

ECMA

Standardizing Information and Communication Systems

**DVD Read-Only Disk
File System Specifications**

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Brief History

This Technical Report is complementary to the Volume and File Structure for Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange Standard, ECMA-167.

This ECMA Technical Report has been adopted by the ECMA General Assembly in February 1998.

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1 General

1.1 Scope

This Technical Report specifies a profile of the ECMA-167 Standard titled Volume and File Structure for Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange for implementations of the Standard on DVD Read-Only disks conforming to the ECMA-ROM Standard. Specifically, this Technical Report specifies a new bridge format for the volume and file structure on DVD Read-Only disks to support the interchange of information between users of both computer systems and dedicated DVD content players.

This new bridge format, which is commonly known as the "UDF Bridge" format. It is based on Standard ECMA-167 and shall conform to OSTA Universal Disk Format (UDF 1.02) specification and ECMA-119 Standard.

The OSTA UDF specification defines a subset of ECMA-167 Standard in order to maximise data interchange and to minimize the cost and complexity on implementing of ECMA-167 Standard. In this Technical Report, imposes some restrictions and additional requirements to OSTA UDF specification for its application to DVD Read-Only disks. These restrictions are necessary to make the development of dedicated DVD content player feasible.

Additionally, the UDF Bridge format has a compatible volume and file structure with the ECMA-119 Standard commonly used with CD-ROM therefore providing the advantage of being easily implemented by existing computer systems.

DVD-Video is one specific application field on the UDF Bridge format, and defines the "DVD-Video Compliant" domain. DVD-Video compliant domain imposes some restrictions on parameter fields for volume and file structures using the UDF Bridge format. These restrictions provide for OS independence and a simple data structure for DVD-Video disks.

1.2 References

- ECMA-6 7-Bit Coded Character Sets (1991)
- ECMA-119 Volume and File Structure of CDROM for Information Interchange (1887)
Note 1: This standard is commonly known by its ISO version, ISO 9660:1988
- ISO/IEC 9945-1 : 1990, Information technology -- Portable Operating System Interface (POSIX) -- Part 1: System Application Program Interface (API) [C Language]
- ECMA-167 Volume and File Structure of Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange (1996)
- The Unicode Standard -- World-wide Character Encoding
- ISO/IEC 10646-1:1993, Information technology - Universal multiple-octet coded character set (UCS) - Part 1: Architecture and basic multilingual plane
- Universal Disk Format Specification (Revision 1.02): 1996
Optical Storage Technology Association
- ECMA-267 120 mm DVD - Read-Only Disk (1997)
- ECMA-268 80 mm DVD - Read-Only Disk (1997)
- ISO/IEC 13800:1996, Information technology – Procedure for the registration of identifiers and attributes for volume and file structure.

1.3 Definitions

1.3.1 anchor point

One of a specified set of logical sector numbers at which descriptors, that identify an extent of a Volume Descriptor Sequence, may be recorded.

1.3.2 application

A program that processes the contents of a file, and may also process selected attribute data relating to the file or to the volume(s) on which the file is recorded.

1.3.3 byte

A string of eight binary digits operated upon as a unit.

1.3.4 Cyclic Redundancy Check (CRC)

A method for computing a signature of a sequence of bytes.

1.3.5 data preparer

A person or other entity, which controls the preparation of the data to be recorded on a volume group.

1.3.6 descriptor

A structure containing descriptive information about a volume or file.

1.3.7 extent

Two definitions apply:

- 1) For the volume structure and ECMA-119 file structure, an extent is defined as a set of logical sectors, the logical sector numbers of which form a continuous ascending sequence. The address, or location, of an extent is the number of the first logical sector in the sequence.
- 2) For the UDF file structure, an extent is defined as a set of logical blocks, the logical block numbers of which form a continuous ascending sequence. The address, or location, of an extent is the number of the first logical block in the sequence.

1.3.8 file segment

The part of a file that is recorded in any one extent.

1.3.9 file set

A collection of the files and directories.

1.3.10 file set number

The number which identifies the file set of a logical volume. One of the file set numbers shall be 0.

1.3.11 file set descriptor number

The number which identifies the File Set Descriptor of a File Set Descriptor Sequence.

1.3.12 file unit

A set of logical sectors that are within an extent and the logical sector numbers of which form a continuous ascending sequence.

1.3.13 file unit size

The number of logical sectors in the file unit of the File Segment.

1.3.14 Group ID

An identification of a group of users.

1.3.15 implementation

A set of processes which enable an information processing system to behave as an originating system, or as a receiving system, or as both types of system.

1.3.16 logical block

The unit of allocation of a logical volume.

- 1.3.17 logical sector**
The unit of allocation of a volume.
- 1.3.18 logical volume**
A non-empty set of partitions.
- 1.3.19 originating system**
An information processing system, which may create a set of files on a volume set for the purpose of data interchange with another system.
- 1.3.20 partition**
An extent of logical sectors within a volume.
- 1.3.21 partition number**
The number which identifies the partitions of a volume. Partition numbers shall be consecutive integers assigned in an ascending sequence starting from 0.
- 1.3.22 physical sector**
The unit of allocation specified in the applicable physical medium format Standard.
- 1.3.23 primary volume descriptor number**
The number which identifies a Primary Volume Descriptor of a Volume Descriptor Sequence. Only one prevailing Primary Volume Descriptor of a Volume Descriptor Sequence shall have a primary volume descriptor number of 0.
- 1.3.24 receiving system**
An information processing system, which can read a set of files from a volume set which has been created by another system for the purpose of data interchange.
- 1.3.25 sector**
The data field of the smallest addressable part of the medium, that may be accessed independently of other addressable parts of the medium.
- 1.3.26 standard for recording**
A standard that specifies the recording method and the addressing method for the information recorded on a medium. The specifications of the standard for recording are specified in ECMA-167 1/5.10.
- 1.3.27 twos complement**
A number calculated such that each bit of the number is inverted (ones are replaced with zeros and vice versa), then one (=000...0001b) is added, ignoring overflow.
- 1.3.28 UDF Bridge format**
A format that conforms with both UDF specification and the ECMA-119 standard.
- 1.3.29 user**
A person or other entity (for example, an application) that causes the invocation of the services provided by an implementation.
- 1.3.30 User ID**
An identification of a user.
- 1.3.31 volume**
A sector address space as specified in the relevant standard for recording.

1.3.32 volume descriptor sequence number

The number which identifies a volume descriptor of a Volume Descriptor Sequence. All volume descriptors with identical Volume Descriptor Sequence Numbers shall have equivalent contents. The prevailing descriptors are specified in ECMA-167 3/8.4.3.

1.3.33 volume group

A group of volumes within a volume set, the contents of which are established at the same time. A volume group shall consist of one or more consecutively numbered volumes.

1.3.34 volume sequence number

The number which identifies the volume in a volume set. The volumes in a volume set shall be numbered with consecutive integers assigned in an ascending sequence starting from 1.

1.3.35 volume set

A collection of one or more volumes with identical volume set identification.

1.3.36 volume set size

The sequence number of the volume having the highest sequence number within the volume group.

1.4 Conventions and notations

1.4.1 Numerical notation

Numbers in decimal notation are represented by decimal digits, namely 0 to 9. Digit(s) represents any digit from digit 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, suffixed by "h".

Numbers in binary notation are represented as a sequence of one or more binary digits namely 0 to 1, suffixed by "b". ZERO represents a single bit with the value 0, and ONE represents a single bit with the value 1.

1.4.2 Arithmetic notation

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

1.4.3 Bit fields

Certain fields or parts of fields are intended to be interpreted as an array of bits. This array of bits shall be referred to as a bit field. Bit positions within an n bit field are numbered such that the least significant bit is numbered 0 and the most significant bit is numbered $n-1$.

1.4.4 Character strings

A value for a sequence of bytes may be specified by a quoted sequence of characters, encoded according to the ECMA-6 Standard. For example, "Sheep" shall represent the bytes 53h, 68h, 65h, 65h, 70h.

1.4.5 Descriptor formats

The notation of descriptor formats is specified in ECMA-167 1/6.3.

1.4.6 Descriptor sequence schema

The notation of descriptor sequence schema is specified in ECMA-167 1/6.6.

1.4.7 List of acronyms

BP : Byte Position within a descriptor, starting with 0 from the first byte of a sector.

RBP : Relative Byte Position within a descriptor, starting with 0.

LBN : Logical Block Number

LSN : Logical Sector Number

PSN : Physical Sector Number

ID : Identifier

ICB : Information Control Block, an entry in an ICB describes each recorded instance of a file.

1.5 Data types of descriptor field

1.5.1 Numerical values

An 8-bit numerical value specified by Uint8 shall be recorded as an 8-bit unsigned number in a one-byte field.

A multiple-byte numerical value specified by UDF shall be recorded in the little endian representation.

A multiple-byte numerical value specified by ECMA-119 shall be recorded in one of following representations: little endian, big endian and both byte orders.

The multiple-byte numerical representation shall be specified by one of the following types:

LB16 A 16-bit little endian representation unsigned number. This representation is identical to Uint16 specified in ECMA-167 1/7.1.3 and the number that is specified in ECMA-119 7.2.1. (For example, the 16-bit hexadecimal number 1234h shall be recorded as 34h, 12h.)

LB32 A 32-bit little endian representation unsigned number. This representation is identical to Uint32 specified in ECMA-167 1/7.1.5 and the number which is specified in ECMA-119 7.3.1. (For example, the 32-bit hexadecimal number 12345678h shall be recorded as 78h, 56h, 34h, 12h.)

LB64 A 64-bit little endian representation unsigned number. This representation is identical to Uint64 specified in ECMA-167 1/7.1.7. (For example, the 64-bit hexadecimal number 123456789ABCDEF0h shall be recorded as F0h, DEh, BCh, 9Ah, 78h, 56h, 34h, 12h.)

MB16 A 16-bit big endian representation unsigned number. This representation is identical to the number that is specified in ECMA-119 7.2.2. (For example, the 16-bit hexadecimal number 1234h shall be recorded as 12h, 34h.)

MB32 A 32-bit big endian representation. This representation is identical to the number that is specified in ECMA-119 7.3.2. (For example, the 32-bit hexadecimal number 12345678h shall be recorded as 12h, 34h, 56h, 78h.)

BB16 A 16-bit both-byte orders representation. This representation is identical to the number that is specified in ECMA-119 7.2.3. (For example, the 16-bit hexadecimal number 1234h shall be recorded as 34h, 12h, 12h, 34h.)

BB32 A 32-bit both-byte orders representation. This representation is identical to the number that is specified in ECMA-119 7.3.3. (For example, the 32-bit hexadecimal number 12345678h shall be recorded as 78h, 56h, 34h, 12h, 12h, 34h, 56h, 78h.)

1.5.2 UDF character sets and coding

A descriptor field specified by a charspec shall consist of a character set type and character set information, which shall be defined in UDF 2.1.2.

OSTA CS0 character set consists of the d-characters that are specified in Unicode 1.1 Standard (excluding FEFFh and FFFEh), and are stored in the OSTA Compressed Unicode format specified in UDF 2.1.1. A descriptor field, which is specified as dstring defined in UDF 2.1.3 or d-characters shall be recorded with this character set.

1.5.3 ECMA-119 character sets and separators

The character set allowed in certain descriptor field shall be **a-characters**, **d-characters**, **a1-characters**, or **d1-characters**.

The a-characters shall be defined as the 57 characters in positions 2/0 to 2/2, 2/5 to 2/15, 3/0 to 3/15, 4/1 to 4/15, 5/0 to 5/10, and 5/15 of ECMA-6. The d-characters shall be defined as the 37 characters in positions 3/0 to 3/9, 4/1 to 5/10, and 5/15 of ECMA-6. The a1-characters is defined in ECMA-119 7.4.2.1. The d1-characters shall be defined in ECMA-119 7.4.2.2.

The characters, which separates the components of a File Identifier, shall be SEPARATOR 1 (represented by 2Eh) or SEPARATOR 2 (represented by 3Bh).

1.5.4 Timestamp

A Timestamp specified in UDF 2.1.4 is shown in table 1.

Table 1: Timestamp

| RBP | Length | Field Name | Contents |
|------------|---------------|--------------------------|-----------------|
| 0 | 2 | Type and Time Zone | LB16 |
| 2 | 2 | Year | LB16 |
| 4 | 1 | Month | UInt8 |
| 5 | 1 | Day | UInt8 |
| 6 | 1 | Hour | UInt8 |
| 7 | 1 | Minute | UInt8 |
| 8 | 1 | Second | UInt8 |
| 9 | 1 | Centiseconds | UInt8 |
| 10 | 1 | Hundreds of Microseconds | UInt8 |
| 11 | 1 | Microseconds | UInt8 |

(RBP 0) Type and Time Zone

The most significant 4 bits of this field, interpreted as a 4-bit number, shall specify the interpretation of the timestamp. This number shall be set to 1 indicating that the timestamp specifies the local time.

The least significant 12 bits of this field, interpreted as a signed 12-bit number in twos complement form, shall be interpreted as follows:

- If the value is in the range of -1440 to 1440 inclusive, then the value specifies the offset, in minutes, of the date and time from Co-ordinated Universal Time such that the value specifies the time zone for the locale time.
- If the value is -2047, then no such value is specified.

(RBP 2) Year

This field specifies the year as a number in the range of 1 to 9999.

(RBP 4) Month

This field specifies the month of the year as a number in the range of 1 to 12.

(RBP 5) Day

This field specifies the day of the month as a number in the range of 1 to 31

(RBP 6) Hour

This field specifies the hour of the day as a number in the range of 0 to 23.

(RBP 7) Minute

This field specifies the minute of the hour as a number in the range of 0 to 59.

(RBP 8) Second

This field specifies the second of the hour as a number in the range of 0 to 59.

(RBP 9) Centiseconds, (RBP 10) Hundreds of Microseconds, (RBP 11) Microseconds

These fields are specified in UDF 3.1.1.1, 3.1.1.2 and 3.1.1.3 for specific operating systems.

1.5.5 Entity Identifier (EntityID)

An entity identifier, designated as EntityID, is specified in ECMA-167 1/7.4 and UDF 2.1.5.

1.5.6 Descriptor Tag (tag)

A Descriptor Tag, designated as tag, is classified into two types as follows:

- A Descriptor Tag for the volume structure shall have a tag specified in UDF 2.2.1.
- A Descriptor Tag for the file structure shall have a tag specified in UDF 2.3.1.

The Tag Serial Number of Descriptor Tag shall contain 0, which specifies a set of descriptors is not identified.

1.5.7 Extent Descriptor (extent_ad)

An Extent Descriptor, designated as extent_ad, is specified in ECMA-167 3/7.1.

1.5.8 Short Allocation Descriptor (short_ad)

A short Allocation Descriptor, designated as short_ad, is specified in ECMA-167 4/14.14.1.

1.5.9 Long Allocation Descriptor (long_ad)

A Long Allocation Descriptor, designated as long_ad, is specified in ECMA-167 4/14.14.2.

1.5.10 Logical block address (lb_addr)

A logical block address, designated as lb_addr, is specified in ECMA-167 4/7.1.

1.6 Recording of descriptors

Any descriptor which has its format specified by Byte Positions (BP) in Volume Structure and ECMA-119 File Structure (or UDF File Structure), shall be recorded so that the first byte of the descriptor coincides with the first byte of a logical sector (or a logical block).

Any descriptor which has its format specified by Relative Byte Positions (RBP) in Volume Structure and ECMA-119 File Structure (or UDF File Structure) have no restrictions on where they may be recorded within a logical sector (or a logical block), except that their location within a descriptor shall be specified in the descriptions of the applicable descriptor.

When the descriptors in Volume Structure and ECMA-119 File Structure (or UDF File Structure) are recorded in a logical sector (or a logical block), all space, if any, after the end of the last descriptor up to the end of the logical sector (or the logical block) is reserved for future standardisation and shall be recorded as all 00h bytes.

2 Volume Structure

2.1 Requirements for DVD Read-Only disk

The requirements for the volume structure of DVD Read-Only disks are summarised as follows:

1. All disks shall be provided with a volume structure that complies with UDF Bridge format.
2. The logical sector size and the logical block size shall be 2048 bytes.
3. A DVD Read-Only disk shall consist of a single volume with a single partition per side. Therefore, the volume sequence number shall be 1 and the maximum volume sequence number shall be 1, and the Interchange Level shall be 2.
4. The logical block number defined by ECMA-119 shall be equal to the logical sector number and shall be different from the logical block number defined by UDF.
5. Anchor Volume Descriptor Pointers shall be recorded in the specified logical sectors having the logical sector number 256 and at least one of the last logical sector number or the last logical sector number – 256.
6. A Main Volume Descriptor Sequence and a Reserve Volume Descriptor Sequence shall be recorded in a volume.
7. The Terminating Descriptor shall be recorded to terminate an extent of a Volume Descriptor Sequence.
8. The Logical Volume Integrity Descriptor Sequence shall contain exactly one Close Logical Volume Integrity Descriptor and no Open Logical Volume Integrity Descriptor.
9. The Unallocated Space Table and the Unallocated Space Bitmap shall not be recorded, as DVD Read-Only disks have no space available for allocation.
10. The Freed Space Table and the Freed Space Bitmap shall not be recorded, as DVD Read-Only disks have no freed space.

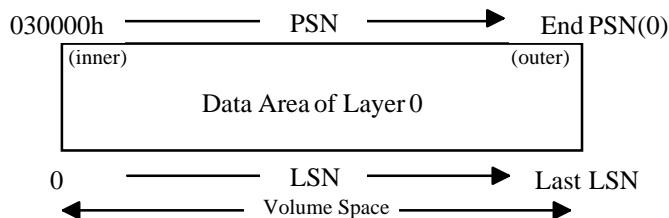
2.2 Volume Space

A DVD Read-Only disk has three types of physical volume formats per side related with the layer structure and the track structure as described in Standard ECMA-ROM. On each physical volume format, a single volume space shall be defined as in figure 1.

