

SMART Device Error Log Reporting

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The following are proposed additions/modifications to the ATA/ATAPI-5 standard to provide the SMART device error log feature. Clause references are to ATA/ATAPI-5 revision 0a.

Add the following to clause 6.12 Self-monitoring, analysis, and reporting technology feature set.

6.12.7 SMART device error log reporting

Logging of reported errors is an optional SMART feature. If error logging is supported by a device, it is indicated in byte 370 of the SMART READ DATA command response. If error logging is supported, the device shall provide information on the last five errors that the device reported as described in the SMART READ LOG SECTOR command (see 8.41.xx). The device may also provide additional vendor specific information on these reported errors.

If error logging is supported, it shall not be disabled when SMART is disabled. Error log information shall be gathered at all times the device is powered on except that logging of errors when in a reduced power mode is optional. If errors are logged when in a reduced power mode, the reduced power mode shall not change. Disabling SMART shall disable the delivering of error log information via the SMART READ LOG SECTOR command.

If a device receives a firmware modification, all error log data shall be discarded and the device error count for the life of the device shall be reset to zero.

Modify table 22 in clause 8.41 SMART to appear as follows.

Table 22 – SMART Feature register values

Value	Command
00h-CFh	Reserved
D0h	SMART READ DATA
D1h	Obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
D3h	SMART SAVE ATTRIBUTE VALUES
D4h	SMART EXECUTE OFF-LINE IMMEDIATE
D5h	SMART READ LOG SECTOR
D6h	SMART WRITE LOG SECTOR
D7h	Obsolete
D8h	SMART ENABLE OPERATIONS
D9h	SMART DISABLE OPERATIONS
DAh	SMART RETURN STATUS
DBh	obsolete
DCh-DFh	reserved
E0h-FFh	vendor specific

Modify table 23 in clause 8.41.5.8 to appear as follows.

Table 23 – Device SMART data structure

Byte	F/V	Descriptions
0-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Vendor specific
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-369	F	SMART capability
370	F	Error logging capability 7-1 Reserved 0 1=Device error logging supported
371-385	R	Reserved
386-510	X	Vendor specific
511	V	Data structure checksum
Key: F=the content of the byte is fixed and does not change. V=the content of the byte is variable and may change depending on the state of the device or the commands executed by the device. X=the content of the byte is vendor specific and may be fixed or variable. R=the content of the byte is reserved and shall be zero.		

Add the following clause.

8.41.xx SMART READ LOG SECTOR

8.41.xx.1 Command code

B0h with the content of the Features register equal to D5h.

8.41.xx.2 Feature set

SMART feature set.

- Optional when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.xx.3 Protocol

PIO data in (see 9.7).

8.41.xx.4 Inputs

The Features register shall be set to D5h. The Sector Count register shall be set to 01h. The Sector Number register shall be set to indicate the log sector desired. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D5h							
Sector Count	01h							
Sector Number	Log sector address							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na			
Command	B0h							

Sector number - Indicates the log sector to be returned as described in table aa. If this command is implemented, all address values for which the contents are defined shall be implemented and all address values defined as host vendor specific shall be implemented. These host vendor specific sectors may be used by the host to store any data desired. If a host vendor specific sector has never been written by the host, when read the content of the sector shall be zeros. Device vendor specific sectors may be used by the device vendor to store any data and need only be implemented if used.

Table aa – Log sector addresses

Log sector address	Content	R/W
00h	Reserved	TBD
01h	SMART error log	RO
02h-05h	Reserved for SMART error log extension	RO
06h	Reserved for SMART self test log	RO
07h-7Fh	Reserved	TBD
80h-9Fh	Host vendor specific	R/W
A0h-BFh	Device vendor specific	VS
C0h-FFh	Reserved	TBD

Key –
 RO - Sector is read only by the host.
 R/W - Sector is read or write by the host.
 TBD - Sector is reserved and read/write status will be assigned when the address is assigned.
 VS - Sector is vendor specific thus read/write ability is vendor specific.

Device/Head register -
 DEV shall indicate the selected device.

