PIONEER proposal:
Group 3 time out for MMC device

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Preface

Group 3 time out proposal is proposed with Enhanced Defect Reporting method for Logical unit assisted Software Defect Management. But Group 3 time out is not limited for defect management. So this document describes Group 3 time out proposal only.

Table of contests

1. Study of current time out model

1.1. Problem

Two problems are reported. 1: Host can not calculate actual time out when drive terminates Read command and Write command with fatal error. 2: In case of real-time streaming, ordinary retry time length of drive till fatal error is too long to control by host.

1.2. No method to determine the command operation time length

If there is no fatal error, Read command and Write command should be performed smoothly. Once a fatal error occurs, host needs to perform recovery sequence or retry action within reasonable time length of the operation. Because some persons may enjoy the real-time operation. Real-time data may be transferred to host during retry action. But there is no method to determine when the logical unit terminates the command with Check Condition at the fatal error. To adjust host recovery sequence, a method to determine the command operation time length is necessary.

1.3. Group 1 time out

Group 1 time out is defined for Read command and Write command. But this time out model does not consider command specific parameter that is transfer block length. The time needed to perform a Read command or a Write command depends on transfer block length. If the value of transfer block length is very big, it takes more than 10 minutes. So many drives report 1 hour or such very long time in Group 1 time out field to cover such extreme case. Host can not calculate actual time out from Group 1 time out value.

1.4. Long retry time length for real-time streaming

Streaming bit is defined in Read12 command and Write12 command to handle real time stream data. Usually these command with Streaming=1 must be performed quickly. The time length of retry sequence of normal read operation and write operation is too long to perform real-time operation of host. Because long retry time itself disturbs the real time streaming. If fatal error has happened, host needs to recover from the fatal error. The long retry time makes the recovery difficult. For real-time streaming purpose, another time out group is necessary.

1.5. Retry Write command at fatal error

When a fatal error occurs on Write 12 command with Streaming=1, it is dangerous to perform retry write sequence by another write command. Because incomplete write and write failure may cause unrecoverable physical problem on the disc. Read 12 command with Streaming=1 is not usable to find good area to write. Because Read 12 command with Streaming=1 may not report EDC error of the sector. To find new good area, another command is necessary.

2. Group 3 time-out for Real time streaming and fixed value

New Group time-out and non changeable value proposal.

2.1. Group 3 time-out for Real time streaming

To adjust application setting, observation of expected time length for the command is necessary. Group 3 time-out is assigned for this proposes. Drive must terminate Read 12/Write 12 command with Streaming=1 and Verify command with G3tout bit=1, within Expected time length defined as follows.

Expected time (1) =Group3 time unit * CEIL(Transfer length / **Unit length**)+ trace time for requested blocks

Group 3 time unit: a unit for Group 3 time out that correspond to read/write one sector

Unit length: a unit of block length correspond to increase a unit of Group 3 time unit

~~Unit length shall be integer multiple of blocking factor.~~

trace time: time to read/write blocks excluding access time and read/write time of the first sector.

Recommended value for Group 3 time unit is 1 to 5 seconds.

Recommended value for Unit length is 256 sectors ~~or more for DVD media~~. It is recommended that transfer length and verification length are set to smaller than Unit length value.

Expected time of Group 3 time out has following three exceptions.

Exception 1: First time OPC time

Exception 2: Sync cache time

Exception 3: Power state transition time to Active state

Group 3 time unit value shows the maximum time of operation when the transfer length field is set to 1 when Power state of drive is Active state. (In case of DVD-RAM, Group 3 time unit value should include 1 zone transition time.)

Host can control the occurrence of these exceptions by command e.g. Send OPC command and Sync cache command. And the occurrence of these exceptions is rare case. So it is not necessary to treat these exceptions as error.

If Group 3 time-out is supported, G3tout bit of Verify command shall be supported as described in Verify(10) command.

2.2. Actual play time for requested sectors

Group 3 time out value shows the minimum time of operation when the transfer length field is set to 1. If transfer length is lager than 1, Expected time is increased to reflect the transfer length of the command. For example, in case of 1X CLV of DVD media, read operation takes 1.48msec/sector. If Group 3 time value is 3 sec and transfer length is 160, Expected time is 3.24 sec (=3+0.00148*(160-1)).

The transfer length field value of usual Read/Write command is assumed 32 and so on. The actual play time for the requested sectors of usual Read/Write command is very small.

