Reduced Block Commands

(RBC)

Draft Proposal (T10/97-260r1)

Reduced Block Commands Editor:

Michael Bryan
Seagate Technology
2400 Trade Centre
Longmont, CO 80503
Tel. (303) 684-1407
Fax (303) 684-1133
E-mail: mike_bryan@notes.seagate.com

Working Draft

Revision 1
January 15, 1998

Information technology —
Reduced Block Commands

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T10 Technical Editor:

Michael Bryan
Seagate Technology
2400 Trade Centre
Longmont, CO 80503
USA

(303)684-1407
(303)684-1133 FAX

mike_bryan@notes.seagate.com

Reference numbers
ISO/IEC xxxxx:199x
ANSI NCITS.xxx-199x

Printed January 15, 1998

Points of contact

T10 Chair:	John B. Lohmeyer Symbios Logic, Inc. 4420 Arrows West Drive Colorado Springs, CO 80907 USA (719) 533-7560 (719) 533-7036 FAX john.lohmeyer@symbios.com
T10 Vice-chair:	Lawrence J. Lamers Adaptec, Inc. 691 South Milpitas Boulevard Milpitas, CA 95035 (408) 957-7817 (408) 957-7193 FAX ljlamers@aol.com
NCITS Secretariat:	NCITS Secretariat 1250 I Street NW, Suite 200 Washington, DC 2000 USA (202) 737-8888 (202) 638-4922 FAX
T10 Bulletin board:	(719) 533-7950
T10 FTP:	ftp.symbios.com/pub/standards/io/x3t10
T10 Home page:	http://www.symbios.com/x3t10
T10 Reflector:	scsi@symbios.com majordomo@symbios.com (to subscribe)
IEEE 1394 Reflector:	p1394@sun.com bob.snively@sun.com (to subscribe)
Document distribution:	Global Engineering 15 Inverness Way East Englewood, CO 80112-5704 USA (800) 854-7179 (303) 792-2181 (303) 792-2192 FAX

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American National Standard
for Information Systems –

Reduced Block Commands (RBC)

Secretariat

Information Technology Industry Council

Not yet approved

American National Standards Institute, Inc.

Abstract

This standard specifies the functional requirements for the SCSI Reduced Block Command set (RBC). RBC permits SCSI block logical units such as flexible disks, rigid disks, optical disks, etc., to attach to computers and provides the definition for their use.

American National Standard

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Published by

American National Standards Institute
1430 Broadway, New York, NY 10018

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Printed in the United States of America

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Foreword

(This foreword is not part of American National Standard NCITS.xxx-199x)

The Reduced Block Command set is designed to provide very efficient initiator-to-target operation of input/output logical units (disks, tapes, printers, etc.) by an operating system.

There are two annexes in this standard. Annex A contains an implementation guide for RBC devices using SBP-2. Annex B contains Event Status Notification sense descriptions.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the NCITS Secretariat, Information Technology Industry Council, 1250 I Street NW, Suite 200, Washington, DC 20005-3922.

This standard was processed and approved for submittal to ANSI by National Committee for Information Technology Standardization (NCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, NCITS had the following members:

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Technical Committee T10 on Lower Level Interfaces, which developed and reviewed this standard, had the following members:

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G. R. Stephens
C. E. Strang, Jr.
T. Totani
D. Wagner
D. Wallace
J. L. Williams
M. Wingard
M. Yokoyama

Revision history

Revision 0 (January141998October 13, 1997)

First release of working draft. Created from prior work performed by the SBP-2 ad hoc working group during 1996 and 1997.

Revision 1 (January 6, 1998)

Cleaned up Abstract, Foreword, Scope, and Purpose wording.

Created new Annex B with clause A.5, Event Status Notification, and its subclauses.

Moved remainder of Annex A to clause 5. Removed much of the duplicate SPC-2 command descriptions.

Combined Annexes B, C, D into new Annex A.

Clause 3.1 Keywords
Removed **non-volatile medium** and **should**.
Added **reserved**.

Clause 3.2 Glossary
Removed **initial node space**, **initial register space**, **initial units space**, **kilobyte**, **octlet**, **operation request block**, and **receive**.

Clause 3.3 Abbreviations
Removed **CDB**.
Added RBC.

Clause 4 Reduced Block Commands
Added **Table 2** – **SPC-2 commands required for RBC devices** for clarity.

Clause 4.1 READ(10) Command
Changed DPO, FUA, and RelAdr bits to Reserved.

Clause 4.2 READ CAPACITY Command
Added command table and definition.