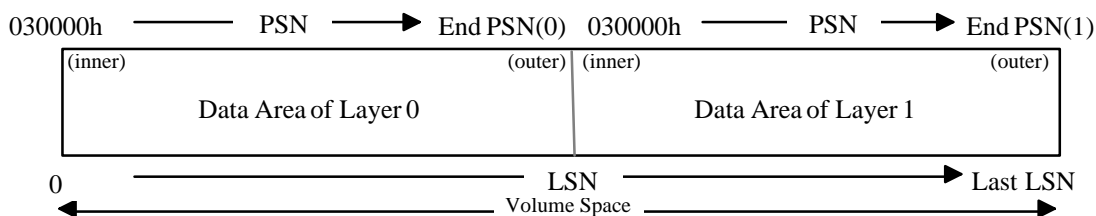
On this volume space, the length of a logical sector shall be 2048 bytes, which is equal to the length of a physical sector. A unique logical sector number shall identify each logical sector of a volume. Logical sector numbers shall be consecutive integers assigned in an ascending sequence, in the order of ascending physical sector number of the physical volume format as in figure 1.

The logical sector number 0 shall be assigned to the sector having the physical sector number 030000h of Layer 0.

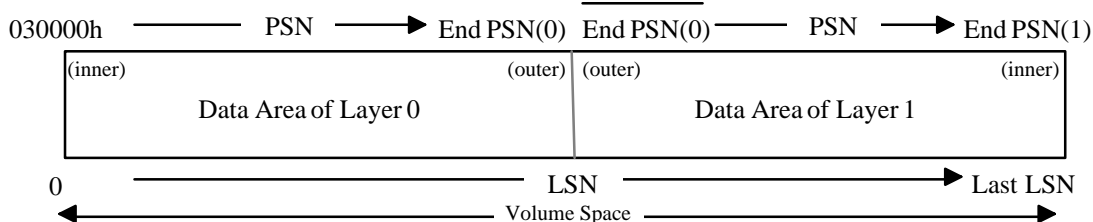
(a) Single-layer type



(b) Dual-layer type with parallel track path



(c) Dual-Layer type with opposite track path



End PSN(i) : The end physical sector number of Data Area of Layer i (i=0 or 1).

End PSN(0) : The number calculated such that each bit of the End PSN(0) is inverted (ones are replaced with zeros and vice versa).

Last LSN : The last logical sector number.

Figure 1 : Logical Sector Assignment

2.3 Volume Structure of UDF Bridge Format

The volume structure of UDF Bridge format shall contain a UDF Bridge Volume Recognition Sequence, two Anchor Points, a Main Volume Descriptor Sequence, a Reserve Volume Descriptor Sequence and a Logical Volume Integrity Sequence.

A UDF Bridge Volume Recognition Sequence shall be allocated in consecutively numbered logical sectors starting with the logical sector number 16 in the volume space. A UDF Bridge Volume Recognition Sequence shall contain a CD-ROM Volume Descriptor Set, a Beginning Extended Area Descriptor, a NSR Descriptor, a Terminating Extended Descriptor and, if any, a Boot Descriptor. And the CD-ROM Volume Descriptor Set shall be allocated in the leading part of the UDF Bridge Volume Recognition Sequence.

The first Anchor Point shall be assigned at the specified logical sector number 256 and the other Anchor Points shall be assigned at the last logical sector number and or the last logical sector number - 256. Each Anchor Point shall consist of an Anchor Volume Descriptor Pointer, which shall specify an extent of both the Main and Reserve Volume Descriptor Sequence.

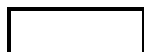
The Main Volume Descriptor Sequence and the Reserve Volume Descriptor Sequence shall contain a Primary Volume Descriptor, an Implementation Use Volume Descriptor, a Partition Descriptor, a Logical Volume Descriptor, an Unallocated Space Descriptor, a Terminating Descriptor and, if any, Trailing Logical Sectors. Both the Main and Reserve Volume Descriptor Sequence extents shall each have a minimum length of 16 logical sectors. The Logical Volume Descriptor shall specify the extent of the Logical Volume Integrity Sequence.

A logical Volume Integrity Sequence shall contain a Logical Volume Integrity Descriptor. The Logical Volume Integrity Sequence shall be terminated by a Terminating Descriptor, an empty logical sector which shall have all 00h bytes or the end of the Logical Volume Integrity Descriptor Sequence Extent which is specified in the Integrity Sequence Extent field of a Logical Volume Descriptor.

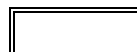
A partition is an extent of a volume and shall be identified by a Partition Number. The information about the partition shall be recorded in the Partition Descriptor. A Logical Volume Descriptor specifies a logical volume identification, the logical block size of the logical volume and an ordered list of partitions comprising the logical volume. A UDF Logical Volume Space shall consist of a single partition.

The logical sector of a partition shall be organised into a logical block of equal length. Each logical block of a partition shall identify by a unique logical block number. Logical block numbers shall be consecutive integers assigned in an ascending sequence. The logical block number 0 shall be assigned to the logical sector having the lowest logical sector number in the UDF Logical Volume Space. This logical block number is different from the logical block number defined by ECMA-119. The logical block number defined by ECMA-119 shall be equal to the logical sector number as shown in figure 2. Both the UDF file structure and the ECMA-119 file structure shall reference the same file set.

| LSN | Descriptors | Structure | LBN | |
|----------------------|---|--|------------------|----------|
| 0 to 15 | Reserved (all 00h bytes) | | | |
| 16 | Primary Volume Descriptor (ECMA-119) | UDF Bridge Volume Recognition | Not Assigned | |
| 17 | Volume Descriptor Set Terminator | | | |
| 18 | Beginning Extended Area Descriptor | | | Sequence |
| 19 | NSR Descriptor | | | |
| 20 | Terminating Extended Area Descriptor | | | |
| 21 to 31 | Reserved (all 00h bytes) | | | |
| 32 | Primary Volume Descriptor (UDF) | Main Volume Descriptor Sequence | | |
| 33 | Implementation Use Volume Descriptor | | | |
| 34 | Partition Descriptor | | | |
| 35 | Logical Volume Descriptor | | | |
| 36 | Unallocated Space Descriptor | | | |
| 37 | Terminating Descriptor | | | |
| 38 to 47 | Trailing Logical Sectors (all 00h bytes) | | | |
| 48 | Primary Volume Descriptor (UDF) | Reserve Volume Descriptor Sequence | | |
| 49 | Implementation Use Volume Descriptor | | | |
| 50 | Partition Descriptor | | | |
| 51 | Logical Volume Descriptor | | | |
| 52 | Unallocated Space Descriptor | | | |
| 53 | Terminating Descriptor | | | |
| 54 to 63 | Trailing Logical Sectors (all 00h bytes) | | | |
| 64 | Logical Volume Integrity Descriptor | Logical Volume Integrity Sequence | | |
| 65 | Terminating Descriptor | | | |
| 66 to 255 | Reserved (all 00h bytes) | | | |
| 256 | Anchor Volume Descriptor Pointer | First Anchor Point | | |
| 257 to p-1 | Path Table / Directory Record | ECMA-119 File Structure | | |
| p to p+q-1 | File Set Descriptor / Terminating Descriptor / File Identifier Descriptor / File Entry | UDF File Structure | 0 to q-1 | |
| p+q to Last LSN-1 | UDF /ECMA-119 Files | File Data Structure | q to Last LBN | |
| Last LSN | Anchor Volume Descriptor Pointer | Second Anchor Point | | |



: UDF Bridge Volume Structure



: CD-ROM Volume Descriptor Set

LBN=LSN-p (p is the first LSN of the UDF Logical Volume Space)

The LSN 16 and 256 are hard coded sector numbers

Note: This example is for illustrative purposes only and shall not be construed as specification.

Figure 2: Example of UDF Bridge Volume Structure

2.4 UDF Bridge Volume Recognition Sequence

The volume recognition of the UDF Bridge format shall conform with Part 2 of ECMA-167. A Volume Recognition Space shall be a contiguous sequence of sectors and begin at the first logical sector on the volume space. The first 16 logical sectors shall be reserved for system use as is specified in ECMA-119. A Volume Recognition Sequence of the UDF Bridge format shall be recorded in consecutively numbered sectors starting with the sector having the logical sector number 16.

A Volume Recognition Sequence of the UDF Bridge format shall consist of a CD-ROM Volume Descriptor Set and an Extended Area, which shall be recorded according to the schema in figure 3.

```
[ Volume Recognition Sequence ] {  
  < CD-ROM Volume Descriptor Set > 1  
  [ Extended Area ] {  
    < Beginning Extended Area Descriptor > 1  
    { < Volume Structure Descriptor > | < Boot Descriptor > } n +  
    < Terminating Extended Area Descriptor > 1  
  } 1  
}
```

Figure 3: Volume Recognition Sequence Schema

A CD-ROM Volume Descriptor Set shall be a set of consecutively recorded Volume Structure Descriptors whose Standard Identifier field shall contain "CD001". A CD-ROM Volume Descriptor Set shall be interpreted according to ECMA-119 as specified in 2.8 CD-ROM Volume Descriptor Set.

One of the volume structure descriptors in a Volume Recognition Sequence shall be a NSR Descriptor, which is specified in 2.4.2 NSR Descriptor. Boot Descriptors specified in ECMA-167 2/9.4 and UDF 5.3 may be recorded in an Extended Area.

2.4.1 Beginning Extended Area Descriptor

A Beginning Extended Area Descriptor specified in ECMA-167 3/9.2 is shown in table 2.

Table 2: Beginning Extended Area Descriptor

| BP | Length | Field Name | Contents |
|----|--------|---------------------|-----------------|
| 0 | 1 | Structure Type | Uint8 = 0 |
| 1 | 5 | Standard Identifier | bytes = "BEA01" |
| 6 | 1 | Structure Version | Uint8 = 1 |
| 7 | 2041 | Structure Data | 00h bytes |

(BP 0) Structure Type

This field shall specify 0 to identify a type of the Volume Structure Descriptor.

(BP 1) Standard Identifier

This field shall specify "BEA01" to identify the Beginning Extended Area Descriptor.

(BP 6) Structure Version

This field shall specify 1 to indicate that the version of this descriptor is specified in ECMA-167.

(BP 7) Structure Data

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.4.2 NSR Descriptor

A NSR Descriptor specified in ECMA-167 3/9.1 is shown in table 3.

Table 3: NSR Descriptor

| BP | Length | Field Name | Contents |
|----|--------|---------------------|-----------------|
| 0 | 1 | Structure Type | UInt8 = 0 |
| 1 | 5 | Standard Identifier | bytes = "NSR02" |
| 6 | 1 | Structure Version | UInt8 = 1 |
| 7 | 1 | Reserved | 00h byte |
| 8 | 2040 | Structure Data | 00h bytes |

(BP 0) Structure Type

This field shall specify 0 to identify a type of the Volume Structure Descriptor.

(BP 1) Standard Identifier

This field shall specify "NSR02" to identify the NSR Descriptor.

(BP 6) Structure Version

This field shall specify 1 to indicate that the version of this descriptor is specified in ECMA-167.

(BP 7) Reserved

This field shall be reserved for future standardisation and shall be set to 00h byte.

(BP 8) Structure Data

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.4.3 Terminating Extended Area Descriptor

A Terminating Extended Area Descriptor specified in ECMA-167 2/9.3 is shown in table 4.

Table 4: Terminating Extended Area Descriptor

| BP | Length | Field Name | Contents |
|----|--------|---------------------|-----------------|
| 0 | 1 | Structure Type | UInt8 = 0 |
| 1 | 5 | Standard Identifier | bytes = "TEA01" |
| 6 | 1 | Structure Version | UInt8 = 1 |
| 7 | 2041 | Structure Data | 00h bytes |

(BP 0) Structure Type

This field shall specify 0 to identify a type of the Volume Structure Descriptor.

(BP 1) Standard Identifier

This field shall specify "TEA01" to indicate the Terminating Extended Area Descriptor.

(BP 6) Structure Version

This field shall specify 1 to indicate that the version of this descriptor is specified in ECMA-167.

(BP 7) Structure Data

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.5 Anchor Point

An Anchor Point shall consist of an Anchor Volume Descriptor Pointer, and identify a Main Volume Descriptor Sequence and a Reserve Volume Descriptor Sequence as specified in ECMA-167 3/8.4.2. For DVD Read-Only disks, two Anchor Volume Descriptor Pointers shall be recorded in the specified logical sectors having the logical sector number 256 and at least one of the last logical sector number or the last logical sector number - 256.

2.5.1 Anchor Volume Descriptor Pointer

An Anchor Volume Descriptor Pointer specified in ECMA-167 3/10.2 is shown in table 5.

Table 5: Anchor Volume Descriptor Pointer

| BP | Length | Field Name | Contents |
|----|--------|---|------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=2) |
| 16 | 8 | Main Volume Descriptor Sequence Extent | extent_ad |
| 24 | 8 | Reserve Volume Descriptor Sequence Extent | extent_ad |
| 32 | 480 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 2.

(BP 16) Main Volume Descriptor Sequence Extent

This field shall specify an extent of the Main Volume Descriptor Sequence.

(BP 24) Reserve Volume Descriptor Sequence Extent

This field shall specify an extent of the Reserve Volume Descriptor Sequence.

(BP 32) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.6 Volume Descriptor Sequence

Both the Main and Reserve Volume Descriptor Sequence shall have the equivalent volume descriptors to specify the characteristics of the volume. A volume descriptor shall be one of the following types:

- Primary Volume Descriptor specified in 2.6.1 Primary Volume Descriptor
- Implementation Use Volume Descriptor specified in 2.6.2 Implementation Use Volume Descriptor
- Partition Descriptor specified in 2.6.4 Partition Descriptor
- Logical Volume Descriptor specified in 2.6.7 Logical Volume Descriptor
- Unallocated Space Descriptor specified in 2.6.9 Unallocated Space Descriptor

The extent of Volume Descriptor Sequence shall have a minimum length of 16 logical sectors according to the schema in figure 4. For DVD Read-Only disks, any trailing logical sectors within the extent shall be recorded all 00h bytes.

```
[ Volume Descriptor Sequence Extent ] {  
    < Volume Descriptor > 5  
    [ Terminator ] {  
        <Terminating Descriptor>  
    } < Trailing Logical Sector > 0 +  
}
```

Figure 4: Volume Descriptor Sequence Schema

For DVD Read-Only disks, the Volume Descriptor Sequence shall contain a Primary Volume Descriptor, an Implementation Use Volume Descriptor, a Partition Descriptor, a Logical Volume Descriptor, and an Unallocated Space Descriptor. An example of the Main and Reserve Volume Descriptor Sequences is shown in figure 2.

2.6.1 Primary Volume Descriptor (UDF)

A Primary Volume Descriptor shall identify the volume and certain attributes of that volume, and shall be recorded in the format as shown in table 6.

Table 6: Primary Volume Descriptor (UDF)

| BP | Length | Field Name | Contents |
|-----|--------|---|------------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=1) |
| 16 | 4 | Volume Descriptor Sequence Number | LB32 |
| 20 | 4 | Primary Volume Descriptor Number | LB32 |
| 24 | 32 | Volume Identifier | dstring |
| 56 | 2 | Volume Sequence Number | LB16 = 1 (for DVD Read-Only disk) |
| 58 | 2 | Maximum Volume Sequence Number | LB16 = 1 (for DVD Read-Only disk) |
| 60 | 2 | Interchange Level | LB16 = 2 (for DVD Read-Only disk) |
| 62 | 2 | Maximum Interchange Level | LB16 = 2 (for DVD Read-Only disk) |
| 64 | 4 | Character Set List | LB32 = 00000001h (see UDF 2.2.2.3) |
| 68 | 4 | Maximum Character Set List | LB32 = 00000001h (see UDF 2.2.2.3) |
| 72 | 128 | Volume Set Identifier | dstring |
| 200 | 64 | Descriptor Character Set | charspec (see UDF 2.1.2) |
| 264 | 64 | Explanatory Character Set | charspec (see UDF 2.1.2) |
| 328 | 8 | Volume Abstract | extent_ad |
| 336 | 8 | Volume Copyright Notice | extent_ad |
| 344 | 32 | Application Identifier | EntityID |
| 376 | 12 | Recording Date and Time | timestamp |
| 388 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5) |
| 420 | 64 | Implementation Use | bytes |
| 484 | 4 | Predecessor Volume Descriptor Sequence Location | LB32 |
| 488 | 2 | Flags | LB16 = 0 (for DVD Read-Only disk) |
| 490 | 22 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 1.

(BP 16) Volume Descriptor Sequence Number

This field shall specify the Volume Descriptor Sequence Number for this descriptor.

(BP 20) Primary Volume Descriptor Number

This field shall specify the assigned Primary Volume Descriptor Number for this Primary Volume Descriptor.

(BP 24) Volume Identifier

This field shall specify an identification of the volume.

(BP 56) Volume Sequence Number

This field shall be set to 1, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(BP 58) Maximum Volume Sequence Number

This field shall be set to 1, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(BP 60) Interchange Level

This field shall be set to 2, as a volume set of a DVD Read-Only disk shall consist of a single volume.

The Interchange Level is specified in ECMA-167 3/11.

(BP 62) Maximum Interchange Level

This field shall be set to 2, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(BP 64) Character Set List

This field shall be set to 00000001h, to indicate that only CS0 shall be supported as specified in UDF 2.2.2.3.

(BP 68) Maximum Character Set List

This field shall be set to 00000001h, to indicate that only CS0 shall be supported as specified in UDF 2.2.2.4.

