SD Memory Card Specifications

Part 2
FILE SYSTEM SPECIFICATION

Version 1.0

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SD Group

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Part2 FILE SYSTEM SPECIFICATION

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1. General

1.1 Scope

This part specifies the volume structure and file structure of the SD Memory Card (Secure Digital Memory Card). The SD Memory Card file system that defines the logical structure uses FAT file system based on ISO/IEC 9293 standard.

It also supports two areas: one for the Data Area that user can access without mutual authentication and one for the Protected Area that user can access after mutual authentication.

1.2 Normative References

1) ISO/IEC646:1991
Information technology - ISO 7-bit code character set for information interchange

2) ISO/IEC9293:1994
Information technology - Volume and file structure of disk cartridges for information interchange

1.3 Definitions

1.3.1 byte

A string of binary digits operated upon as a unit.

1.3.2 defective sector

A sector that cannot be read or written.

1.3.3 descriptor

A recorded structure containing information about the volume or a file.

1.3.4 file

A named collection of information.

1.3.5 sector / block

A unit of data that can be accessed independently of other units on the SD Memory Card.

1.3.6 partition

An extent of sectors within a volume.

1.3.7 user

A person or other entity that causes the invocation of the services provided by an implementation.

1.3.8 volume

A sector address space as specified in the relevant standard for recording.

1.4 Notations

1.4.1 Numerical notation

Numbers in decimal notation are represented by decimal digits, namely 0 to 9.

Numbers in hexadecimal notation are represented as a sequence of one or more hexadecimal digits namely 0 to 9 and A to F, prefixed by "0x".

ZERO represents a single bit with the value 0.

1.4.2 Arithmetic notation

The notation *ip(x)* shall mean the integer part of *x*.

The notation *ceil(x)* shall mean the minimum integer that is greater than *x*.

1.4.3 Character strings

A value for a sequence of bytes may be specified by a quoted sequence of characters, encoded according to the ISO/IEC 646 standard.

1.4.4 List of acronyms

BP : Byte Position within a certain field, starting with 0 from the first byte of the field.
FAT : File Allocation Table.
FDC : Flexible Disk Cartridge.

1.5 Data types

1.5.1 Numerical values in one-byte fields

A numerical value in a one-byte field shall be recorded as an 8-bit number in one-byte field.

1.5.2 Numerical values in two-byte fields

A numerical value in a two-byte field shall be recorded in the little endian representation. It shall be recorded according to ISO/IEC 9293.

1.5.3 Numerical values in four-byte fields

A numerical value in a four-byte field shall be recorded in the little endian representation. It shall be recorded according to ISO/IEC 9293.

1.5.4 Pairs of 12-bit integers

A pair of 12-bit numbers shall be recorded in three-byte field according to ISO/IEC 9293.

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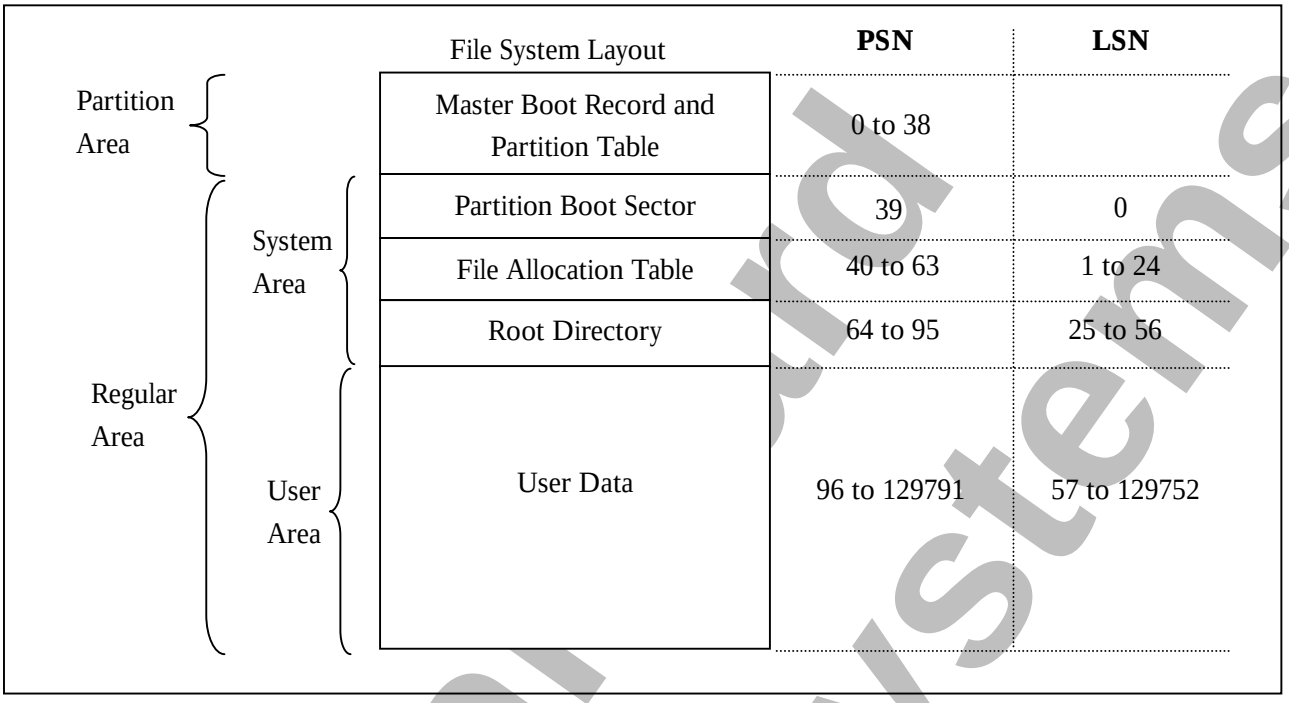
2. Volume Structure

