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MMC-2 ATAPI Implementation Notes

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Technical Editor:
Ron Roberts
Sierra-Pac Technology
PO Box 2389
Shingle Springs, CA 95682

E-mail: rkroberts@aol.com

11.0 ATAPI Implementation Notes

See the X3T13 ATA/ATAPI-4 Specification for information on the connection and protocol to be use for ATAPI C/DVD device.

11.1 Introduction

The ATA/IDE interface has become a de facto industry standard for connection of disk drives in PC‘s. In the interest of simplicity and cost, the ATA/IDE interface was originally designed to support only a small subset of computer peripherals. The expanding use of multimedia, inexpensive program distribution on CD & DVD, and faster and more powerful systems has created the need for enhancements to ATA. This specification is one of those enhancements and provides a simple and inexpensive C/DVD interface through a superset of ATA.

11.2 ATA Signal Utilization

ATAPI Devices will utilize the same signals and timing from the ATA Standard and Extensions.

11.3 ATA Command Utilization

The ATA Task File concept does not contain enough bytes to support some of the command structures, so a command called “ATAPI Packet Command” has been added to allow a Packet to be sent to the Device. The Packet will be transferred by writing multiple times to the Data Register. No random access to the register file in the Peripheral can be done. This technique reduces the number of register addresses needed, but not the actual space needed. Although all the commands for the CD-ROM Device could be sent via this packet mode, some of the existing ATA commands and the full ATA command protocol must be provided for the existing drivers to operate correctly. The C/DVD Device will therefore support some existing ATA commands in addition to the new “ATAPI Packet command”, so that there will be minimal changes to the existing drivers. This minimal set of ATA commands is different than the minimum as defined in the ATA standard, but should be sufficient for normal operation.

11.4 ATA Compatibility

There are several legacy issues with the existing ATA commands, and therefore the Device will respond to the existing ATA Reset Master/Slave Diagnostic Sequence, but not the Identify Drive or Read commands. This will allow the BIOS and older drivers to ignore the Device and not confuse ATAPI data with normal ATA Drive format data. All unsupported ATA commands shall be Aborted, and not executed. As with aborted commands in ATA, an interrupt will be generated to signal the completion with an “aborted” error status.

11.5 Packet Types

To allow for generic packet transfer and the connection of SCSI like peripherals, there shall exist a minimum set of information that is exchanged. This information shall generically support the following:

- Command Packet (Always padded to number of bytes identified in byte 0 of the identify drive data. 00 = 12 bytes, 01 = 16 bytes)

- Command Parameter Data (e.g. Write Data etc.)

- Command Response Data (e.g. Read Data etc.)

- Status. The Status will not take the form of a packet of information. The status will be presented using the ATAPI Status Register (redefinition’s of the ATA Status Register).

11.6 How SCSI is Used by ATAPI

Although the ATAPI Device will utilize many of the actual packet definitions from the SCSI standard, it will NOT use most other features of the normal SCSI Protocol. Thus there are no Phases, no Messages, no sharable bus, (only one Host Computer) and no SCSI Hardware. For those who are familiar with the current SCSI-3 effort, this specification will not conform with that Packetized Standard.

11.6.1 Differences from the SCSI Standard

Some of the major differences from the SCSI Standard:

- Status will use the ATAPI description, rather than a Data Byte passed at the end of the command.

- ATAPI Device is slave during operation rather than the master view of a SCSI Peripheral.

- No messages are supported.

- No disconnect/reconnect or any of the SCSI Pointers.

- No linking.

- All CD Command Packets (CP) are 12 bytes in length, rather than the 6, 8, 10 or 12-byte packets of the SCSI Standard; however, 16-byte ATAPI Command Packets are defined for SAM compatibility for future Devices. The size of the Command Packet required by a Device is defined in word 0 of the ATAPI Identify Device command, allowing Host System Device Drivers to determine the size of the Command Packets before issuing an ATAPI Command Packet.

- No allegiance conditions are used.

This standard will make use of many of the Standard SCSI Command Block definitions and Commands, but some of the commands that would normally be supported by a SCSI Device will not be supported for various reasons. These commands are:

- Reserve and release; as there is only one Host allowed, this is not needed.

