1 Time-out expires, with a Check Condition (Sense Key 06, UNIT ATTENTION, ASC 2Eh, ASCQ 00 INSUFFICIENT TIME FOR OPERATION)

Additionally, the Logical Unit shall set the COMMAND SPECIFIC INFORMATION sense bytes (BYTES 8-11) to the value in seconds that corresponds to the minimum time-out that the host should use when retrying this command. Upon receiving this Check Condition, the operating system shall retry the command with the requested time-out.

Note: a Logical Unit may return this check condition at any point after the command is received, it may even return prior to initiating command.

All commands in Group 2 are commands that may not be able to complete successfully if they are retried. Thus, the Host must ensure that it uses a time-out that is large enough to allow the command to complete under worst case scenarios. This time-out is specified by the Logical Unit in the Group 2 Time-out parameter of the C/DVD Time-out & Protect Page (Bytes 8-9).

0.1.29. DVD-CSS

This Feature identifies Logical Units that supports DVD-CSS (Content Scramble System) for DVD-Video. The Logical Unit shall maintain the integrity of the keys by only using DVD-CSS procedures. This Feature shall be current only if a DVD-CSS protected DVD-Video medium is loaded. Logical units that support CSS for DVD-Video shall implement the commands specified by Table 30.

Table 30 – Commands for DVD-CSS Feature

Op Code	Command Description	Clause
A2h	REPORT KEY	
A3h	SEND KEY	
A7h	SET READ AHEAD	

The REPORT KEY command (see) shall be supported.

The SEND KEY command (see) shall be supported.

The READ DVD STRUCTURE command (see) shall be sup-ported.

0.1.30. Real Time Streaming

This Feature identifies Logical Units that support reporting and setting of performance parameters. The host may request that the logical unit perform at a certain data rate. A host may request a lower rate than the logical unit's maximum to identify a need for a continuous stream of data. This is desired because many applications need their average data rate to be constant, even over short periods of time. If a drive must physically slow the medium to avoid "once around" access delays, this Feature provides the host requirements to the Logical Unit without specifying how that behavior is to be achieved. Logical units that support real time streaming shall implement the commands specified by Table 31.

Table 31 – Commands for REAL TIME STREAMING Feature

Op Code	Command Description	Clause
ACh	GET PERFORMANCE	
A7h	SET READ AHEAD	
B6h	SET STREAMING	

The GET PERFORMANCE command (see) shall be supported.

The SET STREAMING command (see) shall be supported.

The SET READ AHEAD command (see) shall be supported.

0.1.31. Logical Unit Serial Number

This Feature identifies Logical Units that have a serial number. Identification by Vendor ID, Product ID, and serial number shall be unique.

0.1.32. Vendor Unique

All Vendor Unique Features shall be a multiple of 4 bytes in length. Use of Reserved fields in the Feature Descriptor Header is prohibited. Vendors are encouraged to take steps to choose a Feature number unique among all products. The Logical Unit's Vendor ID and Product ID shall be used to qualify which set of Vendor Unique Features may be available.