2.3. Exception 1: Time for the first time OPC

Optimum Power Calibration before a write operation takes several seconds. When OPC is performed, Logical unit can expand Expected time with extra time for the first OPC.

Expected time with OPC =time for the first OPC + Expected time (1)

To avoid this exception, host should issue SendOPC command with DoOPC=1.

2.4. Exception 2: Sync cache time

If logical unit has write data in buffer, when logical unit receives Read 12 command with Streaming=1 or Verify command with G3tout=1, logical unit shall write the data in buffer. Then logical unit shall read the specified blocks. In this case, additional Expected time for Sync cache is added to the Expected time for Read 12 command with Streaming=1 and Verify command with G3tout=1.

Expected time for Sync cache =Group3 time + write time for buffered sectors
Expected time = Expected time for Sync cache + Expected time (1)

Host can assume the Expected time for Sync cache via Read Buffer Capacity command. For example, if device has 2M bytes buffer, device can have about 60 ECC blocks of write data in buffer. In case of 1X CLV of DVD media, Expected time for Sync cache is 4.42 sec (= 3 + 0.00148*(960-1))

To avoid this exception, host should issue Sync cache command.

Logical unit shall report the length of the buffer via Read Buffer capacity command if Group3 bit in the Time-out Feature is set to 1 and the Time-out Feature is current.

2.5. Exception 3: Power state transition time to Active state

When drive is in Idle state or Standby state, drive to be Active state before a operation, it takes a few seconds. When Power state transition is performed, Logical unit can expand Expected time with extra time for the Power state transition.

Expected time with Power state transition = time for the Power state transition + Expected time (1)

To avoid this exception, host should issue Start/Stop command with Strat=1, LoRj=0 and Power condition=0.

2.6. Relation ship of Group 3 time unit and Unit length

Expected time of the command termination will be increased by Group 3 time unit when transfer block length every is increased by Unit length as shown in Figure 0. Changing Group 3 time unit causes big direct impact to host software. Therefor Group 3 time unit value shall not be changed with medium change. If adjustment of command termination time on different media is necessary, different Unit length value for different media shall be used.

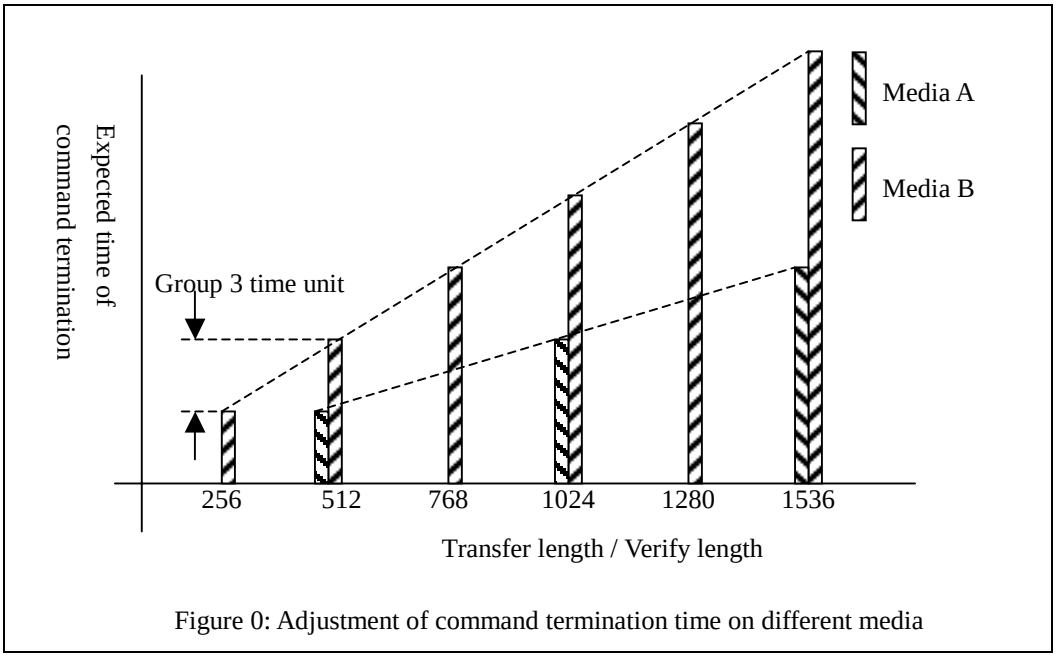


Figure 0: Adjustment of command termination time on different media

2.7. G3tout bit of Verify command

If G3tout bit of Verify command is set to 1, Logical unit shall certify the specified area within Group 3 time unit.