Clause 4.4 SYNCHRONIZE CACHE Command
Changed WCD, Immed, RelAdr, Logical Block Address, and Number of Blocks bits and fields to Reserved.

Clause 4.5 WRITE(10) Command
Changed DPO and RelAdr bits to Reserved.

Changed Clause 4.6 WRITE AND VERIFY, to VERIFY Command
Changed DPO, ByteChk, and RelAdr bits to Reserved.

Clause 4.7 MODE SELECT/SENSE Page Parameters
Added symbol "(c)" to denote bits and fields that are changeable and saveable.
Moved Write Cache Disable bit from SYNCHRONIZE CACHE command.

AMERICAN NATIONAL STANDARD **NCITS.***-199n**

American National Standard
for Information Systems —

Information Technology —
Reduced Block Commands (RBC)

1 Scope and purpose

1.1 Scope

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

1.2 Purpose

The purpose of this document is to provide a command set of reduced requirements and options from SCSI Block Commands 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 is rigid disks and removable media devices attached to Serial Bus and utilizing SBP-2 for command and control.

2 Normative references

The standards named in this section contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision; parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

Copies of the following documents can be obtained from ANSI:

Approved ANSI standards;

Approved and draft regional and international standards (ISO, IEC, CEN/CENELEC and ITUT); and

Approved and draft foreign standards (including BIS, JIS and DIN).

For further information, contact the ANSI Customer Service Department by telephone at (212) 642-4900, by FAX at (212) 302-1286 or *via* the world wide web at http://www.ansi.org.

Additional contact information for document availability is provided below as needed.

2.1 Approved references

The following approved ANSI, international and regional standards (ISO, IEC, CEN/CENELEC and ITUT) may be obtained from the international and regional organizations that control them.

IEEE Std 1394-1995, Standard for a High Performance Serial Bus

ISO/IEC 13213:1994, Control and Status Register (CSR) Architecture for Microcomputer Buses

2.2 References under development

At the time of publication, the following referenced standards were still under development.

IEEE P1394a, Draft Standard for a High Performance Serial Bus (Supplement)

T10 Project 1155D Serial Bus Protocol 2 (SBP-2)

T10 Project 1236D SCSI Primary Commands 2 (SPC-2)

3 Keywords and notation

3.1 Keywords

Several keywords are used to differentiate levels of requirements and optionality, as follows:

3.1.1 expected: A 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.

3.1.2 ignored: A keyword that describes bits, bytes, quadlets, or fields whose values are not checked by the recipient.

3.1.3 mandatory: A keyword that indicates items required to be implemented as defined by this standard.

3.1.4 may: A keyword that indicates flexibility of choice with no implied preference.

3.1.5 optional: A 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.

3.1.6 reserved: A keyword used to describe objects—bits, bytes, and fields—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.

3.1.7 shall: A 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.

3.2 Glossary

The following terms are used in this standard:

3.2.1 byte: Eight bits of data.

3.2.2 command block: Space reserved within an ORB to describe a command intended for a logical unit that controls device functions or the transfer of data to or from device medium. The format and meaning of command blocks are outside of the scope of SBP-2 and are command set- or device-dependent.

3.2.3 logical unit: The part of the unit architecture that is an instance of a device model, *e.g.*, mass storage, CD-ROM or printer. Targets implement one or more logical units; the device type of the logical units may differ.

3.2.4 login: The process by which an initiator obtains access to a set of target fetch agents. The target fetch agents and their control and status registers provide a mechanism for an initiator to signal ORB's to the target.

3.2.5 quadlet: Four bytes, or 32 bits, of data.

3.2.6 register: A term used to describe quadlet aligned addresses that may be read or written by Serial Bus transactions. In the context of this standard, the use of the term register does not imply a specific hardware implementation. For example, the behavior of registers may be emulated by a processor.

3.2.7 status block: A data structure written to system memory by a target when an operation request block has been completed.

3.2.8 system memory: The portions of any node's memory that are directly addressable by a Serial Bus address and which accepts, at a minimum, quadlet read and write access. Computers are the most common example of nodes that make system memory addressable from Serial Bus, but any node, including those usually thought of as peripheral devices, may have system memory.

3.2.9 transaction: An exchange between a requester and a responder that consists of a request and a response subaction. The request subaction transmits a Serial Bus transaction such as quadlet read, block write or lock, from the requesting node to the node intended to respond. Some Serial Bus commands include data as well as transaction codes. The response subaction returns completion status and sometimes data from the responding node to the requesting node.

