JAPAN ELECTRONIC INDUSTRY

DEVELOPMENT ASSOCIATION STANDARD

Design rule

for

Camera File system

Version 1.0

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JAPAN ELECTRONIC INDUSTRY

DEVELOPMENT ASSOCIATION

Background to this standard

The Exif[*1)] image file format standard was established with the aim of realizing a common format for the image files used with digital still cameras and other related equipment, making these products more convenient for end users.

With the rapidly growing popularity of digital still cameras, there are increasing demands for file interchangeability, which will allow images captured on one camera to be viewed on another, or output directly to a printer. ExifR98[*2)] is a set of compatibility recommendations designed to meet such needs, by strictly defining the range of Exif application, and by setting out detailed rules for recording and playing image files not specified in the Exif format.

In addition, CIFF (Camera Image File Format)[*3)] lays out rules for directory and file structures, so that a variety of files can be stored and managed efficiently on removable memory media.

The present specification (Design rule for Camera File system, hereinafter DCF) is based on the above recommendations. It was drawn up for the purpose of simplifying the interchange of image files and related files on digital still cameras and other equipment, while supporting today's higher resolution images and large-capacity memory media.

*1) Exif Version 2.1	Digital Still Camera Image File Format Standard (Exif) Version 2.1, Japan Electronic Industry Development Association (JEIDA), 1998.
*2) ExifR98 Version 1.0	JEIDA Recommended Exif Interoperability Rules (ExifR98) (Exif Annex) Version 1.00, Japan Electronic Industry Development Association (JEIDA), 1998.
*3) CIFF Version 1.0	Details of the standard are available at the following URL: http://www.ciff-forum.com/

Contents

1.　Introduction

1.1.　Purpose

As digital still cameras (DSC) have come to enjoy wide popularity, there is a growing need for direct exchange of images between cameras and other equipment, allowing pictures taken on one camera to be viewed on another, or to be output to a printer. This DCF is aimed at the creation of a user environment in which consumers can combine products more freely and exchange media readily. To this end it specifies rules for recording, reading and handling image files and other related files used on DSC or other equipment.

1.2.　Scope

DCF is applicable to products for writing image files on an interchangeable medium (removable memory) formatted with the DOS FAT file system, and to products for reading (or printing) the images recorded on removable memory by these reader products. Details of the applicable media are given in Annex A.

1.3.　Glossary

DCF	The specification in this document.
Exif Standard	Digital Still Camera Image File Format Standard, Version 2.1 of the Japan Electronic Industry Development Association (JEIDA)
JPEG Standard	ISO/IEC 10918-1 ITU-T Recommendation T81 information technology - Digital compression and coding of continuous-tone still images - Requirements and guidelines
DSC	Digital still camera
PC	Personal computer
DCF-compatible	Compliant with the DCF
DCF media	Removable memory recorded in compliance with the DCF
Play	To display an image or output it as a hard copy
Application	Image application software for use on a PC
File name	An 8-character file name of the DOS/FAT file system, excluding the dot and file extension.
File extension	Three identifying characters used in the DOS/FAT file system following the file name and dot.
Horizontal pixels	The number of pixels of image data in the main scanning direction.
Vertical pixels	The number of pixels of image data in the sub-scanning direction.
Main image	The primary data of the image

Thumbnail	A small version of the main image, used for indexing.

The following are specified in detail in the subsequent chapters, but are summarized here for convenience.

DCF image root directory	The directory directly under the root directory, created in accord with the DCF directory rules.
DCF directory	A directory under the DCF image root directory created in accord with the DCF directory rules, for storing images.
DCF directory name	A directory name assigned in accord with the DCF directory naming conventions.
DCF object	A group of files recorded in accord with DCF.
DCF file name	A file name assigned in accord with the DCF file naming conventions.
Directory number	A three-digit number making up part of the DCF directory name.
File number	A four-digit number making up part of the DCF file name.
Free characters	The five characters following the directory number in a DCF directory name, or the four characters at the head of a DCF file name.
DCF basic file	An image file stored directly under a DCF directory, having a DCF file name and the extension "JPG" and having the DCF-stipulated data structure, based on the Exif standard.
DCF basic main image	An Exif primary image included in a DCF basic file.
DCF basic thumbnail	An Exif thumbnail image included in a DCF basic file.
DCF extended image file	An image file stored directly under a DCF directory, having an extension and data structure different from a DCF basic file.
DCF thumbnail file	A compressed file for storing the thumbnail image of a DCF extended image file.
Protection	Setting the ReadOnly attribute for a DCF object or directory.
Level 1	A playback compatibility level capable of detecting the existence of a DCF basic file and recognizing thumbnail images.
Level 2	A playback compatibility level capable of playing and using DCF basic file main images.
Writer	A recording function compliant with the DCF Writer specification
Reader 1	Playback function in conformity with the DCF Reader 1 specification
Reader 2	Playback function in conformity with the DCF Reader 2 specification

1.4.   Definition of characters used in directory and file names

When a directory or file is created, only the characters shown in Table 1-1 are used. Two-byte characters or other special codes shall not be used. If an existing directory or file name uses lower-case letters, they shall be treated as all upper-case letters.

Table 1-1: Allowed characters

b7					0	0	0	0	0	0	0	0
			b6		0	0	0	0	1	1	1	1
			b5		0	0	1	1	0	0	1	1
			b4		0	1	0	1	0	1	0	1
b3	b2	b1	b0		0	1	2	3	4	5	6	7
0	0	0	0	0				0		P		
0	0	0	1	1				1	A	Q		
0	0	1	0	2				2	B	R		
0	0	1	1	3				3	C	S		
0	1	0	0	4				4	D	T		
0	1	0	1	5				5	E	U		
0	1	1	0	6				6	F	V		
0	1	1	1	7				7	G	W		
1	0	0	0	8				8	H	X		
1	0	0	1	9				9	I	Y		
1	0	1	0	A					J	Z		
1	0	1	1	B					K			
1	1	0	0	C					L			
1	1	0	1	D					M			
1	1	1	0	E					N			
1	1	1	1	F					O	_		

30.H to 39.H, 41.H to 5A.H, and 5F.H are used.