The volume structure of the SD Memory Card is specified in this section. It defines the logical structure of the Data Area. For the identification of the Data Area as a partition, the first sector has Master Boot Record and Partition Table. And the SD Memory Card file system uses the FAT file system (ISO/IEC 9293) and supports both FAT12 and FAT16 as the file system type.

◊ **Figure 2-1 : Example of Volume Structure for Data Area**



PSN : Physical Sector Number

LSN : Logical Sector Number

2.1 Arrangement of the Data Area

2.1.1 Physical Address

Each sector shall be identified by a Physical Address comprising the parameters of SD Memory Card's own.

2.1.2 Physical Sector Number

Each sector on a volume shall be identified by a Physical Sector Number. There shall be a one-to-one correspondence between Physical Address and Physical Sector Number. The Physical Sector Numbers shall be assigned in an ascending sequence, beginning with 0.

2.1.3 Logical Sector Number

Each sector on a partition shall be identified by a Logical Sector Number. The first sector of the partition shall be assigned 0 as Logical Sector Number. There shall be a one-to-one correspondence between Physical Sector Number.

2.1.4 Partition Area and Regular Area

The space on Data Area shall be divided into two parts: Partition Area and Regular Area. And the Regular Area shall be divided into System Area and User Area.

The Partition Area shall occupy sectors with the Physical Sector Numbers 0 to *NOM-1*, where *NOM* is the number of sectors in the Master Boot Record and Partition Table.

The Regular Area is a partition of the volume, and divided into System Area and User Area.

The System Area shall occupy sectors with the Physical Sector Numbers *NOM* to *NOM+SSA*-1, where *SSA* is the number of sectors in the System Area. The System Area shall contain Descriptors that specify the recording format of the Regular Area. No part of any file shall be contained in the System Area.

The User Area shall occupy sectors with the Physical Sector Numbers starting with *NOM+SSA*. The User Area shall contain files and directories, and be recorded user data.

2.2 Arrangement of the User Area

2.2.1 Clusters

The User Area shall be organized into units of allocation called clusters. Each cluster shall consist of the same number of sectors. Each cluster shall be identified by a unique Cluster Number. Cluster Numbers shall be assigned integer number starting with 2.

2.2.2 Status of clusters

A status shall be assigned to each cluster, and shall be one of the following:

- allocated to a file
  The cluster is already allocated.
- available for allocation
  The cluster is prepared for allocate.
- defective
  The cluster is defective. This cluster cannot be allocated.

The status of each cluster shall be identified according to ISO/IEC 9293.

2.3 Arrangement of the Partition Area

The first sector of the Data Area has a Master Boot Record that includes executable codes and Partition Table that includes the information to identify the partition.

