**Universal Serial Bus**
**Mass Storage Class Specification**
**For UASP Bootability**

**Revision 1.0**

**March 04, 2013**

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## Revision History

| Revision | Date | Description |
|---|---|---|
| 1.0 | March 4, 2013 | First published version. |

## 1  Introduction

### 1.1  Purpose

When personal computers and similar devices are powered up, they typically load and begin executing the main operating system from a mass storage device such as a disk drive.  This specification defines a set of commands and associated data sufficient to allow the loading of an operating system stored on a USB Mass Storage Class device.

### 1.2  Scope

This specification fully defines the minimum required set of CDBs and Data a USB Mass Storage device must implement in order for a host to boot from it.

The commands defined herein are taken from other industry command set specifications.  Some of these specifications conflict with each other in minor details.  If there is a conflict between this specification and another, then the definitions in this specification shall take precedence.

### 1.3  Related Documents

Command Sets

| | | |
|---|---|---|
| INCITS 1731-D | SCSI Primary Commands – 4 (SPC-4) Available at http://www.t10.org | |
| INCITS 1799-D | SCSI Block Commands – 3 (SBC-3) Available at http://www.t10.org | |
| INCITS 468-2010 | Information Technology – Multi-Media Commands - 6 (MMC-6) Available at http://www.ansi.org | |
| INCITS 480-2011 | Information Technology – BIOS Enhanced Disk Drive Specification – 4 (EDD-4) Available at http://www.ansi.org | |

Other

| | |
|---|---|
| MSC Overview Rev 1.3 | USB Mass Storage Class Specification Overview, Revision 1.3 Available at http://www.usb.org |
| UASP Rev 1.0 | USB Mass Storage Class USB Attached SCSI Protocol (UASP) Specification, Revision 1.0 Available at http://usb.org |

### 1.4  Terms and Abbreviations

| Term | Description |
|---|---|
| Out of scope | A value that is out of the scope of this specification. The host may attempt to boot from a device that returns an out-of-scope value, or the host may instead attempt to boot from other devices. |
| CDB | Command Descriptor Block – the structure used to communicate commands from a host to a logical unit. |
| UASP | Universal Serial Bus Mass Storage Class USB Attached SCSI Protocol (UASP) |
| Basic device | A basic device does not use a security protocol to manage access to user data |
| Secure device | A secure device uses a security protocol to manage access to user data. See SPC-4. |

## 2  General Device Requirements

The following sections document the commands that are used to support the firmware abstraction layer for devices. These commands are fully documented in the SPC, MMC and SBC documents. The host shall support all values defined herein. The host may, but is not required to, support values that are out of scope. The host may attempt to boot from a device that returns an out-of-scope value, or the host may instead attempt to boot from other devices.

This specification defines requirements for the device types listed in Table 2-1 which support UASP (i.e., Protocol is set to 62h.).

### Table 2-1  Supported Device Peripheral Device Types

| SubClass[1] | Peripheral Device Type[2] | Device Class | SCSI Standards |
|---|---|---|---|
| 06h or 08h | 00h | Direct access block device (e.g., magnetic disk) | SPC-4, SBC-3 |
| 02 or 06h | 05h | CD/DVD device | SPC-4, MMC-6 |
| All other values | All other values | Out of scope | |

1. The SubClass is obtained from the device's USB Interface descriptor (see USB Mass Storage Class Specification Overview)

2. The peripheral device type is obtained from the INQUIRY command.

## 3  SCSI Block Device (SBC) Device Requirements

Table 3-1 specifies the commands that are mandatory or optional for different classes of SCSI Block Command (SBC) devices.

### Table 3-1  Bootability Commands for SBC Devices

| Command | Basic SBC Device | Secure SBC Device | SCSI Standard | Reference |
|---|---|---|---|---|
| INQUIRY | M | M | SPC-4 | 5.3 |
| READ CAPACITY(16) | M | M | SBC-3 | 5.7 |
| READ(16) | M | M | SBC-3 | 5.5 |
| REPORT LUNS | M | M | SPC-4 | 5.9 |
| SECURITY PROTOCOL IN | O | M | SPC-4 | 5.10 |
| SECURITY PROTOCOL OUT | O | M | SPC-4 | 5.11 |
| TEST UNIT READY | M | M | SPC-4 | 5.12 |
| WRITE(16) | M | M | SBC-3 | 5.13 |
| All other commands | Out of scope | | | |

Key:

    M = Mandatory

    O = Optional

## 4  Multi-Media Command (MMC) Device Requirements

The EDD-4 standard (see Related Documents 1.3) should be used for booting.

Table 4-1 specifies the commands that are mandatory or optional for different classes of SCSI Multi-Media Command (MMC) devices.