- Send and receive diagnostics; the ATA EXECUTE DRIVE DIAGS command replaces these commands.

- Change definitions; as there is no SCSI, this command is nonsensical.

- Copy / Copy and Verify; no shared bus so this command can’t be implemented.

- Compare; no shared bus, so this command can’t be implemented.

- Read and Write Buffer; simplification.

- Log Sense and Select; simplification.

- Search Data; simplification.

- Verify; simplification.

11.6.2 Reset Usage

This section describes the three types of resets and how they are used in an ATAPI environment.

Table 214 - Reset Function Mapping

Reset Type	ATAPI
Power-On Reset	Same as Power-On Reset in the proposed ATA/ATAPI-4 X3T13/1153D Standard
Hard Reset	Hard Reset, RESET- bus signal
	ATA SRST. This is a channel reset and as such is treated as a Hard Reset. However the SRST *shall* not reset any mode parameters to the default state.
Device Reset	Device Reset in proposed ATA/ATAPI-4 X3T13/1153D Standard
	ATAPI Soft Reset in SFF8020i

11.6.3 Power On Reset

The Power On Reset shall operate as specified in the proposed ATA/ATAPI-4 X3T13/1153D Standard.

11.6.4 Hard Reset

The Hard Reset corresponds to the Hard Reset (RESET- signal line) and the SRST (ATA/ATAPI Software Reset).

The ATAPI Hard Reset, being different from SCSI, can not reset just one device. In ATAPI all the devices on the same cable are reset.

The effect of these two resets are the same, but usage of the SRST will be restricted. The SRST was defined for use in an ATA environment and should not be used in an ATAPI environment. However there are some specific requirements of the SRST that are specified in the ATA/ATAPI-4 X3T13/1153D Standard. These shall be followed. These are caused because the SRST is a Channel Reset and not a specific device reset.

11.6.5 Device Reset

The Device Reset corresponds to the DEVICE RESET command in the proposed ATA/ATAPI-4 X3T13/1153D Standard. In an earlier standard (SFF8020) the Device Reset was called ATAPI SOFT RESET. The functions off DEVICE RESET and ATAPI SOFT RESET are the same.

The Device Reset is capable of resetting an individual device.

The Device Reset should keep the media-based information such as disc TOC. It expected that the Device Reset will operate quickly. Host drivers expect that the device will be ready to perform other commands quickly after the Device Reset. It is recommended that all information about a previously installed media be maintained across a Device Reset.

The ATAPI version of Device Reset is different from SCSI. Known differences include:

- Device Reset will immediately reset ATAPI logical protocol sequence. SCSI protocols are not affected by the Device Reset.

- Time constraints on the processing of the reset exist in ATAPI but not the SCSI environments.

11.6.6 Function Comparison Table

Table 215 - Reset Function Comparison

Function	Power-On/ Hard Reset	ATA/ATAPI-4 Device Reset
Initialization sequence required	Yes	No
Immediate Bus Release	Yes	Yes
Mode parameters	Reset to default or saved parameters	No change allowed
Cached Lead-in information	Discarded	Should not re-read lead-in
Persistent Prevent Flag	Unlocked	No change allowed
Key Management	Reset to Default state	Reset to Default state

11.6.7 Redundant Command Functionality (Task File vs. Packet)

The SCSI Standard has provided some commands that the ATA Standard also provides. It is the intent of this standard to allow all the functionality to exist, by utilizing only Command Packets. This will allow existing SCSI like drivers to continue to issue packets for all operation, and have some lower level driver convert them to the ATAPI protocol. Unfortunately there are existing low level drivers that would like to continue to use some non data transfer ATA Task File commands. As such both these “Task File” and “Packet” commands will be supported.

11.6.7.1 Door Lock and Door Unlock vs. Prevent / Allow Medium Removal

There exists both an ATA and a Packet method to control the insertion and removal of media. Both of these methods do not provide necessary functionality for the Host operating system. It is therefor recommended that both the ATA Lock/ Unlock and the Packet Prevent/Allow functions not be implemented by a C/DVD device. There now exist a new set of commands, both for ATA and for Packet Commands. These commands control a capability called Media Status Notification. As the functionality for the packet and the register based commands are similar, only the Packet versions of the MSN commands shall be implemented by C/DVD devices.

