ISO/IEC 14776-326

Edition 2.0 2015-09

INTERNATIONAL STANDARD

Information technology – Small computer system interface (SCSI) – Part 326: Reduced block commands (RBC)

ISO/IEC 14776-326:2015-09(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

ISO/IEC 14776-326

Edition 2.0 2015-09

INTERNATIONAL STANDARD

Information technology – Small computer system interface (SCSI) – Part 326: Reduced block commands (RBC)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 35.200

ISBN 978-2-8322-2861-6

CONTENTS

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 326: Reduced block commands (RBC)

FOREWORD

1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

2) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees and ISO member bodies.

3) IEC, ISO and ISO/IEC publications have the form of recommendations for international use and are accepted by IEC National Committees and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC, ISO and ISO/IEC publications is accurate, IEC or ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees and ISO member bodies undertake to apply IEC, ISO and ISO/IEC publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO, IEC or ISO/IEC publication and the corresponding national or regional publication should be clearly indicated in the latter.

5) ISO and IEC do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. ISO or IEC are not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC National Committees or ISO member bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication of, use of, or reliance upon, this ISO/IEC publication or any other IEC, ISO or ISO/IEC publications.

8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this ISO/IEC publication may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14776-326 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This second edition cancels and replaces the first edition published in 2002 and constitutes a minor revision.

This second edition provides additional explanations and corrects mistakes with respect to the first edition.

A list of all parts in the ISO/IEC 14776 series, published under the general title *Information technology – Small computer system interface (SCSI)*, can be found on the IEC website.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE –

Part 326: Reduced block commands (RBC)

1 Scope

This part of ISO/IEC 14776 defines a Reduced Block Command set for logical block devices. The Reduced Block Commands along with the required SPC-2 commands and their restrictions described in this standard, fully specify the complete command set for RBC logical block devices.

The purpose of this part of ISO/IEC 14776 is to provide a command set of reduced requirements and options from SCSI Block Commands (SBC) (ISO/IEC 14776-321) for block devices. The reduced command set is intended to more closely match the functionality required for simple block logical units. The specified commands place no restrictions on device performance. The initial focus of this command set was to enable rigid disks and removable media devices attached to Serial Bus and utilizing SBP-2 (ISO/IEC 14776-232) for command and control.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 13213:1994, *Information technology – Micoprocessor systems – Control and Status Registers (CSR) Architecture for microcomputer buses*

ISO/IEC 14776-232:2001, *Information technology – Small computer system interface (SCSI) – Part 232: Serial Bus Protocol 2 (SBP-2)*

ISO/IEC 14776-321:2001, *Information technology – Small Computer System Interface (SCSI-3) – Part 321: Block commands (SBC)*

ISO/IEC 14776-362:2006, *Information technology – Small computer system interface (SCSI) – Part 362: Multimedia commands-2 (MMC-2)*

ISO/IEC14776-412, *Information technology – Small computer system interface (SCSI) – Part 412: SCSI, Architecture model-2 (SAM-2)*

ISO/IEC 14776-452:2005, *Information technology – Small computer system interface (SCSI) – Part 452: Primary commands-2 (SPC-2)*

IEEE Standard 1394-1995, *High Performance Serial Bus*

IEEE Standard 1394A-2000, *High Performance Serial Bus Amendment 1*

3 Terms, definitions, abbreviations, keywords, and conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
additional sense code
ASC
field in the sense data

Note 1 to entry: See 7.20.2 in ISO/IEC 14776-452:2005.

[SOURCE: ISO/IEC 14776-452:2005, 3.1.2, modified – Reference to SPC-2 added.]

3.1.2
additional sense code qualifier
ASCQ
field in the sense data

Note 1 to entry: See 7.20.2 in ISO/IEC 14776-452:2005.

3.1.3
byte
B
eight bit of data

[SOURCE: ISO/IEC 14776-452:2005, 3.1.9, modified – Definition simplified.]

3.1.4
command descriptor block
CDB
structure of up to 16 B in length used to communicate a command from an initiator to a device

[SOURCE: ISO/IEC 14776-452:2005, 3.1.11, modified – Definition changed.]

3.1.5
EVENT field
byte 0 of the sense data INFORMATION field

Note 1 to entry: See Table 24 for the Event Status INFORMATION field format when the sense code indicates EVENT STATUS NOTIFICATION (38h).

3.1.6
logical unit
part of the device that is an instance of a device model

Note 1 to entry: For example mass storage, CD-ROM or a printer are device models.

Note 2 to entry: In devices that implement one or more logical units, the device type of the logical units may differ.

[SOURCE: ISO/IEC 14776-452:2005, 3.1.30, modified – Definition and explanatory information changed.]

3.1.7
sense data
data describing an error or exceptional device condition that a device delivers to an initiator

[SOURCE: ISO/IEC 14776-452:2005, 3.1.47, modified – Definition simplified and explanatory information deleted.]

3.1.8
sense key
field in the sense data

Note 1 to entry: See 7.20.3 in ISO/IEC 14776-452.

[SOURCE: ISO/IEC 14776-452:2005, 3.1.48, modified – Definition changed.]

3.1.9
status
response information sent from a device to an initiator upon completion of each command

[SOURCE: ISO/IEC 14776-452:2005, 3.1.52, modified – Definition simplified and explanatory information deleted.]

3.1.10
unit attention condition
condition that a logical unit maintains while it has asynchronous status information to report to one or more initiators

[SOURCE: ISO/IEC 14776-452:2005, 3.1.58, modified – "State" has been replaced by "condition" and refence information has been deleted.]

3.1.11
vendor specific
bit, field, code value, etc., not defined in this standard, that may be vendor defined

[SOURCE: ISO/IEC 14776-452:2005, 3.1.59, modified – Minor editorial change of the definition.]

3.2 Abbreviations

The following abbreviations are used in this standard:

ASC Additional Sense Code
ASCQ Additional Sense Code Qualifier
CDB Command Descriptor Block
MMC-2 Multi-Medial Commands 2
RBC Reduced Block Commands (this standard)
SAM-2 SCSI Architecture Model 2
SBC SCSI Block Commands
SBP-2 Serial Bus Protocol 2
SPC-2 SCSI Primary Commands 2

3.3 Keywords

Several keywords are used to differentiate levels of requirements and options, as follows.

3.3.1
expected
keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

3.3.2
ignored
keyword that describes bits, bytes, quadlets, or fields whose values are not checked by the recipient

3.3.3
mandatory
keyword that indicates items required to be implemented as defined by this standard

3.3.4
may
keyword that indicates flexibility of choice with no implied preference

3.3.5
optional
keyword that describes features which are not required to be implemented by this standard. However, if any optional feature defined by the standard is implemented, it shall be implemented as defined by the standard.