When Write 12 command with Streaming bit=1 was encountered fatal error, host may try to write the streaming data to other disc space. To check the status of newly allocated space, Write 12 command with Streaming bit=1 and Read 12 command with Streaming bit=1 are not appropriate command. For this purpose, Verify command with G3tout bit=1 is used. Therefore logical unit needs not perform long retry during certification. If the VERIFY command is terminated with GOOD status, the area should be good for Streaming data writing.

2.8. Recovery from fatal error of Streaming

When fatal error happens at streaming, current Real-time streaming modes defines that it is end of streaming. But for user convenience, host application needs to recover/fix the fatal error condition. Otherwise, the next recording operation should be encountered same fatal error. Because Streaming bit=1 suspends replacement of the defective block by the device, the defective blocks of the medium is still registered as free space. The next operation may start at the defective blocks again.

Streaming fatal error

Seamless recovery

Host allocates buffer for retry action.

Device terminates Read(12), Write(12) command with Streaming=1 within Group3 time unit. If host plans to perform certain times of recovery action, host needs to have buffer to store the data for the time length of retry.

Assumed empty buffer size for recording recovery and assumed data size in the buffer for playback recovery is shown by formula 1.

Size (KB)=data rate (KB/S) x Group3 time unit (S) x number of recovery action: formula 1

Non seamless

Some data may be lost during recovery.

Read(12) command with Streaming=1

In case of streaming playback operation, host can skip certain time length of the content (e.g. video data). The time length is passed till device reported fatal error. When data in the buffer is empty, host can assume the data size to be skipped by formula 1.

Write(12) command with Streaming=1

In case of streaming recording operation, some amount of data may be lost due to buffer overflow. Host can assume the data size to be lost by formula 1.

No on track pre-pit address mark media (e.g. C/DVD-RW)

In case of RW media that does not have pre-pit address mark on recording track, de-track writing or wrong track writing may not be detected immediately. Spot or scratch may cause de-track/cross-track writing. Sometime this may cause unrecoverable problem on the medium. Therefore using another Write(12) command with streaming=1 for retry is not appropriate. Refer to figure 2 - example of RW media characteristics.

To check the status of newly allocated space, Verify(10) command with G3tout=1 should be used.

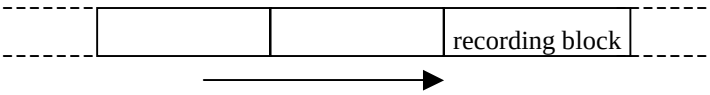
On track pre-pit address mark media (e.g. DVD-RAM)

In case of DVD-RAM media that has pre-pit address mark on recording track, de-track writing or wrong track writing may not cause unrecoverable problem on the medium. Therefore using Write(12) command with streaming=1 for retry is applicable.

Figure 1 - example of Recovery sequence for streaming

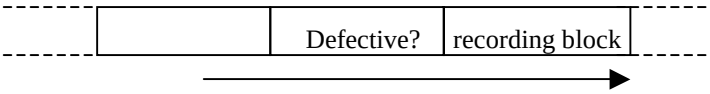
1. Checking the status of newly allocated space

To determine the start position of a recording block on C/DVD-RW media, C/DVD-RW device uses signal that is ATIP Sync of wobble or Land pre-pit Sync in previous block of the recording block. Even if recording block does not have any problem, if previous block has problem and device loses Sync signal, device cannot start recording correctly.



Device traces to find Sync for recording

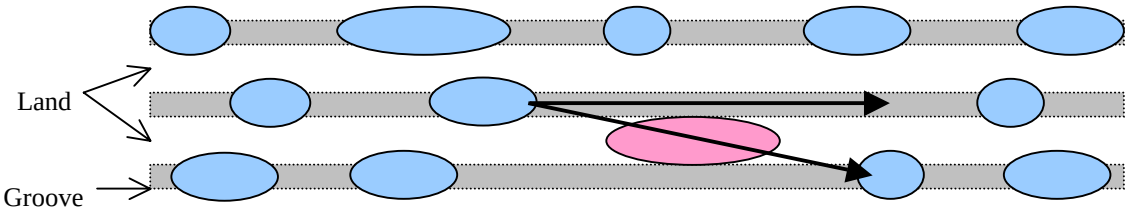
To check the status, certification from previous block of recording block is proper measures.