11.6.7.2 ATAPI Identify Drive vs. Inquiry

The ATAPI IDENTIFY DRIVE command has information that the low level drivers use to perform ATA interface hardware configuration. Information in the Identify Drive shall continue to look exactly as the ATA Identify Drive does for compatibility reasons. As the information in the Inquiry Command cannot be returned by the ATAPI Identify Drive Command, the Inquiry Command will be supported for use by higher level drivers.

11.6.7.3 Initialize Drive Parameters and Set Features vs. Mode Sense and Mode Select

The INITIALIZE DRIVE PARAMETERS command does not contain a method to provide non ATA device configuration information, and will not be used. As such the Mode Select and Mode Sense from the SCSI standard shall be supported. The combination of Mode Select and Set Features commands contain all the necessary functionality and is most compatible with the existing BIOSes and OS Drivers.

11.6.8 ATAPI Device Reset

Note: For performance reasons, a Device reset may not force reading of TOC.

11.6.9 Execute Drive Diagnostics

This command shall perform the internal diagnostic tests implemented by the drive. The DRV bit is ignored. Both drives, if present, shall execute this command. See the ATA Standard (X3T9.2/791D) for more information.

Implementer's Note: ATAPI device drivers issuing the Execute Diagnostics command will cause all ATA and ATAPI de-vices to execute a diagnostic command resulting in a device reset. To prevent unwanted resets and or driver compatibility issues, ATAPI drivers should not issue the Execute Diagnostics command. The command is implemented by ATAPI devices for ATA compatibility only.

11.6.10 ATAPI Identify Device

The ATAPI IDENTIFY DEVICE command enables the host to receive parameter information from the drive. For more information see ATA/ATAPI-4 Standard.

11.7 Command Packet Description

An ATAPI command is communicated by sending a Command Packet to the Device. For several commands, the Command Packet is accompanied by a list of parameters sent upon receiving an interrupt following the Command Packet being sent. See the specific commands for detailed information.

The Command Packet always has an operation code as its first byte.

For all commands, if there is an invalid parameter in the Command Packet, then the ATAPI Device shall abort the command without altering the medium.

Table 216 - Typical Command Packet for Most Commands

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			Reserved				
2	(MSB)							
3	Logical Block Address (if required)							
4								
5								(LSB)
6	Reserved							
7 - 8	(MSB)							
	Transfer Length (if required) or Parameter List Length (if required) or Allocation Length (if required)							(LSB)
9	Reserved							
10	Reserved							
11	Reserved							

Table 217 - Typical Command Packet for Some Extended Commands

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			Reserved				
2	(MSB)							
3	Logical Block Address (if required)							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length (if required) or Parameter List Length (if required) or Allocation Length (if required)							
8								
9								(LSB)
10	Reserved							
11	Reserved							

11.7.1 Operation Code

The operation code of the Command Packet has a group code field and a command code field. The three-bit group code field provides for eight groups of command codes. The five-bit command code field provides for thirty-two command codes in each group. Thus, a total of 256 possible operation codes exist. Operation codes are defined in the subsequent sections.

Table 218 - Operation Code

Bit	7	6	5	4	3	2	1	0
	Group Code			Command Code				

Note: The Group / Command code fields have been kept for backward compatibility and are not used by ATAPI.

11.7.2 Logical Block Address

The logical block address shall begin with block zero and be contiguous up to the last logical block.

11.7.3 Transfer Length

The Transfer Length Field specifies the amount of data to be transferred, usually the number of blocks. For several commands the transfer length indicates the requested number of bytes to be sent as defined in the command description. For these commands the Transfer Length Field may be identified by a different name. See the following descriptions and the individual command descriptions for further information.

In commands that use multiple bytes for the transfer length, a transfer length of zero indicates that no data transfer shall take place. A value of one or greater indicates the number of blocks that shall be transferred.

Note: The Group / Command code fields have been kept for backward compatibility and are not used by ATAPI.