3.3.6
reserved
keyword used to describe objects (eg., bits, bytes, and field) or the code values assigned to these objects in cases where either the object or the code value is set aside for future standardization. Usage and interpretation may be specified by future extensions to this or other standards. A reserved object shall be zeroed or, upon development of a future standard, set to a value specified by such a standard. The recipient of a reserved object shall not check its value. The recipient of a defined object shall check its value and reject reserved code values.

3.3.7
shall
keyword that indicates a mandatory requirement. Designers are required to implement all such mandatory requirements to assure interoperability with other products conforming to this standard.

3.4 Conventions

The following conventions shall be understood by the reader in order to comprehend this standard.

3.4.1 Non-numeric values

Lowercase is used for words having the normal English meaning. Certain words and terms used in this standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in Clause 3 or in the text where they first appear.

The names of abbreviations, commands, and acronyms are in all uppercase (e.g., TEST UNIT READY command).

Fields are shown in small caps (e.g., LOGICAL BLOCK ADDRESS).

Fields containing only one bit are usually referred to as the NAME bit instead of the NAME field.

Formal lists connoted by letters (e.g., a) red; b) blue; c) green) are in an arbitrary order. Formal lists connoted by numbers (e.g., 1) red; 2) blue; 3) green) are in a required sequential order.

If a conflict arises between text, tables, or figures, the order of precedence to resolve conflicts is text; then tables; and finally figures. Not all tables or figures are fully described in text. Tables show data format and values. Notes do not constitute any requirements for implementations.

3.4.2 Numeric values

The ISO convention of numbering is used (i.e., the thousands and higher multiples are separated by a space and a comma is used as the decimal point as in 65 536 or 0,5).

Decimal numbers are represented by Arabic numerals without subscripts or by their English names (e.g., 42, or twelve).

Hexadecimal numbers are represented by digits from the character set 0 to 9 and A to F followed by the lower-case h (e.g., 2Ah).

Binary numbers are represented by digits from the character set 0 and 1 followed by the lower-case b (e.g., 0010 1010b).

The most significant bit of a binary quantity is shown on the left side and represents the highest algebraic value position in the quantity.

For the sake of legibility, binary and hexadecimal numbers are separated into groups of four digits separated by spaces.

4 RBC device model

4.1 General

RBC logical units store blocks of data for later retrieval. Each block of data is stored at a unique location. Initiators send WRITE commands to store the blocks of data (i.e., write operations) and READ commands to retrieve the blocks of data (i.e., read operations). Other commands sent by the initiator may cause write and read operations to occur.

A write operation causes one or more blocks of data to be written on the medium. A read operation causes one or more blocks of data to be read from the medium. A verify operation confirms that one or more blocks of data were correctly written and may be read without error from the medium.

Blocks of data are stored by a process that causes localized changes or transitions within the medium. The changes made to the medium to store the blocks of data may be volatile (i.e., not retained through off/on power cycles) or non-volatile (retained through off/on power cycles). The medium may be divided in parts that are used for data blocks, parts that are reserved for defect management, and parts that are reserved for use by the target for the management of the logical unit.

4.2 Removable medium device

The medium in a RBC device may be removable (e.g., used in a floppy disk drive) or non-removable (e.g. used in a fixed disk drive). Typically, removable medium is contained within a cartridge (or jacket) to prevent damage to the recording surfaces.

A removable medium has an attribute of being mounted or de-mounted on a suitable transport mechanism. A removable medium is mounted when the device/media combination is capable of performing write or read operations and the initiator is informed of this status. A removable medium is de-mounted at any other time (e.g., during loading, unloading, or storage).

Initiators may determine whether a RBC removable medium device is capable of performing read or write operations by one of three methods:

a) enabling Asynchronous Event Reporting (see SPC-2) in the device and examining the event information transmitted from the device;
b) issuing a TEST UNIT READY command and examining the returned status information; or
c) issuing a MODE SENSE command for Mode Page 06h (see 5.9.4) and examining the state of the READD bit or WRITED bit. If the READD bit is set to one, then the media is not readable. If the WRITED bit is set to one, then the media is not writable.

Until the RBC removable medium device and media are ready to be accessed, a READ(10) command shall cause the device to return status of CHECK CONDITION (02h), sense key of NOT READY (02h), and an ASC of LOGICAL UNIT NOT READY (04h). The ASCQ shall reflect the current state of the device/media.

When the device becomes ready, a unit attention condition shall be established. The sense key value shall be set to UNIT ATTENTION (06h), and the ASC/ASCQ to event STATUS NOTIFICATION/MEDIA CLASS EVENT (38h/04h). The EVENT field contained within the sense data INFORMATION field shall be set to NEW MEDIA READY FOR ACCESS (02h). When the unit attention condition is delivered to the initiator, the status shall be set to CHECK CONDITION (02h).

4.3 Command usage

4.3.1 General

RBC devices are not required to support the REQUEST SENSE command or the SEND DIAGNOSTIC command. Devices that do not provide the Auto Sense function, Asynchronous Event Reporting, or the GET EVENT/STATUS NOTIFICATION command (see MMC-2) shall implement the REQUEST SENSE command.

All sense key, ASC, and ASCQ names and values contained in this standard are defined in SPC-2. No additional or alternative meaning is intended by the use of such names and values in this standard.

4.3.2 Using the INQUIRY command

The INQUIRY command (see SPC-2 and 6.2) may be used by an initiator to determine the configuration of a logical unit. RBC devices return information that includes type and standard version. The device may also return the vendor identification number, model number, and other vendor specific information. It is recommended that devices provide the capability to return this information upon completing power-on initialization. A device may take more time to return certain portions of this information, especially if the information shall be retrieved from the medium.

4.3.3 Using the REQUEST SENSE command

Whenever a command completes with CHECK CONDITION status and Auto Sense data is not provided, the initiator that received the error status should send a REQUEST SENSE command to acquire the sense data describing the cause of the condition. If the initiator sends a command other than REQUEST SENSE, the sense data is lost.

Devices may be required to support the REQUEST SENSE command if they are unable to provide command progress information by any other method.

4.3.4 FORMAT UNIT command progress determination

The FORMAT UNIT command (see 5.2) requires IMMED bit support because it may consume significantly more time to complete than normal read or write commands. If the IMMED bit is set to one, the device is required to return status as soon as the command descriptor block is

validated. The device then completes the format operation. Initiators may determine the progress of the format operation in several ways.

RBC devices may provide format progress information using one of the following methods:

a) progress is reported via Asynchronous Event Reporting. If the initiator and device support this feature, the RBC device initiates progress reporting;

b) progress is reported via the GET EVENT/STATUS NOTIFICATION (see MMC-2) command. Following the return of GOOD status, the initiator may poll the device for command progress by issuing a GET EVENT/STATUS NOTIFICATION command. The returned data contains progress information as defined in 7.5.6; or

c) progress is reported via the PROGRESS INDICATION field in the sense-key specific bytes of REQUEST SENSE command sense data. See the SPC-2 standard for a description of this method.

The first two methods return data in the Event Status Notification format described in 7.5.6.