8.41.xx.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

8.41.xx.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Sector Number, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	na	IDNF	na	ABRT	na	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	Na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

UNC shall be set to one if SMART log sector is uncorrectable.

IDNF shall be set to one if SMART log sector's ID field could not be found or data structure checksum error occurred.

ABRT shall be set to one if this command is not supported, if SMART is not enabled, if the log sector address is not implemented, or if other register values are invalid.

ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be set to one indicating that a device fault has occurred.

DRQ shall be cleared to zero indicating that there is no data to be transferred.

ERR shall be set to one if any Error register bit is set to one.

8.41.xx.7 Prerequisites

DRDY set to one. SMART enabled.

8.41.xx.8 Description

This command returns the indicated log sector to the host.

Table bb defines the 512 bytes that make up the SMART error log sector. All multi-byte fields shown in this structure follow the byte ordering described in 3.2.7.

Table bb – SMART error log sector

Byte	Descriptions
0	SMART error log version
1	Error log pointer
2-91	First error log data structure
92-181	Second error log data structure
182-271	Third error log data structure
272-361	Fourth error log structure
362-451	Fifth error log structure
452-453	Device error count
454-510	Reserved
511	Data structure checksum

The value of the SMART error log version byte shall be 01h.

The error log pointer indicates the error log data structure representing the most recent error. Only values 1 through 5 are valid.

An error log data structure shall be presented for each of the last five errors reported by the device. These error log data structure entries are viewed as a circular buffer. That is, the first error shall create the first error log data structure; the second error, the second error log structure; etc. The sixth error shall create an error log data structure that replaces the first error log data structure; the seventh error replaces the second error log structure, etc. The error log pointer indicates the most recent error log structure. If fewer than five errors have occurred, the unused error log structure entries shall be zero filled. Table cc describes the content of a valid error log data structure.

The device error count field shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device. These errors shall include UNC errors, IDNF errors for which the address requested was valid, servo errors, write fault errors, etc. This count shall not include errors attributed to the receipt of faulty commands such as commands codes not implemented by the device or requests with invalid parameters or invalid addresses. If the maximum value for this field is reached, the count shall remain at the maximum value when additional errors are encountered and logged.

Table cc – Error log data structure

Byte	Descriptions
n - n+11	First command data structure
n+12 - n+23	Second command data structure
n+24 - n+35	Third command data structure ...
n+36 - n+47	Fourth command data structure
n+48 - n+59	Fifth command data structure
n+60 - n+89	Error data structure

The fifth command data structure shall contain the command or reset for which the error is being reported. The fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported, the third command data structure should contain the command or reset preceding the one in the fourth command data structure, etc. If fewer than four commands and resets preceded the command or reset for which the error is being reported, the unused command data structures shall be zero filled, for example, if only three commands and resets preceded the command or reset for which the error is being reported, the first command data structure shall be zero filled. In some devices, the hardware implementation may preclude the device from reporting the commands that preceded the command for which the error is being reported or that preceded a reset. In this case, the

command data structures shall be zero filled. If the command data structure represents a command or software reset, the content of the command data structure shall be as shown in figure dd. If the command data structure represents a hardware reset, the content of byte n shall be FFh, the content of bytes n+1 through n+7 are vendor specific, and the content of bytes n+8 through n+11 shall contain the timestamp.

The error data structure shall contain the error description of the command for which an error was reported as described in table ee. If the error was reported for a hardware reset, the content of bytes n+1 through n+7 shall be vendor specific and the remaining bytes shall be as defined in table ee.

Table dd – Command data structure

Byte	Descriptions
n	Content of the Device Control register when the Command register was written.
n+1	Content of the Features register when the Command register was written.
n+2	Content of the Sector Count register when the Command register was written.
n+3	Content of the Sector Number register when the Command register was written.
n+4	Content of the Cylinder Low register when the Command register was written.
n+5	Content of the Cylinder High register when the Command register was written.
n+6	Content of the Device/Head register when the Command register was written.
n+7	Content written to the Command register.
n+8 - n+11	Timestamp

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap around.