(BP 72) Volume Set Identifier

This field shall specify an identification of the volume set. The first 16 characters of this field shall be set to a unique value, as specified in UDF 2.2.2.5. To guarantee Volume Sets with unique identifiers, the first 8 characters of the unique part should come from a CS0 hexadecimal representation of a 32-bit time value, and the remaining 8 characters are free for implementation use. The remained characters of this field may be set to any allowed value.

(BP 200) Descriptor Character Set

This field shall specify the d-characters allowed in the Volume Identifier and Volume Set Identifier field.

The contents of the charspec are specified in UDF 2.1.2.

(BP 264) Explanatory Character Set

This field shall specify how to interpret the contents of the Volume Abstract and Volume Copyright Notice extents. The contents of the charspec are specified in UDF 2.1.2.

(BP 328) Volume Abstract

This field shall specify an extent of logical sectors containing an abstract for this volume. If the extent length is 0, no abstract is specified.

(BP 336) Volume Copyright Notice

This field shall specify an extent of logical sectors containing a copyright notice for this volume. If the extent length is 0, no copyright notice is specified.

(BP 344) Application Identifier

This field shall specify an identification of an application. If this field contains all 00h bytes, no application is identified.

(BP 376) Recording Date and Time

This field shall indicate the date and time of the day at which this descriptor was recorded.

(BP 388) Implementation Identifier

This field shall specify an identification of an implementation. The contents of the EntityID are specified in UDF 2.1.5.

(BP 420) Implementation Use

This field shall be reserved for implementation use.

(BP 484) Predecessor Volume Descriptor Sequence Location

This field shall specify the address of the extent of logical sectors in which the immediately preceding extent of the Volume Descriptor Sequence of the volume is recorded. If this field contains 0, no extent is identified.

(BP 488) Flags

This field shall be set to 0 for DVD Read-Only disks, as a volume set shall consist of a single volume.

(BP 490) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.6.2 Implementation Use Volume Descriptor

An Implementation Use Volume Descriptor shall identify an implementation and contain information for that implementation's use, and shall be recorded in the format as shown in table 7. The intended purpose of this descriptor is to aid in the identification of a volume within a volume set that belongs to a specific logical volume.

Table 7: Implementation Use Volume Descriptor

| BP | Length | Field Name | Contents |
|----|--------|-----------------------------------|--------------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=4) |
| 16 | 4 | Volume Descriptor Sequence Number | LB32 |
| 20 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5 and 2.2.7.1) |
| 52 | 460 | Implementation Use (see 2.6.3) | bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 4.

(BP 16) Volume Descriptor Sequence Number

This field shall specify the Volume Descriptor Sequence Number for this descriptor.

(BP 20) Implementation Identifier

This field shall specify an identification of an implementation that may recognize and act upon the contents of the Implementation Use field. The contents of the EntityID are specified in UDF 2.1.5. and the Identifier field of the EntityID shall be set to "*UDF LV Info" as specified in UDF 2.2.7.1.

(BP 52) Implementation Use

This field is specified in UDF 2.2.7.2 and shall be recorded in the format as shown in table 8.

2.6.3 Implementation Use field

A Implementation Use field shall be recorded in the format as shown in table 8.

Table 8: Implementation Use field

| RBP | Length | Field Name | Contents |
|------------|---------------|---------------------------|--------------------------|
| 0 | 64 | LVI Charset | charspec (see UDF 2.1.2) |
| 64 | 128 | Logical Volume Identifier | dstring |
| 192 | 36 | LV Info1 | dstring |
| 228 | 36 | LV Info2 | dstring |
| 264 | 36 | LV Info3 | dstring |
| 300 | 32 | Implementation ID | EntityID (see UDF 2.1.5) |
| 332 | 128 | Implementation Use | bytes |

(RBP 0) LVI Charset

This field shall specify the character sets allowed in the Logical Volume Identifier and LV Info fields.

The contents of the charspec are specified in UDF 2.1.2.

(RBP 64) Logical Volume Identifier

This field shall identify the logical volume referenced by this descriptor.

(RBP 192) LV Info1, (RBP 228) LV Info2, (RBP 264) LV Info3

These fields should contain additional information to aid in the identification of the media as specified in UDF 2.2.7.2.3.

(RBP 300) Implementation ID

This field is specified in UDF 2.1.5.

(RBP 332) Implementation Use

This area may be used by the implementation to store any additional implementation specific information.

2.6.4 Partition Descriptor

A Partition Descriptor shall specify the size and location of a partition, and shall be recorded in the format as shown in table 9. Only one Partition Descriptor shall be recorded, as a DVD Read-Only disk shall consist of a single partition per volume.

Table 9: Partition Descriptor

| BP | Length | Field Name | Contents |
|------------|---------------|--|-----------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=5) |
| 16 | 4 | Volume Descriptor Sequence Number | LB32 |
| 20 | 2 | Partition Flags (see ECMA-167 figure 3/12) | LB16 |
| 22 | 2 | Partition Number | LB16 |
| 24 | 32 | Partition Contents (see 2.6.5) | EntityID |
| 56 | 128 | Partition Contents Use (see 2.6.6) | bytes |
| 184 | 4 | Access Type | LB32 = 1 (for DVD Read-Only disk) |
| 188 | 4 | Partition Starting Location | LB32 |
| 192 | 4 | Partition Length | LB32 |
| 196 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5) |
| 228 | 128 | Implementation Use | bytes |
| 356 | 156 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 5.

(BP 16) Volume Descriptor Sequence Number

This field shall specify the Volume Descriptor Sequence Number for this descriptor.

(BP 20) Partition Flag

This field shall specify certain characteristics of the partition as specified in ECMA-167 figure 3/12.

(BP 22) Partition Number

This field shall specify the numeric identifier for the partition.

(BP 24) Partition Contents

This field shall specify an identification of how to interpret the contents of the partition. The identifications are specified in ECMA-167 figure 3/13. This field shall be recorded in the format as shown in table 10.

(BP 56) Partition Contents Use

This field shall specify information required for the interpretation of the information recorded on the partition identified by this Partition Descriptor. This field shall consist of a Partition Header Descriptor as shown in table 11.

(BP 184) Access Type

This field shall specify the access methods that are permitted on the logical sectors of the partition described by this descriptor. For DVD Read-Only disks, this field shall be set to 1, which is interpreted as Read Only.

(BP 188) Partition Starting Location

This field shall specify the logical sector number at which the partition begins.

(BP 192) Partition Length

This field shall specify the number of logical sectors that comprise the partition.

(BP 196) Implementation Identifier

This field shall specify an identification of an implementation. The contents of the EntityID for this descriptor are specified in UDF 2.1.5.

(BP 228) Implementation Use

This field shall be reserved for implementation use.

(BP 356) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.6.5 Partition Contents field

A Partition Contents field shall be recorded in the format as shown in table 10.

Table 10: Partition Contents field

| RBP | Length | Field Name | Contents |
|------------|---------------|-------------------|--|
| 0 | 1 | Flags | UInt8 = 00000010b (for DVD Read-Only disk) |
| 1 | 23 | Identifier | bytes = "+NSR02" (for DVD Read-Only disk) |
| 24 | 8 | Identifier Suffix | bytes |

(RBP 0) Partition Contents Flag

This field shall specify certain characteristics of the entity identifier as specified in ECMA-167 figure 1/10. For DVD Read-Only disks, this field shall be set to 00000010b.

(RBP 1) Partition Contents Identifier

The identification is specified in ECMA-167 figure 3/13. For DVD Read-Only disks, this field shall be set to "+NSR02" which means that the contents of the partition are according to ECMA-167.

(RBP 24) Partition Contents Identifier Suffix

This field shall specify further identification in a manner not specified by ECMA-167 and UDF.

2.6.6 Partition Header Descriptor of Partition Contents Use field

A Partition Header Descriptor shall specify the Unallocated Space Set, the Freed Space Set and the Partition Integrity Table as specified in ECMA-167 4/14.3, and shall be recorded in the format as shown in table 11.

Table 11: Partition Header Descriptor of Partition Contents Use field

| RBP | Length | Field Name | Contents |
|------------|---------------|---------------------------|---|
| 0 | 8 | Unallocated Space Table | short_ad = all 0's (for DVD Read-Only disk) |
| 8 | 8 | Unallocated Space Bitmap | short_ad = all 0's (for DVD Read-Only disk) |
| 16 | 8 | Partition Integrity Table | short_ad = all 0's (see UDF 2.3.3.1) |
| 24 | 8 | Freed Space Table | short_ad = all 0's (for DVD Read-Only disk) |
| 32 | 8 | Freed Space Bitmap | short_ad = all 0's (for DVD Read-Only disk) |
| 40 | 88 | Reserved | 00h bytes |

(RBP 0) Unallocated Space Table

This field shall specify the Unallocated Space Table for this partition (see ECMA-167 4/10). For DVD Read-Only disks, this field shall be set to all 0's to indicate that no Unallocated Space Table is specified.

(RBP 8) Unallocated Space Bitmap

This field shall identify the extent in which the Unallocated Space Bitmap for this partition (see ECMA-167 4/10) is recorded. For DVD Read-Only disks, this field shall be set to all 0's to indicate that no Unallocated Space Bitmap is specified.

(RBP 16) Partition Integrity Table

This field shall be specify the partition Integrity Table for this partition (see ECMA-167 4/11). This field shall be set to all 0's, since Partition Integrity Entries are not used, as specified in UDF 2.3.3.1.

(RBP 24) Freed Space Table

This field shall specify the Freed Space Table for this partition (see ECMA-167 4/10). For DVD Read-Only disks, this field shall be set to all 0's to indicate that no Freed Space Table is specified.

(RBP 32) Freed Space Bitmap

This field shall identify the extent in which the Freed Space Bitmap for this partition is recorded (see ECMA-167 4/10). For DVD Read-Only disks, this field shall be set to all 0's, to indicate that no Freed Space Bitmap is specified.

(RBP 40) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.6.7 Logical Volume Descriptor

A Logical Volume Descriptor shall specify an identification of the logical volume, the logical block size of the logical volume, identification of the partitions comprising the logical volume and attributes of the logical volume. The Partition Maps field of a Logical Volume Descriptor shall be a single map as a DVD Read-Only disk shall be made with a single partition per volume. A Logical Volume Descriptor shall be recorded in the format as shown in table 12.

Table 12: Logical Volume Descriptor

| BP | Length | Field Name | Contents |
|------------|---------------|-----------------------------------|--------------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=6) |
| 16 | 4 | Volume Descriptor Sequence Number | LB32 |
| 20 | 64 | Descriptor Character Set | charspec (see UDF 2.1.2) |
| 84 | 128 | Logical Volume Identifier | dstring |
| 212 | 4 | Logical Block Size | LB32 = 2048 (for DVD Read-Only disk) |
| 216 | 32 | Domain Identifier | EntityID (see UDF 2.1.5) |
| 248 | 16 | Logical Volume Contents Use | long_ad |
| 264 | 4 | Map Table Length | LB32 = 6 (for DVD Read-Only disk) |
| 268 | 4 | Number of Partition Maps | LB32 = 1 (for DVD Read-Only disk) |
| 272 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5) |
| 304 | 128 | Implementation Use | bytes |
| 432 | 8 | Integrity Sequence Extent | extent_ad |
| 440 | 6 | Partition Map(s) (see 2.6.8) | bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 6.

(BP 16) Volume Descriptor Sequence Number

This field shall specify the Volume Descriptor Sequence Number for this descriptor.

(BP 20) Descriptor Character Set

This field shall specify the d-characters allowed in the Logical Volume Identifier field. The contents of the charspec are specified in UDF 2.1.2.

(BP 84) Logical Volume Identifier

This field shall specify an identification of the logical volume.

(BP 212) Logical Block Size

This field shall be set to 2048 for DVD Read-Only disks, to specify the size of a logical block in bytes.

(BP 216) Domain Identifier

This field shall specify an identification of a domain that shall specify rules on the use of, and restrictions on, certain fields in the descriptors. The contents of the EntityID for this descriptor are specified in UDF 2.1.5 and 2.2.4.3. In this specifications, the Domain Identifier field shall be set to "*OSTA UDF Compliant" and the UDF Revision field shall be set to 0102h to indicate that this specifications comply with OSTA UDF Specification Revision 1.02. For DVD Read-Only disks, the Soft Write-Protect and Hard Write-Protect flag specified in UDF 2.1.5.3 shall be set to ONE.

(BP 248) Logical Volume Contents Use

This field shall specify the location and the length of the extent in which the first File Set Descriptor Sequence of the logical volume is recorded.

(BP 264) Map Table Length

This field shall be set to 6 for DVD Read-Only disks, to specify the length of the Partition Maps field in bytes.

(BP 268) Number of Partition Maps

This field shall be set to 1 for DVD Read-Only disks, to specify the number of Partition Maps recorded in the Partition Maps field.

(BP 272) Implementation Identifier

This field shall specify an identification of an implementation. The contents of the EntityID are specified in UDF 2.1.5.

(BP 304) Implementation Use

This field shall be reserved for implementation use.

(BP 432) Integrity Sequence Extent

This field shall specify the first extent of the Logical Volume Integrity Sequence.

(BP 440) Partition Map(s)

The Partition Map shall be limited to Type 1 Partition Map, as specified in UDF 2.2.4.6. The Type 1 Partition Map identifies a partition on a volume in the volume set. This field shall be recorded in the format as shown in table 13.

2.6.8 Type 1 Partition Map

A Type 1 Partition Map shall be recorded in the format as shown in table 13.

Table 13: Type 1 Partition Map

| RBP | Length | Field Name | Contents |
|------------|---------------|------------------------|---|
| 0 | 1 | Partition Map Type | UInt8 = 1 (see UDF 2.2.4.6) |
| 1 | 1 | Partition Map Length | UInt8 = 6 |
| 2 | 2 | Volume Sequence Number | LB16 = 1 (for DVD Read-Only disk) |
| 4 | 2 | Partition Number | LB16 (same as BP22 of Partition Descriptor) |

(RBP 0) Partition Map Type

This field shall be set to 1 as specified in UDF 2.2.4.6, to indicate the type of the partition map.

(RBP 1) Partition Map Length

This field shall be set to 6, to specify the length, in bytes, of this partition map.

(RBP 2) Volume Sequence Number

This field shall be set to 1, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(RBP 4) Partition Number

This field shall be set equal to the value recorded in the Partition Number field of the Partition Descriptor (see 2.6.4).

2.6.9 Unallocated Space Descriptor

An Unallocated Space Descriptor shall identify volume space available for allocating to partitions or for recording the Volume Descriptor Sequence of the volume, and shall be recorded in the format as shown in table 14. Even if there is no free volume space, this descriptor shall be recorded as specified in UDF 2.2.5.

Table 14: Unallocated Space Descriptor

| BP | Length | Field Name | Contents |
|----|--------|-----------------------------------|-----------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=7) |
| 16 | 4 | Volume Descriptor Sequence Number | LB32 |
| 20 | 4 | Number of Allocation Descriptors | LB32 = 0 (for DVD Read-Only disk) |
| 24 | 0 | Allocation Descriptors | extent_ad |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 7.

(BP 16) Volume Descriptor Sequence Number

This field shall specify the Volume Descriptor Sequence Number for this descriptor.

(BP 20) Number of Allocation Descriptors

This field shall specify the number of allocation descriptors recorded in this descriptor. This field shall be set to 0, as a DVD Read-Only disk shall have no available volume space.

(BP 24) Allocation Descriptors

This field shall specify the extent of unallocated space.

2.6.10 Terminating Descriptor

For DVD Read-Only disks, a Terminating Descriptor shall be used to terminate an extent of a Volume Descriptor Sequence and may be used to terminate an extent of a Logical Volume Integrity Sequence, and shall be recorded in the format as shown in table 15.

Table 15: Terminating Descriptor

| BP | Length | Field Name | Contents |
|----|--------|----------------|------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=8) |
| 16 | 496 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 8.

(BP 16) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.7 Logical Volume Integrity Sequence

A Logical Volume Integrity Sequence describes the state of the information recorded on a logical volume as specified in ECMA-167 3/8.8.2, and shall contain a Logical Volume Integrity Descriptor as specified in UDF 2.2.6. The Logical Volume Integrity Sequence shall be terminated by a Terminating Descriptor, an empty logical sector which shall have all 00h bytes or the end of the Logical Volume Integrity Descriptor Sequence Extent which is specified in the Integrity Sequence Extent field of a Logical Volume Descriptor. The type of a Logical Volume Integrity Descriptor shall be a Close Integrity Descriptor for DVD Read-Only disks.

A Logical Volume Integrity Sequence shall be recorded as a sequence of extents, according to the schema in figure 5.

```
[ Logical Volume Integrity Descriptor Sequence Extent] 1 {
    < Close Logical Volume Integrity Descriptor > 1+
    [Terminator] {
        <Terminating Descriptor>
        | <empty logical sector>
    } 0+
}
```

Figure 5 : Logical Volume Integrity Descriptor Sequence Schema

An example of the Logical Volume Integrity Sequence is shown in figure 2.

2.7.1 Logical Volume Integrity Descriptor

A Logical Volume Integrity Descriptor shall specify the integrity status of a logical volume and shall be recorded in the format as shown in table 16. The Free Space Table and Size Table shall be a single table, as a DVD Read-Only disk shall consist of a single partition per volume.