4.4 Using the PREVENT ALLOW MEDIUM REMOVAL command

4.4.1 General

The PREVENT ALLOW MEDIUM REMOVAL command (see SPC-2) allows an initiator to restrict the de-mounting of the medium. This is useful in maintaining system integrity. If the removable medium device implements a cache, the command allows the initiator to ensure that all logical blocks of the medium contain the most recent data prior to permitting de-mounting of the removable medium.

If the initiator issues a START STOP UNIT command (see 5.5) to eject the cartridge, and the removable medium device is prevented from de-mounting by the PREVENT ALLOW MEDIUM REMOVAL command, the START STOP unit command is rejected by the device.

If the RMB bit is set to zero in the standard INQUIRY command data (see 6.2.1), the PREVENT ALLOW MEDIUM REMOVAL command may not be supported. If the RMB bit is set to one in the standard INQUIRY command data (see 6.2.1), the PREVENT ALLOW MEDIUM REMOVAL command is supported (see 6.5).

4.4.2 START STOP UNIT command state restrictions

A removable medium device shall be in Prevent state 00b or 10b (see SPC-2) in order to successfully process a START STOP UNIT command (see 5.5) with the POWER CONDITIONS field (see Table 8) set to the Sleep power condition (i.e., 5h).

If a removable medium device in Prevent state 01b or 11b receives a START STOP UNIT command with the POWER CONDITIONS field set to the Sleep power condition, the device shall respond with status set to CHECK CONDITION (02h), the sense key to ILLEGAL REQUEST (05h), and the ASC/ASCQ to ILLEGAL POWER CONDITION REQUEST (2Ch/05h).

A removable medium device in the Sleep power condition shall eject the media without causing the media to spin up in accordance with the PREVENT/ALLOW MEDIUM REMOVAL command requirements (see SPC-2).

See Table 8 for a description of the POWER CONDITIONS field values.

4.5 Logical Blocks

Data are addressed on the RBC device in a group referred to as a logical block. This is a common attribute of RBC devices in that they are block addressable only.

Blocks of data are stored on the medium along with additional information that the medium controller uses to manage the storage and retrieval of the blocks. The format of the additional information is defined by other standards or is vendor specific and is hidden from the application client during normal read or write operations.

The address of the first logical block is zero. The address of the last logical block is [n-1], where [n] is the number of logical blocks available on the medium. A READ CAPACITY command (see 5.4) may be used to determine the value of [n-1].

If a command is issued that requests access to a logical block not within the capacity of the medium, the command is terminated with a status of CHECK CONDITION (02h), a sense key of ILLEGAL REQUEST (05h), and an ASC/ASCQ of LOGICAL BLOCK ADDRESS OUT OF RANGE (21h/00h).

The number of bytes of data contained in a logical block is known as the block length. Each logical block has a block length associated with it. The block length is almost always greater than one byte and is typically (but by no means always) a multiple of 512 B. In addition, a logical block does not necessarily bear any relation to the physical block size of the storage medium.

The LOGICAL BLOCK SIZE field in the RBC Device Parameters MODE SENSE page (see 5.9.4) describes the block length that is used on the medium. A MODE SELECT command may be used to set the logical block size, if the field is changeable.

The default NUMBER OF LOGICAL BLOCKS value may be obtained by requesting the default MODE SENSE data (see SPC-2) for the RBC Device Parameters MODE SENSE page. The current NUMBER OF LOGICAL BLOCKS value may be obtained by requesting the saved MODE SENSE data for this page.

The location of a logical block on the medium does not necessarily have a relationship to the location of any other logical block. However, in a typical logical unit the logical blocks are located in an ascending order. The time to access the logical block at address [x] and then the logical block at address [x+1] need not be less than time to access [x] and then [x+100].

4.6 Reservations

If the bus protocol does not inherently provide the ability to reserve and release access to a device, then this function may be supported by the RESERVE command and the RELEASE command (see SPC-2).

Reservation restrictions are placed on commands as a result of access qualifiers associated with the type of reservation.

The details of what commands are allowed under what types of reservations are described in Table 1. For the reservation restrictions placed on commands for the Reserve/Release management method, see Table 1 column [A]. For the reservation restrictions placed on commands for the Persistent Reservations management method, see Table 1 column [B].

In Table 1, the following key words are used:

allowed: Commands issued by initiators not holding the reservation or by initiators not registered when a registrants only persistent reservation is present should complete normally.

conflict: Commands issued by initiators not holding the reservation or by initiators not registered when a registrants only persistent reservation is present shall not be performed and the device server shall terminate the command with a RESERVATION CONFLICT status.

Commands from initiators holding a reservation should complete normally. The behavior of commands from registered initiators when a registrants only persistent reservation is present is specified in Table 1.

A command that does not explicitly write the medium shall be checked for reservation conflicts before the command enters the current task state for the first time. Once the command has entered the current task state (see SAM-2), it shall not be terminated with a RESERVATION CONFLICT due to a subsequent reservation.

A command that explicitly writes the medium shall be checked for reservation conflicts, before the device server modifies the medium or cache as a result of the command. Once the command has modified the medium, it shall not be terminated with a RESERVATION CONFLICT due to a subsequent reservation.

For each command, this standard, SPC-2, or a related command standard defines the conditions that result in RESERVATION CONFLICT. Depending on the particular command standard the conditions are defined in that standard's device model clause or in the clauses that define the specific commands.

Table 1 – RBC direct access commands that are allowed in the presence of various reservations

Command	Addressed LU is reserved by another Initiator (A)	Addressed LU has this type of persistent reservation held by another Initiator (B)				
		From any Initiator		From registered Initiator (RO all types)	From Initiator not registered	
		Write Excl	Excl Access		Write Excl – RO	Excl Access – RO
FORMAT UNIT	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
READ (10)	Conflict	Allowed	Conflict	Allowed	Allowed	Conflict
READ CAPACITY	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
START STOP UNIT Start = 0 and Power Condition = 0	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
START STOP UNIT Start = 1 or Power Condition <>0	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
VERIFY (10)	Conflict	Allowed	Conflict	Allowed	Allowed	Conflict
WRITE (10)	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict

5 Reduced Block Commands

5.1 General

The Reduced Block Command set (RBC) for block device logical units is shown in Table 2. The SCSI Primary Commands (SPC-2) required for RBC device implementations are also shown in Table 2 and summarized in Clause 6. Support is indicated for fixed or removable drives.