◊ **Table 2.3-1 Master Boot Record and Partition Table**

BP	Length	Field Name	Contents
0	446	Master Boot Record	Not Restricted
446	16	Partition Table (partition1)	Refer to Table2.3-2
462	16	Partition Table (partition2)	All 0x00
478	16	Partition Table (partition3)	All 0x00
494	16	Partition Table (partition4)	All 0x00
510	2	Signature Word	0x55, 0xaa

(BP 0 to 445) Master Boot Record

The content of this field is not specified by this specification.

(BP 446 to 461) Partition Table (partition1)

This field shall specify the information of first partition in the volume. This partition means Regular Area that user can access without mutual authentication. It shall be recorded according to Table 2.3-2.

(BP 462 to 477) Partition Table (partition2)

This field shall be recorded as ZEROs, as a volume shall consist of single Regular Area.

(BP 478 to 493) Partition Table (partition3)

This field shall be recorded as ZEROs, as a volume shall consist of single Regular Area.

(BP 494 to 509) Partition Table (partition4)

This field shall be recorded as ZEROs, as a volume shall consist of single Regular Area.

(BP 510 and 511) Signature Word

This field shall be recorded as 0x55 (BP 510) and 0xaa (BP 511).

◊ **Table 2.3-2 Partition Table**

BP	Length	Field Name	Contents
0	1	Boot Indicator	0x00 or 0x80
1	1	Starting Head	Numeric Value
2	2	Starting Sector / Starting Cylinder	Numeric Value
4	1	System ID	0x01 or 0x04 or 0x06
5	1	Ending Head	Numeric Value
6	2	Ending Sector / Ending Cylinder	Numeric Value
8	4	Relative Sector	Numeric Value
12	4	Total Sector	Numeric Value

(BP 0) Boot Indicator
This field shall be recorded as 0x80 if SD Memory Card is used for boot. Otherwise, this field shall be recorded as 0x00.

(BP 1) Starting Head
This field shall specify the starting head of the partition.

(BP 2 and 3) Starting Sector / Starting Cylinder
This field shall specify the starting sector and cylinder of the partition. 6 bits (Bit 0 to Bit 5 in BP 2) in this field shall be used for starting sector. 10 bits (Bit 6 and Bit 7 in BP 2, Bit 0 to Bit 7 in BP 3) in this field shall be used for starting cylinder.

(BP 4) System ID
This field shall specify the type of file system. It shall be recorded as 0x01 if the partition size is less than 32680 sectors. And it shall be recorded as 0x04 if the one is less than 65536 sectors. Otherwise, it shall be recorded as 0x06.

(BP 5) Ending Head
This field shall specify the ending head of the partition.

(BP 6 and 7) Ending Sector / Ending Cylinder
This field shall specify the ending sector and cylinder of the partition. 6 bits (Bit 0 to Bit 5 in BP 6) in this field shall be used for ending sector. 10 bits (Bit 6 and Bit 7 in BP 6, Bit 0 to Bit 7 in BP 7) in this field shall be used for ending cylinder.

(BP 8 to 11) Relative Sector
This field shall specify the number of sectors existing before the starting sector of this partition.

(BP 12 to 15) Total Sector
This field shall specify the number of sectors on the partition.

2.4 Arrangement of the System Area

2.4.1 System Area

The System Area shall contain the Partition Boot Sector, the Root Directory and the File Allocation Table (FAT) recorded twice.

2.4.2 Partition Boot Sector

The first sector of the System Area shall contain the Partition Boot Sector including the FDC Descriptor. The FDC Descriptor shall contain the parameters for the partition.

2.4.3 File Allocation Table (FAT)

The FAT shall contain a Format Identifier and some entries, each of which indicates cluster of the User Area. These entries shall be numbered consecutively starting with 2 and the Entry Number shall be equal to the Cluster Number of the corresponding cluster.
Each entry in the FAT shall indicate the status of the corresponding cluster. The FAT entries shall be used to identify the set of clusters that are allocated to each file.

2.4.4 Root Directory

The Root Directory shall be recorded in the System Area following the second occurrence of the FAT.

3. File Structure

3.1 Partition Boot Sector

There is a Partition Boot Sector at the head of a partition and it contains an FDC Descriptor or an Extended FDC Descriptor. The FDC Descriptor and the Extended FDC Descriptor are compliant to ISO/IEC 9293. The Extended FDC is used for the default.