If lower-case letters from 61.H through 7A.H are used, they shall be treated as upper-case letters from 41.H to 5A.H.

1.5. Approach to playback compatibility

In considering playback compatibility, a division is made into two levels as follows.

Level 1

Even when a device is incapable of reproducing the DCF basic main image in a DCF basic file recorded on DCF media, it shall be able to read and display the corresponding DCF basic thumbnail.

Level 2

Level 2 compatibility means the ability to read and display DCF basic main images in DCF basic files, within the supported pixel count specification. Layout is left up to individual product specifications.

DCF, in stipulating as mandatory items the rules for directory and file naming and the form of thumbnail image recording, establishes as a minimum condition that a DSC, for example, shall implement level 1 playback compatibility. Printers or other playback products, whose primary function is to reproduce main images, are expected to implement level 2 compatibility, for which a supported pixel count specification is defined.

2. Definition of DCF-compatible products

2.1. DCF and recording media

DCF is intended to enable files to be used interchangeably among different equipment using the same kinds of DCF media. It must be noted carefully that equipment using different kinds of media will not be able to exchange files even if they adopt DCF.

The media to which DCF applies are listed in Annex A.

2.2. Configuration of DCF specification

DCF consists of the three specifications shown in Figure 2-1.

DCF media specification (Chapter 3)

The status of data that should be on DCF media, and the status of data for enabling files to be exchanged among DCF-compatible products are specified.

Writer specification (Chapter 4)

Based on the media specification in Chapter 3, the Writer specification stipulates the directory and file structure for recording data, and the file operations.

Reader specifications (Chapters 5 and 6)

The directory and file scope, playback methods and deletion methods are specified for reading data from DCF media recorded in accord with the DCF media specification in Chapter 3.
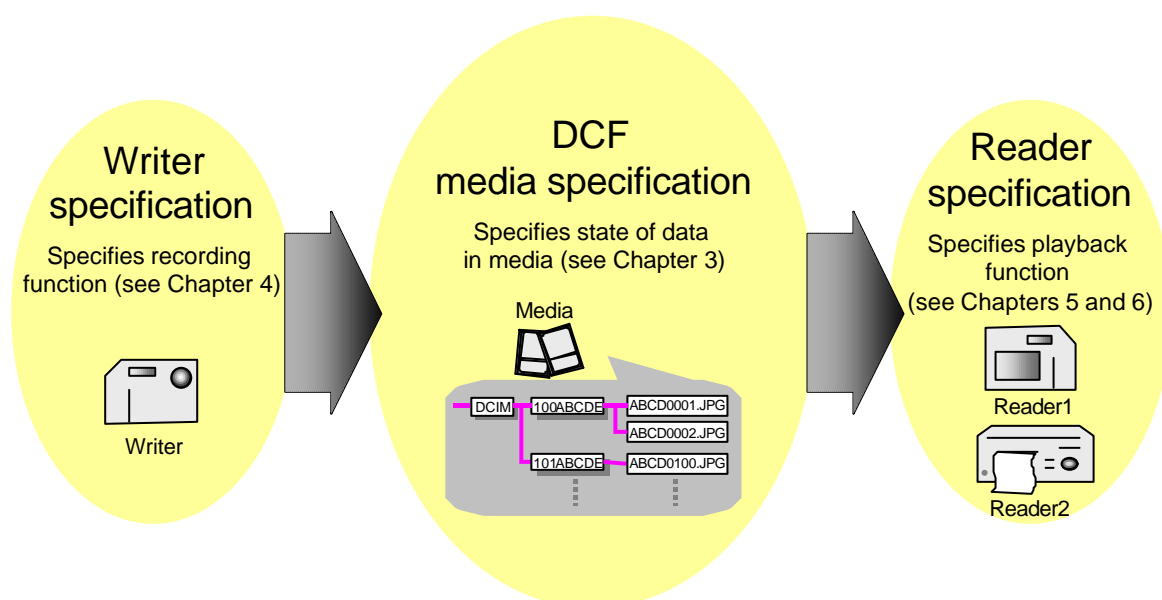
Figure 2-1: DCF standards

2.3. Classification of functions

The functions of DCF-compatible equipment are classified into Writer, Reader 1, and Reader 2 functions as shown in Table 2-1. This classification is based on the recording and playback functions with which the products are equipped, and is not a classification of equipment specifications. (On the applicable equipment, see 2.4.)

Table 2-1: Classification of DCF functions

Classification		Functionality	Remarks
Writer		Functionality for recording in conformity with the DCF Writer specification.	Includes move, copy and delete functions.
Reader	Reader 1	Playback function in conformity with the DCF Reader 1 specification.	Equipped with Level 1 playback compatibility. Only equipment whose primary function is that of a Writer may be equipped with the Reader 1 functionality. Includes move, copy and delete functions.
	Reader 2	Playback function in conformity with the DCF Reader 2 specification.	Equipped with Level 2 playback compatibility. Assumed here are printers and other equipment whose main function is main image playback. Playback here means display playback and printing. Includes move, copy and delete functions.

On Level 1 and Level 2, see section 1.5.

2.4. Categories of DCF-compatible equipment

The categories of DCF-compatible equipment are the four types shown in Table 2-2. The products given are only examples and are not intended to specify the equipment.