Table 2 – Reduced Block Command set

Command name	OpCode	Command Support		Reference
		Fixed	Removable	
FORMAT UNIT	04h	O	O	5.2
INQUIRY	12h	M	M	SPC-2 [a]
MODE SELECT(6)	15h	M	M	SPC-2 [a]
MODE SENSE(6)	1Ah	M	M	SPC-2 [a]
PERSISTENT RESERVE IN	5Eh	O	O	SPC-2 [a]
PERSISTENT RESERVE OUT	5Fh	O	O	SPC-2 [a]
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	N/A	M	SPC-2 [a]
READ (10)	28h	M	M	5.3
READ CAPACITY	25h	M	M	5.4
RELEASE(6)	17h	O	O	SPC-2 [a]
REQUEST SENSE	03h	O	O	SPC-2 [a]
RESERVE(6)	16h	O	O	SPC-2 [a]
START STOP UNIT	1Bh	M	M	5.5
SYNCHRONIZE CACHE	35h	O	O	5.6
TEST UNIT READY	00h	M	M	SPC-2 [a]
VERIFY (10)	2Fh	M	M	5.7
WRITE (10)	2Ah	M	M	5.8
WRITE BUFFER	3Bh	M	O	SPC-2 [a]

[a] – See Clause 6.

– Command Support key: M = support is mandatory; N/A = not applicable; O = support is optional.

The CONTROL byte (i.e., the last byte of the CDB) shall be set to zero.

5.2 FORMAT UNIT command

This command (see Table 3) formats the media into addressable logical blocks. This command is optional for both fixed and removable medium devices. An Initiator shall examine the state of the FORMATD bit in the MODE SENSE RBC Device Parameters page (see Table 14) to determine whether the device supports this command.

Table 3 – FORMAT UNIT command

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (04h)							
1	Reserved							
2	Reserved				IMMED	PROGRESS	PERCENT/ TIME	INCREMENT
3	Reserved							
4	Reserved							
5	CONTROL (00h)							

An immediate (IMMED) bit set to zero indicates that status shall be returned after the format operation has completed. An IMMED bit set to one indicates that this device shall return status as soon as the command descriptor block has been validated.

The PROGRESS bit indicates whether the initiator is requesting periodic format progress updates. If this bit is set to zero, no progress report shall be generated. If the PROGRESS bit is set to one, then the device shall generate format progress based upon the values of the PERCENT/TIME and the INCREMENT bit. Refer to 4.3.4 for a description of the progress reporting mechanisms for the format operation.

The PERCENT/TIME bit and INCREMENT bit determine the method used to report format progress, whether in a percentage of completion or in total elapsed time.

If the PERCENT/TIME bit is set to zero, format progress shall be reported in total time elapsed. If the PERCENT/TIME bit is set to one, format progress shall be reported in percentage of completion.

The INCREMENT bit specifies the granularity of progress reported. When this bit is set to zero, the device reports progress in 5 % or 5 s increments, depending on the value of the PERCENT/TIME bit. When this bit is set to one, the device reports progress in 1 % or 1 s increments, depending on the value of the PERCENT/TIME bit.

Initiators should set the INCREMENT bit value to zero to avoid the bus usage penalties associated with a value of one.

When requested by setting the PROGRESS bit to one in the CDB, format progress shall be reported with a status of CHECK CONDITION (02h), a sense key of NOT READY (02h), and an ASC/ASCQ of LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (04h/04h). The sense data INFORMATION field shall contain the total number of increments (i.e., percentage complete or time in seconds) that have elapsed since command processing began.

Upon successful completion of the FORMAT UNIT command, status shall be set to CHECK CONDITION (02h), the sense key to UNIT ATTENTION (06h), and the ASC/ASCQ to EVENT STATUS NOTIFICATION/MEDIA CLASS EVENT (38h/04h). The EVENT field contained within the sense data INFORMATION field shall be set to NEW MEDIA READY FOR ACCESS (02h).

The initiator shall respond by issuing a MODE SENSE command followed by READ CAPACITY command.

If the FORMAT UNIT command fails, the device shall return a status of CHECK CONDITION (02h), a sense key of MEDIA ERROR (03h), an ASC/ASCQ of FORMAT COMMAND FAILED (31h /01h).

After the problem is corrected (e.g., media replaced) and the device becomes ready, the initiator shall issue a MODE SENSE command followed by a READ CAPACITY command to determine the device's physical parameters.

While a FORMAT UNIT command is in progress, the device shall not process any command received but shall respond with the progress report information described in this subclause.

5.3 READ(10) Command

The READ(10) command (see Table 4) requests that the device transfer data to the initiator. The most recent data value written in the addressed logical blocks shall be returned.

Table 4 – READ (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (28h)							
1	Reserved							
2	(MSB)							
3				LOGICAL BLOCK ADDRESS				
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8				TRANSFER LENGTH				(LSB)
9	CONTROL (00h)							

The LOGICAL BLOCK ADDRESS field specifies the first logical block of the range of logical blocks that shall be read.

The TRANSFER LENGTH field specifies the number of contiguous logical blocks of data that shall be read. A TRANSFER LENGTH field set to zero indicates that no logical blocks shall be read. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be read.

5.4 READ CAPACITY command

The READ CAPACITY command (see Table 5) provides a means for the initiator to request the current capacity of the RBC device.

Table 5 – READ CAPACITY Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (25h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	CONTROL (00h)							

READ CAPACITY data (see Table 6) shall be returned to the initiator prior to sending GOOD status for the command.

Table 6 – READ CAPACITY data

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1								
2				RETURNED LOGICAL BLOCK ADDRESS				
3								(LSB)
4	(MSB)							
5								
6				BLOCK LENGTH IN BYTES				
7								(LSB)

The RETURNED LOGICAL BLOCK ADDRESS field and the BLOCK LENGTH IN BYTES field are those of the last logical block of the media contained in the device.

If the device does not contain media, then it shall return status of CHECK CONDITION (02h), sense key of NOT READY (02h), and an ASC of LOGICAL UNIT NOT READY (04h). The ASCQ shall reflect the current state of the device/media.

5.5 START STOP UNIT command

5.5.1 General

The START STOP UNIT command (see Table 7) requests that the device enable or disable the logical unit for media access operations and controls certain power conditions.

Table 7 – START STOP UNIT Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Bh)							
1	Reserved							IMMED
2	Reserved							
3	Reserved							
4	POWER CONDITIONS				Reserved		LOEJ	START
5	CONTROL (00h)							

An immediate (IMMED) bit set to zero indicates that status shall be returned after the operation is completed. An IMMED bit set to one indicates that status shall be returned as soon as the command descriptor block has been validated.

The other fields in the START STOP UNIT command are described in 5.5.2 and 5.5.3.

5.5.2 Power conditions

5.5.2.1 Overview

The POWER CONDITIONS field requests that the logical unit be placed into the power condition defined in Table 8. If this field contains any valid value other than zero, then the START bit and the LOEJ (see 5.5.3) bit shall be ignored.

The POWER CONDITIONS field states are shown in Table 8. RBC device support for each state is also shown.

Table 8 – POWER CONDITIONS

Code	Support	Description
0h	M	No change in power condition.
1h	M	Place device in Active power condition (see 5.5.2.2).
2h	M	Place device in Idle power condition (see 5.5.2.3).
3h	M	Place device in Standby power condition (see 5.5.2.4).
4h	–	Reserved
5h	M	Place device in Sleep power condition (see 5.5.2.5).
6h	–	Reserved
7h	O	Device Control power condition (see 5.5.2.6).
8h to Fh	–	Reserved

Key:

M = Command implementation is mandatory.