**Table 4-1  Bootability Commands for MMC Devices**

| Command | Basic MMC Device | Secure MMC Device | SCSI Standard | Reference |
|---|---|---|---|---|
| INQUIRY | M | M | SPC-4 | 5.3 |
| READ CAPACITY | M | M | MMC-6 | 5.6 |
| READ TOC/PMA/ATIP | M | M | MMC-6 | 5.8 |
| READ(10) | M | M | MMC-6 | 5.4 |
| REPORT LUNS | M | M | SPC-4 | 5.9 |
| SECURITY PROTOCOL IN | O | M | SPC-4 | 5.10 |
| SECURITY PROTOCOL OUT | O | M | SPC-4 | 5.11 |
| TEST UNIT READY | M | M | SPC-4 | 5.12 |
| All other commands | Out of scope | | | |

Key:

      M = Mandatory

      O = Optional

## 5  SCSI Commands

### 5.1  Overview

Table 4 specifies the SCSI commands referenced by this specification, along with the standards which fully define them. This specification describes the CDBs and parameters required for USB bootability. See the referenced standards for complete information.

**Table 5-1  SCSI Command References**

| | SCSI Standard | Reference |
|---|---|---|
| **Common Commands** | | |
|     INQUIRY | SPC-4 | 5.3 |
|     REPORT LUNS | SPC-4 | 5.9 |
|     SECURITY PROTOCOL IN | SPC-4 | 5.10 |
|     SECURITY PROTOCOL OUT | SPC-4 | 5.11 |
|     TEST UNIT READY | SPC-4 | 5.12 |
| **SCSI Block Commands** | | |
|     READ(16) | SBC-3 | 5.5 |
|     READ_CAPACITY(16) | SBC-3 | 5.7 |
|     WRITE(16) | SBC-3 | 5.13 |
| **Multi-Media Commands** | | |
|     READ(10) | MMC-6 | 5.4 |
|     READ CAPACITY | MMC-6 | 5.6 |
|     READ TOC/PMA/ATIP | MMC-6 | 5.8 |

### 5.2  Sense Data

UAS devices return status and sense data in the Sense IU for every I_T_L_Q nexus transaction. Initiators shall determine how much sense data was returned by the device by examining the LENGTH field in the Sense IU and the ADDITIONAL SENSE LENGTH field in the sense data (if that field was returned.) Initiators should assume the bytes not transferred are zeros.

Device servers shall return fixed-format or descriptor-format sense data according to SPC-4. If the sense data returned by the device server (i.e., the LENGTH field of the Sense IU) is non-zero, then it shall return at least all the fields listed in Table 5-2.

**Table 5-2  Sense Data Requirements**

| Field or Bit | Host Requirements |
|---|---|
| RESPONSE CODE | 70h or 71h: Fixed format sense data; see SPC-4.<br>72h or 73h: Descriptor format sense data; see SPC-4.<br>All other values are out of scope |
| SENSE KEY | See SPC-4 |
| ADDITIONAL SENSE CODE | See SPC-4 |
| ADDITIONAL SENSE CODE QUALIFIER | See SPC-4 |
| ADDITIONAL SENSE LENGTH | See SPC-4 |
| All other fields | Out of scope |

### 5.3  INQUIRY Command

The INQUIRY command requests that information regarding parameters of the device server be sent to the initiator.

See SPC-4 for information on the CDB fields for the INQUIRY command.

Table 5-3 specifies the host requirements for the standard INQUIRY data returned by the device server:

**Table 5-3  Standard INQUIRY response requirements**

| Field or Bit | Host Requirements |
|---|---|
| PERIPHERAL DEVICE TYPE field | See Table 2-1 |
| RMB bit | The host shall support rmb values of both zero and one |
| ADDITIONAL LENGTH field | The host shall support Additional Length values 1Fh to FAh. All others (i.e. 00h to 1Eh and FBh to FFh) are out of scope. |
| PRODUCT IDENTIFICATION field | This field shall contain only ASCII printable characters (i.e., code values 20h to 7Eh). |
| PRODUCT REVISION LEVEL field | This field shall contain only ASCII printable characters (i.e., code values 20h to 7Eh). |
| VERSION DESCRIPTOR fields | These fields provide for identifying up to eight standards to which the SCSI target device and/or logical unit claim conformance. |

### 5.4 READ(10) Command

The READ(10) command requests that the device server transfer data to the initiator. The most recent data value written in the addressed logical block is returned.

Table 5-4 specifies the host requirements for the CDB fields for the READ(10) command.

**Table 5-4  READ(10) CDB field requirements**

| CDB Field | Host Requirements |
|---|---|
| TRANSFER LENGTH | A value of zero indicates that no logical blocks are transferred. This condition is not considered an error. Any other value indicates the number of logical blocks that are transferred. |
| All others | See MMC-6 |

### 5.5 READ(16) Command

The READ(16) command requests that the device server transfer data to the initiator. The most recent data value written in the addressed logical block is returned.

Table 5-5 specifies the host requirements for the CDB fields for the READ(16) command.