Table 2-2: Categories of DCF-compatible equipment

	Recording			Playback				Typical products
				A				
	A	B	C	DCF basic main images	DCF basic thumb-nails	B	C	
Category 1 (Writer only)	M	O	O	N	N	N	O *1	Record-only DSC, scanner, etc.
Category 2 (Writer+Reader 1)	M	O	O	T		O	O	DSC with simple playback function, etc.
Category 3 (Writer+Reader 2)	M	O	O	M	O	O	O	DSC with playback function; printer/player with recording function; application software, etc.
Category 4 (Reader 2)	N	N	O *2	M	O	O	O	Printer, player, print service, etc.

A: DCF basic files

B: DCF objects other than DCF basic files

C: Other files

M: Mandatory function

O: Optional function

N: Not to be implemented. Does not apply to move, delete and copy functions.

T: Thumbnail substitute playback function required

*1) Having a function for image playback but having neither Reader 1 nor Reader 2 functionality is prohibited.

*2) Being a Reader with an image recording function but not having a Writer function is prohibited.

P r i n c i p l e

Of the above DCF-compatible systems, the general form of a DSC is for the time being considered to be Category 2 (Writer & Reader 1). The desirable form of the future DSC, however, is Category 3 (Writer & Reader 2), since it is preferable that a DSC be able to play DCF basic main images.

3. DCF media standard

3.1. Directory definition

The following are defined here.

- Directory structure
- Directory name

3.1.1. DCF image root directory

The directory with the name "DCIM" directly under the root directory is called DCF image root directory. DCIM stands for "Digital Camera IMages".

3.1.2. DCF directories

The directories that store DCF objects are called DCF directories. They are created directly under the DCF image root directory. The directory names conforming to the following rules are called DCF directory names.

- The directory name is 8 characters in length.
- The first three characters are a number between "100" and "999"; numbers "000" through "099" shall not be used. This number is referred to as the directory number.
- The rest of the name after the directory number shall be five characters. These are referred to here as the DCF directory name Free characters.
- These five characters consist only of the upper-case alphanumeric characters shown in Table 1-1. They shall not contain two-byte characters or special codes.

The conventions of DCF directory names are illustrated in Table 3-1.

Table 3-1 DCF directory naming example (excluding extension)

Specification	Directory number			Free characters (5 alphanumerics)				
Example	1	0	0	A	B	C	D	E

The Read Only attribute of the DOS FAT file system may be assigned to each directory to prevent accidental deletion. This is called directory protection. No other directory attributes are specified.

Directory operations are handled as per the Writer and Reader specifications.

3.1.3. Other directories

The following is prohibited. No specification is made regarding other directories.

- DCF file names are used as directory names under the DCF image root directory.

3.1.4. Directory example

A typical DCF directory is shown in Figure 3-1.
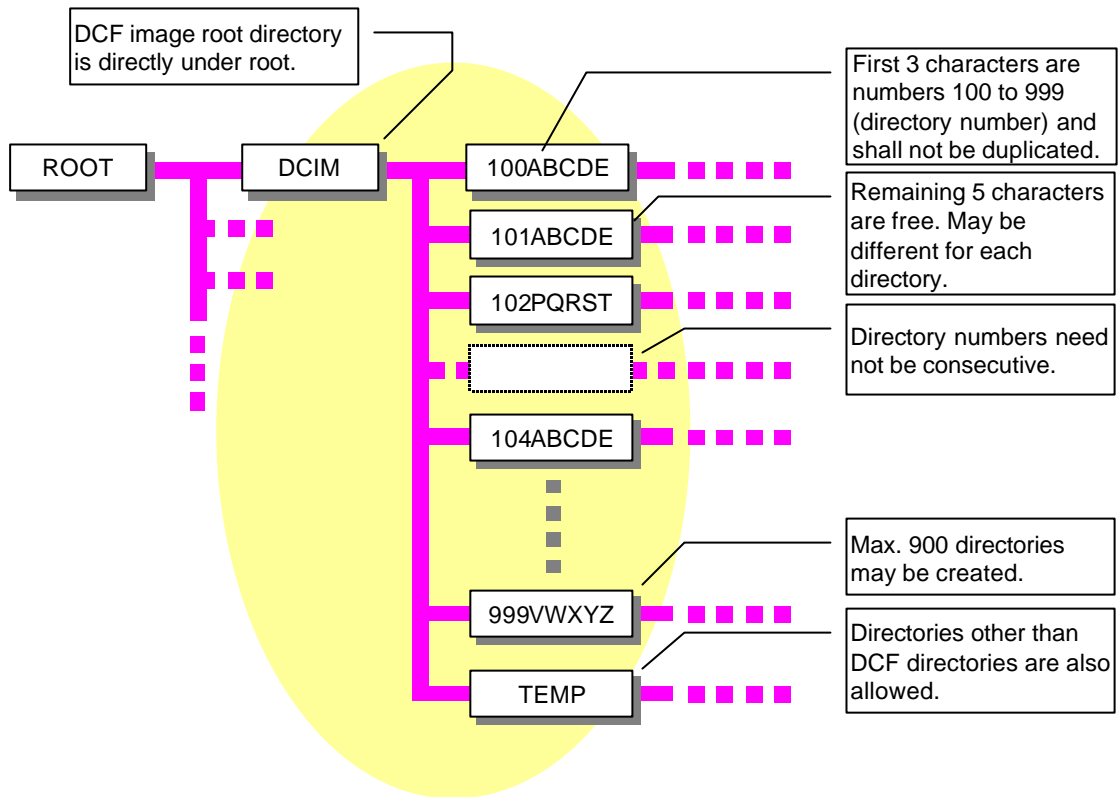
Figure 3-1: Typical DCF directory

3.2. File definition

3.2.1. DCF file names

File names conforming to the following rules are called DCF file names.