O = Command implementation is optional.

The device shall terminate any command received that requires more power consumption than allowed by the START STOP UNIT command's most recent power condition setting. Status shall be set to CHECK CONDITION (02h), the sense key to ILLEGAL REQUEST (05h), and the ASC/ASCQ to LOW POWER CONDITION ACTIVE (5Eh/00h).

It is not an error to request a device be placed into the same power condition in which it currently resides.

5.5.2.2 Active power condition

Devices in the Active power condition are at their highest power consumption level.

For hard disk drives, this typically means that the drive is spinning and capable of executing a media access command without a significant delay.

5.5.2.3 Idle power condition

Devices in the Idle power condition are at a lower power consumption level than when in the Active power condition, but still have a significant portion of their circuitry consuming power. For hard disk drives, this typically means that the drive is spinning, but not capable of performing a media access command without a delay.

5.5.2.4 Standby power condition

Devices in the Standby power condition are at a lower power consumption level than when in the Idle power condition and do not have a significant portion of their circuitry consuming power. For hard disk drives, this typically means that the drive is not spinning, but the interface is fully active.

Prior to entering the Standby power condition the device shall ensure that logical blocks in cache have their most recent data value recorded on the physical medium.

5.5.2.5 Sleep power condition

Devices in the Sleep power condition are at a lower power consumption level than when in the Standby condition and have very little of the drive circuitry consuming power. A device reset may be required before access to the device is allowed.

Prior to entering the Sleep power condition the device shall ensure that logical blocks in cache have their most recent data value recorded on the physical medium.

5.5.2.6 Device Control power condition

Devices in the Device Control power condition are allowed to control their own power consumption level. However, the level of device control is governed by the value of the POWER/PERFORMANCE field in RBC Device Parameters page (see 5.9.4).

5.5.3 Enable/Disable bits

A load/eject (LOEJ) bit set to zero requests that no action be taken regarding loading or ejecting the medium. A LOEJ bit set to one requests that the medium shall be:

a) ejected if the START bit is set to zero; or

b) loaded if the START bit is set to one.

A START bit set to zero requests that the device be stopped (i.e., the media is inaccessible for data transfers). A START bit set to one requests the device be made ready for use. Table 9 describes the functional relationship of the START STOP UNIT control bits.

Table 9 – START STOP control bit definitions

Power Conditions	LOEJ	START	Description
1h to 7h	N/A	N/A	LOEJ and START ignored
0	0	0	Stop the medium
0	0	1	Make medium ready
0	1	0	Unload medium
0	1	1	Load medium

5.6 SYNCHRONIZE CACHE command

The SYNCHRONIZE CACHE command (see Table 10) ensures that logical blocks in the cache have their most recent data value recorded on the physical medium. If a more recent data value for a logical block exists in the cache than on the physical medium, then the logical block from the cache shall be written to the physical medium. Logical blocks are not necessarily removed from the cache as a result of the SYNCHRONIZE CACHE command.

Devices that return the WCD bit set to one in the MODE SENSE RBC Device Parameter page (see 5.9.4) may terminate a SYNCHRONIZE CACHE command by returning a status of CHECK CONDITION (02h), a sense key of ILLEGAL REQUEST (05h) and an ASC of INVALID COMMAND OPERATION CODE (20h).

Table 10 – SYNCHRONIZE CACHE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (35h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	CONTROL (00h)							

5.7 VERIFY command

The VERIFY command (see Table 11) requests that the device verify the data written on the medium.

Table 11 – VERIFY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Fh)							
1	Reserved							
2	(MSB)							
3				LOGICAL BLOCK ADDRESS				
4								
5								(LSB)
6	Reserved							
7	(MSB)			VERIFICATION LENGTH				
8								(LSB)
9	CONTROL (00h)							

The LOGICAL BLOCK ADDRESS field specifies the starting logical block address on the device for the data to be accessed.

The VERIFICATION LENGTH field specifies the number of contiguous logical blocks of data that shall be verified. A VERIFICATION LENGTH field set to zero indicates that no logical blocks shall be verified. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be verified.

The VERIFY command verifies that the data written on the media by a previous WRITE command is readable without any uncorrectable errors at the time of execution of the VERIFY command. It does not guarantee the information is complete or valid.

5.8 WRITE(10) command

The WRITE(10) command (see Table 12) requests that the device write data be transferred from the initiator to the medium.

Table 12 – WRITE(10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Ah)							
1	Reserved				FUA	Reserved		
2	(MSB)							
3				LOGICAL BLOCK ADDRESS				
4								
5								(LSB)
6	Reserved							
7	(MSB)			TRANSFER LENGTH				
8								(LSB)
9	CONTROL (00h)							

A force unit access (FUA) bit set to zero indicates that the device may satisfy the command by accessing the cache memory if the WCD bit in the RBC mode page (see 5.9.4) is set to zero.

For write operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the initiator prior to writing the logical blocks to the medium. Any error that occurs after GOOD status is returned is a deferred error.

A FUA bit set to one indicates that the device shall access the media in performing the command prior to returning GOOD status. A WRITE command shall not return GOOD status until the logical blocks have actually been written on the media (i.e., the data is not write cached).

If the device supports write caching, force unit access support shall be implemented. If write caching is not supported, the FUA bit may be ignored.

The LOGICAL BLOCK ADDRESS field specifies the first logical block of the range of logical blocks that shall be written.

The TRANSFER LENGTH field specifies the number of contiguous logical blocks of data that shall be written. A TRANSFER LENGTH of zero indicates that no logical blocks shall be written. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be written.

5.9 Mode parameters

5.9.1 General

The header format and page format used by RBC devices for the MODE SELECT(6) command (see 6.3) and MODE SENSE(6) command (see 6.4) are described in 5.9.

5.9.2 Mode parameter list

The mode parameter list shown in Table 13 contains a header followed by the RBC Device Parameters page. No block descriptor is required for RBC devices.

Table 13 – Mode parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0 to 3	Mode parameter header							
4 to 17	RBC device parameter page							

5.9.3 Mode Parameter header

The mode parameter header is described in SPC-2. For RBC devices the MEDIUM TYPE field, DEVICE-SPECIFIC PARAMETER field, and BLOCK DESCRIPTOR LENGTH field shall contain zero.

5.9.4 RBC Device Parameter's page

The RBC Device Parameter's page (see Table 14) provides general configuration information and it allows modification of that configuration, when permitted by the device. An initiator may attempt to change any or all parameters contained in the page using a MODE SELECT command (see 6.3). No error status shall be returned for attempts to change parameters that are not changeable.

The initiator may issue a MODE SENSE(6) command (see 6.4) for the same page in order to determine which parameters have changed.