Table 16: Logical Volume Integrity Descriptor

| BP | Length | Field Name | Contents |
|----|--------|---|--|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=9) |
| 16 | 12 | Recording Date | timestamp |
| 28 | 4 | Integrity Type | LB32 = 1 (for DVD Read-Only disk) |
| 32 | 8 | Next Integrity Extent | extent_ad = all 0's (for DVD Read-Only disk) |
| 40 | 32 | Logical Volume Contents Use (see 2.7.2) | bytes |
| 72 | 4 | Number of Partitions | LB32 = 1 (for DVD Read-Only disk) |
| 76 | 4 | Length of Implementation Use (=L_IU) | LB32 |
| 80 | 4 | Free Space Table | LB32 = 0 (for DVD Read-Only disk) |
| 84 | 4 | Size Table | LB32 |
| 88 | L_IU | Implementation Use (see 2.7.3) | bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 9.

(BP 16) Recording Date

This field shall specify the date and time of day when this descriptor was recorded.

(BP 28) Integrity Type

This field shall specify the type of Integrity Descriptor which is specified in ECMA-167 figure 3/23. For DVD Read-Only disks, this field shall be set to 1 to indicate that the descriptor is a Close Integrity Descriptor.

(BP 32) Next Integrity Extent

This field shall specify the next extent of the Logical Volume Integrity Sequence. For DVD Read-Only disks, this field shall be set to all 0's to indicate that no next extent is specified.

(BP 40) Logical Volume Contents Use

This field shall specify information required for interpretation of the information recorded on the associated logical volume. The Logical Volume Header Descriptor shown in table 17 shall be recorded in this field.

(BP 72) Number of Partitions

This field shall be set to 1, as a logical volume of a DVD Read-Only disk shall consist of a single partition.

(BP 76) Length of Implementation Use (=L_IU)

This field shall specify the length, in bytes, of the Implementation field.

(BP 80) Free Space Table

This field shall be set to 0 for DVD Read-Only disks, to indicate that there is no available space.

(BP 84) Size Table

This field shall specify the size, in logical blocks, of the partition.

(BP 88) Implementation Use

This field shall specify an identification of an implementation as specified in UDF 2.2.6.4. This field shall be recorded in the format as shown in table 18.

2.7.2 Logical Volume Header Descriptor of Logical Volume Contents Use field

A Logical Volume Header Descriptor shall specify a numeric file and directory identifier, and shall be recorded in the format as shown in table 17.

Table 17: Logical Volume Header Descriptor of Logical Volume Contents Use field

| RBP | Length | Field Name | Contents |
|-----|--------|------------|-----------|
| 0 | 8 | Unique ID | LB64 |
| 8 | 24 | Reserved | 00h bytes |

(RBP 0) Unique ID

This field shall specify a value that is greater than the value of the Unique ID field in any File Entry recorded on the associated logical volume.

(RBP 8) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

2.7.3 Implementation Use field

An Implementation Use field specified in UDF 2.2.6.4 shall be recorded in the format as shown in table 18.

Table 18: Implementation Use field

| RBP | Length | Field Name | Contents |
|-----|--------|----------------------------|--------------------------|
| 0 | 32 | Implementation ID | EntityID (see UDF 2.1.5) |
| 32 | 4 | Number of Files | LB32 |
| 36 | 4 | Number of Directories | LB32 |
| 40 | 2 | Minimum UDF Read Revision | LB16 |
| 42 | 2 | Minimum UDF Write Revision | LB16 |
| 44 | 2 | Maximum UDF Write Revision | LB16 |
| 46 | a | Implementation Use | bytes |

a = L_IU - 40

(RBP 0) Implementation ID

This field is specified in UDF 2.1.5.

(RBP 32) Number of Files

This field shall specify the current number of files in the associated logical volume.

(RBP 36) Number of Directories

This field shall specify the current number of directories in the associated logical volume.

(RBP 40) Minimum UDF Read Revision

This field shall specify the recommended minimum revision of the UDF specification that an implementation is required to support to successfully be able to read all potential structures on the media. This number shall be stored in binary coded decimal format, for example 0102h would indicate revision 1.02 of the UDF specification.

(RBP 42) Minimum UDF Write Revision

This field shall specify the minimum revision of the UDF specification that an implementation is required to support to successfully be able to modify all structures on the media. This number shall be stored in binary coded decimal format, for example 0102h would indicate revision 1.02 of the UDF specification.

(RBP 44) Maximum UDF Write Revision

This field shall specify the maximum revision of the UDF specification that an implementation which has modified the media has supported. An implementation shall update this field only if it has modified the media and the level of the UDF specification it supports is higher than the current value of this field. This number shall be stored in binary coded decimal format, for example 0102h would indicate revision 1.02 of the UDF specification.

(RBP 46) Implementation Use

This field shall specify the implementation specific information unique to the implementation identified by the implementation ID. The length of this field shall be L_IU-46.

2.8 CD-ROM Volume Descriptor Set

A CD-ROM Volume Descriptor shall be one of the following types:

- Primary Volume Descriptor specified in **2.8.1 Primary Volume Descriptor (ECMA-119)**
- Supplementary Volume Descriptor specified in ECMA-119 8.5
- Volume Descriptor Set Terminator specified in **2.8.2 Volume Descriptor Set Terminator**
- Boot Record specified in ECMA-119 8.2
- Volume Partition Descriptor specified in ECMA-119 8.6

A CD-ROM Volume Descriptor Set shall be a sequence of volume descriptors recorded in consecutively numbered logical sectors starting with the logical sector with logical sector number 16. Each successive Volume Descriptor shall be recorded in the logical sector with the next higher logical sector number than that of the logical sector in which the previous Volume Descriptor is recorded. A CD-ROM Volume Descriptor Set Sequence shall contain one Primary Volume Descriptor recorded at least. The sequence shall consist of two or more volume descriptors consecutively according to the schema in figure 6.

```
[ CD-ROM Volume Descriptor Sequence] {  
    < CD-ROM Volume Descriptor > 1 +  
    [Terminator] {  
        < Volume Descriptor Set Terminator > 1 +  
    }  
}
```

Figure 6: CD-ROM Volume Descriptor Set Sequence Schema

2.8.1 Primary Volume Descriptor (ECMA-119)

A Primary Volume Descriptor shall identify the volume, a system which can recognize and act upon the content of the logical sectors with logical sector numbers 0 to 15, the size of the volume space, the version of the standard which applies to the Volume Descriptor, the location of the Directory Records and the Path Table Records and certain attributes of the volume. The Primary Volume Descriptor shall be recorded in the format as shown in table 19.

Table 19: Primary Volume Descriptor (ECMA-119)

| BP | Length | Field Name | Contents |
|-------------|---------------|--|---------------------------------------|
| 0 | 1 | Volume Descriptor Type | UInt8 = 1 |
| 1 | 5 | Standard Identifier | bytes = "CD001" |
| 6 | 1 | Volume Descriptor Version | UInt8 = 1 |
| 7 | 1 | Unused Field | 00h byte |
| 8 | 32 | System Identifier | a-characters |
| 40 | 32 | Volume Identifier | d-characters |
| 72 | 8 | Unused Field | 00h bytes |
| 80 | 8 | Volume Space Size | BB32 |
| 88 | 32 | Unused Field | 00h bytes |
| 120 | 4 | Volume Set Size | BB16 = 1 (for DVD Read-Only disks) |
| 124 | 4 | Volume Sequence Number | BB16 = 1 (for DVD Read-Only disks) |
| 128 | 4 | Logical Block Size | BB16 = 2048 (for DVD Read-Only disks) |
| 132 | 8 | Path Table Size | BB32 |
| 140 | 4 | Location of Occurrence of Type L Path Table | LB32 |
| 144 | 4 | Location of Optional Occurrence of Type L Path Table | LB32 |
| 148 | 4 | Location of Occurrence of Type M Path Table | MB32 |
| 152 | 4 | Location of Optional Occurrence of Type M Path Table | MB32 |
| 156 | 34 | Directory Record for Root Directory (see 3.6.1) | bytes |
| 190 | 128 | Volume Set Identifier | d-characters |
| 318 | 128 | Publisher Identifier | a-characters |
| 446 | 128 | Data Preparer Identifier | a-characters |
| 574 | 128 | Application Identifier | a-characters |
| 702 | 37 | Copyright File Identifier | d-characters, SEPARATOR 1,SEPARATOR 2 |
| 739 | 37 | Abstract File Identifier | d-characters, SEPARATOR 1,SEPARATOR 2 |
| 776 | 37 | Bibliographic File Identifier | d-characters, SEPARATOR 1,SEPARATOR 2 |
| 813 | 17 | Volume Creation Date and Time (see ECMA-119 Table 5) | Digit(s) |
| 830 | 17 | Volume Modification Date and Time (see ECMA-119 Table 5) | Digit(s) |
| 847 | 17 | Volume Expiration Date and Time (see ECMA-119 Table 5) | Digit(s) |
| 864 | 17 | Volume Effective Date and Time (see ECMA-119 Table 5) | Digit(s) |
| 881 | 1 | File Structure Version | UInt8 = 1 |
| 882 | 1 | Reserved | 00h byte |
| 883 | 512 | Application Use | not specified |
| 1395 | 653 | Reserved | 00h bytes |

(BP 0) Volume Descriptor Type

This field shall specify an 8-bit number indicating that the volume descriptor is a Primary Volume Descriptor. The number in this field shall be 1.

(BP 1) Standard Identifier

This field shall specify an identification of ECMA-119. The characters in this field shall be "CD001".

(BP 6) Volume Descriptor Version

This field shall specify as an 8-bit number an identification of the version of the specification of the Primary Volume Descriptor, and shall be set to 1 to indicate the structure of ECMA-119.

(BP 7) Unused Field

This field shall be set to 00h byte.

(BP 8) System Identifier

This field shall specify as identification of a system which may recognize and act upon the content of the logical sectors with logical sector numbers 0 to 15 of the volume.

(BP 40) Volume Identifier

This field shall specify an identification of the volume.

(BP 72) Unused Field

This field shall be set to all 00h bytes.

(BP 80) Volume Space Size

For DVD Read-Only disks, this field shall specify as a 32-bit number the number of logical sector in which the volume space of the volume is recorded.

(BP 88) Unused Field

This field shall be set to all 00h bytes.

(BP 120) Volume Set Size

This field shall be set to 1, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(BP 124) Volume Sequence Number

This field shall be set to 1, as a volume set of a DVD Read-Only disk shall consist of a single volume.

(BP 128) Logical Block Size

This field shall be set to 2048 for DVD Read-Only disks, to specify the size of a logical block in bytes.

(BP 132) Path Table Size

This field shall specify as a 32-bit number the length in bytes of a recorded occurrence of the Path Table identified by this descriptor.

(BP 140) Location of Occurrence of Type L Path Table

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent that contains an occurrence of the Path Table. Multiple-byte numerical values in a record of this occurrence of the Path Table shall be recorded with the **little endian** representation. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(BP 144) Location of Optional Occurrence of Type L Path Table

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent that contains an optional occurrence of the Path Table. If the value is 0, it shall mean that the extent shall not be expected to have been recorded. Multiple-byte numerical values in a record of this occurrence of the Path

Table shall be recorded with the **little endian** representation. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(BP 148) Location of Occurrence of Type M Path Table

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent that contains an occurrence of the Path Table. Multiple-byte numerical values in a record of this occurrence of the Path Table shall be recorded with the **big endian** representation. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(BP 152) Location of Optional Occurrence of Type M Path Table

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent that contains an optional occurrence of the Path Table. If the value is 0, it shall mean that the extent shall not be expected to have been recorded. Multiple-byte numerical values in a record of this occurrence of the Path Table shall be recorded with the **big endian** representation. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(BP 156) Directory Record for Root Directory

This field shall contain an occurrence of the Directory Record for the Root directory. This field shall be recorded according to 3.6.1.

(BP 190) Volume Set Identifier

This field shall specify an identification of the volume set of which the volume is a member.

(BP 318) Publisher Identifier

This field shall specify an identification of the user who specified what shall be recorded on the volume.

All bytes of this field shall be set to 20h, when no such user is identified.

(BP 446) Data Preparer Identifier

This field shall specify an identification of the person or other entity that controls the preparation of the data to be recorded on the volume group of which the volume is a member. All bytes of this field shall be set to 20h, when no such data preparer is identified.

(BP 574) Application Identifier

This field shall specify an identification of the specification of how the data are recorded on the volume group of which the volume is a member. All bytes of this field shall be set to 20h, when no such application is identified.

(BP 702) Copyright File Identifier

This field shall specify an identification of a file described by the Root directory and containing a copyright statement for those volumes of the volume set the sequence numbers of which are less than, or equal to, the assigned volume set size of the volume. All bytes of this field shall be set to 20h, when no such file is identified.

(BP 739) Abstract File Identifier

This field shall specify an identification of a file described by the Root directory and containing an abstract statement for those volumes of the volume set the sequence numbers of which are less than, or equal to, the assigned volume set size of the volume. All bytes of this field shall be set to 20h, when no such file is identified.

(BP 776) Bibliographic File Identifier

This field shall specify an identification of a file described by the Root directory and containing bibliographic records interpreted according to standards that are the subject of an agreement between the originator and the recipient of the volume. All bytes of this field shall be set to 20h, when no such file is identified.

(BP 813) Volume Creation Date and Time

This field shall specify the date and the time of the day at which the information in the volume was created. This field shall be recorded according to ECMA-119 8.4.26.1. All digits shall be set to 0, when the date and time are not specified.

(BP 830) Volume Modification Date and Time

This field shall specify the date and the time of the day at which the information in the volume was last modified. This field shall be recorded according to ECMA-119 8.4.26.1. All digits shall be set to 0, when the date and time are not specified.

(BP 847) Volume Expiration Date and Time

This field shall specify the date and the time of the day at which the information in the volume may be regarded as obsolete. This field shall be recorded according to ECMA-119 8.4.26.1. All digits shall be set to 0, when the date and time are not specified. If the date and time are not specified then the information shall not be regarded as obsolete.

(BP 864) Volume Effective Date and Time

This field shall specify the date and the time of the day at which the information in the volume may be used. This field shall be recorded according to ECMA-119 8.4.26.1. All digits shall be set to 0, when the date and time are not specified. If the date and time are not specified then the information may be used at once.

(BP 881) File Structure Version

This field shall specify as an 8-bit number the version of the specification of the records of a directory and a Path Table. 1 shall indicate the structure of ECMA-119.

(BP 882) Reserved

This field shall be reserved for future standardisation and shall be 00h byte.

(BP 883) Application Use

This field shall be reserved for application use. The content of this field is not specified by ECMA-119.

(BP 1395) Reserved

This field shall be reserved for future standardisation and shall be all 00h bytes.

2.8.2 Volume Descriptor Set Terminator

The recorded set of Volume Descriptors shall be terminated by a sequence of one or more Volume Descriptor Set Terminator. The Volume Descriptor Set Terminator shall be recorded in the format as shown in table 20.

Table 20: Volume Descriptor Set Terminator

| BP | Length | Field Name | Contents |
|-----------|---------------|---------------------------|-----------------|
| 0 | 1 | Volume Descriptor Type | UInt8 = 255 |
| 1 | 5 | Standard Identifier | bytes = "CD001" |
| 6 | 1 | Volume Descriptor Version | UInt8 = 1 |
| 7 | 2041 | Reserved | 00h bytes |

(BP 0) Volume Descriptor Type

This field shall specify as an 8-bit number indicating that the Volume Descriptor is a Volume Descriptor Set Terminator. The number shall be set to 255.

(BP 1) Standard Identifier

This field shall specify an identification of ECMA-119. The characters in this field shall be "CD001".

(BP 6) Volume Descriptor Version

This field shall specify as an 8-bit number an identification of the version of the specification of the Volume Set Terminator. This field shall be set to 1 to indicate the structure of ECMA-119.

(BP 7) Reserved

This field shall be reserved for future standardisation and shall be all 00h bytes.

3 File Structure

3.1 Requirements for DVD Read-Only disk

The requirements for the file structure of DVD Read-Only disks are specified as follows:

1. All disks shall be provided with UDF file structure and ECMA-119 file structure.
2. Only Short Allocation Descriptors shall be used in the Allocation Descriptors field of the File Entry.

An example of a directory structure for DVD-Video and DVD-Audio is shown in figure 7.