◊ **Table 3.1-1 FDC Descriptor**

BP	Length	Field Name	Contents
0	3	Jump Command	bytes
3	8	Creating System Identifier	a-characters
11	2	Sector Size	Numeric Value
13	1	Sectors per Cluster	Numeric Value
14	2	Reserved Sector Count	Numeric Value
16	1	Number of FATs	Numeric Value
17	2	Number of Root-directory Entries	Numeric Value
19	2	Total Sectors	Numeric Value
21	1	Medium Identifier	0xf8
22	2	Sectors per FAT	Numeric Value
24	2	Sectors per Track	Numeric Value
26	2	Number of Sides	Numeric Value
28	2	(Reserved for future standardization)	0x0000
30	480	(Reserved for system use)	Not Restricted
510	2	Signature Word	0x55, 0xaa

◊ **Table 3.1-2 Extended FDC Descriptor**

BP	Length	Field Name	Contents
0	3	Jump Command	bytes
3	8	Creating System Identifier	a-characters
11	2	Sector Size	Numeric Value
13	1	Sectors per Cluster	Numeric Value
14	2	Reserved Sector Count	Numeric Value
16	1	Number of FATs	Numeric Value
17	2	Number of Root-directory Entries	Numeric Value
19	2	Total Sectors	Numeric Value
21	1	Medium Identifier	0xf8
22	2	Sectors per FAT	Numeric Value
24	2	Sectors per Track	Numeric Value
26	2	Number of Sides	Numeric Value
28	4	Number of Hidden Sectors	Numeric Value
32	4	Total Sectors	Numeric Value
36	1	Physical Disk Number	0x80
37	1	Reserved	0x00
38	1	Extended Boot Record Signature	0x29
39	4	Volume ID Number	Numeric Value
43	11	Volume Label	d-characters
54	8	File System Type	d-characters
62	448	(Reserved for system use)	Not Restricted
510	2	Signature Word	0x55, 0xaa

(BP 0 to 2) Jump Command
This field shall specify the jump command to the boot program. It shall be recorded as 0xeb (BP 0), 0xXX (BP 1) and 0x90 (BP 2), or 0xe9 (BP 0), 0xXX (BP 1) and 0xXX (BP 2). 0xXX means that the value is not specified in this specification.

(BP 3 to 10) Creating System Identifier
This field shall specify identification for the system. This field shall be recorded using a-characters and according to ISO/IEC 9293 9.

(BP 11 and 12) Sector Size
This field shall specify the size of a sector in bytes. It shall be recorded as the number 512.

(BP 13) Sectors per Cluster
This field shall specify the number of sectors per cluster. It shall be recorded the following number: 1, 2, 4, 8, 16, 32 or 64. The Cluster Size shall be the multiple size of the erase block size determined by the physical layer. If the erase block size is larger than 32KB, the Cluster Size shall be 32KB and this field shall be recorded 64.

(BP 14 and 15) Reserved Sector Count
This field shall specify the number of sectors reserved for system use. It shall be recorded as the number 1.

(BP 16) Number of FATs
This field shall specify the number of FATs. It shall be recorded as the number 2.

(BP 17 and 18) Number of Root-directory Entries
This field shall specify the number of entries in the Root Directory. It shall be recorded as the number 512.

(BP 19 and 20) Total Sectors
This field shall specify the number of sectors on the partition. It shall be recorded according to ISO/IEC 9293 9.

(BP 21) Medium Identifier
This field shall be recorded as 0xf8 for this specification.

(BP 22 and 23) Sectors per FAT
This field shall specify the number of sectors that shall be occupied by each FAT. It shall be recorded according to ISO/IEC 9293 9.

(BP 24 and 25) Sectors per Track
This field shall specify the number of sectors in each track. This parameter depends on the SD Memory Card's parameter. It shall be recorded according to ISO/IEC 9293 9.

(BP 26 and 27) Number of Sides
This field shall specify the number of sides that can be recorded. This parameter depends on the SD Memory Card's parameter. It shall be recorded according to ISO/IEC 9293 9.

(BP 28 and 29) Field reserved for future standardization
This field shall be reserved for future standardization. It shall contain only ZEROs.

(BP 30 to 509) Field reserved for system use
This field shall be reserved for system use. It shall be not specified in this specification.

(BP 510 and 511) Signature Word
This field shall be recorded as 0x55 (BP 510) and 0xaa (BP 511).

(Extended FDC Descriptor BP 28 to 31) Number of Hidden Sectors
This field shall specify the number of sectors existing before the starting sector of this partition.