Table 14 – RBC Device Parameters page format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (1b)	Reserved	PAGE CODE (06h)					
1	PAGE LENGTH (0Bh)							
2	Reserved							WCD
3	(MSB)	LOGICAL BLOCK SIZE						
4								(LSB)
5	(MSB)	NUMBER OF LOGICAL BLOCKS						
6								
7								
8								
9								(LSB)
10	POWER/PERFORMANCE							
11	Reserved				READD	WRITED	FORMATD	LOCKD
12	Reserved							

A write cache disable (WCD) bit set to zero specifies that the device may return GOOD status for a WRITE command after successfully receiving the data and prior to having successfully written it to the medium. A WCD bit set to one specifies that the device shall return GOOD status for a WRITE command after successfully writing all of the data to the medium.

Devices that cannot physically lock the media or are unable to prevent media removal (e.g., floppy drives, PCMCIA drives, Flash cards, etc.) shall ignore the WCD bit and shall report WCD set to one.

The LOGICAL BLOCK SIZE field indicates the number of user data bytes contained in a logical block.

The NUMBER OF LOGICAL BLOCKS field indicates the number of logical blocks contained in the user data area.

Setting the POWER CONDITIONS field of the START STOP UNIT command (see 5.5) to Device Control (07h) enables the POWER/PERFORMANCE field.

The POWER/PERFORMANCE field specifies the POWER/PERFORMANCE management level. Higher values permit the device to give more emphasis to performance than power conservation. A value of FFh causes the drive to provide the highest performance possible, not affected by power conservation. A value of 00h causes the drive to provide the highest power conservation, regardless of its effect on performance.

Changes in the level of power and performance for specific values of the POWER/PERFORMANCE field are vendor specific.

A read disabled (READD) bit set to zero indicates that the media may be read by an initiator. A READD bit set to one indicates that an initiator cannot read the media.

A write disabled (WRITED) bit set to zero indicates that the media may be written. A WRITED bit set to one indicates that an initiator cannot write the media.

A FORMAT DISABLED (FORMATD) bit set to zero indicates that the media may be formatted. A FORMATD bit set to one indicates that an initiator cannot format the media. The FORMATD bit shall not be set to zero if the WRITED bit is set to one.

A lock disabled (LOCKD) bit set to zero indicates that the media may be locked by the PREVENT/ALLOW MEDIUM REMOVAL command (see 6.5). A LOCKD bit set to one indicates that the media cannot be locked by the PREVENT/ALLOW MEDIUM REMOVAL command. If the RMB bit in the standard INQUIRY command data is not set to one, then the LOCKD bit shall be set to one.

6 SPC-2 implementation requirements for RBC devices

6.1 General

RBC devices require several commands defined in SPC-2 to function in a system. Bit and field exceptions contained in the commands listed in Table 15 are described in the referenced subclauses.

Table 15 – Required SPC-2 commands

Command name	Opcode	Command Support		Reference
		Fixed	Removable	
INQUIRY	12h	M	M	6.2
MODE SELECT(6)	15h	M	M	6.3
MODE SENSE(6)	1Ah	M	M	6.4
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	N/A	M	6.5
REQUEST SENSE	03h	O	O	6.6
TEST UNIT READY	00h	M	M	6.7
WRITE BUFFER	3Bh	M	O	6.8
Command Support key: M = support is mandatory; N/A = not applicable; O = support is optional.				

6.2 INQUIRY command

6.2.1 Standard INQUIRY data

The standard INQUIRY data format is reproduced in Table 16. Several standard INQUIRY data bits and fields are restricted for RBC compatibility. Only the restricted fields and their required values, if any, are named. Refer to SPC-2 for descriptions of the INQUIRY command and of the standard INQUIRY data fields and bits that are not named in Table 16. Logical unit support for these other bits and fields may be mandatory or optional, as specified by SPC-2.

Table 16 – Standard Inquiry data format

Bit Byte	7	6	5	4	3	2	1	0
0				PERIPHERAL DEVICE TYPE (0Eh)				
1	RMB							
2								
3	AERC		NORMACA (0b)					
4								
5								
6								
7	RELADR (0b)				LINKED (0b)			
8								
9								
...								
n								

RBC devices are identified by a PERIPHERAL DEVICE TYPE field set to 0Eh.

A removable medium bit (RMB) set to zero indicates that the medium is not removable. A RMB bit set to one indicates that the medium is removable.

If the transport protocol provides a mechanism for asynchronous event reporting, RBC devices shall support the function and indicate that support by setting the ASYNCHRONOUS EVENT REPORTING CAPABILITY (AERC) bit to one.

RBC devices shall report sense data using the Auto Sense method if the transport protocol supports this function. RBC devices shall clear all tasks as the result of any device error.

RBC devices shall not support Auto Contingent Allegiance and shall ignore the NACA bit in the CDB Control byte. Therefore, RBC devices shall return the NORMACA bit set to zero in standard INQUIRY data.

The RELADR bit shall be set to zero. Relative Addressing is not supported by RBC devices.

The LINKED bit shall be set to zero. LINKED commands are not supported by RBC devices.

6.2.2 INQUIRY vital product data pages

6.2.2.1 General

The vital product data pages that are mandatory for RBC devices are described in 6.2.2. This standard defines the required pages but not the page content. The page content is defined in SPC-2.

6.2.2.2 Unit serial number VPD page

The Unit Serial Number VPD page (i.e., page 80h) shall be supported by RBC devices as described in SPC-2.

6.2.2.3 Device Identification VPD page

The Data Device Identification VPD page (i.e., page 83h) shall be supported by RBC devices as described in SPC-2.

6.3 MODE SELECT(6) command

The MODE SELECT(6) command (see Table 17 and SPC-2) provides a means for an initiator to specify device parameters to a RBC device. It is a complementary command to the MODE SENSE(6) command.

Table 17 – MODE SELECT(6) Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (15h)							
1	Reserved			PF (1b)	Reserved			SP
2	Reserved							
3	Reserved							
4	PARAMETER LIST LENGTH							
5	CONTROL (00h)							

The page format (PF) bit shall be set to one.

For non-removable medium devices the save pages (SP) bit shall be set to one. This indicates that the device shall perform the specified MODE SELECT operation and shall save, to a non-volatile vendor-specific location, all the changeable pages, including any sent with the command.

For removable medium devices support of the SP bit is optional. Such devices may be unable to save changeable information to a non-volatile medium. Therefore, if the SP bit is set to one, removable medium devices may return a status of CHECK CONDITION (02h), a sense key of ILLEGAL REQUEST (05h) and an ASC of INVALID FIELD IN CDB (24h).

The PARAMETER LIST LENGTH field specifies the length in bytes of the mode parameter list. A parameter length of zero shall not be considered an error.

An initiator may attempt to change any or all parameters contained in a mode page The device shall ignore non-changeable parameters in the MODE SELECT parameter data. This shall not be considered an error.

The initiator may issue a MODE SENSE command for the same page in order to determine which parameters have changed.