**Table 5-5  READ(16) CDB requirements**

| CDB Field | Host Requirements |
|---|---|
| TRANSFER LENGTH | A value of zero indicates that no logical blocks are transferred. This condition is not considered an error. Any other value indicates the number of logical blocks that are transferred. |
| All others | See SBC-3 |

### 5.6 READ CAPACITY Command

The READ CAPACITY command provides a means for the initiator to request information regarding the capacity of the installed medium of the device server.

See MMC-6 for information on the CDB fields for the READ CAPACITY command.

SBC devices should use READ CAPACITY(16) instead.

Table 5-6          specifies the data that shall be transferred from the device server.

**Table 5-6  READ CAPACITY response requirements**

| Field | Requirements |
|---|---|
| LAST LOGICAL BLOCK ADDRESS | The Last Logical Block Address field holds the last valid LBA for use with media access commands. The meaning varies by media type. |
| All other fields | See MMC-6 |

### 5.7 READ CAPACITY(16) Command

The READ CAPACITY(16) command provides a means for the initiator to request information regarding the capacity of the installed medium of the device server.

SBC-3 for information on the CDB fields for the READ CAPACITY(16) command.

Table 5-7 specifies the host requirements for the READ CAPACITY(16) data returned by the device server:

**Table 5-7  Standard READ CAPACITY(16) response requirements**

| Field | Requirements |
|---|---|
| RETURNED LOGICAL BLOCK ADDRESS | The last valid LBA for use with media access commands |
| LOGICAL BLOCK LENGTH IN BYTES | The logical block size |
| LOGICAL BLOCKS PER PHYSICAL BLOCK EXPONENT | This indicates if the device has more than one logical block per physical block. |
| LOWEST ALIGNED LOGICAL BLOCK ADDRESS | This is relevant if the device has more than one logical block per physical block. |
| All other fields | See SBC-3 |

### 5.8  READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP command is used by the initiator to identify a multi-session CD.

Table 5-8 specifies the host requirements for the CDB fields for the READ TOC/PMA/ATIP command.

**Table 5-8  READ TOC/PMA/ATIP CDB requirements**

| CDB Field | Host Requirements |
|---|---|
| Format | Shall be set to zero |
| MSF | Shall be set to 0 to indicate that the return CD address values are specified in LBA format, not minute second frame |
| Allocation Length | Shall be set to 0Ch |
| All others | See MMC-6 |

### 5.9  REPORT LUNS Command

The REPORT LUNS command requests that the peripheral device logical unit inventory to be sent to the initiator. The inventory indicates the number of accessible logical units in the device and their logical unit numbers.

Table 5-9 specifies the requirements for the REPORT LUNS CDB.

**Table 5-9  REPORT LUNS CDB requirements**

| Field or Bit | Host Requirements |
|---|---|
| SELECT REPORT | Shall be set to 00h |
| All other fields | Out of scope |

### 5.10   SECURITY PROTOCOL IN Command

The SECURITY PROTOCOL IN command is used to retrieve security protocol information or the results of one or more SECURITY PROTOCOL OUT commands.

See SPC-4 for information on the CDB fields for the SECURITY PROTOCOL IN command, and for the format of the data returned from the device server.

### 5.11   SECURITY PROTOCOL OUT Command

The SECURITY PROTOCOL OUT command is used to is used to send data to the logical unit. The data sent specifies one or more operations to be performed by the logical unit. The format and function of the operations depends on the contents of the SECURITY PROTOCOL field. Depending on the protocol specified by the SECURITY PROTOCOL field, the application client may use the SECURITY PROTOCOL IN command (see 6.40) to retrieve data derived from these operations.

See SPC-4 for information on the CDB fields for the SECURITY PROTOCOL OUT command, and for the format of the data transferred to the device server.

### 5.12   TEST UNIT READY Command

The TEST UNIT READY command provides a means to check if the device server is ready.

This is not a request for a self-test. If the device server would accept an appropriate medium-access command without returning CHECK CONDITION status, this command returns a GOOD status. If the device server cannot become operational or is in a state such that a initiator action is required to make the device server ready, the device server returns CHECK CONDITION status with a sense key of NOT READY.

The TEST UNIT READY command is useful in that it allows a initiator to poll a device server until it is ready without the need to allocate space for returned data. It is especially useful to check media status. Devices are expected to respond promptly to indicate the current status of the device server.

See SPC-4 for information on the CDB fields for the TEST UNIT READY command.

### 5.13   WRITE(16) Command

The WRITE(16) command requests that the device server write the data transferred by the initiator to the medium.

Table 13 specifies the host requirements for the CDB fields for the WRITE(16) command

**Table 5-10  WRITE(16) CDB requirements**

| Field | Host Requirements |
|---|---|
| TRANSFER LENGTH | A value of zero indicates that no logical blocks are transferred. This condition is not considered an error and no data is written. Any other value indicates the number of logical blocks that are transferred. |
| All others | See SBC-3 |