(Extended FDC Descriptor BP 32 to 35) Total Sectors
This field shall specify the number of sectors on the partition if the field in BP 19 and 20 is recorded as ZEROs. It shall be recorded according to ISO/IEC 9293 9.

(Extended FDC Descriptor BP 36) Physical Disk Number
This field shall specify the BIOS physical disk number. This field shall be recorded as 0x80.

(Extended FDC Descriptor BP 37) Reserved
This field shall be reserved for future standardization. It shall be recorded as ZEROs. It shall be recorded according to ISO/IEC 9293 9.

(Extended FDC Descriptor BP 38) Extended Boot Record Signature
This field shall be used to identify the descriptor type in the Extended FDC Descriptor when either BP 19 or BP 20 is not recorded as ZEROs. This field shall be recorded as 0x29.

(Extended FDC Descriptor BP 39 to 42) Volume ID Number
This field shall specify the volume identification number. It shall be recorded according to ISO/IEC 9293 9.

(Extended FDC Descriptor BP 43 to 53) Volume Label
This field shall specify the volume label. It shall be recorded according to ISO/IEC 9293 9.

(Extended FDC Descriptor BP 54 to 61) File System Type
This field shall specify the type of the file system. It shall be recorded according to ISO/IEC 9293 9.

(Extended FDC Descriptor BP 62 to 509) Field reserved for system use
This field shall be reserved for system use. It shall be not specified in this specification.

(Extended FDC Descriptor BP 510 and 511) Signature Word
This field shall be recorded as 0x55 (BP 510) and 0xaa (BP 511).

3.2 File Allocation Table

The File Allocation Table supports both the 12-bit FAT and the 16-bit FAT. The FAT structure is compliant to ISO/IEC 9293. The FAT type shall be determined by the number of clusters that depends on the parameter from the physical layer. If the cluster number is less than 4085, FAT12 shall be used. Otherwise, FAT16 shall be used. The first byte of the FAT shall specify the format identifier and be recorded 0xf8. In case of FAT12, the byte 2 and 3 shall be recorded as 0xff each. In case of FAT16, the byte 2, 3 and 4 shall be recorded as 0xff each. The sectors of the FAT may include unused area, because the number of clusters shall determine the FAT size in byte. This unused area shall be recorded as ZEROs.

◊ Table 3.2-1 FAT Entry Value

FAT Entry Value		Contents
FAT12	FAT16	
000	0000	Indicates that the corresponding cluster is not in use and may be allocated to a file or a directory.
002 to MAX	0002 to MAX	Indicates that the corresponding cluster is already allocated. The value of the entry is the cluster number of the next cluster following this corresponding cluster. Max shall be the Maximum Cluster Number.
MAX+1 to FF6	MAX+1 to FFF6	Shall be reserved for future standardization and shall not be used.
FF7	FFF7	Indicates that the corresponding cluster has a defective cluster.
FF8 to FFF	FFF8 to FFFF	The corresponding cluster is already allocated, and it is the final cluster of the file.

3.3 File directories

3.3.1 Characteristics

A Directory is a Descriptor that shall contain a set of Directory entries each of which identifies a file, a Volume Label, another Directory or is unused. A Directory can contain the 65536 Directory entries.
The format of the file name for the Directory entries should supports 8.3 format. Although the Long File Name (LFN) can exist in the Directory entries, the SD Memory Card file system may ignore these entries, and refers to only the file name of 8.3 format that is stored with the LFN.
The character code in the Directory entry can be used the code which is permitted by the ISO/IEC 9293.

3.3.2 Directory entry types

Directory entries shall contain descriptive information about the files recorded on the partition. There are some types of these entries as below:

- File Entry

  A File Entry shall specify information of a file.

- Volume Label Entry

  A Volume Label Entry shall specify the volume label of the partition.

- Sub-directory Pointer Entry

  A Sub-directory Pointer Entry shall specify information of a directory.

- Sub-directory Identifier Entry

  A Sub-directory Identifier Entry shall identify a file as a Sub-directory.

- Sub-directory Parent Pointer Entry

  A Sub-directory Parent Pointer Entry shall specify information of its parent directory.

- Not-currently-in-use Entry

  A Not-currently-in-use Entry shall specify the entry is not used and able to allocate.