6.4 MODE SENSE(6) command

The MODE SENSE(6) command (see Table 18 and SPC-2) provides a means for an RBC device to report device parameters to an initiator. It is a complementary command to the MODE SELECT(6) command.

Table 18 – MODE SENSE(6) Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Ah)							
1	Reserved				DBD (1b)	Reserved		
2	PC		PAGE CODE					
3	Reserved							
4	ALLOCATION LENGTH							
5	CONTROL (00h)							

The disable block descriptors (DBD) bit shall be set to one.

The page control (PC) field specifies the type of mode parameter values to be returned in the mode page.

The device shall respond to values in PC field as follows.

a) If Current values are requested (i.e., the PC is set to 00b), return the Current values of the mode parameters established by the last MODE SELECT command. If the device implements no distinction between current and saved parameters, then it shall report identical values in response to a PC field set to either 00b or 11b. If Saved or Current values are not available, report Default values.

b) If Default values are requested (i.e., the PC is set to 10b), return the Default values; or

c) If Saved values are requested (i.e., the PC is set to 11b), return valid restored mode parameters, or restore the mode parameters and return them.

6.5 PREVENT ALLOW MEDIUM REMOVAL

RBC devices shall support the PREVENT ALLOW MEDIUM REMOVAL command (see SPC-2) if the removable medium bit (RMB) bit is set to one in the standard INQUIRY data (see 6.2.1).

6.6 REQUEST SENSE command

RBC devices shall support the REQUEST SENSE command (see SPC-2) if Auto Sense data is not provided or if either Asynchronous Event Notification or the GET EVENT/STATUS NOTIFICATION command (see MMC-2) is not supported.

If the REQUEST SENSE command is supported it shall be implemented as described in SPC-2.

6.7 TEST UNIT READY command

RBC devices shall report information exceptions via:

a) the unit attention condition (with the associated asynchronous event notification, if enabled; or

b) the response to the TEST UNIT READY command (see SPC-2).

The TEST UNIT READY status response shall include information exception status only after a threshold has been exceeded. After the associated asynchronous event notification has been successfully sent to the initiator the device shall clear the information exception status from the TEST UNIT READY response.

The required sense key is RECOVERED ERROR (01h), and the ASC is FAILURE PREDICTION THRESHOLD EXCEEDED (5Dh). The ASCQ values are described in Table 19.

Table 19 – FAILURE PREDICTION ASCQ XY definitions

ASCQ X	Description	ASCQ Y	Description
0h	Defined by SPC-2	0h	General hard drive failure
1h	Hardware impending failure	1h	Drive error threshold exceeding limits
2h	Controller impending failure	2h	Data error rate exceeding limits
3h	Data Channel impending failure	3h	Seek error rate exceeding limits
4h	Servo impending failure	4h	LBA reassignment exceeding limits
5h	Spindle impending failure	5h	Access times exceeding limits
6h	Firmware impending failure	6h	Start Unit times exceeding limits
7h	Reserved	7h	Channel parametrics indicate impending failure
8h	Vendor Specific in SPC-2	8h	Controller detected impending failure
9h	Vendor Specific in SPC-2	9h	Throughput performance
Ah	Vendor Specific in SPC-2	Ah	Seek time performance
Bh	Vendor Specific in SPC-2	Bh	Spin-up retry count
Ch	Vendor Specific in SPC-2	Ch	Drive calibration retry count
Dh	Vendor Specific in SPC-2	Dh	Reserved
Eh	Vendor Specific in SPC-2	Eh	Reserved
Fh	Refer to SPC-2	Fh	Reserved

6.8 WRITE BUFFER Command

6.8.1 General

The WRITE BUFFER command (see Table 20 and SPC-2) is used by RBC devices to download and save microcode. RBC devices are required to support mode 101b and mode 111b. Support for all other modes is optional.

Table 20 – WRITE BUFFER Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (3Bh)							
1	Reserved					MODE		
2	Reserved							
3	(MSB)							
4	BUFFER OFFSET							
5								(LSB)
6	(MSB)							
7	PARAMETER LIST LENGTH							
8								(LSB)
9	CONTROL (00h)							

6.8.2 Download microcode and save mode (101b)

In this mode, vendor-specific Microcode or control information shall be transferred to the device and, if the WRITE BUFFER command is completed successfully, shall also be saved in a non-volatile memory space (semiconductor, disk, or other). The downloaded code shall then be effective after each power-cycle and reset until it is supplanted in another download microcode and save operation.

After the WRITE BUFFER command has completed successfully, the device shall generate a unit attention condition. If asynchronous event notification is enabled, all initiators except the one that issued the WRITE BUFFER command shall be notified of the unit attention condition. The device shall set the sense key to UNIT ATTENTION (02h) and the ASC/ASCQ to MICROCODE HAS BEEN CHANGED (3Fh/01h).

The PARAMETER LIST LENGTH field specifies the maximum number of bytes that shall be transferred from the initiator to the device.

If the logical unit cannot process this command because of a device condition, the device shall terminate the command and return a status of CHECK CONDITION (02h), a sense key of ILLEGAL REQUEST (05h) and an ASC of COMMAND SEQUENCE ERROR (2Ch).

6.8.3 Download microcode with offsets and save mode (111b)

In this mode, the initiator may split the transfer of the vendor-specific microcode or control information over two or more WRITE BUFFER commands.

If the logical unit cannot process this command because of a device condition, the device shall terminate the command and return a status of CHECK CONDITION (02h), a sense key of ILLEGAL REQUEST (05h) and an ASC of COMMAND SEQUENCE ERROR (2Ch).

Refer to SPC-2 for a complete description of this mode.

7 Asynchronous event notification for RBC devices

7.1 General

RBC devices shall notify initiators of the ability to support asynchronous event notification by setting the asynchronous event reporting capability (AERC) bit to one in the standard data format of the standard INQUIRY data (see 6.2.1).

Table 21 describes conditions that may be communicated to an initiator as an asynchronous event.

Table 21 – Asynchronous Event conditions

Sense key	ASC	Description
01h	5Dh	RECOVERED ERROR. FAILURE PREDICTION THRESHOLD EXCEEDED
02h	04h	LOGICAL UNIT NOT READY (reported only on transition or at power on)
03h	nnh	MEDIUM ERROR. Multiple causes
06h	38h	Unit Attention. Event Status Notification
06h	5Eh	Unit Attention. Power condition Change Notification
06h	28h	Unit Attention. Not Ready to Ready transition. Medium may have changed
06h	29h	Unit Attention. Power on reset, bus reset, etc.
NOTE This table is not intended to be a complete list.		

7.2 Unit attention

7.2.1 General

A unit attention condition may be reported via asynchronous event notification. Logical units may queue unit attention conditions; more than one unit attention condition may exist at the same time. Refer to Table 21 for a description of unit attention conditions that may be reported via asynchronous event notification.