- The file name is 8 characters (not including the file extension).
- The first four characters consist only of the upper-case alphanumeric characters shown in Table 1-1. These are referred to as the DCF file name Free characters. They shall not contain two-byte characters or special codes.
- The four characters that follow are a number between "0001" and "9999". "0000" shall not be used. These four digits are referred to as File number.
- Files with the same file number stored in the same DCF directory are considered to be object component files as defined in 3.2.2.

The DCF file naming conventions are illustrated in Table 3-2.

Table 3-2 DCF file naming example (excluding extension)

Specification	Free (4 alphanumerics)				File number			
Example	A	B	C	D	0	0	0	1

3.2.2. DCF objects

DCF objects are file groups defined as follows.

(A) Purpose of DCF objects

Of the files stored on DCF media, objects may be created for the files related with each other, such as the main image file and the related audio file, to be handled together, for the greater convenience of users.

(B) Object definition

All files stored in a DCF directory with DCF file names are DCF object components. The free characters of the file name and the extensions may be different for files belong to the same object. A standalone file for which no other file with the same file number exists is still a DCF object. Two or more files in a DCF directory that share the same file number belong to the same DCF object. Files in directories that are not located under a DCF directory are not DCF object components, regardless of their file name.

(C) Files included in objects

DCF defines three kinds of files included in DCF objects. For two of these, the file extension and data structure are also defined. Files with other extensions and data structures not specified in DCF may also be included in a DCF object.

DCF basic file
- An image file conforming to the Exif standard.
- The extension is "JPG"
- The data structure and other details are given in 3.3.

DCF extended image file
- A file with a DCF file name but having an extension and data structure other than that of DCF basic files.
- The extension is not specified, but shall not be "JPG" or "THM".
- The data structure is not specified.

DCF thumbnail file
- A file containing only a thumbnail image. It will be possible to achieve level 1 equivalent playback compatibility of a DCF extended image file.
- It shall always coexist with the corresponding DCF extended image file.
- The extension is "THM".
- The data structure and other details are given in 3.4.

The rules for DCF object structure and elements prohibit the following.
- More than one DCF basic file in the same object.
- More than one DCF thumbnail file in the same object.
- A DCF basic file and DCF thumbnail file in the same object.
- A standalone DCF thumbnail file with no corresponding DCF extended image file in the same object.
- Files with the extension "JPG" other than DCF basic files.
- A file with the extension "THM" having a data format other than that of a DCF thumbnail file.

(D) Object file attributes

The Read Only attribute of the DOS FAT file system may be set for each file as Protection of individual objects, to prevent accidental deletion. A DCF object is protected when all the files in the object are set with the Read Only attribute. No specification is made regarding other file attributes.

(E) Object operation

Object handling is as stipulated in the Writer and Reader specifications.

3.3. DCF basic files

3.3.1. Purpose

Image files conforming to Exif Ver. 2.1 and recorded as stipulated in this chapter are called DCF basic files. The purpose of DCF basic files is to achieve interchangeability of image files among DCF-compatible devices and applications. For level 2 playback compatibility to be realized among DCF-compatible devices and applications, the image files shall be DCF basic files.

3.3.2. Directory, file names and extensions

A DCF basic file is a component of a DCF object, is stored directly under a DCF directory, has a DCF file name, and has the extension "JPG".

3.3.3. Images in a DCF basic file

An Exif primary image in a DCF basic file is called a DCF basic main image. An Exif thumbnail image in a DCF basic file is called a DCF basic thumbnail.

3.3.4. Data structure of a DCF basic main image

(A) Data structure

The only supported data format for DCF basic main image data is Exif compressed format (JPEG format). The pixel composition and sampling may be either YCbCr4:2:2 or YCbCr4:2:0.

(B) Data compression

The compression ratio of DCF main basic images is not specified. The JPEG data structure is as stipulated in the Exif standard. Insertion of a restart marker is optional. As Huffman Table, the Typical Huffman Table specified in the JPEG standard shall be used.

(C) Pixel count

The number of pixels is not specified.

(D) Image aspect ratio

The image aspect ratio is not specified.

3.3.5. Attribute information

Attribute information is recorded as follows, based on the Exif standard.

(A) Exif tag structure

The byte order used in the TIFF structure may be either Big Endian or Little Endian, as in the Exif specification.

(B) Image-related information

Image-related information shall be recorded, as per the Exif standard. In addition to the Exif mandatory tags, inclusion of the following tags is mandatory in DCF.

Make (0th IFD, mandatory)

In the Exif standard this is optional, but its inclusion is mandatory here so the Writer manufacturer name can be determined.

Tag	=	271 (10F.H)
Type	=	ASCII
Count	=	Any
Default	=	none

Model (0th IFD, mandatory)

In the Exif standard this is optional, but its inclusion is mandatory here so the Writer model name can be determined.

Tag	=	272 (110.H)
Type	=	ASCII
Count	=	Any
Default	=	none

DateTimeOriginal (Exif IFD, mandatory)

In the Exif standard this is optional, but its inclusion is mandatory here so the original image creation date and time can be determined. If the date and time the original image was shot are unknown, this field may be filled with spaces as stipulated in the Exif standard.

Tag	=	36867 (9003.H)
Type	=	ASCII
Count	=	20
Default	=	none

DateTimeDigitized (Exif IF, mandatory)

In the Exif standard this is optional, but its inclusion is mandatory here so the digital data creation date and time can be determined. If the date and time of digital data creation are unknown, this field may be filled with spaces as stipulated in the Exif standard.