Verify from previous block of recording block

2. De-track/Cross-track problem

C/DVD-RW media uses Land as guard band and Groove as recording track. C/DVD-RW device uses Groove signal for tracking servo. Read only device uses recorded mark signal for tracking servo. If recorded mark was created on Land, Read only device may not be able to follow correct track and may encountered read failure. C/DVD-RW device cannot erase the recorded mark on Land area. So this problem is unrecoverable usually.



ROM device may not be able to follow track.

figure 2 - example of RW media characteristics

2.9. Recommended Time-out value handling

The G1 Minimum Time-out field, G2 Minimum Time-out field and G3 Time unit field in the Mode Parameter Page 1Dh may not be changeable. Even if the field is changeable, device may round up the host specified value because the device has its own minimum time to perform retry in a command. Host should check whether these fields are changeable or not by issuing MODE SENSE command with Changeable Value prior to issue MODE SELECT command. Also host should check whether the selected value is accepted by issuing MODE SENSE command with Current value after the MODE SELECT command.

3. Command description

To enable necessary functionality, Pioneer proposes following command and parameter modification and addition.

3.1. Get Configuration command (46h)

Add new Group3 bit to feature 0105h: Time-out Feature.

13.4.2.27 Feature 0105h: Time-out Feature

Bit / Byte	7	6	5	4	3	2	1	0
0	MSB Feature Code							
1	0105h							LSB
2	Reserved		Version=1				Persistent	Current
3	Additional Length = 04h							
4	Reserved							Group3
5	Reserved							
6	MSB **Unit length**							
7								LSB

The Version filed shall be set to 1.

Group3 bit of one indicates that Logical unit supports Group3 time-out in *Time-out & Protect* Mode Page (1Dh). If Real-time Streaming Feature is not supported, this bit shall not be set to one. If this bit is set to 1, Logical unit shall support handling of G3tout bit in Verify command.

Unit length: a unit of block length corresponds to increase a unit of Group 3 time unit
When the Group3 bit is set to 0, Unit length field is not valid.

3.2. Time-out & Protect Mode Page

Add Group 3 time unit capability.

13.11.35 Time-out & Protect Mode Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Dh)					
1	Page length (0Ah)							
2	Reserved							
3	Reserved							
4	Reserved				**G3Enable**	TMOE	DISP	SWPP
5	Reserved							
6	MSB Group 1 Minimum Time-out (Seconds)							
7								LSB
8	MSB Group 2 Minimum Time-out (Seconds)							
9								LSB
10	MSB **Group 3 Time unit** (100 milliseconds)							
11								LSB

G3Enable bit, when set to 1, enables the Group 3 Time-out capability. A G3Enable bit of zero disables the Group 3 Time-out capability. **The default value of this bit is vender specific.**

Group 3 Time unit (100 milliseconds) shall specify termination time length of Command set in Group 3 time out. If time-out is happened, Logical unit shall not generate ASC/ASCQ 6/2E/00

INSUFFICIENT TIME FOR OPERATION and/or Device Busy Class Events to expand working time. Logical unit shall terminate the command as defined by the command. It may be fatal error termination.

3.3. Read 12 command

If Streaming bit is set to 1, device supports Group3 time-out and G3Enable bit in Mode Page 1Dh is set to 1, device shall terminate this command within Group 3 time-out.

3.4. Verify command

13.47 Table 467 - VERIFY (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0								
1	LUN (Obsolete)			DPO	Reserved	BlkVfy	BytChk	RelAdr
2	MSB							
3				Logical Block Address				
4								
5								LSB
6	G3tout	Reserved						
7	MSB							
8				Verification length				LSB
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

If device supports Group 3 time-out, G3tout bit of one shall not be considered as ILLEGAL REQUEST. If G3tout bit is set to 1, C/DVD-RW profile is current and G3Enable bit in Mode Page 1Dh is set to 1, device shall terminate this command within Group 3 time-out. Even in other cases, device should not take long time to retry in the command.

3.5. Write 12 command

If Streaming bit is set to 1, device supports Group3 time-out and G3Enable bit in Mode Page 1Dh is set to 1, device shall terminate this command within Group 3 time-out.