3.2.10 unit: A component of a Serial Bus node that provides processing, memory, I/O or some other functionality. Once the node is initialized, the unit provides a CSR interface that is typically accessed by device driver software at an initiator. A node may have multiple units, which normally operate independently of each other. Within this standard, a unit is equivalent to a target.

3.2.11 unit architecture: The specification of the interface to and the services provided by a unit implemented within a Serial Bus node.

3.2.12 unit attention: A state that a logical unit maintains while it has unsolicited status information to report to one or more logged-in initiators. A unit attention condition shall be created as described elsewhere in this standard or in the applicable command set- and device-dependent documents. A unit attention condition shall persist for a logged-in initiator until a) unsolicited status that reports the unit attention condition is successfully stored at the initiator or b) the initiator's login becomes invalid or is released. Logical units may queue unit attention conditions; after the first unit attention condition is cleared, another unit attention condition may exist.

3.3 Abbreviations

The following are abbreviations that are used in this standard:

CSR	Control and status register
EUI-64	Extended Unique Identifier, 64-bits
ORB	Operation request block
RBC	Reduced Block Commands
SBP-2	Serial Bus Protocol 2

3.4 Conventions

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

3.4.1 Non-numeric values

a) The names of abbreviations, commands, and acronyms are in all uppercase (e.g., IDENTIFY DEVICE).

b) Fields containing only one bit are usually referred to as the "name" bit instead of the "name" field.

3.4.2 Numeric values

Decimal, hexadecimal and, occasionally, binary numbers are used within this standard. By editorial convention, decimal numbers are most frequently used to represent quantities or counts. Addresses are uniformly represented by hexadecimal numbers. Hexadecimal numbers are also used when the value represented has an underlying structure that is more apparent in a hexadecimal format than in a decimal format. Binary numbers are used infrequently and generally limited to the representation of bit patterns within a field.

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

b) Hexadecimal numbers are represented by digits from the character set 0 – 9 and A – F followed by the subscript 16, e.g. $2A_{16}$.

c) Binary numbers are represented by digits from the character set 0 and 1 followed by the subscript 2, e.g. $0010\ 1010_2$.

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

4 Reduced Block Commands

The Reduced Block Command set (RBC) for block device logical units is shown in Table 1. Each command is mandatory.

Table 1 – Reduced Block Command set

Command name	Opcode	Reference
READ (10)	28_{16}	RBC
READ CAPACITY	25_{16}	RBC
START STOP UNIT	$1B_{16}$	RBC
SYNCHRONIZE CACHE	35_{16}	RBC
WRITE (10)	$2A_{16}$	RBC
WRITE AND VERIFY (10)	$2E_{16}$	RBC

The SCSI Primary Commands (SPC-2) required for RBC device implementation are shown in Table 2. Each command is mandatory.

Restrictions are placed on the listed commands so that their implementation conforms to the goal of simple and efficient device design. Those restrictions are defined in clause 5. Each command is mandatory.

Table 2 – SPC-2 commands required for RBC devices

Command name	Opcode	Reference
INQUIRY	12_{16}	SPC-2
MODE SELECT	55_{16}	SPC-2
MODE SENSE	$5A_{16}$	SPC-2
TEST UNIT READY	00_{16}	SPC-2
WRITE BUFFER	$3B_{16}$	SPC-2

The Control byte (the last byte of the Command Descriptor Bytes) shall be set to zero.

4.1 READ(10) command

The READ(10) command (see Table 3) requests that the device transfer data to the initiator. The most recent data value written in the addressed logical block shall be returned.

Table 3 – READ(10) command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (28_{16})							
1	Reserved							
2	(MSB)	Logical Block Address						
3								
4								
5								(LSB)
6	Reserved							
7	(MSB)	Transfer Length						
8		Transfer Length						(LSB)
9	Control = 00_{16}							

The Logical Block Address field specifies the starting logical block address on the device for the read data to be accessed.

The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be transferred.

4.2 READ CAPACITY command

The READ CAPACITY command (see Table 4) provides a means for the initiator to request the current capacity of the RBC device.

Table 4 – READ CAPACITY command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (25_{16})							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control = 00_{16}							

READ CAPACITY data (see Table 5) shall be returned to the initiator prior to sending status for the command. The Logical Block Address and the Block Length in Bytes are those of the last logical block on the logical unit.

Table 5 – READ CAPACITY data

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Logical Block Address				
2								
3								(LSB)
4	(MSB)							
5				Block Length in Bytes				
6								
7								(LSB)

4.3 START STOP UNIT command

The START STOP UNIT command (see Table 6) requests that the device enable or disable the logical unit for media access operations and controls certain power conditions.