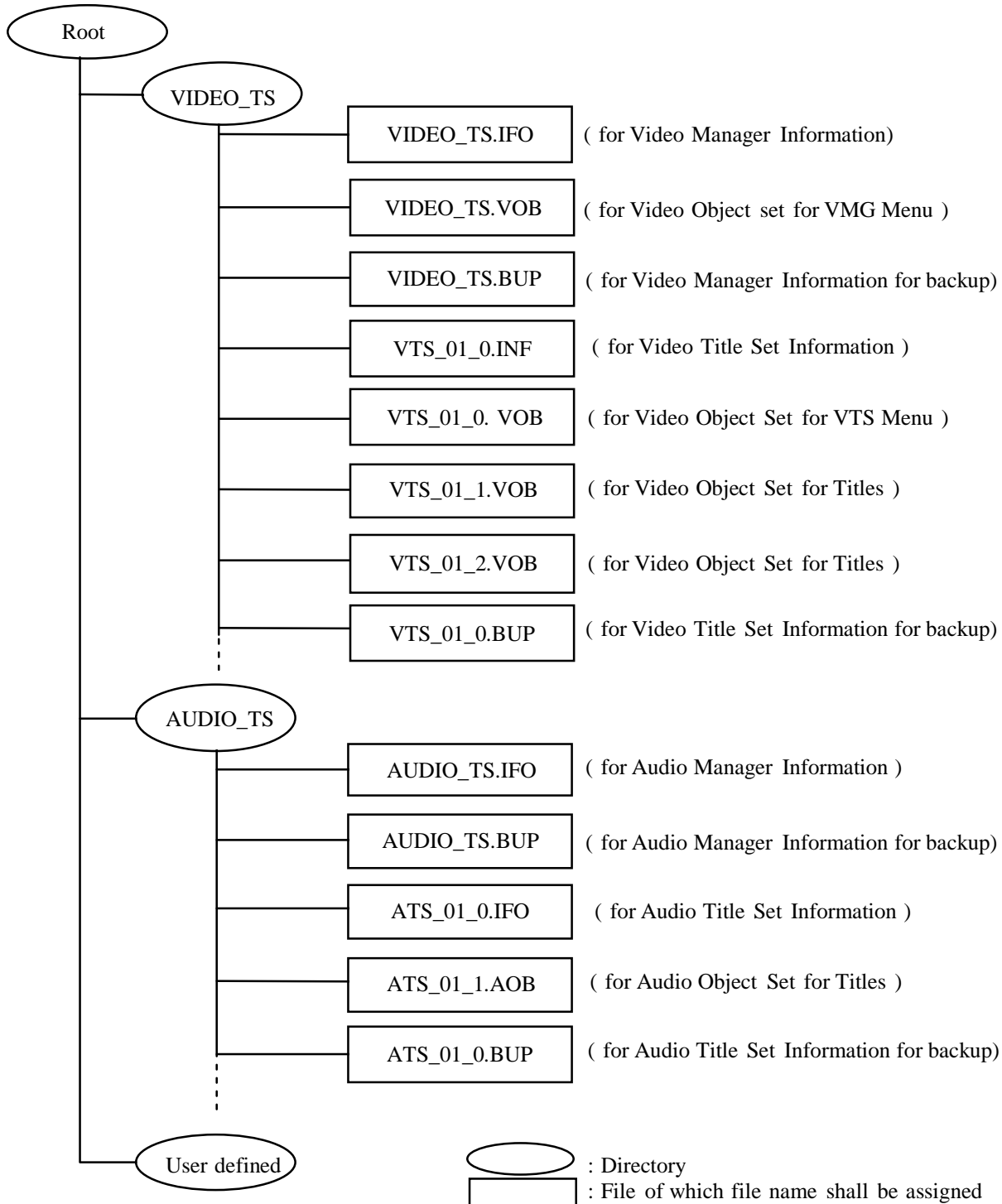


Figure 7: Example of Directory Structure

3.2 UDF File Structure

A UDF File Structure conforms to Part 4 of ECMA-167. For example, a file structure which contains a File Set Descriptor Sequence, Directories and ICBs with strategy type 4, is recorded as shown in table 21.

A File Set Descriptor in its sequence shall identify the root directory describing a set of files by specifying the address of an ICB. A directory shall contain a set of File Identifier Descriptors that specify the name of a component file or the name of a component subdirectory, or identify the parent directory of the directory.

A File Identifier Descriptor identifies a parent directory or a component file or subdirectory by specifying the address of an ICB. As specified in UDF, the ICB strategy type 4 should be used and the ICB strategy type 4096 may be used. When the ICB strategy type 4 is used, then the ICB hierarchy shall consist of a single ICB having one File Entry. A File Entry shall specify the attributes of the file and the location of the file.

Table 21: Example of UDF File Structure

| LBN | Descriptors | Structure |
|------------|--|-----------------------------------|
| 0 | File Set Descriptor | File Set Descriptor |
| 1 | Terminating Descriptor | Sequence |
| 2 | File Entry(Root Directory) | Root ICB |
| 3 | File Identifier Descriptor(parent directory) File Identifier Descriptor(VIDEO_TS) File Identifier Descriptor(AUDIO_TS) | Root Directory |
| 4 | File Entry(VIDEO_TS) | VIDEO_TS ICB |
| 5 | File Identifier Descriptor(parent directory) File Identifier Descriptor(VIDEO_TS.IFO) File Identifier Descriptor(VIDEO_TS.VOB) File Identifier Descriptor(VIDEO_TS.BUP) File Identifier Descriptor(VTS_01_0.IFO) File Identifier Descriptor(VTS_01_0.VOB) File Identifier Descriptor(VTS_01_1.VOB) File Identifier Descriptor(VTS_01_2.VOB) File Identifier Descriptor(VTS_01_0.BUP) | VIDEO_TS Directory |
| 6 | File Entry(VIDEO_TS.IFO) | VIDEO_TS Files ICBs |
| 7 | File Entry(VIDEO_TS.VOB) | |
| 8 | File Entry(VIDEO_TS.BUP) | |
| 9 | File Entry(VTS_01_0.IFO) | |
| 10 | File Entry(VTS_01_0.VOB) | |
| 11 | File Entry(VTS_01_1.VOB) | |
| 12 | File Entry(VTS_01_2.VOB) | |
| 13 | File Entry(VTS_01_0.BUP) | |
| 14 | File Entry(AUDIO_TS) | AUDIO_TS ICB |
| 15 | File Identifier Descriptor(parent directory) File Identifier Descriptor(AUDIO_TS.IFO) File Identifier Descriptor(AUDIO_TS.BUP) File Identifier Descriptor(ATS_01_0.IFO) File Identifier Descriptor(ATS_01_1.AOB) File Identifier Descriptor(ATS_01_0.BUP) | AUDIO_TS Directory |
| 16 | File Entry(AUDIO_TS.IFO) | AUDIO_TS Files ICBs |
| 17 | File Entry(AUDIO_TS.BUP) | |
| 18 | File Entry(ATS_01_0.IFO) | |
| 19 | File Entry(ATS_01_1.AOB) | |
| 20 | File Entry(ATS_01_0.BUP) | |

3.3 UDF File Set Descriptor Sequence

A file set recorded on a partition is identified by a File Set Descriptor which identifies the root of a directory hierarchy describing a set of files and certain attributes of the file set. The File Set Descriptor shall be recorded in a File Set Descriptor Sequence as specified in ECMA-167 4/8.3.1. A DVD Read-Only disk shall consist of a single file set per volume. Therefore, a File Set Descriptor Sequence shall contain only one File Set Descriptor. The File Set Descriptor Sequence shall be terminated by a Terminating Descriptor, an empty logical block which shall have all 00h bytes or the end of the File Set Descriptor Sequence Extent which is specified in a Logical Volume Contents field of a Logical Volume Descriptor.

For DVD Read-Only disks, a File Set Descriptor Sequence shall be recorded according to the schema in figure 8.

```
[File Set Descriptor Sequence Extent] {
    < File Set Descriptor > 1
    [Terminator] {
        <Terminating Descriptor>
        | <empty logical block>
    } 0+
}
```

Figure 8: File Set Descriptor Sequence Schema

3.3.1 File Set Descriptor

A File Set Descriptor shall identify a set of files and directories, and shall be recorded in the format as shown in table 22.

Table 22: File Set Descriptor

| BP | Length | Field Name | Contents |
|------------|--------|---|--|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=256) |
| 16 | 12 | Recording Date and Time | timestamp |
| 28 | 2 | Interchange Level | LB16 = 3 (see UDF 2.3.2.1) |
| 30 | 2 | Maximum Interchange Level | LB16 = 3 (see UDF 2.3.2.2) |
| 32 | 4 | Character Set List | LB32 = 00000001h (see UDF 2.3.2.3) |
| 36 | 4 | Maximum Character Set List | LB32 = 00000001h (see UDF 2.3.2.4) |
| 40 | 4 | File Set Number | LB32 = 0 (see UDF 2.3.2) |
| 44 | 4 | File Set descriptor Number | LB32 = 0 (for DVD Read-Only disk) |
| 48 | 64 | Logical Volume Identifier Character Set | charspec (see UDF 2.1.2) |
| 112 | 128 | Logical Volume Identifier | dstring |
| 240 | 64 | File Set Character Set | charspec (see UDF 2.1.2) |
| 304 | 32 | File Set Identifier | dstring |
| 336 | 32 | Copyright File Identifier | dstring |
| 368 | 32 | Abstract File Identifier | dstring |
| 400 | 16 | Root Directory ICB | long_ad |
| 416 | 32 | Domain Identifier | EntityID (see UDF 2.1.5) |
| 448 | 16 | Next Extent | long_ad = all 0's (for DVD Read-Only disk) |
| 464 | 48 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 256.

(BP 16) Recording Date and Time

This field shall indicate the date and time of the day at which this descriptor was recorded.

(BP 28) Interchange Level

This field shall be set to 3 as specified in UDF 2.3.2.1. The Interchange level is specified in ECMA-167 4/15.

(BP 30) Maximum Interchange Level

This field shall be set to 3 as specified in UDF 2.3.2.2.

(BP 32) Character Set List

This field shall be set to 00000001h, to indicate that only CS0 shall be supported as specified in UDF 2.3.2.3.

(BP 36) Maximum Character Set List

This field shall be set to 00000001h, to indicate that only CS0 shall be supported as specified in UDF 2.3.2.4.

(BP 40) File Set Number

This field shall be set to 0 to indicate that a DVD Read-Only disk shall consist of one file set as specified in UDF 2.3.2.

(BP 44) File Set Descriptor Number

This field shall be set to 0 for DVD Read-Only disks, to indicate that only one File Set Descriptor shall be recorded.

(BP 48) Logical Volume Identifier Character Set

This field shall specify the d-characters allowed in the Logical Volume Identifier field. The contents of the charspec are specified in UDF 2.1.2.

(BP 112) Logical Volume Identifier

This field shall specify an identification of the logical volume on which the file set is recorded.

(BP 240) File Set Character Set

This field shall specify the d-characters allowed in certain field of descriptors described in Part 4 of ECMA-167 that are within the scope of the File Set Descriptor. The contents of the charspec are specified in UDF 2.1.2.

(BP 304) File Set Identifier

This field shall specify an identification of the file set identified by this File Set Descriptor.

(BP 336) Copyright File Identifier

This field shall identify a file in the root directory containing a copyright statement for the information recorded in the file set identified by this File Set Descriptor. This field shall contain all 00h bytes, when no copyright file is identified.

(BP 368) Abstract File Identifier

This field shall identify a file in the root directory containing an abstract for the information recorded in the file set identified by this File Set Descriptor. This field shall contain all 00h bytes, when no abstract file is identified.

(BP 400) Root Directory ICB

This field shall specify the location of an ICB describing the root directory by long_ad. For example of table 21, the root directory ICB is located at logical block number 2.

(BP 416) Domain Identifier

This field shall specify an identification of a domain that shall specify rules on the use of, and restrictions on, certain fields in the descriptors. The contents of the EntityID for this descriptor are specified in UDF 2.1.5 and

2.3.2.7. In this specifications, the Domain Identifier field shall be set to "*OSTA UDF Compliant" and the UDF Revision field shall be set to 0102h to indicate that this specifications comply with OSTA UDF Specification Revision 1.02. For DVD Read-Only disks, the Soft Write-Protect and Hard Write-Protect flag specified in UDF 2.1.5.3 shall be set to ONE.

(BP 448) Next Extent

This field shall specify the next extent where File Set Descriptors may be recorded. For DVD Read-Only disks, this field shall be set to all 0's to indicate that no next extent is specified.

(BP 464) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

3.3.2 Terminating Descriptor

A Terminating Descriptor may be used to terminate an extent of a File Set Descriptor Sequence for DVD Read-Only disks, and shall be recorded in the format as shown in table 23.

Table 23: Terminating Descriptor

| BP | Length | Field Name | Contents |
|----|--------|----------------|------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=8) |
| 16 | 496 | Reserved | 00h bytes |

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 8.

(BP 16) Reserved

This field shall be reserved for future standardisation and all bytes shall be set to 00h.

3.4 UDF Directories

A directory contains zero or more file or directory identifications. A directory hierarchy shall be a set of directories descended from a single root directory.

A directory shall contain a set of File Identifier Descriptors as specified in ECMA-167 4/8.6, and shall be recorded according to the schema in figure 9.

```
{  
    < File Identifier Descriptor >  
} 0 +
```

Figure 9: Directory Schema

A File Identifier Descriptor is specified with RBP, there for as specified in ECMA-167 4/13 it has no restrictions on where it may be recorded within a logical block. All space, if any, after the end of the last descriptor up to the end of the logical block shall be recorded as all 00h bytes.

3.4.1 File Identifier Descriptor

A File Identifier Descriptor shall specify the name of a component file or the name of a component subdirectory, or identify the parent directory of the directory. A File Identifier Descriptor identifies a parent directory or a component file or subdirectory by specifying the address of an ICB, and shall be recorded in the format as shown in table 24.

Table 24: File Identifier Descriptor

| RBP | Length | Field Name | Contents |
|------------|---------------|--------------------------------------|----------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=257) |
| 16 | 2 | File Version Number | LB16 = 1 (see UDF 2.3.4.1) |
| 18 | 1 | File Characteristics | UInt8 |
| 19 | 1 | Length of File Identifier (=L_FI) | UInt8 |
| 20 | 16 | ICB | long_ad |
| 36 | 2 | Length of Implementation Use (=L_IU) | LB16 |
| 38 | L_IU | Implementation Use | EntityID (see UDF 2.1.5) |
| a | L_FI | File Identifier | d-characters |
| b | c | Padding | bytes |

$$a = L_IU + 38$$

$$b = L_FI = L_IU + 38$$

$$c = 4 \times ip((L_FI+L_IU+38+3)/4)-(L_FI+L_IU+38)$$

(RBP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 257.

(RBP 16) File Version Number

This field shall be set to 1 as specified in UDF 2.3.4.1, because there shall be only one version of a file.

(RBP 18) File Characteristics

This field shall specify certain characteristics of the file. This field has Existence bit, Directory bit, Deleted bit, and Parent bit as specified in ECMA-167 4/14.4.3. The usage of the File Characteristics under various operating systems is specified in UDF 3.3.1.1.

(RBP 19) Length of File Identifier

This field shall specify the length, in bytes, of the File Identifier field. If the Parent bit of the File Characteristics field is set to ONE, the length of the File Identifier field shall be 0 as specified in ECMA-167 4/14.4.4.

(RBP 20) ICB

This field shall specify the address of an ICB describing the file by long_ad.

(RBP 36) Length of Implementation Use

This field shall specify the length, in bytes, of the Implementation Use field. L_UI shall be an integral multiple of 4. As specified in UDF 2.3.4.2, this field may be 0, indicating that the Implementation Use field has not been used.

(RBP 38) Implementation Use

As specified in UDF 2.3.4.3, if the length of the Implementation Use field is non zero then the first 32 bytes of this field shall be interpreted as specifying the Implementation Entity Identifier. The contents of the EntityID are specified in UDF 2.1.5.

(RBP a) File Identifier

This field shall specify an identification for the file described by the ICB identified in the ICB field. The outline of the File Identifier translation algorithm for specific operating systems is specified in UDF 4.2.2.1.

(RBP b) Padding

This field shall be $4 \times ip((L_FI+L_IU+38+3)/4)-(L_FI+L_IU+38)$ bytes long and shall contain all 00h bytes.

3.5 ICB

An ICB is defined in ECMA-167 4/8.10. Each recorded instance of a file shall be described by an entry in Information Control Block (ICB). The set of entries describing the recorded instances of a file shall be described by entries in one or more ICBs. These ICBs shall form an ICB hierarchy. As specified in UDF 2.3.5.1, the ICB strategy type 4 should be used and ICB strategy type 4096 may be used. When the ICB strategy type 4 is used, the ICB hierarchy shall consist of a single ICB having one File Entry. The ICB strategy type 4096 is defined in UDF 6.6, and is efficient to support a history of all versions of a file as described in ECMA-167 4/8.10.

3.5.1 File Entry

A file shall be described by a File Entry that shall specify the attributes of the file and the location of the file's recorded data. The File Entry is a direct entry recorded in an ICB, and shall be recorded in the format as shown in table 25.

Table 25: File Entry

| BP | Length | Field Name | Contents |
|-----|--------|--|-----------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=261) |
| 16 | 20 | ICB Tag (see 3.5.2) | icbtag |
| 36 | 4 | Uid | LB32 |
| 40 | 4 | Gid | LB32 |
| 44 | 4 | Permissions (see 3.5.4) | LB32 |
| 48 | 2 | File Link Count | LB16 |
| 50 | 1 | Record Format | UInt8 = 0 (see UDF 2.3.6.1) |
| 51 | 1 | Record Display Attributes | UInt8 = 0 (see UDF 2.3.6.2) |
| 52 | 4 | Record Length | LB32 = 0 (see UDF 2.3.6.3) |
| 56 | 8 | Information Length | LB64 |
| 64 | 8 | Logical Blocks Recorded | LB64 |
| 72 | 12 | Access Time | timestamp |
| 84 | 12 | Modification Time | timestamp |
| 96 | 12 | Attribute Time | timestamp |
| 108 | 4 | Checkpoint | LB32 = 1 (for DVD Read-Only disk) |
| 112 | 16 | Extended Attribute ICB | long_ad |
| 128 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5) |
| 160 | 8 | Unique Id | LB64 (see UDF 2.3.6.5) |
| 168 | 4 | Length of Extended Attributes (=L_EA) | LB32 |
| 172 | 4 | Length of Allocation Descriptors (=L_AD) | LB32 |
| 176 | L_EA | Extended Attributes (see 3.6) | bytes |
| a | L_AD | Allocation Descriptors | bytes |

a = L_EA+176

(BP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 261.

(BP 16) ICB Tag

The ICB Tag shall specify the ICB strategy type, file type, and file characteristics. This field shall be recorded in the format as shown in table 26.

(BP 36) Uid

This field shall specify the User ID of the file's owner. As specified in UDF 3.3.3.1, for operating systems that do not support the concept of a user identifier, the implementation shall set this field to $2^{32}-1$ to indicate an invalid Uid.

(BP 40) Gid

This field shall specify the Group ID of the file's owner. As specified in UDF 3.3.3.2, for operating systems that do not support the concept of a group identifier, the implementation shall set this field to $2^{32}-1$ to indicate an invalid Gid.

(BP 44) Permissions

This field shall specify file access allowed to certain classes of users and shall be recorded in the format as shown in table 28.