Tag	=	36868 (9004.H)
Type	=	ASCII
Count	=	20
Default	=	none

(C) DCF identifying information

Information is specified in the Interoperability IFD for identifying a file as a DCF basic file. See the Exif standard for details of the Interoperability IFD. Tags in the Interoperability IFD are specified as follows in DCF.

InteroperabilityIndex (Interoperability IFD, mandatory)

Since the file content is equivalent to ExifR98 Version 1.0, the value is "R98". The tag including end code is 4 bytes. Note that this differs from the value (THM) defined for DCF thumbnail files in section 3.4.4.

```
Tag      =    1 (1.H)
Type     =    ASCII
Count    =    4
Default  =    "R98"
```

InteroperabilityVersion (Interoperability IFD, mandatory)

This tag records the Interoperability version. Since the file content is equivalent to ExifR98, the value is the 4-byte ASCII "0100" meaning Version 1.00. This is not terminated by NULL since the Type is UNDEFINED.

```
Tag      =    2 (2.H)
Type     =    UNDEFINED
Count    =    4
Default  =    0100
```

RelatedImageFileFormat (Interoperability IFD, optional)

This is normally used in a DCF thumbnail file, but it may also be included in a DCF basic file, in which case it indicates that file's own format (Exif JPEG Ver. 2.1, etc.). It is recorded as an ASCII character string.

```
Tag      =    4096 (1000.H)
Type     =    ASCII
Count    =    Any
Default  =    none
```

RelatedImageWidth (Interoperability IFD, optional)

This is normally used in a DCF thumbnail file, but it may also be included in a DCF basic file, in which case it indicates the number of horizontal pixels of that image itself.

```
Tag      =    4097 (1001.H)
Type     =    SHORT or LONG
Count    =    1
Default  =    none
```

RelatedImageLength (Interoperability IFD, optional)

This is normally used in a DCF thumbnail file, but it may also be included in a DCF basic file, in which case it indicates the number of vertical pixels of that image itself.

```
Tag      =    4098 (1002.H)
Type     =    SHORT or LONG
Count    =    1
Default  =    none
```

(D) Color space

The *ColorSpace* tag declares sRGB in the *Exif IFD* specified in the Exif standard, as follows.

ColorSpace (Exif IFD, mandatory)

This tag declares sRGB.

```
Tag      = 40961 (A001.H)
Type     = SHORT
Value    = 1 (sRGB)
```

Count　　= 1

3.3.6.　DCF basic thumbnail data structure

(A)　Image data format

The thumbnail data structure is in accord with the Exif compressed thumbnail specification. The pixel composition and sampling is YCbCr4:2:2. The reason for limiting to one choice here is to ensure Level 1 playback compatibility.

(B)　Compressed data

The JPEG data structure is as specified in Exif. As in the Exif specification, no restart marker is inserted. As Huffman Table, the Typical Huffman Table specified in the JPEG standard shall be used. The compression ratio of DCF basic thumbnails is not specified.

(C)　Number of pixels

The number of pixels for thumbnail recording is 160 horizontal pixels by 120 vertical pixels, chosen as a size large enough to enable the image to be recognized. Any other pixel size is prohibited.

(D)　Image aspect ratio

The aspect ratio defined by the above pixel size shall be used even if this means a different aspect ratio for the DCF basic main image and DCF basic thumbnail. The method of generating thumbnails and their layout are not specified, but it is recommended that black (RGB all 0) be used as padding data when padding of thumbnail images is implemented.

3.3.7.　Image data format in DCF basic files

The DCF basic main image format is summarized in Table 3-3. The DCF basic thumbnail data format is summarized in Table 3-4.

Table 3-3 DCF Basic Main Image Data Format

Compression	Number of pixels	Aspect ratio	Chrominance sampling	Compression ratio	Huffman Table	Color space
Compressed (JPEG)	Not specified	Not specified	4:2:2 or 4:2:0	Not specified	Typical	sRGB

Table 3-4 DCF Basic Thumbnail Data Format

Compression	Number of pixels	Aspect ratio	Chrominance sampling	Compression ratio	Huffman Table
Compressed (JPEG)	160×120 (fixed)	4:3 (fixed)	4:2:2 (fixed)	Not specified	Typical

3.4.   DCF thumbnail files

3.4.1.   Purpose

DCF extended image files recorded with proprietary functions often cannot be played on other Reader systems. In order to allow the images and their attributes to be checked on other systems and achieve playback equivalent to DCF basic file level 1 compatibility, small indexing files are defined, which are recorded separate from the DCF extended image files. These are called DCF thumbnail files.

The inclusion of DCF thumbnail files with DCF extended image files is not mandatory. For this reason, level 1-equivalent compatibility is not necessarily achieved for DCF extended image files.

Likewise, it should be noted carefully that even if DCF thumbnail files are used, this does not guarantee playback equivalent to DCF basic file level 2 compatibility.

3.4.2.   Directory, file name and extension

DCF thumbnail files shall be located in the same directory as their corresponding DCF extended image file. They have a DCF file name and "THM" as the file extension. The file number is the same as that of the corresponding DCF extended image file, and together they belong to one DCF object.

3.4.3.   Image data structure

(A)   Data format

The data structure of a DCF thumbnail file is that specified in the Exif standard for compressed thumbnails. If the file has attribute information, however, the structure may be the same as the Exif file using APP1 and APP2 as specified in the Exif standard for compressed files. It shall not have APPn markers other than APP1 and APP2, or COM markers. APP1 shall not contain a thumbnail of the thumbnail. The DCF thumbnail file data structure is outlined in Figure 3-2.