- Never-used Entry

  A Never-used Entry shall specify the end of the directory. It shall not appear before any other type of Directory entry.

These entries shall be recorded according to ISO/IEC 9293 11.

3.3.3 General definition of Directory entry fields

Table 3.3.3-1 indicates the structure of the Directory entry field.

◊ **Table 3.3.3-1 Directory Entry Field**

BP	Length	Field Name	Contents
0	8	Name	Depends on entry type
8	3	Name Extension	d-characters
11	1	Attributes	8 bits
12	10	Reserved Field	bytes
22	2	Time Recorded	Numeric Value
24	2	Date Recorded	Numeric Value
26	2	Starting Cluster Number	Numeric Value
28	4	File Length	Numeric Value

(BP 0 to 7) Name
The content and the description of this field shall depend on the entry type. It shall be recorded according to ISO/IEC 9293 11.

(BP 8 to 10) Name Extension
The content and the description of this field shall depend on the entry type. The content of this field shall be d-characters. It shall be recorded according to ISO/IEC 9293 11.

(BP 11) Attributes
This field shall specify the attributes of the entry. It shall be recorded according to ISO/IEC 9293 11.

(BP 12 to 21) Reserved Field
The content of this field shall depend on the entry type. If this entry is LFN entry, this field shall not be specified in this specification. Otherwise, it shall be recorded as ZEROs.

(BP 22 and 23) Time Recorded
This field shall contain a 16-bit integer representing a time. It shall be recorded according to ISO/IEC 9293 11.

(BP 24 and 25) Date Recorded
This field shall contain a 16-bit integer representing a date. It shall be recorded according to ISO/IEC 9293 11.

(BP 26 and 27) Starting Cluster Number
The content of this field shall depend on the entry type. It shall be recorded according to ISO/IEC 9293 11.

(BP 28 to 31) File Length
The content of this field shall depend on the entry type. It shall be recorded according to ISO/IEC 9293 11.

3.4 User Area

The User Area shall be organized into clusters. Each cluster has a Cluster Number respectively. The first cluster in the User Area is corresponding to Cluster Number 2.

Although it is available to read/write by the sector, it is necessary to transact reading/writing with the unit whose minimum size is the same as that of the recommended reading/writing at the physical layer. Other than that, there are no special restrictions for the SD Memory Card file system.

Annex

Annex A: File System Layout

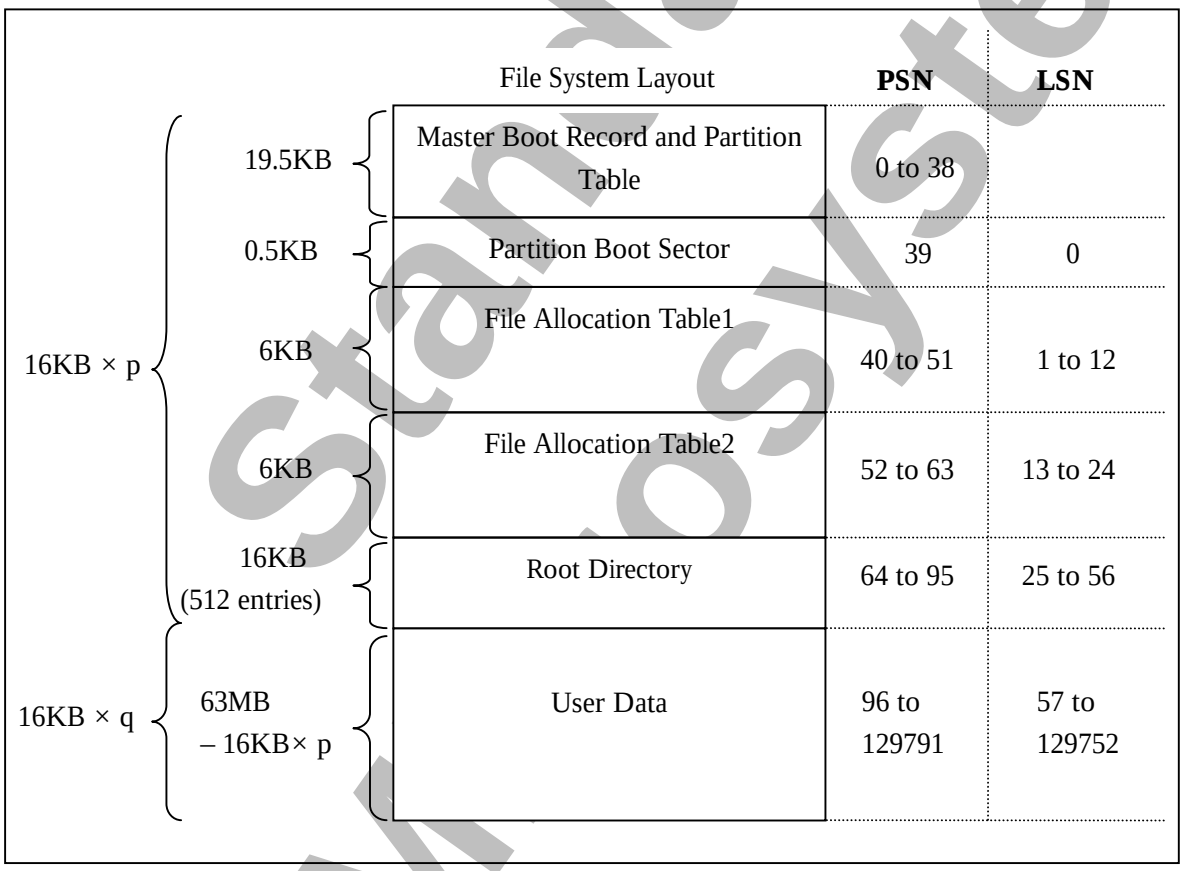
Reading/writing of the User Area should be done with the unit whose minimum size is the same as the recommended size of reading/writing at physical layer. Therefore, Cluster Size shall be determined considering the recommended size. And the head sector of the User Area must be started with the multiple offset of the Cluster Size.