7.2.2 Power condition change notification

RBC devices shall notify an initiator of the intent to change power conditions via asynchronous event notification. The status value shall be set to CHECK CONDITION (02h), the sense key to UNIT ATTENTION (06h), and the ASC to POWER CONDITION CHANGE NOTIFICATION (5Eh). The ASCQ shall be set to the value of the new power condition plus 40h as shown in Table 22.

Table 22 – Power condition sense code and qualifier values

ASC	ASCQ	Description
5Eh	41h	POWER CONDITION CHANGE TO ACTIVE
5Eh	42h	POWER CONDITION CHANGE TO IDLE
5Eh	43h	POWER CONDITION CHANGE TO STANDBY
5Eh	45h	POWER CONDITION CHANGE TO SLEEP
5Eh	47h	POWER CONDITION CHANGE TO DEVICE CONTROL

An initiator shall respond with a START STOP UNIT command (see 5.5) within eight seconds, if it intends to manage the power transition. If the initiator does not respond within eight seconds, the device may transition to a new power condition. If the initiator responds with a START STOP UNIT command within eight seconds, and sets the power condition value equal-to or greater-than the current value, the device shall not transition to a lower power condition.

7.3 Deferred errors

Deferred errors shall also be reported via asynchronous event notification. Deferred errors may be produced as a result of cached data management or support of the immediate function in commands such as START STOP UNIT (see 5.5) or FORMAT UNIT (see 5.2).

7.4 Information exception condition notification

RBC devices shall notify the initiator when an information exception condition exists via asynchronous event notification. The status value shall be set to CHECK CONDITION (02h), the sense key to RECOVERED ERROR (01h), the ASC to FAILURE PREDICTION THRESHOLD EXCEEDED (5Dh), and the ASCQ to the failure prediction threshold descriptor value. See Table 19 for failure prediction ASCQ values.

7.5 Event status notification

7.5.1 General

Through the use of asynchronous event notification, RBC devices may report asynchronous events the moment they occur.

If the initiator does not support asynchronous event notification, alternative methods shall be used to determine the state of the device/media combination. Refer to the GET EVENT/STATUS NOTIFICATION command (see SPC-2) for a description of those alternative methods.

7.5.2 Event Status sense information

The following sense data shall be used for the event status notification, unit attention condition. The status value shall be set to CHECK CONDITION (02h). The sense key shall be set to UNIT ATTENTION (06h). The ASC shall be set to EVENT STATUS NOTIFICATION (38h). The ASCQ shall be set to the appropriate value shown in Table 23.

Table 23 – Event status ASCQ values

ASCQ	Name	Description
02h	POWER MANAGEMENT CLASS EVENT	Indicates that a Power Management Class event has occurred or is impending.
04h	MEDIA CLASS EVENT	Indicates that a Media Class event has occurred.
06h	DEVICE BUSY CLASS EVENT	Indicates that a Device Busy Class event has occurred.

For each of the sense key, ASC, and ASCQ values above, the contents of the sense data INFORMATION field further describe the event status. The general format of the sense data INFORMATION field is shown in Table 24.

Table 24 – Event Status INFORMATION field format

Bit Byte	7	6	5	4	3	2	1	0
0	EVENT							
1	STATUS							
2	Event specific							
3	Event specific							

The following subclauses provide specific sense data INFORMATION field definitions for each ASCQ value described in Table 23.

7.5.3 Power Management CLASS event INFORMATION field

Table 25 shows the INFORMATION field format for a POWER MANAGEMENT CLASS EVENT.

Table 25 – POWER MANAGEMENT CLASS EVENT INFORMATION field format

Bit Byte	7	6	5	4	3	2	1	0
0	event							
1	status							
2	Reserved							
3	Reserved							

Table 26 shows the EVENT field values associated with the POWER MANAGEMENT CLASS EVENT.

Table 26 – POWER MANAGEMENT CLASS EVENT EVENT field

EVENT field	Description
00h	Power condition is unchanged.
01h	The device successfully changed to the specified power condition.
02h	The device failed to enter the last commanded power condition and is still operating at the state specified in the STATUS field.
03h to FFh	Reserved

Table 27 shows the STATUS field values for a POWER MANAGEMENT CLASS EVENT. The state names and values match those specified in the START STOP UNIT command (see 5.5) POWER CONDITIONS field.

Table 27 – POWER MANAGEMENT CLASS EVENT STATUS field

STATUS field	Description
00h	Reserved
01h	The device is in the Active state.
02h	The device is in the Idle state.
03h	The device is in the Standby state.
04h	Reserved
05h	Not applicable (i.e., Sleep state)
06h	Reserved
07h	The device is in the Device Control state.
08h – FFh	Reserved

7.5.4 MEDIA CLASS EVENT INFORMATION field

Table 28 shows the INFORMATION field format for a MEDIA CLASS EVENT.

Table 28 – MEDIA CLASS EVENT INFORMATION field format

Bit Byte	7	6	5	4	3	2	1	0
0	event							
1	Reserved						media present	door or tray open
2	start slot							
3	end slot							

Table 29 shows the EVENT field values associated with a MEDIA CLASS EVENT.

Table 29 – MEDIA CLASS EVENT EVENT field

EVENT field	Description
00h	Media status is unchanged.
01h	Eject request: the user has issued a request to eject the slot or media.
02h	The specified slot has received new media and the media is ready to be accessed.
03h	Media Removal: the media has been removed from the specified slot and the device is unable to access the media without user intervention.
04h to FFh	Reserved

The DOOR OR TRAY OPEN bit indicates the mechanical position of the device's door or tray. A DOOR OR TRAY OPEN bit set to one indicates that the door or tray is open. A DOOR OR TRAY OPEN bit set to zero indicates that the door or tray is closed.

The MEDIA PRESENT bit indicates whether media is installed in the device. A MEDIA PRESENT bit set to one indicates that media is present in the device. A MEDIA PRESENT bit set to zero indicates that no media is present.

The MEDIA PRESENT bit is reported independently from the DOOR OR TRAY OPEN bit. If the device cannot report the media state while the door or tray is open, then the MEDIA PRESENT bit shall be set to zero when the DOOR OR TRAY OPEN bit is set to zero.

The START SLOT field defines the first slot of a multiple slot device to which the media status notification applies. For devices that do not support multiple slots, this field shall be reserved.

The END SLOT field defines the last slot of a multiple slot device to which the media status notification applies. For devices that do not support multiple slots, this field shall be reserved.

7.5.5 DEVICE BUSY CLASS EVENT INFORMATION field

Table 30 shows the information field format for a DEVICE BUSY CLASS EVENT.

Table 30 – DEVICE BUSY CLASS EVENT information field format

Bit Byte	7	6	5	4	3	2	1	0
0	event							
1	status							
2	(MSB)			time				
3								(LSB)

Table 31 shows the EVENT field values associated with a DEVICE BUSY CLASS EVENT.

Table 31 – DEVICE BUSY CLASS EVENT EVENT field

EVENT field	Description
00h	No event is available.
01h	A time-out has occurred.
02h	Immediate command progress indication
02h to FFh	Reserved