Table 6 – START STOP UNIT command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code ($1B_{16}$)							
1	Reserved							Immed
2	Reserved							
3	Reserved							
4	Power Conditions				Reserved		LOEJ	START
5	Control = 00_{16}							

An *Immediate* (Immed) bit of one indicates that status shall be returned as soon as the command descriptor block has been validated. An *Immed* bit of zero indicates that status shall be returned after the operation is completed.

The *power conditions* field requests the logical unit to be placed into the power condition defined in Table 7. If this field contains any value other than zero, then the START and the LOEJ bits shall be ignored.

For RBC devices using SBP-2, the logical unit may notify the initiator of the change of power state via unsolicited status, depending on the value of the unsolicited_status_enable variable.

Table 7 – Power condition descriptions

Code	Description
0	No change in power conditions.
1	Place device in Active state
2	Place device in Idle state
3	Place device in Standby state
4	Reserved
5	Place device in Sleep state
6 - F_{16}	Reserved

If the START STOP UNIT command is issued with the Power Conditions field set to 1, 2, or 3 the device shall terminate any command received that requires more power than allowed by the START STOP UNIT command's most recent power condition setting with a CHECK CONDITION status, sense key of ILLEGAL REQUEST and sense code of POWER CONDITION ACTIVE.

If the START STOP UNIT command is issued with the Power Conditions field set to 5, the device shall ignore the Immediate bit.

Prior to entering the Sleep state or executing the STOP UNIT command, the target shall ensure that logical blocks in cache have their most recent data value recorded on the physical medium .

It is not an error to request a device be placed into the same power state that it currently occupies.

A *Load/Eject* (LOEJ) bit of zero requests that no action be taken regarding loading or ejecting the medium. A LOEJ bit of one requests that the medium shall be unloaded if the START bit is zero. A LOEJ bit of one requests that the medium is to be loaded if the START bit is one

A *START* bit of zero requests that the device be stopped (media shall not be accessed by the initiator). A *START* bit of one request the device be made ready for use.

4.4 SYNCHRONIZE CACHE command

The SYNCHRONIZE CACHE command (see Table 8) ensures that logical blocks in 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 memory than on the physical medium, then the logical block from the cache memory shall be written to the physical medium. Logical blocks are not necessarily removed from the cache memory as a result of the synchronize cache operation. The SYNCHRONIZE CACHE function may also be required implicitly by other functions as defined in other clauses of this standard.

Table 8 – SYNCHRONIZE CACHE command format

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (35_{16})							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control = 00_{16}							

4.5 WRITE(10) command

The WRITE(10) command (see Table 9) requests that the device write data transferred from the initiator to the medium.

Table 9 – WRITE(10) command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code ($2A_{16}$)							
1	Reserved				FUA	Reserved		
2	(MSB)							
3				Logical Block Address				
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8				Transfer Length				(LSB)
9	Control = 00_{16}							

A Force Unit Access (FUA) bit of zero indicates that the device may satisfy the command by accessing the cache memory. 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 the GOOD status is returned is a deferred error, and information regarding the error is not reported until a subsequent command.

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

The Logical Block Address field specifies the starting logical block address on the device for the read data to be accessed.

The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be transferred.

4.6 VERIFY command

The VERIFY command (see Table 10) requests that the device verify the data written on the medium.

Table 10 – VERIFY command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code ($2F_{16}$)							
1	Reserved							
2	(MSB)	Logical Block Address						
3								
4								
5								(LSB)
6	Reserved							
7	(MSB)	Verification Length						
8		Verification Length						(LSB)
9	Control = 00_{16}							

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 of 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.

4.7 MODE SELECT/SENSE page parameters

The RBC Device Parameters page (see Table 11) is intended to provide general configuration information and to allow modification of that configuration where necessary. The symbol (c) contained in a field or bit indicates that the value may be changed and saved.

Table 11 – RBC device parameters page format (06_{16})

Bit Byte	7	6	5	4	3	2	1	0
0	PS = 1	Rsvd	Page Code (06_{16})					
1	Page Length (08_{16})							
2	Reserved							WCD (c)
3	(MSB)	Logical Block Size						
4	Logical Block Size							(LSB)
5	(MSB)	Number of Logical Blocks (c)						
6								
7								
8								
9	Number of Logical Blocks (c)							(LSB)

A *Write Cache Disable* (WCD) bit of zero specifies that the device server 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 of one specifies that the device shall return GOOD status for a WRITE command after successfully writing all of the data to the medium.