The structure of the file system should be implemented as follows.

1. The combined size of Master Boot Record, Partition Table, Partition Boot Sector, File Allocation Table and Root Directory is a multiple size of the Cluster Size.
2. The number of the sectors before Partition Boot Sector adjusts the above size.
3. Master Boot Record and Partition Boot Sector belong to different cluster.
4. The first sector of the Master Boot Record and the first sector of the User Data are always placed on the cluster boundary.

The following is an example of a partition when the size of the cluster is 16KB.

◊ **Figure A-1 : Example of File System Layout**



p,q : a natural number

PSN : Physical Sector Number

LSN : Logical Sector Number

Annex B: CHS Recommendation

The following table shows the recommendation for CHS parameter. In this table, Card Capacity means the total size of Data Area and Protected Area.

◊ **Table B-1 CHS Recommendation**

Card Capacity	Number of Heads	Sectors per Track
~2MB	2	16
~16MB	2	32
~32MB	4	32
~128MB	8	32
~256MB	16	32
~504MB	16	63
~1008MB	32	63
~2016MB	64	63
~2048MB	128	63

The following is an example of a Partition Table when the size of the Data Area 63MB.

◊ **Table B-2 Example of Partition Table**

BP	Length	Field Name	Contents
0	1	Boot Indicator	0x00
1	1	Starting Head	1
2	2	Starting Sector / Starting Cylinder	8 / 0
4	1	System ID	0x06
5	1	Ending Head	7
6	2	Ending Sector / Ending Cylinder	32 / 506
8	4	Relative Sector	39
12	4	Total Sector	129753

Annex C: Sectors per Cluster and Boundary Unit Recommendation for Data Area

The following table shows the recommendation for Sectors per Cluster and Boundary Unit of Data Area.

Number of sectors before the starting sector of User Data is multiple size of Boundary Unit. In this table, Card Capacity means the total size of Data Area size and Protected Area size.

◊ **Table C-1 Sectors per Cluster and Boundary Unit Recommendation (Data Area)**

Card Capacity	Sectors per Cluster	Boundary Unit
~8MB	16	16
~64MB	32	32
~256MB	32	64
~1024MB	32	128
~2048MB	64	128

Maximum Data Area size and format parameters are shown in following table.

◊ **Table C-2 Maximum Data Area size and format parameters**

Card Capacity	Sectors per Cluster	Max Data Area size(sector)	an example(values depend on Data Area size)				
			Clusters	FAT Sec	Hidden	FAT bits	User Data Offset
~4MB	16	8032	498	2	27	12	64
~8MB	16	16224	1010	3	25	12	64
~16MB	32	32448	1011	3	57	12	96
~32MB	32	64896	2025	6	51	12	96
~64MB	32	129792	4053	12	39	12	96
~128MB	32	259584	8106	32	95	16	192
~256MB	32	519168	16216	64	95	16	256
~512MB	32	1038336	32432	127	225	16	512
~1024MB	32	2076672	64872	254	227	16	768
~2048MB	64	4153344	64884	254	227	16	768

However,

Card Capacity…SD Card Capacity.

