Library Specification
for
Lifetime and Log SD Card

Sony Corporation

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Notes

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1. Introduction

The **Lifetime and Log SD Card** (hereafter, the "SD card") is a special-purpose microSD card that allows users to obtain the card's remaining lifetime information. In addition to the standard SD card's specification, this card is designed based on special access and command specifications.

This document defines the **sonysd** library, which enables obtaining the lifetime information and error log from the SD card.

2. Features of the Lifetime and Log SD Card

The following table shows the features of the SD card.
Note that the power-off detection and write error notification are initially turned off at the system startup or card insertion. To use these features, they shall be turned on each time the system starts or the card is inserted.

Features	Description	Standard SD	Lifetime and Log SD Card
Standard SD capabilities	—	✓	✓
Lifetime notification	Returns the card-guaranteed amount of data that can be written and the accumulated amount of data already written.		✓
Spare block usage notification	Returns the usage rate of spare blocks. This value ranges from 0 to 100, and if the value becomes 100, the card becomes read-only.		✓
Error logging	Returns the log about the write/erase/read error that has occurred within the card.		✓
Power-off detection	Counts the number of times		✓

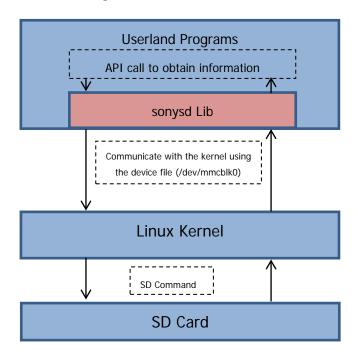|	power disconnection occurred during write/erase operations.		
Write error notification	Returns a write error to the host when it occurs.		✓

3. Software Block Diagram

Figure 1 Block Diagram for SD Card Access

Figure 1 shows the software block diagram illustrating how the **sonysd** library is related to other components within the system.

The **sonysd** library operates in the userland, closely working with the user programs as a shared library. It exposes the information retrieval API to upper applications.

If an application calls an API function to obtain the card information, the library calls ioctl to issue an SD command, and copies the obtained information to the buffer to return to the caller.

4. Available Information from the SD Card Using the Library

4.1. Lifetime Information

Using the **sonysd** library can obtain the following lifetime-related information from the SD card.

Parameter Name	Size	Description
Life Information1	8 bytes	Accumulated amount of data that has been written
Life Information2	8 bytes	Card-guaranteed amount of data that can be written
Data Size per Unit	4 bytes	Size (in sectors) of data to be written when Life Information1 is updated.
Spare Block Rate	4 bytes	Usage rate of spare blocks
Number of Sudden Power Failure	4 bytes	Indicates how many times power disconnection occurred during write/erase operations
Operation Mode	4 bytes	Enables/disables power-off detection and write error notification

4.2. Log Information

Using the **sonysd** library can obtain the following log information from the SD card.

Parameter Name	Size	Description
Error No.	2 bytes	Error log number. This number is not necessarily a contiguous serial number.

Error Type	1 byte	Indicates an error type.
		    Write page error: 0x01
		    Read page error: 0x02
		    Erase block error: 0x03
		    Timeout error: 0x04
		    CRC error: 0x05

Block Type	1 byte	Indicates a block type.

		SLC mode: 0x01
		MLC mode: 0x02
		TLC mode: 0x03
Logical CE	1 byte	Information about the flash memory in which an error occurred
Physical Plane	1 byte	Information about the flash memory in which an error occurred
Physical Block	2 bytes	Information about the flash memory in which an error occurred
Physical Page	2 bytes	Information about the flash memory in which an error occurred
Erase Block Count	4 bytes	Information about how many times a physical block has been erased before the error occurs on that block.
Error Type of Timeout	2 bytes	Indicates the cause of the error. Flash: 0x01 Controller: 0x02
Write Page Error Count	2 bytes	Number of times an error has occurred
Read Page Error Count	2 bytes	Number of times an error has occurred
Erase Block Error Count	2 bytes	Number of times an error has occurred
Timeout Count	2 bytes	Number of times an error has occurred
CRC Error Count	2 bytes	Number of times an error has occurred
SD Command	2 bytes	SD command when an error was detected
Sector Address	4 bytes	Address for which the command was issued to read or write data.
Response	4 bytes	Response from the card for the command issued
SD Command History	-	Describes the last 5 SD commands issued

5.   API Specification

This library provides the following functions.