11.7.4 Parameter List Length

The Parameter List Length is used to specify the number of bytes to be sent to the Drive. This field is typically used in Command Packets for parameters that are sent to a Drive (e.g. mode parameters, diagnostic parameters, etc.). A parameter length of zero indicates that no data shall be transferred.

11.7.5 Allocation Length

The Allocation Length Field specifies the maximum number of bytes that a Host Computer has allocated for returned data. An allocation length of zero indicates that no data shall be transferred. The Drive shall terminate the data transfer when allocation length bytes have been transferred or when all available data have been transferred to the Host Computer, whichever is less. The allocation length is used to limit the maximum amount of data (e.g. sense data, mode data, etc.) returned to a Host Computer. When data is truncated, no error is generated, except for the Mechanism Status Command that shall generate a Parameter List Length Error.

11.8 Status

A Status byte shall be sent from the Drive to the Host Computer at the completion of each command unless the command is terminated by one of the following events:

1. A hard reset condition.

2. An unexpected event.

Status is normally presented at the end of a command, but in some cases may occur prior to transferring the Command Packet.

For a description of the Status Byte see ATA/ATAPI-4.

11.9 Immediate Command Processing Considerations

Immediate commands are a class of commands which return completion status to the host system before they are finished executing the command. The purpose of immediate commands is to allow the host to execute more than one command at a time on the same IDE cable.

ATAPI devices use the DSC bit to indicate the completion status of the seek operation of immediate commands. No INTRQ is issued by these device when the DSC bit is set, so it the responsibility of the ATAPI driver to poll this bit to deter-mine the completion status of the immediate command.

Some Commands that make use of this immediate capability are:

Play Audio Play Audio MSF Play CD Seek Scan

11.10 Command Processing Considerations and Exception Conditions

The following sections describe some exception conditions and errors associated with command processing and the sequencing of commands.

11.10.1 Parameter Rounding

Certain parameters sent to an ATAPI Device with various commands contain a range of values. ATAPI devices may choose to implement only selected values from this range. When the ATAPI Device receives a value that it does not support, it either rejects the command (CHECK CONDITION status with ILLEGAL REQUEST sense key) or it rounds the value received to a supported value. The ATAPI device shall reject unsupported values unless rounding is permitted in the description of the parameter.

Rounding of parameter values, when permitted 1 , shall be performed as follows - An ATAPI device that receives a parameter value that is not an exact supported value shall adjust the value to one that it supports and shall return CHECK CONDITION status with a sense key of RECOVERED ERROR. The additional sense code shall be set to ROUNDED PARAMETER. The Host Computer is responsible for issuing an appropriate command to learn what value the ATAPI device has selected.

11.11 Unit Attention Condition

The ATAPI device shall generate a unit attention whenever the ATAPI device has been reset by a hard reset condition, or by a power-on reset. The ATAPI device shall also generate a unit attention condition whenever one of the following events occurs:

1. A removable Disc or Cartridge may have been changed.

2. The version or level of microcode has been changed.

3. INQUIRY or Packet Identify Drive Data has been changed.

4. The mode parameters in effect for the Host Computer have been restored from non-volatile memory.

5. Any other event occurs that requires the attention of the Host Computer.

6. Any Disc or Cartridge has been manually moved within a Changer.

The ATAPI device may queue unit attention conditions. After the first unit attention condition is cleared, another unit attention condition may exist (e.g. a power on condition followed by a microcode change condition).

The unit attention condition shall persist, until the Host Computer clears the condition as described in the following paragraphs.

If an INQUIRY command is received from an Host Computer with a pending unit attention condition, the ATAPI device shall perform the INQUIRY command and shall not clear the unit attention condition. If a REQUEST SENSE command is received from a Host Computer with a pending unit attention condition, then the ATAPI device shall either:

1. report any pending sense data and preserve the unit attention condition, or,

2. report the unit attention condition, may discard any pending sense data, and clear the unit attention condition.

If an Host Computer issues a command other than INQUIRY or REQUEST SENSE while a unit attention condition exists for that Host, the ATAPI device shall not perform the command and shall report CHECK CONDITION status unless a higher priority status as defined by the ATAPI device is also pending (e.g. BUSY).