(BP 48) File Link Count

This field shall specify the number of File Identifier Descriptors identifying this ICB.

(BP 50) Record Format

This field shall be set to 0 as specified in UDF 2.3.6.1, to indicate that this field does not specify the structure of the information recorded in the file.

(BP 51) Record Display Attributes

This field shall be set to 0 as specified in UDF 2.3.6.2, to indicate that this field does not specify the structure of the information recorded in the file.

(BP 52) Record Length

This field shall be set to 0 as specified in UDF 2.3.6.3, to indicate that this field does not specify the structure of the information recorded in the file.

(BP 56) Information Length

The file size in bytes. This value shall be equal to the sum of the Information Length of the Allocation Descriptors for the body of the file.

(BP 64) Logical Blocks Recorded

The number of recorded logical blocks specified by the Allocation Descriptors for the body of the file.

(BP 72) Access Time

For DVD Read-Only disks, this field shall specify the most recent time of file creation. This date and time shall not be earlier than the File Creation Time specified in the File Times Extended Attribute, if any.

(BP 84) Modification Time

For DVD Read-Only disks, this field shall specify the most recent time of file creation. This date and time shall not be earlier than the File Creation Time specified in the File Times Extended Attribute, if any. The content of this field shall be identical to the content of the Access Time field.

(BP 96) Attribute Time

For DVD Read-Only disks, this field shall specify the most recent time of file creation. This date and time shall not be earlier than the File Creation Time specified in the File Times Extended Attribute, if any. The content of this field shall be identical to the content of the Access Time field.

(BP 108) Checkpoint

This field shall be set to 1 for DVD Read-Only disks, because of the first instance of a file.

(BP 112) Extended Attribute ICB

This field shall specify the ICB describing the extended attribute file that is specified in ECMA-167 4/9. The extent's length shall be set to 0, when no Extended Attribute ICB is specified. The Extended Attribute for specific operating systems are specified in UDF 3.3.4.

(BP 128) Implementation Identifier

This field shall specify an identification of an implementation. The contents of the EntityID for this descriptor are specified in UDF 2.1.5.

(BP 160) Unique Id

This field shall specify a numeric identifier for this file. All File Entries with the same contents of this field shall describe the same file or directory. As specified in UDF 2.3.6.5, for the root directory this value shall be set to 0 and the values 1-15 are reserved for specific implementations.

(BP 168) Length of Extended Attributes

This field shall specify the length, in bytes, of the Extended Attributes field. L_EA shall be an integral multiple of 4.

(BP 172) Length of Allocation Descriptors

This field shall specify the length, in bytes, of the Allocation Descriptors field.

(BP 176) Extended Attributes

This field shall contain an extended attributes space that is defined in ECMA-167 4/9. The recorded extended attributes shall occupy at most L_EA bytes and any unused bytes shall be set to 00h.

The Extended Attribute for specific operating systems is specified in UDF 3.3.4.

(BP a) Allocation Descriptors

This field shall be a sequence of Allocation Descriptors defined in ECMA-167 4/12.1. For DVD Read-Only disks, Only Short Allocation Descriptors shall be used.

3.5.2 ICB Tag

As specified in UDF 2.3.5, an ICB Tag shall specify the strategy type, file type, and file characteristics, and shall be recorded in the format as shown in table 26. Some parameters of the ICB Tag for strategy type 4096 are specified in UDF 6.6.

Table 26: ICB Tag

| RBP | Length | Field Name | Contents |
|------------|---------------|---|-----------------|
| 0 | 4 | Prior Recorded Number of Direct Entries | LB32 |
| 4 | 2 | Strategy Type | LB16 |
| 6 | 2 | Strategy Parameter | LB16 |
| 8 | 2 | Maximum Number of Entries | LB16 |
| 10 | 1 | Reserved | 00h byte |
| 11 | 1 | File Type | UInt8 |
| 12 | 6 | Parent ICB Location | lb_addr |
| 18 | 2 | Flags (see 3.5.3) | LB16 |

(RBP 0) Prior recorded Number of Direct Entries

This field shall specify the number of Direct Entries recorded in this ICB hierarchy prior to this entry.

(RBP 4) Strategy Type

This field should be set to 4 or may be set to 4096 as specified in UDF 2.3.5.1. The strategy type is specified in ECMA-167 4/14.6.2.

(RBP 6) Strategy Parameter

This field shall be interpreted according to the strategy specified by the Strategy Type field.

(RBP 8) Maximum Number of Entries

This field shall specify the maximum number of entries, including both direct and indirect, that may be recorded in this ICB.

(RBP 10) Reserved

This field shall be reserved for future standardisation and shall be set to 00h byte.

(RBP 11) File Type

This field shall specify the type of the file as specified in ECMA-167 4/14.6.6. A value of 4 shall mean that the file is a directory. As specified in UDF 2.3.5.2, a value of 5 shall be used for a standard byte addressable file, not 0. The user interface requirements for this field is specified in UDF 4.2.1.1.

(RBP 12) Parent ICB Location

This field shall specify the location of the ICB which contains an indirect entry specifying the ICB that this descriptor is recorded in. If this field contains 0, no such ICB is specified.

(RBP 18) Flags

This field shall specify recording information about the file as specified in ECMA-167 4/14.6.8. This field shall be recorded in the format as shown in table 27.

3.5.3 Flags field in ICB Tag

This field is defined in ECMA-167 4/14.6.8, and certain bits of this field are specified in UDF 2.3.5.4.

This field shall be recorded in the format as shown in table 27.

Table 27: Flags field in ICB Tag

| Bit | Description | Contents |
|--------------|-------------------------------|--|
| 0-2 | Type of Allocation Descriptor | 0 : Short Allocation Descriptor (for DVD Read-Only disk) |
| 3 | Directory Sort | ZERO : unsorted (see UDF 2.3.5.4) |
| 4 | Non-relocatable | ZERO or ONE |
| 5 | Archive | ZERO or ONE |
| 6 | Setuid | ZERO or ONE |
| 7 | Setgid | ZERO or ONE |
| 8 | Sticky | ZERO or ONE |
| 9 | Contiguous | ZERO or ONE |
| 10 | System | ZERO or ONE |
| 11 | Transformed | ZERO : not transformed (see UDF 2.3.5.4) |
| 12 | Multi-versions | ZERO : not multi-versions (see UDF 2.3.5.4) |
| 13-15 | Reserved | ZEROs |

(Bit 0-2) Type of Allocation Descriptor

These bits shall be the value 0 which means that Short Allocation Descriptors are used.

(Bit 3) Directory Sort

If the file is not a directory, this bit shall be reserved for future standardisation and set to ZERO. If the file is a directory and this bit is set to ZERO, the directory need not be sorted according to ECMA-167 4/8.6.1. As specified in UDF 2.3.5.4, this bit shall be set to ZERO.

(Bit 4) Non-relocatable

If set to ZERO, shall mean that there are no restrictions on how the Allocation Descriptors specifying the file's data may be modified. If set to ONE, the Allocation Descriptors shall not be modified such that either the address of an extent of the file is changed or that the recorded length of an extent is reduced.

(Bit 5) Archive

This bit shall be set to ONE when the file is created or is written. This bit shall be set to ZERO in an implementation-dependent manner.

(Bit 6) Setuid

This bit shall be interpreted as the S_ISUID bit as specified in ISO/IEC 9945-1. For certain operating systems, this bit is specified in UDF 3.3.2.1.1.

(Bit 7) Setgid

This bit shall be interpreted as the S_ISGID bit as specified in ISO/IEC 9945-1. For certain operating systems, this bit is specified in UDF 3.3.2.1.1.

(Bit 8) Sticky

This bit shall be interpreted as the C_ISVTX bit as specified in ISO/IEC 9945-1. For certain operating systems, this bit is specified in UDF 3.3.2.1.1.

(Bit 9) Contiguous

If set to ZERO, then an extent of a file need not begin at the first logical block after the last logical block of the preceding extent of the file. If set to ONE, then each extent of a file shall begin at the first logical block after the last logical block of the preceding extent of the file.

(Bit 10) System

This bit shall be reserved for implementation use. For certain operating systems, this bit is specified in UDF 3.3.2.1.1.

(Bit 11) Transformed

This bit shall be set to ZERO as specified in UDF 2.3.5.4, to indicate that the recorded bytes of the data space of the file are those supplied by the user.

(Bit 12) Multi-versions

If the file is not a directory, this bit shall be reserved for future standardisation and shall be set to ZERO. If the file is a directory and the bit is set to ZERO, then no two File Identifier Descriptors recorded in the directory shall have the same contents of their File Identifier field. As specified in UDF 2.3.5.4 this bit shall be set to ZERO.

(Bit 13-15) Reserved

All bits shall be set to ZERO.

3.5.4 Permissions field in File Entry

As defined in ECMA-167 4/14.9.5, this field shall specify file access allowed to certain classes of users as follows:

- If the User ID is the same as the Uid field, then bits 10 -14 shall apply.
- Otherwise, if the user's Group ID is the same as the Gid field, then bits 5-9 shall apply.
- Otherwise, bits 0-4 shall apply.

The allowed access shall be defined as shown in table 28. For specific operating systems, this field is specified in UDF 3.3.3.3.

Table 28: Permissions field in File Entry

| Bit | Description | Contents |
|-------|------------------------|--|
| 0 | Other Execute | ZERO or ONE |
| 1 | Other Write | ZERO : Other not write (for DVD Read-Only disk) |
| 2 | Other Read | ZERO or ONE |
| 3 | Other Change Attribute | ZERO : Other not change attribute (for DVD Read-Only disk) |
| 4 | Other Delete | ZERO : Other not delete (for DVD Read-Only disk) |
| 5 | Group Execute | ZERO or ONE |
| 6 | Group Write | ZERO : Group not write (for DVD Read-Only disk) |
| 7 | Group Read | ZERO or ONE |
| 8 | Group Change Attribute | ZERO : Group not change attribute (for DVD Read-Only disk) |
| 9 | Group Delete | ZERO : Group not delete (for DVD Read-Only disk) |
| 10 | Owner Execute | ZERO or ONE |
| 11 | Owner Write | ZERO : Owner not write (for DVD Read-Only disk) |
| 12 | Owner Read | ZERO or ONE |
| 13 | Owner Change Attribute | ZERO : Owner not change attribute (for DVD Read-Only disk) |
| 14 | Owner Delete | ZERO : Owner not delete (for DVD Read-Only disk) |
| 15-31 | Reserved | ZEROs |

(Bit 0) Other Execute

If set to ZERO, shall mean that the user may not execute the file. If set to ONE, shall mean that the user may execute the file.

(Bit 1) Other Write

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not write the file.

(Bit 2) Other Read

If set to ZERO, shall mean that the user may not read the file. If set to ONE, shall mean that the user may read the file.

(Bit 3) Other Change Attribute

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not change any attributes of the file.

(Bit 4) Other Delete

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not delete the file.

(Bit 5) Group Execute

If set to ZERO, shall mean that the user may not execute the file. If set to ONE, shall mean that the user may execute the file.

(Bit 6) Group Write

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not write the file.

(Bit 7) Group Read

If set to ZERO, shall mean that the user may not read the file. If set to ONE, shall mean that the user may read the file.

(Bit 8) Group Change Attribute

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not change any attributes of the file.

(Bit 9) Group Delete

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not delete the file.

(Bit 10) Owner Execute

If set to ZERO, shall mean that the user may not execute the file. If set to ONE, shall mean that the user may execute the file.

(Bit 11) Owner Write

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not write the file.

(Bit 12) Owner Read

If set to ZERO, shall mean that the user may not read the file. If set to ONE, shall mean that the user may read the file.

(Bit 13) Owner Change Attribute

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not change any attributes of the file.

(Bit 14) Owner Delete

This bit shall be set to ZERO for DVD Read-Only disks, to indicate that the user may not delete the file.

(Bit 15-31) Reserved

All bits shall be set to ZERO.

3.6 Extended Attribute

An extended attribute shall specify an attribute type, an attribute subtype, and may specify attribute specific information associated with a file as specified in ECMA-167 4/9. All the extended attributes shall be recorded in one or more extended attributes spaces associated with that file.

An extended attributes space of a file is one of the following:

- The Extended Attributes field of the file's File Entry
- A file described by an ICB identified in the file's File Entry

In each case, an extended attributes space shall be recorded according to the schema shown in figure 10.

<Extended Attribute Header Descriptor>
<Extended Attribute> 0+

Figure 10: Extended Attributes Space Schema

Extended attributes shall be recorded contiguously in three non-overlapping areas within an extended attributes space as follows:

- The first area, starting with the first byte after the Extended Attribute Header Descriptor, is reserved for the recording of attributes that have attribute types 1, 5, 6, and 12.

- The second area, starting at a byte specified in the Implementation Attributes Location field of the Extended Attribute Header Descriptor, is reserved for the recording of attribute types 2048 to 65535. Attribute types 2049 to 65535 inclusive are specified by the registration according to ISO/IEC 13800 as specified in ECMA-167 4/9.
- The third area, starting at a byte specified in the Application Attributes Location of the Extended Attribute Header Descriptor, is reserved for the recording of attribute types 65536 and above.

For DVD Read-Only disks, the Implementation Use Extended Attributes for Free Extended Attribute Space specified in 3.6.3 and Copyright Management Information specified in 3.6.4 shall be recorded in the Extended Attributes field of the File Entry.

3.6.1 Extended Attribute Header Descriptor

The Extended Attribute Header Descriptor shall be recorded in the format as shown in table 29.

Table 29: Extended Attribute Header Descriptor

| RBP | Length | Field Name | Contents |
|-----|--------|------------------------------------|--------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=262) |
| 16 | 4 | Implementation Attributes Location | LB32 |
| 20 | 4 | Application Attributes Location | LB32 |

(RBP 0) Descriptor Tag

The Tag Identifier field of this Descriptor Tag shall contain 262.

(RBP 16) Implementation Attributes Location

This field shall specify the start of the implementation use extended attributes as a byte offset from the start of an extended attributes space in which extended attributes of the current file shall be recorded. If the extended attributes of which types have 2048 to 65535 do not exist, then this field shall specify the end of the extended attributes space as specified in UDF 3.3.4.1.

(RBP 20) Application Attributes Location

This field shall specify the start of the application use extended attributes as a byte offset from the start of an extended attributes space in which extended attributes of the current file shall be recorded. If the extended attributes of with types have 65536 and above do not exist, then this field shall specify the end of the extended attributes space as specified in UDF 3.3.4.1.

3.6.2 Implementation Use Extended Attribute

An attribute type and an attribute subtype shall specify the type of an extended attribute. For the Free Extended Attribute space and the Copyright Management Information, the Implementation Use Extended Attribute that has attribute type 2048 and attribute subtype 1 shall be used.

The Implementation Use Extended Attribute shall be recorded in the format as shown in table 30.

Table 30: Implementation Use Extended Attribute

| RBP | Length | Field Name | Contents |
|-----|--------|--|--------------------------|
| 0 | 4 | Attribute Type | LB32 = 2048 |
| 4 | 1 | Attribute Subtype | UInt8 = 1 |
| 5 | 3 | Reserved | 00h bytes |
| 8 | 4 | Attribute Length | LB32 |
| 12 | 4 | Implementation Use Length (=IU_L) | LB32 |
| 16 | 32 | Implementation Identifier | EntityID (see UDF 2.1.5) |
| 48 | IU_L | Implementation Use (see 3.6.3 and 3.6.4) | bytes |

(RBP 0) Attribute Type

This field shall be set to 2048.

(RBP 4) Attribute Subtype

This field shall be set to 1.

(RBP 5) Reserved

This field shall be reserved for future standardisation and shall be recorded as all 00h bytes.

(RBP 8) Attribute Length

This field shall specify the length of the entire extended attribute. As specified in UDF 3.3.4.5, for variable length extended attributes defined using the Implementation Use Extended Attribute, the Attribute Length field should be large enough to leave padding space between the end of the Implementation Use field and the end of the Implementation Use Extended Attribute.

(RBP 12) Implementation Use Length

This field shall specify the length of the Implementation Use field.

(RBP 16) Implementation Identifier

This field shall specify an identification of an implementation that can recognize and act upon the contents of the Implementation Use field.

(RBP 48) Implementation Use

For DVD Read-Only disks, for the Free Extended Attribute Space and the Copyright Management Information this field shall be specified in 3.6.3 and 3.6.4.

3.6.3 Free Extended Attribute Space of Implementation Use field

The Free Extended Attribute Space shall be specified in the Implementation Use Extended Attribute to indicate unused space within the extended attributes space as specified in UDF 3.3.4.5.1. The Implementation Identifier field of this Implementation Use Extended Attribute shall be set to:

"*UDF FreeEASpace"

The Implementation Use field of this Implementation Use Extended Attribute shall be recorded in the format as shown in table 31.

Table 31: Free Extended Attribute Space of Implementation Use field

| RBP | Length | Field Name | Contents |
|------------|---------------|-------------------|------------------------------------|
| 0 | 2 | Header Checksum | LB16 |
| 2 | 2 | Free EA Space | bytes = 0 (for DVD Read-Only disk) |

(RBP 0) Header Checksum

This field represents a 16-bit checksum of the Implementation Use Extended Attribute header as specified in UDF 3.3.4.5. The Attribute Type field through the Implementation Identifier field inclusively represents the data covered by the checksum. The header checksum field is used to aid disaster recovery of the extended attributes space.

(RBP 2) Free EA Space

This field shall be set to 0 for DVD Read-Only disks.

3.6.4 Copyright Management Information of Implementation Use field

The Copyright Management Information shall be specified in the Implementation Use Extended Attribute, which is recorded in the Extended Attributes field of the File Entry for each file. The Implementation Identifier field of the Implementation Use Extended Attribute shall be set to:

"*UDF DVD CGMS Info"

The Implementation Use field of this Implementation Use Extended Attribute shall be recorded in the format as shown in table 32.