Table 5-1 List of Service Functions

Function	Description
sonysd_get_info	This function gets lifetime information from the SD card.
sonysd_get_errlog	This function gets an error log from the SD card.
sonysd_set_operation_mode	This function sets the operation mode for the SD card.
sonysd_set_devpath	This function changes the path of the device file.
sonysd_debug_print_info	This function prints information for debugging.

5.1.   Getting Lifetime Information from the SD Card

5.1.1. sonysd_get_info

This function issues the ioctl command to get lifetime information from the SD card. The result is stored in a data structure.

[Format]

      int sonysd_get_info(sonysd_info *info);

[Argument]

Type	Name	Description	IN/OUT
sonysd_info *	Info	Specify a pointer to the sonysd_info structure. The structure shall be allocated by the caller.	OUT

[Return value]

Value	Description
SONYSD_SUCCESS	Success.
SONYSD_ERR_OTHER	Error. Failed to get lifetime information.
SONYSD_ERR_NOCARD	Error. SD card is not inserted.
SONYSD_ERR_UNSUPPORT	Error. The SD card doesn't support lifetime notification.

[Type / condition for this API call]

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

sonysd_info is a structure which has the following members.

Type	Name	Description
unsigned long long	life_information_num	Numerator of life information.
unsigned long long	life_information_den	Denominator of life information.
unsigned long	data_size_per_unit	Unit of life_information_num and life_information_den.
unsigned long	spare_block_rate	Usage rate of spare blocks.
unsigned long	num_of_sudden_power_failure	Number of times power disconnection occurred
unsigned long	operation_mode	This value indicates whether the SD card's special features are enabled.

5.2. Getting an Error Log from the SD Card

5.2.1. sonysd_get_errlog

This function issues the ioctl command to get an error log from the SD card. The result is stored in a data structure.

[Format]

int sonysd_get_errlog(sonysd_errlog *log);

[Argument]

Type	Name	Description	IN/OUT
sonysd_errlog *	log	Specify a pointer to the sonysd_errlog structure. The structure shall be allocated by the caller.	OUT

[Return value]

Value	Description
SONYSD_SUCCESS	Success.
SONYSD_ERR_OTHER	Error. Failed to get lifetime information.
SONYSD_ERR_NOCARD	Error. SD card is not inserted.
SONYSD_ERR_UNSUPPORT	Error. The SD card doesn't support lifetime notification.

[Type / condition for this API call]

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

sonysd_errlog is a structure which has the following members.

Type	Name	Description
int	count	Number of error items.
sonysd_err[]	items	Array of sonysd_err.

sonysd_err is a structure which has the following members.

Type	Name	Description
unsigned short	error_no	Error No.
unsigned char	error_type	Error Type
unsigned char	block_type	Block Type
unsigned char	logical_CE	Logical CE
unsigned char	physical_plane	Physical Plane
unsigned short	physical_block	Physical Block
unsigned short	physical_page	Physical Page
unsigned short	error_type_of_timeout	Erase Block Count
unsigned long	erase_block_count	Error Type of Timeout
unsigned short	write_page_err_count	Write Page Error Count
unsigned short	read_page_error_count	Read Page Error Count
unsigned short	erase_block_error_count	Erase Block Error Count
unsigned short	timeout_count	Timeout Count
unsigned short	crc_error_count	CRC Error Count
sonysd_cmd[]	command	Array of sonysd_cmd. 0th item is the command that triggered this error. 1st to 5th items are the commands issued before this error occurred.

sonysd_cmd is a structure which has the following members.

Type	Name	Description
unsigned short	cmd	SD Command.
unsigned long	addr	Sector Address.
unsigned long	resp	Response.

5.3. Setting the Operation Mode for the SD Card

5.3.1. sonysd_set_operation_mode

This function issues the ioctl command to set the operation mode for the SD card. The operation mode is initially OFF when the operating system boots or the SD card is inserted (default). To use the features of detecting power disconnection during an operation or getting notification about a write error, the operation mode shall be set to ON every time the system starts up or the SD card is inserted.

[Format]

    int sonysd_set_operation_mode(unsigned long on_off);

[Argument]

Type	Name	Description	IN/OUT
unsigned long	on_off	0: Operation mode is OFF (default) 1: Operation mode is ON	IN

[Return value]

Value	Description
SONYSD_SUCCESS	Success.
SONYSD_ERR_OTHER	Error. Failed to get lifetime information.
SONYSD_ERR_NOCARD	Error. SD card is not inserted.
SONYSD_ERR_UNSUPPORT	Error. The SD card doesn't support lifetime notification.