Table ee – Error data structure

Byte	Descriptions
n	Reserved
n+1	Content of the Error register after command completion occurred.
n+2	Content of the Sector Count register after command completion occurred.
n+3	Content of the Sector Number register after command completion occurred.
n+4	Content of the Cylinder Low register after command completion occurred.
n+5	Content of the Cylinder High register after command completion occurred.
n+6	Content of the Device/Head register after command completion occurred.
n+7	Content written to the Status register after command completion occurred.
n+8 - n+26	Extended error information
n+27	State
n+28 - n+29	Life timestamp

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap around.

Extended error information shall be vendor specific.

State shall contain a value indicating the state of the device when command was written to the Command register or the reset occurred as described in table ff.

Life timestamp shall contain the power-on lifetime of the device in hours when command completion occurred.

Table ff – State field values

Value	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle with BSY cleared to zero
x4h	Executing SMART Off-line or self test
x5h-xAh	Reserved
xBh-xFh	Vendor unique
The value of x is vendor specific.	

Sleep indicates the reset for which the error is being reported was received when the device was in the Sleep mode.

Standby indicates the command or reset for which the error is being reported was received when the device was in the Standby mode.

Active/Idle with BSY cleared to zero indicates the command or reset for which the error is being reported was received when the device was in the Active or Idle mode and BSY was cleared to zero.

Executing SMART off-line or selftest indicates the command or reset for which the error is being reported was received when the device was in the process of executing a SMART off-line or selftest.

8.41.yy SMART WRITE LOG SECTOR

8.41.yy.1 Command code

B0h with the content of the Features register equal to D6h.

8.41.yy.2 Feature set

SMART feature set.

- Optional when the SMART feature set is implemented.
- Use prohibited when the PACKET Command feature set is implemented.

8.41.yy.3 Protocol

PIO data out (see 9.8).

8.41.yy.4 Inputs

The Features register shall be set to D6h. The Sector Count register shall be set to 01h. The Sector Number register shall be set to indicate the log sector to be written. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D6h							
Sector Count	01h							
Sector Number	Log sector address							
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	obs	na	obs	DEV	na			
Command	B0h							

Sector number - Indicates the log sector to be written as described in table aa. If this command is implemented, all address values defined as host vendor specific shall be implemented. These host vendor specific sectors may be used by the host to store any data desired. Device vendor specific may be used by the device vendor to store any data and need only be implemented if used. If the host attempts to write to a read only (RO) log sector address, the device shall return command aborted.

Device/Head register -

DEV shall indicate the selected device.

8.41.yy.5 Normal outputs

Register	7	6	5	4	3	2	1	0
Features	na							
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be cleared to zero.

DRQ shall be cleared to zero.

ERR shall be cleared to zero.

8.41.yy.6 Error outputs

If the device does not support this command, if SMART is disabled, or if the values in the Features, Sector Number, Cylinder Low, or Cylinder High registers are invalid, the device shall return command aborted. If the host attempts to write to a read only (RO) log sector address, the device shall return command aborted.

Register	7	6	5	4	3	2	1	0
Error	na	na	na	IDNF	na	ABRT	na	obs
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	Na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

Error register -

IDNF shall be set to one if SMART log sector's ID field could not be found.

ABRT shall be set to one if this command is not supported, if SMART is not enabled, if the log sector address is not implemented, or if other register values are invalid.

ABRT may be set to one if the device is not able to complete the action requested by the command.

Device/Head register -

DEV shall indicate the selected device.

Status register -

BSY shall be cleared to zero indicating command completion.

DRDY shall be set to one indicating that the device is capable of receiving any command.

DF (Device Fault) shall be set to one indicating that a device fault has occurred.

DRQ shall be cleared to zero indicating that there is no data to be transferred.

ERR shall be set to one if any Error register bit is set to one.

8.41.yy.7 Prerequisites

DRDY set to one. SMART enabled.

8.41.yy.8 Description

This command writes a 512 byte data sector to the indicated log sector.