Table 32: Copyright Management Information of Implementation Use field

| RBP | Length | Field Name | Contents |
|-----|--------|-------------------------------|----------|
| 0 | 2 | Header Checksum | LB16 |
| 2 | 1 | CGMS Information | byte |
| 3 | 1 | Data Structure Type | Uint8 |
| 4 | 4 | Protection System Information | bytes |

(RBP 0) Header Checksum

This field represents a 16-bit checksum of the Implementation Use Extended Attribute header as specified in UDF 3.3.4.5.

(RBP 2) CGMS Information

This field shall be recorded in the format as shown in table 33.

Table 33: CGMS Information field

| Bit | Description | Contents |
|-----|----------------------|---------------|
| 0-3 | Reserved | ZEROs |
| 4-5 | CGMS | 0, 1, 2, or 3 |
| 6 | Reserved | ZERO |
| 7 | Copyrighted Material | ZERO or ONE |

(Bit 0-3) Reserved

All bits shall be set to ZERO.

(Bit 4-5) CGMS

When the Copyrighted Material bit is set to ONE, the CGMS (Copyright Generation Management System) field shall be interpreted as a 2-bit unsigned binary number as follows:

- 3: No copying is permitted
- 2: One generation of copies may be made
- 1: Condition is not be used
- 0: Copying is permitted without restriction

When the Copyrighted Material bit is set to ZERO, this field shall be reserved.

(Bit 6) Reserved

This bit shall be set to ZERO.

(Bit 7) Copyrighted Material

ONE: This file contains Copyrighted Material (including Audio/Video Object data).

ZERO: This file contains no Copyrighted Material.

(RBP 3) Data Structure Type

This field shall be specified to identify the data structure of Protection System Information field. The type specified in this field shall be interpreted as shown in table 34.

Table 34: Data Structure Interpretation

| Type | Interpretation |
|-------|--|
| 0 | The Protection System Information field shall be defined as shown in table 35. |
| 1-255 | Reserved |

(RBP 4) Protection System Information

This field shall be specified to identify the protection system for copyright management. For Data Structure Type 0, this field shall be defined as shown in table 35.

Table 35: Protection System Information field for Data Structure Type 0

| RBP | Length | Field Name | Contents |
|-----|--------|------------------------|-----------|
| 0 | 1 | Protection System Type | Uint8 |
| 1 | 3 | Reserved | 00h bytes |

(RBP 0) Protection System Type

The value of this field is defined as follows:

0: This file has no specific data structure for protection system.

1: This file has a specific data structure for protection system 1.

All other values are reserved for future standardisation.

(RBP 1) Reserved

This field shall be recorded as all 00h bytes.

3.7 ECMA-119 Directory Structure and Path Table

A directory shall be recorded as a file containing a set of records each of which identifies a File Segment or another directory.

A Directory Record shall contain information to locate a File Segment, information to locate any Extended Attribute Record, the identification of the file, and certain attributes of the file and the File Segment.

The first or only Directory Record recorded in a logical sector shall begin at the first byte of the logical sector. Each subsequent Directory Record recorded in that logical sector shall begin at the byte immediately following the last byte of the preceding Directory Record in that logical sector. Each Directory Record shall end in the logical sector in which it begins. Unused byte positions after the last Directory Record in a logical sector shall be set to 00h.

A Path Table recorded on a volume shall contain a set of records describing a directory hierarchy. For each directory in the directory hierarchy other than the root directory, the Path Table shall contain a record which identifies the directory, its parent directory and its location. The records in a Path Table shall be numbered starting from 1. The first record in the Path Table shall identify the root directory and its location.

A Path Table shall be either a Type L Path Table or a Type M Path Table.

In a Type L Path Table, a numerical value shall be recorded according to LB16 if represented as a 16-bit number and according to LB32 if represented as a 32-bit number.

In a Type M Path Table, a numerical value shall be recorded according to MB16 if represented as a 16-bit number and according to MB32 if represented as a 32-bit number.

An example of the ECMA-119 Directory Structure and the Path Table is shown in table 36.

Table 36: Example of ECMA-119 Directory Structure and Path Table

| LSN | Contents | |
|------------|--|-------------------------------|
| 257 | Type L Path Table Record for Root Directory Type L Path Table Record for AUDIO_TS Type L Path Table Record for VIDEO_TS | Type L Path Table |
| 258 | Type M Path Table Record for Root Directory Type M Path Table Record for AUDIO_TS Type M Path Table Record for VIDEO_TS | Type M Path Table |
| 259 | Directory Record for Root Directory (1st) Directory Record for Root Directory (2nd) Directory Record for AUDIO_TS Directory Record for VIDEO_TS | Directory Records of Root |
| 260 | Directory Record for VIDEO_TS Directory Record for Parent Directory Directory Record for VIDEO_TS.BUP Directory Record for VIDEO_TS.IFO Directory Record for VIDEO_TS.VOB Directory Record for VTS_01_0.BUP Directory Record for VTS_01_0.IFO Directory Record for VTS_01_0.VOB Directory Record for VTS_01_1.VOB Directory Record for VTS_01_2.VOB | Directory Records of VIDEO_TS |
| 261 | Directory Record for AUDIO_TS Directory Record for Parent Directory Directory Record for ATS_01_0.BUP Directory Record for ATS_01_0.IFO Directory Record for ATS_01_1.AOB Directory Record for AUDIO_TS.BUP Directory Record for AUDIO_TS.IFO | Directory Records of AUDIO_TS |

3.7.1 Directory Record

A Directory Record shall be recorded in the format as shown in table 37.

Table 37: Directory Record

| RBP | Length | Field Name | Contents |
|------------|---------------|--|--|
| 0 | 1 | Length of Directory Record (=LEN_DR) | UInt8 |
| 1 | 1 | Extended Attribute Record Length | UInt8 |
| 2 | 8 | Location of Extent | BB32 |
| 10 | 8 | Data Length | BB32 |
| 18 | 7 | Recording Date and Time (see ECMA-119 Table 9) | numerical value |
| 25 | 1 | File Flags (see ECMA-119 Table 10) | 8 bits |
| 26 | 1 | File Unit Size | UInt8 |
| 27 | 1 | Interleave Gap Size | UInt8 |
| 28 | 4 | Volume Sequence Number | BB16 = 1 (for DVD Read-Only disk) |
| 32 | 1 | Length of File Identifier (=LEN_FI) | UInt8 |
| 33 | LEN_FI | File Identifier | d-characters, d1-characters, SEPARATOR 1, SEPARATOR 2, 00h or 01h byte |
| a | b | Padding | 00h byte |
| c | d | System Use (see 3.7.2) | bytes |

a=33+LEN_FI

b = 0 if the Length of the File Identifier field is an odd number,

b = 1 if the Length of the File Identifier field is an even number.

c = a + b

d = LEN_DR-c

(RBP 0) Length of Directory record

This field shall specify as an 8-bit number the length in byte of this Directory Record.

(RBP 1) Extended Attribute Record Length

This field shall contain an 8-bit number which specify the assigned Extended Attribute Record length if an Extended Attribute Record is recorded.

(RBP 2) Location of Extent

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(RBP 10) Data Length

This field shall specify as a 32-bit number the data length of the File Segment.

(RBP 18) Recording Date and Time

This field shall indicate the date and the time of the day at which the information in the extent described by the Directory Record was recorded. The format of this field is specified in ECMA-119 table 9.

(RBP 25) File Flags

This field shall specify certain characteristics of the file as specified in ECMA-119 table 10.

(RBP 26) File Unit Size

This field shall contain an 8-bit number. This number shall specify the assigned file unit size for the File Segment if the File Segment is recorded in interleaved mode. Otherwise this field shall be set to 0.

(RBP 27) Interleave Gap Size

This field shall contain an 8-bit number. This number shall specify the assigned Interleave Gap for the File Segment if the File Segment is recorded in interleaved mode. Otherwise this field shall be set to 0.

(RBP 28) Volume Sequence Number

This field shall specify as a 16-bit number the ordinal number of the volume in the volume set on which the extent described by this Directory Record is recorded. For DVD Read-Only disks, this field shall be set to 1.

(RBP 32) Length of File Identifier

This field shall specify as a 18-bit number the length in bytes of the File Identifier field of this Directory Record.

(RBP 33) File Identifier

This field shall specify an identification for the file or directory as specified in ECMA-119 9.1.11.

(RBP a) Padding Field

This field shall be present in the Directory Record only if the length of the File Identifier field is an even number. If present, this field shall be set to 00h byte.

(RBP c) System Use

The Copyright Management Information shall be recorded in the last 6 bytes of this field. If the remainder of this field present, the remainder shall be reserved for system use.

3.7.2 Copyright Management Information of System Use field

The Copyright Management Information shall be specified in the last 6 bytes of the System Use field of the Directory Record for each file and shall be recorded in the format as shown in table 38.

Table 38: Copyright Management Information of System Use field

| RBP | Length | Field Name | Contents |
|-----|--------|-------------------------------|----------|
| 0 | 1 | CGMS Information | byte |
| 1 | 1 | Data Structure Type | UInt8 |
| 2 | 4 | Protection System Information | bytes |

(RBP 0) CGMS Information

This field shall be recorded in the format as shown in table 39.

Table 39: CGMS Information

| RBP | Description | Contents |
|-----|----------------------|---------------|
| 0-3 | Reserved | ZEROs |
| 4-5 | CGMS | 0, 1, 2, or 3 |
| 6 | Reserved | ZERO |
| 7 | Copyrighted Material | ZERO or ONE |

(Bit 0-3) Reserved

All bits shall be set to ZERO.

(Bit 4-5) CGMS

When the Copyrighted Material bit is set to ONE, the CGMS (Copyright Generation Management System) field shall be interpreted as a 2-bit unsigned binary number as follows:

- 3: No copying is permitted
- 2: One generation of copies may be made
- 1: Condition is not be used
- 0: Copying is permitted without restriction

When the Copyrighted Material bit is set to ZERO, this field shall be reserved.

(Bit 6) Reserved

This bit shall be set to ZERO.

(Bit 7) Copyrighted Material

ONE: This file contains Copyrighted Material (including Audio/Video Object data).

ZERO: This file contains no Copyrighted Material.

(RBP 1) Data Structure Type

This field shall be specified to identify the data structure of Protection System Information field. The type specified in this field shall be interpreted as shown in table 40.

Table 40: Data Structure Interpretation

| Type | Interpretation |
|-------|--|
| 0 | The Protection System Information field shall be defined as shown in table 41. |
| 1-255 | Reserved |

(RBP 2) Protection System Information

This field shall be specified to identify the protection system for copyright management. For Data Structure Type 0, this field shall be defined as shown in table 41.

Table 41: Protection System Information field for Data Structure Type 0

| RBP | Length | Field Name | Contents |
|-----|--------|------------------------|-----------|
| 0 | 1 | Protection System Type | Uin8 |
| 1 | 3 | Reserved | 00h bytes |

(RBP 0) Protection System Type

The value of this field is defined as follows:

- 0: This file has no specific data structure for protection system.
- 1: This file has a specific data structure for protection system 1.

All other values are reserved for future standardisation.

(RBP 1) Reserved

This field shall be recorded as all 00h bytes.

3.7.3 Path Table Record

The Path Table Record shall be recorded in the format as shown in table 42.

Table 42: Path Table Record

| RBP | length | Field Name | Contents |
|------------|---------------|--|---------------------------------------|
| 0 | 1 | Length of Directory Identifier (=LEN_DI) | Uint8 |
| 1 | 1 | Extended Attribute Record Length | Uint8 |
| 2 | 4 | Location of Extent | LB32 or MB32 |
| 6 | 2 | Parent Directory Number | LB16 or MB16 |
| 8 | LEN_DI | Directory Identifier | d-characters, d1-characters, 00h byte |
| a | b | Padding | 00h byte |

a=8+LEN_DI

b = 0 if the Length of Directory Identifier field is an even number,

b = 1 if the Length of Directory Identifier field is an odd number.

(RBP 0) Length of Directory Identifier

This field shall specify as an 8-bit number the length in bytes of the Directory Identifier field of this Path Table Record.

(RBP 1) Extended Attribute Record Length

This field shall contain an 8-bit number. This number shall specify the assigned Extended Attribute Record length if an Extended Attribute Record is recorded. Otherwise this field shall be set to 0.

(RBP 2) Location of Extent

This field shall specify as a 32-bit number the logical sector number of the first logical sector allocated to the extent in which the directory is recorded. For DVD Read-Only disks, the logical block number defined by ECMA-119 shall be equal to the logical sector number.

(RBP 6) Parent Directory Number

This field shall specify as a 16-bit number the record number in the Path Table for the parent directory of the directory.

(RBP 8) Directory Identifier

This field shall specify as identification for a directory.

(RBP a) Padding

This field shall be present in this Path Table Record only if the number in the Length of Directory Identifier field is an odd number. If present, this field shall be set to 00h byte.

Annex A
(normative)

Requirements for DVD-Video disk

A.1 General

This Annex specifies requirements of parameter fields for volume and file structure on DVD-Video disks, which are defined in Part 3 VIDEO SPECIFICATIONS of DVD Specifications for Read-Only Disc. These requirements are defined to provide both for operating system independence and for a simple data structure.

A.2 Entity Identifier of Implementation Identifier field

The Entity ID, which is specified in the following descriptors, shall be recorded in the format as shown in table A.1:

- Implementation Identifier field of Primary Volume Descriptor
- Implementation ID field in Implementation Use field of Implementation Use Volume Descriptor
- Implementation Identifier field of Partition Descriptor
- Implementation Identifier field of Logical Volume Descriptor
- Implementation Identifier field of Logical Volume Integrity Descriptor
- Implementation Identifier field of File Entry

The Length of Implementation Use field in the File Identifier Descriptor shall be set to 0. Therefore the Implementation Use field which is specified as EntityID in the File Identifier Descriptor shall not be present.

Table A.1 : Entity Identifier of Implementation Identifier field

| RBP | Length | Field Name | Contents |
|------------|---------------|-------------------------|--|
| 0 | 1 | Flags | UInt8 = 0 |
| 1 | 23 | Identifier | bytes = "*Developer ID" (for DVD-Video disk) |
| 24 | 1 | OS Class | UInt8 = 0 (for DVD-Video disk) |
| 25 | 1 | OS Identifier | UInt8 = 0 (for DVD-Video disk) |
| 26 | 6 | Implementation Use Area | bytes |

(RBP 1) Identifier

This field shall be set to "*Developer ID" which each authoring system developer shall register.

(RBP 24) OS Class

This field shall be set to 0, which means that OS is undefined.

(RBP 25) OS Identifier

This field shall be set to 0.

(RBP 26) Implementation Use Area

This field shall contain the implementation specific information including the Authoring Software Version of the authoring system developer.

A.3 UDF Identifier Suffix

The UDF Identifier Suffix which is specified in UDF 2.1.5.3 is recorded in the Implementation Identifier field in the Implementation Use Volume Descriptor and the Identifier field of UDF Extended Attribute shall be recorded in the format as shown in table A.2.

Table A.2: UDF Identifier Suffix

| RBP | Length | Field Name | Contents |
|------------|---------------|-------------------|--------------------------------|
| 0 | 2 | UDF Revision | LB16 = 0102h |
| 2 | 1 | OS Class | UInt8 = 0 (for DVD-Video disk) |
| 3 | 1 | OS Identifier | UInt8 = 0 (for DVD-Video disk) |
| 4 | 4 | Reserved | 00h bytes |

(RBP 2) OS Class

This field shall be set to 0, which means that OS is undefined.

(RBP 3) OS Identifier

This field shall be set to 0.

A.4 Identifiers

The certain identifier shall be recorded in the following field. For example, the title name may be recorded.

- Volume Identifier field of Primary Volume Descriptor (UDF)
- Volume Set Identifier field of Primary Volume Descriptor (UDF)
- Logical Volume Identifier field in Implementation Use field of Implementation Use Volume Descriptor
- Logical Volume Identifier field of Logical Volume Descriptor
- Logical Volume Identifier field of File Set Descriptor
- File Set Identifier field of File Set Descriptor
- Volume Identifier field of Primary Volume Descriptor (ECMA-119)
- Volume Set Identifier field of Primary Volume Descriptor (ECMA-119)

A.5 Anchor Volume Descriptor Pointer

Anchor Volume Descriptor Pointers shall be recorded in the specified logical sectors having the logical sector number 256 and the last logical sector number.

A.6 Volume Set Identifier field in Primary Volume Descriptor

The Volume Set Identifier field in the Primary Volume Descriptor shall be recorded in the format as shown in table A.3.

Table A.3: Volume Set Identifier field in Primary Volume Descriptor

| RBP | Length | Field Name | Contents |
|------------|---------------|----------------------|-----------------|
| 0 | 1 | Compression ID | Uint8 = 8 |
| 1 | 8 | Time Value | bytes |
| 9 | 8 | Implementation Use | bytes |
| 17 | 110 | Allowed Value | bytes |
| 127 | 1 | Length of Characters | Uint8 |

(RBP 0) Compression ID

This field shall be set to 8 which specifies that characters of the Time Value field, the Implementation Use field and Allowed Value field shall be compressed as 8 bits per character.

(RBP 1) Time Value

This field shall specify character strings coded by ISO/IEC 646 of hexadecimal representation of a 32-bit time value. The 32-bit time format is defined in table A.4.