The pixel composition and sampling is YCbCr4:2:2 only, as with DCF basic thumbnails specified at 3.3.6. .

(B)   Compressed data specification

This is the same as that for DCF basic thumbnails specified at 3.3.6.

(C)   Pixel count

This is the same as that for DCF basic thumbnails specified at 3.3.6.

(D)   Image aspect ratio

This is the same as that for DCF basic thumbnails specified at 3.3.6.

3.4.4.   Attribute information

When attribute information is included, it is recorded as follows.

(A)   Exif tag structure

The byte order used in the TIFF structure may be either Big Endian or Little Endian, as in the Exif specification.

SOI   ; Start of Image
EOI   ; End of Image
APP1 ; Application marker segment 1, Exif info is written.
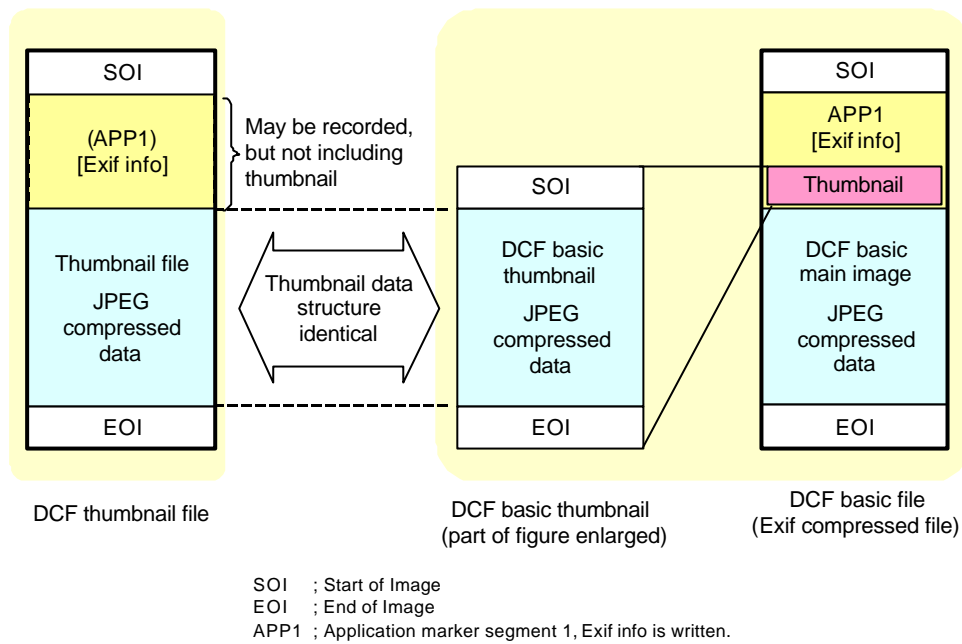
Figure 3-2: DCF thumbnail file structure

(B)   Image-related information

When attribute information is included, it is recorded as in the Exif standard. In addition to Exif mandatory tags, the following tags are mandatory for DCF thumbnail files.

Make (0th IFD, mandatory when attribute information is recorded)
The contents are the same as for DCF basic files (see 3.3.5).

Model (0th IFD, mandatory when attribute information is recorded)
The contents are the same as for DCF basic files (see 3.3.5).

DateTimeOriginal (Exif IFD, mandatory when attribute information is recorded)
The contents are the same as for DCF basic files (see 3.3.5).

DateTimeDigitized (Exif IFD, mandatory when attribute information is recorded)
The contents are the same as for DCF basic files (see 3.3.5).

(C)   DCF thumbnail identification information

DCF identifying information is specified in the *Interoperability IFD*. For details of the *Interoperability IFD*, see the separate Exif standard. In DCF, the following tags are specified in the *Interoperability IFD*.

InteroperabilityIndex
(Interoperability IFD, mandatory when attribute information is recorded)
The value is "THM". The tag including end code is 4 bytes. Note that this differs from the value ("R98") specified as attribute information with DCF basic files.

Tag   =   1 (1.H)

Type   =   ASCII
Count   =   4
Default   =   "THM"

Interoperability Version
(Interoperability IFD, mandatory when attribute information is recorded)

Records the Interoperability version. The value here is ASCII "0100" meaning Version 1.00. This not terminated by NULL since the Type is UNDEFINED.

Tag   =   2 (2.H)
Type   =   UNDEFINED
Count   =   4
Default   =   0100

RelatedImageFileFormat (Interoperability IFD, optional)

This tag is used to record in a DCF thumbnail file the file format of the corresponding DCF extended image file. It consists of an ASCII character string.

Tag   =   4096 (1000.H)
Type   =   ASCII
Count   =   Any
Default   =   none

RelatedImageWidth (Interoperability IFD, optional)

This tag is used to record in a DCF thumbnail file the horizontal pixel count of the corresponding DCF extended image file.

Tag   =   4097 (1001.H)
Type   =   SHORT or LONG
Count   =   1
Default   =   none

RelatedImageLength (Interoperability IFD, optional)

This tag is used to record in a DCF thumbnail file the vertical pixel count of the corresponding DCF extended image file.

Tag   =   4098 (1002.H)
Type   =   SHORT or LONG
Count   =   1
Default   =   none

(D) Color space

The *ColorSpace* tag in the *Exif IFD* specified in the Exif standard declares sRGB as follows.

ColorSpace (Exif IFD, mandatory when attribute information is recorded)

The contents are the same as for DCF basic files (see 3.3.5).

3.4.5. DCF thumbnail file data structure

The thumbnail data specifications for DCF thumbnail files are summarized in Table 3-5.