Sectors per Cluster…number of sectors per cluster. This parameter is defined from Card Capacity.

Max Data Area size…maximum number of sectors for Data Area.

Clusters…number of clusters in User Data. This parameter varies with the Data Area size.

FAT Sec…number of sectors per FAT. This parameter varies with the Data Area size.

Hidden…number of sectors existing before Partition Boot Sector. This parameter varies with the Data Area size.

FAT bits…If the area is formatted with FAT12, FAT bits is 12. And If the area is formatted with FAT16, FAT bits is 16. This parameter varies with the Data Area size.

User Data Offset…number of sectors existing before the starting sector of User Data.

Sectors per Cluster is defined from Card Capacity. Clusters, FAT Sec, Hidden, FAT bits, and User Data Offset vary with the Data Area size (Use the parameters in Table C-1 for calculation).

Annex D: Format Parameter Computations

In this section, format parameter computations is proposed. Data Area should be formatted by the following steps.

1. Sectors per Cluster(SC) is determined from the area size.
2. Number of Root-directory Entries(RDE) is 512.
3. Sector Size(SS) is 512.
4. Reserved Sector Count(RSC) is 1.
5. Total Sectors(TS) is the number of all sectors of the area.
6. FAT bits(12[FAT12], 16[FAT16]) is determined by SC and TS.
7. Sectors per FAT(SF) is computed as following:

$$SF = ceil\{ \frac{TS/SC \times FAT\ bits}{SS \times 8} \}$$

8. Number of sectors in the system area(SSA) is computed as following:

$$SSA = RSC + 2 \times SF + ceil(\frac{32 \times RDE}{SS})$$

9. Number of Sectors in Master Boot Record(NOM) is computed as following:

$$NOM + SSA = BU \times n$$

   Here, n means the minimum natural number satisfying above expression. And BU means the Boundary Unit determined by Annex C.

10. If NOM isn't equal to BU, NOM is added BU.
11. Maximum Cluster Number(MAX) is computed as following:

$$MAX = ip(\frac{TS - NOM - SSA}{SC}) + 1$$

12. Sectors per FAT(SF') is recalculated as following:

$$SF' = ceil\{ \frac{[2 + (MAX - 1)] \times FAT\ bits}{SS \times 8} \}$$

    In this formula, 'MAX-1' means the number of clusters. And '2+(MAX-1)' means the number of FAT entries including two signature entries.

13. If SF' isn't equal to SF, SF' is used as SF. And recalculate from step 8.
14. If SF' is equal to SF, parameter computing is complete.

Example of a SD Memory Card including 63MB Data Area:

- TS=129792 Sectors

- SC=32 Sectors
- RDE=512 Entries
- SS=512 B
- RSC=1 Sectors
- FAT bits=12[FAT12]
- SF=12 Sectors
- SSA=57 Sectors
- NOM= 39 Sectors
- MAX=4054

Example of Extend FDC Descriptor for the Above Example:

◊ **Table D-1 Extended FDC Descriptor (Regular Area)**

BP	Length	Field Name	Contents
0	3	Jump Command	0xEB,0x00,0x90
3	8	Creating System Identifier	"SYSTEMID"
11	2	Sector Size	512
13	1	Sectors per Cluster	32
14	2	Reserved Sector Count	1
16	1	Number of FATs	2
17	2	Number of Root-directory Entries	512
19	2	Total Sectors	0
21	1	Medium Identifier	0xF8
22	2	Sectors per FAT	12
24	2	Sectors per Track	32
26	2	Number of Sides	8
28	4	Number of Hidden Sectors	39
32	4	Total Sectors	129753
36	1	Physical Disk Number	0x80
37	1	Reserved	0x00
38	1	Extended Boot Record Signature	0x29
39	4	Volume ID Number	0x01234567
43	11	Volume Label	"VOLUME1 "
54	8	File System Type	"FAT12 "
62	448	(Reserved for system use)	Not Restricted
510	2	Signature Word	0x55aa