Table A.4 : 32-bit time format for DVD-Video disk

| Bit | Length | Description | Contents |
|--------------|---------------|----------------------|-------------------------------------|
| 0-4 | 5bits | Seconds divided by 2 | a number between 0 and 29 inclusive |
| 5-10 | 6bits | Minute | a number between 0 and 59 inclusive |
| 11-15 | 5bits | Hour | a number between 0 and 23 inclusive |
| 16-20 | 5bits | Day | a number between 1 and 31 inclusive |
| 21-24 | 4bits | Month | a number between 1 and 12 inclusive |
| 25-31 | 7bits | Year | a number relative to 1980 |

For example, the date and time for 14:35:50 on November 28, 1995 has the decimal number 15:11:28:14:35:25 as Year : Month : Day : Hour : Minute : Seconds divided by 2 and the value of 32-bit time format is the binary number 0001111b: 1011b: 11100b: 01110b: 100011b: 11001b and also the hexadecimal number 1F7C7479h. Then the value of the Time Value field is 31h, 46h, 37h, 43h, 37h, 34h, 37h, 39h.

(RBP 9) Implementation Use

This field is used for information use freely.

(RBP 17) Allowed Value

This field shall specify an identification of the volume set as any allowed value.

(RBP 127) Length of Characters

This field shall be set to the number of bytes used to record the characters in this Volume Set Identifier field.

A.7 Logical Volume Integrity Sequence

A Logical Volume Integrity Sequence shall be terminated by a Terminating Descriptor.

A.8 Logical Volume Header Descriptor of Logical Volume Contents Use field

Table A.5: Logical Volume Header Descriptor of Logical Volume Contents Use field

| RBP | Length | Field Name | Contents |
|-----|--------|------------|--|
| 0 | 8 | Unique ID | LB64 < 2 ³¹ -1 (for DVD-Video disk) |
| 8 | 24 | Reserved | 00h bytes |

(RBP 0) Unique ID

This field shall specify a value that is greater than the value of the Unique ID field in any File Entry recorded on the associated logical volume. Implementations shall keep this value less than 2³¹-1.

A.9 File Set Descriptor Sequence

The File Set Descriptor Sequence shall be terminated by a Terminating Descriptor.

A.10 File Entry

Each specific file and each directory shall be recorded in only a single extent. This requirement is applied for the specific files, which are defined in Part 3 VIDEO SPECIFICATIONS including the Jacket Picture Format, the root directory and the directories for retrieving the specific file.

Table A.6: File Entry

| BP | Length | Field Name | Contents |
|-----|--------|---------------------------------------|---------------------------------------|
| 0 | 16 | Descriptor Tag | tag (Tag Identifier=261) |
| 16 | 20 | ICB Tag | icbtag (see A.11 for DVD-Video disk) |
| 36 | 4 | UId | LB32 |
| 40 | 4 | Gid | LB32 |
| 44 | 4 | Permissions | LB32 |
| 48 | 2 | File Link Count | LB16 |
| 50 | 1 | Recorded Format | UInt8 = 0 |
| 51 | 1 | Recorded Display Attributes | UInt8 = 0 |
| 52 | 4 | Record Length | LB32 = 0 |
| 56 | 8 | Information Length | LB64 |
| 64 | 8 | Logical Blocks Recorded | LB64 |
| 72 | 12 | Access Time | timestamp |
| 84 | 12 | Modification Time | timestamp |
| 96 | 12 | Attribute Time | timestamp |
| 108 | 4 | Checkpoint | LB32 = 1 |
| 112 | 16 | Extended Attribute ICB | long_ad |
| 128 | 32 | Implementation Identifier | EntityID (see A.2 for DVD-Video disk) |
| 160 | 8 | Unique Id | LB64 |
| 168 | 4 | Length of Extended Attributes (=L_EA) | LB32 |
| 172 | 4 | Length of Allocation Descriptors | LB32 = 8 (for DVD-Video disk) |
| 176 | L-EA | Extended Attributes | bytes |
| a | 8 | Allocation Descriptors | bytes |

$$a = L_EA + 176$$

(BP 16) ICB Tag

The ICB Tag field is specified in A.11 ICB Tag.

(BP 128) Implementation Identifier

The Implementation Identifier field is specified in A.2 EntityID for Implementation Identifier.

(BP 172) Length of Allocation Descriptors

This field shall be set to 8. It means that only one Short Allocation Descriptor shall be recorded in the Allocation Descriptors field.

(BP 176) Allocation Descriptors

A Short Allocation descriptor shall be recorded in this field.

A.11 ICB Tag

Each specific file and each directory shall be recorded with the ICB strategy type 4. The ICB Tag shall be recorded in the format as shown in table A.7. This requirement is applied for the specific files, which are defined in Part 3 VIDEO SPECIFICATIONS including the Jacket Picture Format, the root directory and the directories for retrieving the specific file.

Table A.7: ICB Tag

| BP | Length | Field Name | Contents |
|-----------|---------------|---|--|
| 0 | 4 | Prior Recorded Number of Direct Entries | LB32 = 0 (for DVD-Video disk) |
| 4 | 2 | Strategy Type | LB16 = 4 (for DVD-Video disk) |
| 6 | 2 | Strategy Parameter | LB16 = 0 (for DVD-Video disk) |
| 8 | 2 | Maximum Number of Entries | LB16 = 1 (for DVD-Video disk) |
| 10 | 1 | Reserved | 00h byte |
| 11 | 1 | File Type | Uin8 |
| 12 | 6 | Parent ICB Location | lb_addr = all 0's (for DVD-Video disk) |
| 18 | 2 | Flags (see A.12) | LB16 |

(RBP 0) Prior recorded Number of Direct Entries

This field shall be set to 0, because the ICB hierarchy shall consist of a single ICB.

(RBP 4) Strategy Type

This field shall be set to 4.

(RBP 6) Strategy Parameter

This field shall be set to 0.

(RBP 8)Maximum Number of Entries

This field shall be set to 1.

(RBP 12) Parent ICB Location

This field shall be set to all 0's, as there shall be no parent ICB.

(RBP 18) Flags

This field shall be recorded in the format as shown in table A.8.

A.12 Flags field in ICB Tag

Table A.8: Flags field in ICB Tag

| Bit | Description | Contents |
|-------|-------------------------------|--|
| 0-2 | Type of Allocation Descriptor | 0 : Short Allocation Descriptor |
| 3 | Directory Sort | ZERO : unsorted |
| 4 | Non-relocatable | ONE : Non-relocatable (for DVD-Video disk) |
| 5 | Archive | ZERO or ONE |
| 6 | Setuid | ZERO or ONE |
| 7 | Setgid | ZERO or ONE |
| 8 | Sticky | ZERO or ONE |
| 9 | Contiguous | ONE : Contiguous (for DVD-Video disk) |
| 10 | System | ZERO or ONE |
| 11 | Transformed | ZERO : not transformed |
| 12 | Multi-versions | ZERO : not Multi-versions |
| 13-15 | Reserved | ZEROs |

(Bit 4) Non-relocatable

This bit shall be set to ONE in order to guarantee the characteristic performance of these systems.

(Bit 9) Contiguous

This bit shall be set to ONE in order to guarantee the characteristic performance of these systems.

A.13 Copyright Management Information

The identical values of the CGMS Information field in the Copyright Management Information shall be recorded in UDF and ECMA-119 file structure in which every files compose a Video Manager or a Video Title Set.

A.14 Boot Descriptor

No Boot Descriptor and no Boot Record shall be recorded in the UDF Bridge Volume Recognition Sequence.

A.15 CD-ROM Volume Descriptor Set

A CD-ROM Volume Descriptor Set Sequence shall contain one Primary Volume Descriptor and one Volume Descriptor Set Terminator, and may have one Supplementary Volume Descriptor. The Primary Volume Descriptor shall be located at the logical sector number 16.

A.16 Primary Volume Descriptor (ECMA-119)

Table A9: Primary Volume Descriptor (ECMA-119)

| BP | Length | Field Name | Contents |
|------|--------|--|--|
| 0 | 1 | Volume Descriptor Type | UInt8 = 1 |
| 1 | 5 | Standard Identifier | bytes = "CD001" |
| 6 | 1 | Volume Descriptor Version | UInt8 = 1 |
| 7 | 1 | Unused Field | 00h byte |
| 8 | 32 | System Identifier | 20h bytes (for DVD-Video disk) |
| 40 | 32 | Volume Identifier | d-characters |
| 72 | 8 | Unused Field | 00h bytes |
| 80 | 8 | Volume Space Size | BB32 |
| 88 | 32 | Unused Field | 00h bytes |
| 120 | 4 | Volume Set Size | BB16 = 1 |
| 124 | 4 | Volume Sequence Number | BB16 = 1 |
| 128 | 4 | Logical Block Size | BB16 = 2048 |
| 132 | 8 | Path Table Size | BB32 |
| 140 | 4 | Location of Occurrence of Type L Path Table | LB32 |
| 144 | 4 | Location of Optional Occurrence of Type L Path Table | LB32 |
| 148 | 4 | Location of Occurrence of Type M Path Table | MB32 |
| 152 | 4 | Location of Optional Occurrence of Type M Path Table | MB32 |
| 156 | 34 | Directory Record for Root Directory (see A.17) | bytes |
| 190 | 128 | Volume Set Identifier | d-characters |
| 318 | 128 | Publisher Identifier | a-characters |
| 446 | 128 | Data Preparer Identifier | a-characters |
| 574 | 128 | Application Identifier | a-characters |
| 702 | 37 | Copyright File Identifier | d-characters, SEPARATOR 1, SEPARATOR 2 |
| 739 | 37 | Abstract File Identifier | d-characters, SEPARATOR 1, SEPARATOR 2 |
| 776 | 37 | Bibliographic File Identifier | d-characters, SEPARATOR 1, SEPARATOR 2 |
| 813 | 17 | Volume Creation Date and Time | Digit(s) |
| 830 | 17 | Volume Modification Date and Time | Digit(s) |
| 847 | 17 | Volume Expiration Date and Time | Digit(s) |
| 864 | 17 | Volume Effective Date and Time | Digit(s) |
| 881 | 1 | File Structure Version | UInt8 = 1 |
| 882 | 1 | Reserved | 00h byte |
| 883 | 512 | Application Use | not specified |
| 1395 | 653 | Reserved | 00h bytes |

(BP 8) System Identifier

This field shall be set to all 20h bytes.

A.17 Directory Record

Table A.10: Directory Record

| RBP | Length | Field Name | Contents |
|------------|---------------|--------------------------------------|---|
| 0 | 1 | Length of Directory Record (=LEN_DR) | UInt8 |
| 1 | 1 | Extended Attribute Record Length | UInt8 = 0 (for DVD-Video disk) |
| 2 | 8 | Location of Extent | BB32 |
| 10 | 8 | Data Length | BB32 |
| 18 | 7 | Recording Date and Time | numerical value |
| 25 | 1 | File Flags | 8 bits |
| 26 | 1 | File Unit Size | UInt8 = 0 (for DVD-Video disk) |
| 27 | 1 | Interleave Gap Size | UInt8 = 0 (for DVD-Video disk) |
| 28 | 4 | Volume Sequence Number | BB16 = 1 |
| 32 | 1 | Length of File Identifier (=LEN_FI) | UInt8 |
| 33 | LEN_FI | File Identifier | d-characters, SEPARATOR 1, SEPARATOR 2, 00h or 01h byte |
| a | b | Padding | 00h byte |
| c | 6 | System Use | bytes |

a = 33 + LEN_FI

b = 0 if the Length of the File Identifier field is an even number,

b = 1 if the Length of the File Identifier field is an odd number.

c = a + b

(RBP 1) Extended Attribute Record Length

This field shall contain an 8-bit number. This field shall be set to 0, which means that no Extended Attribute Record is recorded.

(RBP 26) File Unit size

This field shall contain an 8-bit number. This field shall be set to 0, which means that the file section is recorded in non-interleaved mode.

(RBP 27) Interleave Gap Size

This field shall contain an 8-bit number. This field shall be set to 0, which means that the file section is recorded in non-interleaved mode.

(RBP c) System Use

The Copyright Management Information shall be recorded in this 6-byte field.

A.18 Path Table Record

Table A.11 : Path Table Record

| RBP | length | Field Name | Contents |
|------------|---------------|--|--------------------------------|
| 0 | 1 | Length of Directory Identifier (=LEN_DI) | UInt8 |
| 1 | 1 | Extended Attribute Record Length | UInt8 = 0 (for DVD-Video disk) |
| 2 | 4 | Location of Extent | LB32 or MB32 |
| 6 | 2 | Parent Directory Number | LB16 or MB16 |
| 8 | LEN_DI | Directory Identifier | d-characters, 00h byte |
| a | b | Padding | 00h byte |

a = 8 + LEN_DI

b = 0 if the Length of Directory Identifier field is an even number,

b = 1 if the Length of Directory Identifier field is an odd number.

(RBP 1) Extended Attribute Record Length

This field shall contain an 8-bit number. This field shall be set to 0 which means that no Extended Attribute Record is recorded.

A.19 Directory and File names

The following requirements for files and directories shall be adhered to by DVD-Video disk implementations.

A directory named "VIDEO_TS" shall be a subdirectory of the root directory.

A Video Manager Information, a Video Object Set for Video Manager Menu, a Video Manager Information for backup, a Video Title Set Information, a Video Object Set for Video Title Set Menu, and a Video Title Set Information for backup shall be recorded each in a data space of a component file of the VIDEO_TS directory.

A Video Object Set for Titles with a size of 1GB (=2³⁰bytes) or greater should be divided into multiple files (up to 9 files) such that the size of each file shall be less than 1GB (=2³⁰bytes). These files shall be component files of the VIDEO_TS directory. Allocation of these component files within a Video Object Set for Titles shall be such that each file is contiguously allocated.

The file name and directory name shall be applied according to the following rules:

1) Directory Name

- The fixed directory name for DVD-Video shall be "VIDEO_TS".

2. File Name for Video Manager (VMG)

- The fixed file name for Video Manager Information shall be "VIDEO_TS.IFO".
- The fixed file name for Video Object Set for VMG Menu shall be "VIDEO_TS.VOB".
- The fixed file name for Video Manager Information for backup shall be "VIDEO_TS.BUP".

3. File Name for Video Title Set (VTS)

- The file name for Video Title Set Information shall be "VTS_@@_0.IFO".
- The file name for Video Object Set for VTS Menu shall be "VTS_@@_0.VOB".
- The file name for Video Object Set for Title shall be "VTS_@@_#.VOB".
- The file name for Video Title Set Information for backup shall be "VTS_@@_0.BUP".
- "@@" shall be two characters of "01" - "99" to be assigned to the files of the Video Title Set number.

- "#" is assigned consecutively in the ascending order from 1 to 9 for each Video Object Set for Title.

4. Compression ID in OSTA Compressed Unicode format

- The Compression ID which is recorded in the File Identifier field of the File Identifier Descriptor shall be set to 8.
- For example, the File Identifier of VIDEO_TS directory shall be recorded as 08h + "VIDEO_TS" in the File Identifier field and length of this File Identifier shall be 9.

Annex B

(informative)

How to Read UDF Volume and File Structure

It is recommended that DVD-Video Player uses UDF File System, because of the expected shift from ECMA-119 to UDF based File System. An example of how to read a VIDEO_TS.IFO on a DVD-Video disk is described as follows:

PROCEDURE 1. Volume Recognition Sequence

- A volume recognition area shall start logical sector 16.
- Find a NSR Descriptor in which the Standard Identifier field shall contain "NSR02".

PROCEDURE 2. Anchor Point

- Read the first Anchor Point located at logical sector 256 which specifies the location of a Main Volume Descriptor Sequence.
- If the first Anchor Point couldn't be read, read the second Anchor Point located at Last LSN.

PROCEDURE 3. Volume Descriptor Sequence

- Read the Main Volume Descriptor Sequence, if this sequence couldn't be read, a Reserve Volume Descriptor Sequence should be read.
- Find the location of a File Set Descriptor which is specified in a Logical Volume Descriptor of the sequence.
- Find the partition starting location which is specified in a Partition Descriptor of the sequence.

PROCEDURE 4. File Set Descriptor

- Read the File Set Descriptor and find the location and length of a File Entry describing a root directory.

PROCEDURE 5. Root Directory File Entry

- Read the root directory File Entry and find the attributes and location of the root directory.

PROCEDURE 6. Root Directory

- Read the root directory which is consist of File Identifier Descriptors.
- Find the File Identifier Descriptor in which a File Identifier field identifies VIDEO_TS and a File Characteristics field specifies that the file is a directory.
- Read the File Identifier Descriptor and find the location of a File Entry describing the VIDEO_TS directory.

PROCEDURE 7. File Entry of VIDEO_TS

- Read the File Entry of the VIDEO_TS directory and find the location and length of the VIDEO_TS directory.

PROCEDURE 8. VIDEO_TS directory

- Read the VIDEO_TS directory, which consists of File Identifier Descriptors.
- Find the File Identifier Descriptor in which a File Identifier field identifies VIDEO_TS.IFO and a File Characteristics field specifies that the file is not a directory.
- Read the File Identifier Descriptor and find the location of a File Entry describing the VIDEO_TS.IFO file.

PROCEDURE 9. File Entry of VIDEO_TS.IFO

- Read the File Entry of the VIDEO_TS.IFO file and find the location of the VIDEO_TS.IFO file.

Annex C
(informative)

UDF Bridge Volume Recognition Sequence with Boot Record

When an ECMA-119 (ISO 9660) Boot Record is used, this Boot Record shall be located in a specific logical sector with logical sector number 17 as shown in table C.1.

Table C.1: Example of UDF Bridge Volume Recognition Sequence with Boot Record

| LSN | Descriptors |
|------------|--------------------------------------|
| 16 | Primary Volume Descriptor (ECMA-119) |
| 17 | Boot Record (ECMA-119) |
| 18 | Volume Descriptor Set Terminator |
| 19 | Beginning Extended Area Descriptor |
| 20 | NSR Descriptor |
| 21 | Terminating Extended Area Descriptor |

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