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.

NOTE – The default Number of Logical Blocks value may be obtained by requesting the Default Mode Sense data for this page. The current Number of Logical Blocks value may be obtained by requesting the Saved Mode Sense for this page.

5 SPC-2 implementation requirements for RBC devices

RBC devices require several commands defined in SPC-2 to function in a system. Support for various bits and fields contained in those commands listed in Table 12 has been restricted in order to conform to the goal of reduced complexity for RBC devices. Bit and field restrictions are described in the following clauses.

Table 12 – RBC required SPC-2 commands

Command name	Opcode
INQUIRY	12_{16}
MODE SELECT	55_{16}
MODE SENSE	$5A_{16}$
TEST UNIT READY	00_{16}
WRITE BUFFER	$3B_{16}$

5.1 INQUIRY command

No restrictions are placed on the INQUIRY command for RBC devices.

5.2 MODE SELECT(10) command

The MODE SELECT(10) command provides a means for the initiator to specify device parameters to the mass storage device. Devices shall also implement the MODE SENSE(10) command.

Table 13 – MODE SELECT(10) command format

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (55_{16})							
1				PF = 1				SP = 1
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	Parameter list length						
8	Parameter list length							(LSB)
9	Control = 00_{16}							

The Page Format (PF) bit shall be set to one.

The Save Pages (SP) bit shall be set to one, indicating 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.

The device shall NOT validate the non-changeable parameters against the current values that existed for those mode parameters prior to executing the MODE SELECT command.

5.3 MODE SENSE(10) command

Table 14 – MODE SENSE(10) command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code ($5A_{16}$)							
1					DBD = 1			
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	Allocation length						
8	Allocation length							(LSB)
9	Control = 00_{16}							

The Disable Block Descriptors (DBD) bit shall be set to one.

The Page Control (PC) field defines the type of mode parameter values to be returned in the mode pages. The Page Control field is defined in Table 15.

Table 15 – Simple hard disk page control values

Code	Type of parameter	Support
00_b	Current	Optional
01_b	Changeable	Not supported
10_b	Default	Mandatory
11_b	Saved	Mandatory

NOTE – RBC devices only support Saved and Default parameter values. Since the SP bit is required to be one for the MODE SELECT command, Current and Saved values are the same.

A Page Code of $3F_{16}$ indicates that all mode pages implemented by the device shall be returned to the initiator.

5.3.1 Initial response

After a power-up condition or hard reset condition, the device shall respond in the following manner:

a) If default values are requested, report the default values;

b) If saved values are requested, report valid restored mode parameters, or restore the mode parameters and report them. If the saved values of the mode parameters are not able to be accessed from the non-volatile vendor-specific location, terminate the command with CHECK CONDITION status and set the sense key to NOT READY;

c) If current values are requested, report saved values as described in b).

5.4 TEST UNIT READY command

Table 16 defines the suggested GOOD and CHECK CONDITION status responses to the TEST UNIT READY command. Other conditions, including deferred errors, may result in other responses (e.g., BUSY status).

RBC devices shall report SMART status via the TEST UNIT READY status response. The required Key, ASC, and ASCQ values are described in Table 16 and Table 17.

Table 16 – Preferred TEST UNIT READY sense values

Status	Sense Key	ASC, ASCQ
00_{16} - Good	00_{16} - No Sense	00_{16}, 00_{16} - No additional sense information
02_{16} - Check Condition	05_{16} - Illegal Request	25_{16}, 00_{16} - Logical Unit not supported
02_{16} - Check Condition	02_{16} - Not Ready	04_{16}, 00_{16} - Logical Unit not ready cause not reportable
02_{16} - Check Condition	02_{16} - Not Ready	04_{16}, 01_{16}- Logical Unit becoming ready
02_{16} - Check Condition	01_{16} - Recovered Error	$5D_{16}$,XY [1] - SMART threshold exceeded,
NOTE 1 – See Table 17 for SMART ASCQ responses.		