[Type / condition for this API call]

API type	Context	Multiple call

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

5.4.   Changing the Path of the Device File

5.4.1. sonysd_set_devpath

This function changes the path of the device file for the MMC block device driver. The default path is /dev/mmcblk0, and it does not need to be changed except in a special case.

[Format]

   void sonysd_set_devpath(const char* path);

[Argument]

Type	Name	Description	IN/OUT
const char*	path	Path of the device file for MMC block device driver.	IN

[Return value]

   None.

[Type / condition for this API call]

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

5.5.   Printing Information for Debugging

5.5.1. sonysd_debug_print_info

This function prints life information stored in the sonysd_info structure to the standard error output. This function is provided for the debugging purpose.

[Format]

    void sonysd_debug_print_info(sonysd_info *info);

[Argument]

Type	Name	Description	IN/OUT
sonysd_info*	info	Pointer to the sonysd_info structure.	IN

[Return value]

    None.

[Type / condition for this API call]

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

5.5.2. sonysd_debug_print_errlog

[Function]

This function prints an error log stored in the sonysd_errlog structure to the standard error output.

[Format]

    void sonysd_debug_print_errlog(sonysd_errlog *errlog);

[Argument]

Type	Name	Description	IN/OUT
sonysd_errlog*	log	Pointer to the sonysd_errlog structure.	IN

[Return value]

    None.

[Type / condition for this API call]

API type	Context	Multiple call

API type	Context	Multiple call
Synchronous		Inhibited

[Note]

6.　　About the Test Program

The test program **sonysd_test.c** is provided in the same folder as the library source file.

This program can be used as a sample program to understand how to use API functions.

The **sonysd_test** can be used as follows:

```
% ./sonysd_test info
Obtains lifetime information and displays it.
```

```
% ./sonysd_test err
Obtains an error log and displays it.
```

```
% ./sonysd_test on
Sets the operation mode to ON.
```

```
% ./sonysd_test off
Sets the operation mode to OFF.
```

```
% ./sonysd_test info /dev/mmcblk1
Changes the device file for the SD card (the default is /dev/mmcblk0).
```

7. File Configuration

7.1. Source Files

Table 7-1 Source Files

File Name	Description
src/sonysd_lib.c	Implementation of API functions.
src/sonysd_kernel.c	Functions for calling ioctl.
src/sonysd_test.c	Sample program.

7.2. Include Files

Table 7-2 Include Files

File Name	Description
include/sonysd.h	Header file of this library.
src/sonysd_local.h	Header file used locally in the library.

7.3. External Reference Files

Table 7-3 External Reference Files

File Name	Description
None	-

7.4. Other Files

Table 7-4 Other Files

File Name	Description
src/Makefile	Makefile for the library generation.

8. Limitations and Notes

8.1. Access to the SD Card during an API Call

While the following functions are invoked, read or write access to the SD card from a different process or different thread may cause a function failure.

- sonysd_get_info
  If this function fails to obtain information because the SD card is accessed from a different process or different thread, it returns SONYSD_ERR_UNSUPPORT. If it returns SONYSD_SUCCESS, it assures that the information has been correctly read.

- sonysd_get_errlog
  If this function fails to obtain information because the SD card is accessed from a different process or different thread, it returns SONYSD_ERR_UNSUPPORT, or it returns SONYSD_SUCCESS while however storing invalid error information in a structure.

- sonysd_set_operation_mode
  If this function fails to obtain information because the SD card is accessed from a different process or different thread, it returns SONYSD_ERR_UNSUPPORT. If it returns SONYSD_SUCCESS, it assures that the intended value is set.

To avoid these errors, the following conditions shall be met:

- Stop the recording of video or audio before invoking any of these functions.
- Never read from or write to the SD card through the file system when invoking any of these functions.
- Run sync immediately before invoking any of these functions, in order to prevent the OS from accessing the SD card on its own timing.

Note: If these limitations need to be removed for allowing the SD card to be accessed during a function call, the kernel shall be modified. For more details, please contact Sony.

8.2.   Multi-threading and Multi-processing

The functions of this library do not support multi-threading or multi-processing. If multiple threads invoke functions of this library concurrently, those functions may fail. Similarly, if multiple processes invoke functions of this library concurrently, those functions may fail.

If multiple threads or processes use this library's functions, the caller shall use mutex for locking the object.

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