Table 3-5: DCF thumbnail file format

Compression	Number of pixels	Aspect ratio	Chrominance sampling	Compression ratio	Huffman Table	Color Space
JPEG (Exif)	160 × 120 (fixed)	4:3 (fixed)	4:2:2 (fixed)	Not specified	Typical	sRGB

3.5. Tag requirement levels

3.5.1. DCF basic file attribute information

Some of optional tags specified in Exif standard are mandatory in DCF. This level difference is shown for the *0th IFD*, *Exif IFD* and *Interoperability IFD* in Table 3-6, Table 3-7, and Table 3-8, respectively. The requirement level of the *1st IFD* and *GPS IFD* is the same as in the Exif standard.

3.5.2. DCF thumbnail file attribute information

The tags specified in the Exif standard are mandatory in DCF when attribute information is included in the DCF thumbnail files, but in some cases at a different requirement level than in Exif. This level difference is shown for the *0th IFD, Exif IFD* and *Interoperability IFD* in Table 3-6, Table 3-7, and Table 3-8, respectively. There is no *1st IFD* tag (thumbnail of thumbnail).The requirement level of the *GPS IFD* is the same as in the Exif standard.

Table 3-6: *0th IFD* requirement level

Field Name	Tag No.		Requirement Level		
	Dec	Hex	Exif Standard	DCF Images	Thumbnail Files
Make	271	10F	R	M	C
Model	272	110	R	M	C

Table 3-7: *Exif IFD* requirement level

Field Name	Tag No.		Requirement Level		
	Dec	Hex	Exif Standard	DCF Images	Thumbnail Files
DateTimeOriginal	36867	9003	O	M	C
DateTimeDigitized	36868	9004	O	M	C
Interoperability IFD Pointer	40965	A005	O	M	C

Table 3-8: *Interoperability IFD* requirement level

Field Name	Tag No.		Requirement Level		
	Dec	Hex	Exif Standard	DCF Images	Thumbnail Files
Interoperability Index	1	1	O	M	C
Interoperability Version	2	2	O	M	C
RelatedImageFileFormat	4096	1000	N	O	O
RelatedImageWidth	4097	1001	N	O	O
RelatedImageLength	4098	1002	N	O	O

Notation

M: Mandatory (shall be recorded)

C: Conditionally mandatory (shall be recorded when attribute information is included)

R: Strongly recommended (shall be recorded unless prevented by hardware or other restrictions)

O: Optional (recorded if required by particular equipment)

N: Not recorded

3.6. File structure example

An example of the file structure in a DCF directory is shown in Figure 3-3.

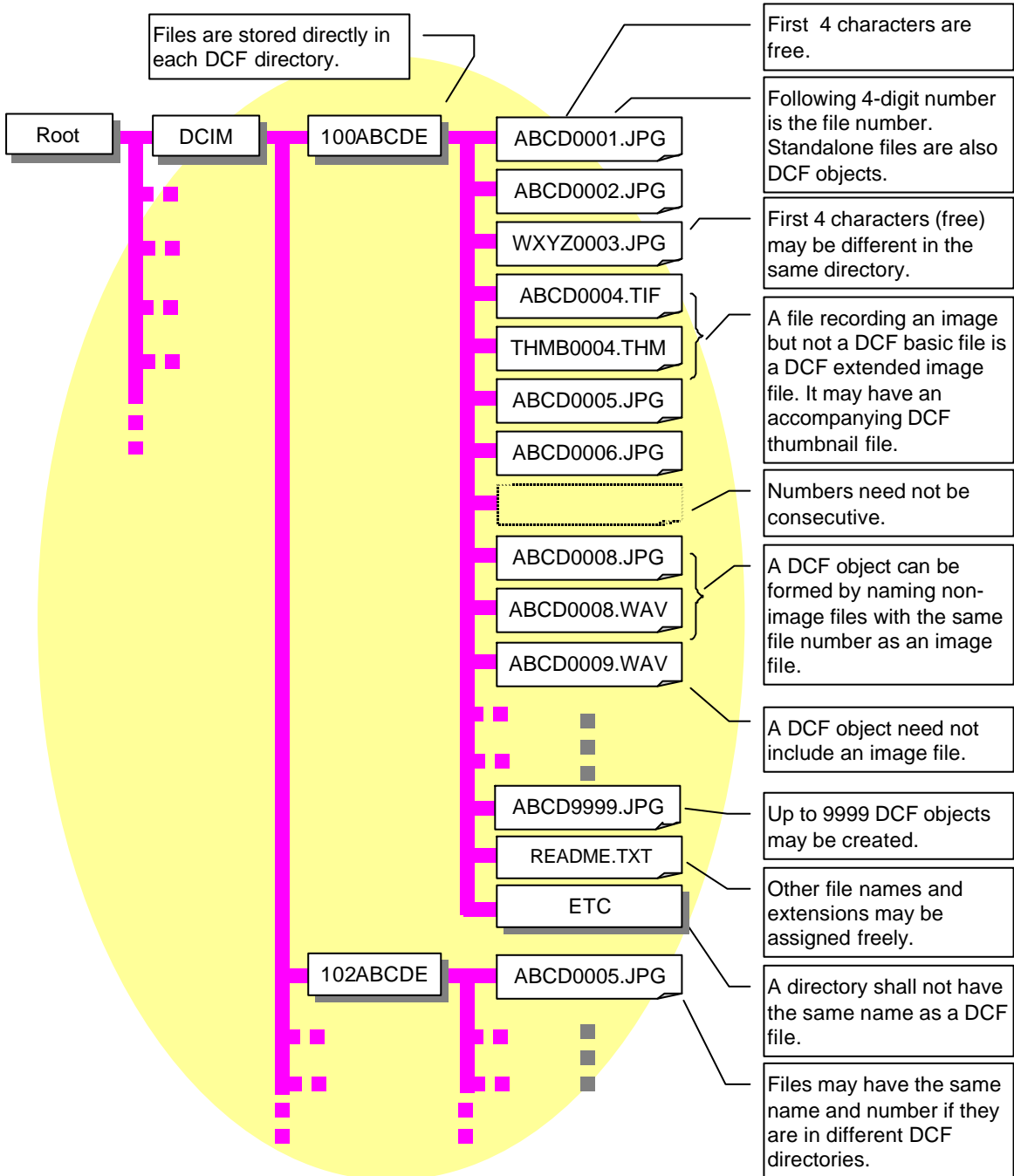|				
	Files are stored directly in each DCF directory.			First 4 characters are free.
Root	DCIM	100ABCDE	ABCD0001.JPG	Following 4-digit number is the file number. Standalone files are also DCF objects.
			ABCD0002.JPG	
			WXYZ0003.JPG	First 4 characters (free) may be different in the same directory.
			ABCD0004.TIF	A file recording an image but not a DCF basic file is a DCF extended image file. It may have an accompanying DCF thumbnail file.
			THMB0004.THM	
			ABCD0005.JPG	
			ABCD0006.JPG	
				Numbers need not be consecutive.
			ABCD0008.JPG	A DCF object can be formed by naming non-image files with the same file number as an image file.
			ABCD0008.WAV	
			ABCD0009.WAV	
				A DCF object need not include an image file.
			ABCD9999.JPG	Up to 9999 DCF objects may be created.
			README.TXT	Other file names and extensions may be assigned freely.
			ETC	
		102ABCDE	ABCD0005.JPG	A directory shall not have the same name as a DCF file.
				Files may have the same name and number if they are in different DCF directories.