Table 17 – SMART ASCQ XY definitions

ASCQ X	Description	ASCQ Y	Description
0	Defined by SPC-2	0	General hard drive failure
1	Hardware impending failure	1	Drive error threshold exceeding limits
2	Controller impending failure	2	Data error rate exceeding limits
3	Data Channel impending failure	3	Seek error rate exceeding limits
4	Servo impending failure	4	LBA reassignment exceeding limits
5	Spindle impending failure	5	Access times exceeding limits
6	Firmware impending failure	6	Start Unit times exceeding limits
7	Reserved	7	Channel parametrics indicate impending failure
8	Reserved	8	Controller detected impending failure
9	Reserved	9	Throughput performance
A	Reserved	A	Seek time performance
B	Reserved	B	Spin-up retry count
C	Reserved	C	Drive calibration retry count
D	Defined by SPC-2	D	Reserved
E	Defined by SPC-2	E	Reserved
F	Defined by SPC-2	F	Reserved

5.5 WRITE BUFFER Command

The WRITE BUFFER command (see Table 18) is used to download and save microcode.

Table 18 – WRITE BUFFER command format

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code ($3B_{16}$)							
1	Reserved					Mode = 101_b		
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Parameter List Length							
8								(LSB)
9	Control = 00_{16}							

5.5.1 Download Microcode and Save Mode (101_b)

In this mode, vendor-specific microcode or control information shall be transferred to the device and, if the WRITE BUFFER command is completed successfully, also shall 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. When the download microcode and save command has completed successfully the device server shall generate a Unit Attention status block and send it, via unsolicited status if enabled, to all initiators except the one that issued the WRITE BUFFER command. When reporting the Unit Attention condition, the device shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

The Parameter List Length specifies the maximum number of bytes that shall be transferred from the initiator to the device.

Annex A
RBC device implementation guide for SBP-2

A.1 SBP-2 storage model

The SBP-2 Storage Model describes general characteristics and functions of RBC devices when implemented using SBP-2. It is intended to provide design information and lead to a better understanding of RBC device functionality.

A.1.1 Model configuration

This configuration is used only as an example of a common implementation. The following assumptions are made for this model configuration.

- The device supports a single logical unit.
- The device does not support multiple initiators.
- The device does not support isochronous data transfers.

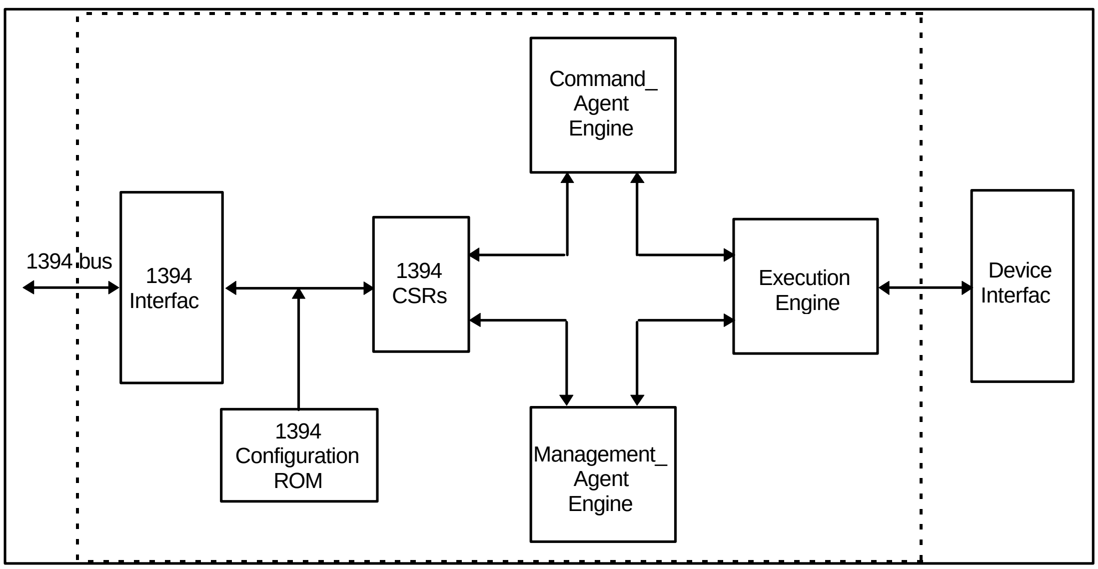

Figure A.1 – Mass storage interface block diagram

A.1.2 Model operation

The block diagram in **Figure A.1** indicates the functional blocks contained in a RBC device that supports SBP-2. This section describes the function of those blocks when processing a list of ORBs. The ORBs contain READ commands in this example.

After power-on or bus reset, the Command_Agent and Management_Agent engines are in the Reset state.

The initiator reads the RBC device's Configuration ROM data in order to determine it's 1394 capabilities, SBP-2 capabilities, EUI-64 value, command set identifiers, software versions, and Management_Agent CSR address.