> 1. Generally, the ATAPI device should adjust maximum-value fields down to the next lower supported value than the one specified by the Host Computer. Minimum-value fields should be rounded up to the next higher supported value than the one specified by the Host Computer. In some cases, the type of rounding (up or down) is explicitly specified in the description of the parameter.

11.12 Commands and Parameters

The ATAPI commands were derived from the SCSI command set.

With the exception of the CD-ROM MSF addressing technique, the interface uses logical rather than physical addressing for all data blocks. Each Device may be interrogated to determine how many blocks it contains.

11.12.1 Operation Code Types

Table 219 - Operation Code Types

Operation Code Type	Description
M	Mandatory - Commands so designated *shall* be implemented in order to meet the minimum requirement of this Specification.
O	Optional - Commands so designated, if implemented, *shall* be implemented as defined in this Specification.
R	Reserved - Operation codes so designated *shall not* be used. They are reserved for future extensions to this Specification.

Commands are classified as mandatory, optional, or vendor-specific. ATAPI devices are required to implement all mandatory commands and may implement other commands as well. ATAPI devices contain commands that facilitate the writing of self-configuring software drivers that can discover all necessary attributes without prior knowledge of specific peripheral characteristics (such as storage capacity).

Table 220 - Packet Commands for ATAPI C/DVD Devices

Command Description	Opcode	Type	Reference
FORMAT UNIT	04h	M	section A-6 on page 267
FLUSH CACHE	35h	M	section 9.1.1 on page 89
GET EVENT STATUS NOTIFICATION	4Ah	M	section 9.1.2 on page 91
INQUIRY	12h	M	section 9.1.3 on page 97
LOAD/UNLOAD C/DVD	A6h	O	section 9.1.4 on page 101
MECHANISM STATUS	BDh	M	section 9.1.5 on page 103
MODE SELECT (10)	55h	M	section 9.1.6 on page 107
MODE SENSE (10)	5Ah	M	section 9.1.7 on page 109
PAUSE/RESUME	4Bh	M*	section 10.1.1 on page 177
PLAY AUDIO (10)	45h	M*	section 10.1.2 on page 179
PLAY AUDIO MSF	47h	M*	section 10.1.3 on page 182
PLAY CD	BCh	O	section 10.1.4 on page 185
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	section 9.1.9 on page 131
READ (12)	A8h	M	section 9.1.10 on page 133
READ C/DVD CAPACITY	25h	O	section 9.1.12 on page 141
READ CD	BEh	M	section 10.1.5 on page 189
READ CD MSF	B9h	M	section 10.1.6 on page 201
READ DISC INFORMATION	51h	M	section 10.1.7 on page 203
READ DVD STRUCTURE	ADh	M	section 9.1.11 on page 135
READ FORMATTED CAPACITIES	23h	M	section 9.1.17 on page 159
READ HEADER	44h	M	
READ TOC/PMA/ATIP	43h	M	section 10.1.10 on page 221
READ TRACK INFORMATION	52h	M	section 10.1.11 on page 235
REPORT KEY	A4h	M	section 9.1.15 on page 151
REQUEST SENSE	03h	M	section 9.1.18 on page 163
SCAN	BAh	M*	section 10.1.12 on page 241
SEEK	2Bh	M	section 9.1.19 on page 171
SEND KEY	A3h	M	section 9.1.13 on page 143
START STOP UNIT	1Bh	M	section 9.1.14 on page 147
STOP PLAY / SCAN	4Eh	M*	section 10.1.13 on page 245
TEST UNIT READY	00h	M	section 9.1.20 on page 173
VERIFY (12)	AFh	O	section A-7 on page 271
WRITE DVD STRUCTURE	BFh	O	section 9.1.11 on page 135
WRITE (12)	AAh	O	section A-8 on page 273
WRITE and VERIFY (12)	AEh	O	section A-9 on page 275

Key: M = command implementation is mandatory.
O = command implementation is optional.
* = indicates an Audio command. If any audio command is implemented, then all audio commands shall be implemented.