The initiator performs a Login operation prior to any request to the RBC device. To perform a Login, the initiator writes its Login ORB address to the Management_Agent register. The Login ORB should contain either the current or master password for the Login to be successful. The RBC device returns the Login response to the bus address specified in the Login ORB. One field of the Login response contains the Command_Agent's CSR base address.

Prior to initiating command transfers, the initiator builds a list of Command_Block ORBs in system memory. The list may be as short as one ORB, but this example assumes a list length of more than one. The last ORB in the list contains a NULL Next_ORB pointer which indicates the end of the list to the RBC device's Command_Agent fetch engine.

To transition the Command_Agent state from Reset to Active the initiator writes the offset of the first ORB in the ORB list to the RBC device's ORB_Pointer CSR address. This allows the Command_Agent fetch engine to begin fetching ORBs from initiator memory. If the initiator writes to the Doorbell CSR, the RBC device will ignore the Doorbell at this time.

The RBC device fetches ORBs until its ORB space is full or until an ORB containing a NULL Next_ORB pointer is fetched. Fetched ORBs are routed to the Execution engine. The Execution engine may reorder the commands contained in the ORBs for best performance.

As each READ command is executed the RBC device transfers READ data to the initiator's memory space via block write requests.

Following the data transfer portion of each command the RBC device writes a Status Block to the initiator's Status_FIFO address. The Status_FIFO address for Command Block ORBs is contained in the Login ORB. The status block contains SBP-2 specific command information as well as general sense information.

If an ORB containing a Null Next_ORB pointer is fetched the Execution engine completes all fetched commands, including the one in the just fetched ORB, before the Command_Agent transitions to the Suspended state.

If additional commands are to be executed, the initiator creates a new list of Command_Block ORBs; changes the Next_ORB pointer in the last ORB of the old list from NULL to the offset of the first ORB in the new list; then writes to the RBC device's Doorbell CSR address. This transitions the Command_Agent to the Active state.

The RBC device fetches the new Next_ORB pointer value from the last ORB of the old list and begins fetching ORBS from the new list at that offset.

If the Command_Agent fetch engine has not reached the ORB containing a Null Next_ORB pointer, (and is still in the Active state) the RBC device ignores any writes to the Doorbell CSR address.

This sequence may continue until the RBC device is reset, power is removed, or an error occurs.

A.2 RBC device configuration ROM requirements

Although most Configuration ROM entries are generic, several contain information that is specific to each device type. Hard disk drive specific Configuration ROM information is defined in this section.

A.2.1 Unit Directory - Command_Set

The *Command_Set entry* (key - $3A_{16}$) is an immediate entry that, in combination with the

Command_Set_Spec_ID entry specifies the command set supported by the unit.

39_{16}	Command_Set

A.2.2 Unit Directory - Command_Set_Revision

The *Command_Set_Revision* entry (key - $3B_{16}$) is an immediate entry that specifies the current revision level of the command set implemented by the unit.

$3B_{16}$	Command_Set_Revision

A.2.3 Unit Directory - Logical_Unit_Number

The *Logical_Unit_Number* entry (key - 14_{16}) is an immediate entry that specifies the device type and the logical unit number of a logical unit supported by the drive. The format of this entry is defined in SBP-2 and duplicated here with additional field information for hard disk drives.

key (14_{16})	reserved	device_type (00_{16})	logical_unit_number (00_{16})

The *device_type* field indicates the peripheral device type implemented by the logical unit. The value defined by the command set for hard disk drives is 00_{16}.

The logical_unit_number field indicates the value of a logical unit supported by the drive. For hard disk drives that support one logical unit, the value is 0000_{16}.

A.3 RBC device security requirements (normative)

RBC Devices shall implement security against unauthorized media access as defined in the security annex of SBP-2.

The master password, referenced in SBP-2, is contained in the INQUIRY command, Vital Product Data page 80_{16}. Following a successful Login operation, the host must request that the device perform the INQUIRY command, in order to obtain the device's serial number.

Annex B
Event Status Notification

Previous mass storage device interfaces have been unable to consistently and reliably support asynchronous event notification. As a substitute, initiators have used the GET EVENT STATUS NOTIFICATION command to acquire asynchronous event status from devices. The GESN command was used to either poll the device's event status or, if the device supported queued commands, the GESN command did not complete until an event occurred. The polling method requires the initiator to provide a timer in order to repetitively acquire device status. The queued command method requires a device to process the GESN command in a different manner from all other queued commands. To solve this problem asynchronous event notification has been made a fundamental part of SBP-2 and RBC devices.

Through the use of Unsolicited Status, mass storage devices may report asynchronous events the moment that they occur. The initiator need only process the status block to determine the cause of the event. The device is no longer required to support the GESN command in the polled or queued mode. It simply builds and transmits a status block whenever an event occurs.

B.1 Unsolicited status sense definitions

The following table describes unsolicited status sense key and sense code values that may be written to an initiator's Status_FIFO if the initiator has previously written to the device's unsolicited_status_enable register.

Table B.1 – Unsolicited status sense key/code values

Sense key	Sense code	Description
02_{16}	04_{16}	Device Not Ready (reported only on transition or at power on.)
06_{16}	28_{16}	Not Ready to Ready transition. Medium may have changed.
06_{16}	29_{16}	Power on reset, bus reset, etc.
06_{16}	$7F_{16}$	Event Status Notification.

Deferred errors may also be reported as unsolicited status.

B.2 Event status sense information

In order to support traditional Event Status Notification through the use of Unsolicited Status, specific Status, Sense Key, and Sense Code values must be combined.

Status = 02_{16}, Check Condition, indicates that the condition of the device has changed.

Sense Key = 06_{16}, Unit Attention, indicates that an event has occurred that the device must communicate to the initiator.

Sense Code = $7F_{16}$, Event Status Notification, indicates that an asynchronous event has occurred.

Sense Qualifier values are:

– 02_{16}, Power Management Class Event, indicates that a Power Management event has occurred.
– 04_{16}, Media Class Event, indicates that a Media Class event has occurred.
– 06_{16}, Device Busy Class Event, indicates that a Device Busy Class event has occurred.

The contents of the Information field further define the event status. Interpretation of the values are dependent upon the Sense Key, Code, and Qualifier values. The following tables provide the Event Status Information values for each Sense Qualifier type described above.

Table B.2 – Event status information format

Information			
byte 0	byte 1	byte 2	byte 3
event	status	event specific	event specific

B.2.1 Power Management Information Values

Table B.3 – Power management information format

Information			
byte 0	byte 1	byte 2	byte 3
event	status	reserved	reserved

Table B.4 – Power management information values - Event field

Event field	**Description**
00_{16}	No power state change.
01_{16}	The device successfully changed to the specified power state.
02_{16}	The device failed to enter the last requested power state and is still operating at the state specified in the Power Status field.
03_{16} - FF_{16}	Reserved.

Table B.5 – Power management information values - Status field

Status field	Description
00_{16}	Reserved.
01_{16}	The device is in the Active state.
02_{16}	The device is in the Idle state.
03_{16}	The device is in the Standby state.
04_{16} - FF_{16}	Reserved.

B.2.2 Media event information values

Table B.6 – Media event information format

Information			
byte 0	byte 1	byte 2	byte 3
event	status	start slot	end slot

Table B.7 – Media event information value - Event field

Event field	Description
00_{16}	Media status is unchanged.
01_{16}	Eject request. The user has issued a request to eject the slot or media.
02_{16}	The specified slot has received new media and the media is ready to be accessed.
03_{16}	Media Removal. The media has been removed from the specified slot and the target is unable to access the media without user intervention.
04_{16} - FF_{16}	Reserved.

Table B.8 – Media event information value - Status field

Bit Byte	7	6	5	4	3	2	1	0
1	Reserved						Media Present	Door or Tray Open

The **Door or Tray Open bit** indicates the mechanical position of the device’s door or tray. A **Door or Tray Open** value of 1 indicates that the door or tray is open. A value of 0 indicates that the door or tray is closed.

The **Media Present** bit indicates whether media is installed in the device. A value of 1 indicates that media is present in the device. A value of 0 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, this bit shall be set to 0 when the Door or Tray Open bit is 0.

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

B.2.3 Device Busy Event Information Values

Table B.9 – Device busy information format

Information			
byte 0	byte 1	byte 2	byte 3
event	status	Time (MSB)	Time (LSB)

The **Time** field is the predicted amount of time remaining for the device to become not busy, in units of 100ms.

Table B.10 – Device busy event information values - Event field

Event field	Description
00_{16}	No event is available.
01_{16}	A time-out has occurred.
02_{16} - FF_{16}	Reserved.

Table B.11 – Device busy event information values - Status field

Status field	Description
00_{16}	No event. The device is ready to accept commands.
01_{16}	The device is in the process of waking up from a lower power state.
02_{16}	The device is in the process of completing an earlier command.
03_{16}	The device is in the process of completing a deferred operation, such as a write.
04_{16} - FF_{16}	Reserved.