Figure 3-3: Typical file structure in a DCF directory

4. Writer specification

4.1. Directories

4.1.1. Creating directories

(A) DCF image root directory

A Writer shall have a function for creating a DCF image root directory on the DCF recording medium if no such directory exists.

(B) DCF directories

A maximum of 900 DCF directories may be created under the DCF image root directory. The directory numbering rules are as follows.

- If a new DCF directory is being created when no other DCF directory exists directly under the DCF image root directory on the DCF recording medium, any directory number may be assigned.

- When an additional DCF directory is added, it is recommended that it be given a directory number of 1 greater than the largest existing directory number.

- Directory numbers shall not be duplicated on the same recording medium.

(C) Other directories

It is permissible to locate directories besides the DCF image root directory directly below the root directory.

It is likewise permissible to locate directories besides DCF directories, based on individual equipment specifications, under the DCF image root directory.

Directories based on individual equipment specifications may be created inside a DCF directory, but a DCF file name shall not be used for the directory name in this case.

4.1.2. Deleting directories

It is permissible for deletion of a specific DCF directory to result in a directory number discontinuity. A user attempting to delete a protected directory shall be presented with a warning to this effect. When an entire removable medium is initialized (formatted), the handling of directory protection is left up to the specifications for individual equipment.

4.2. Files

4.2.1. Creating files

(A) Image files

Image files are recorded in a DCF directory in accord with the specifications below.

To assure interoperability across Writer and Reader using DCF basic files, all Writer products shall have a function for recording DCF basic files. DCF extended image files may be recorded as well, for the sake of proprietary functions. Note, however, that when recording an image file in a DCF directory other than a DCF basic file, it shall be made a DCF extended image file.

(B) DCF thumbnail files

A single thumbnail file may be recorded in the same directory as a DCF extended image file, and may be included in a DCF object.

(C) Other composing a DCF object

Files other than DCF basic files, DCF extended image files, and DCF thumbnail files may be given a DCF file name and recorded.

Another file having a DCF file name may be included in a DCF object, by giving it the same file number as another file. A file shall not, however, be recorded with a file number without the express intention of the Writer user.

(D) Files without a DCF file name

When a file other than an image file is recorded in a DCF directory, it may be given any desired file name, but shall not have the "JPG" or "THM" file extension.

4.2.2. File number

The rules for recording file numbers are as follows.

- If there is no DCF file name among the files in the DCF directory where a file is to be stored, any initial file number may be used.

- If a DCF file name already exists in the DCF directory where a file is to be stored, it is recommended that the file number be assigned as the largest existing number + 1.

- Within the same DCF directory, the file numbers of DCF basic files shall not be duplicated. DCF basic files in different DCF directories may have the same file number.

- File numbers may be duplicated in the same directory for the purpose of forming a DCF object. Note, however, that when a DCF basic file and DCF extended image file are made part of the same object, a Reader will normally give playback priority to the DCF basic file (see Chapters 5 and 6), which may result in a different file being played than the one intended by the Writer user. For this reason, it is best to avoid recording a DCF basic file and DCF extend image file in the same object; or if they are in the same object, to notify the Writer user of this possibility either in the manual or by displaying a notice on the Writer display.

- The upper limit on the number of DCF objects that may be stored in one DCF directory is 9999, the same as the number of file numbers.

4.2.3. Deleting files

(A) DCF objects

All DCF objects, that is all DCF basic files, DCF extended image files, DCF thumbnail files and other files with DCF file names, are deleted, moved and copied in object units (see 7.4.). Copying is treated in the same way as recording a new file. Moving is treated as a combination of copying and deletion. It is possible, with the Writer user's express intention, to delete, move, or copy one or some of the files in an object. A protected object shall not be deleted without presenting the user with a warning to that effect.

If a DCF object contains a file with the Hidden attribute, that file is also treated as part of the object. The Hidden flag may be ignored.

When an entire removable medium is initialized (formatted), the handling of protection is left up to the specifications for individual equipment.

(B) Files that are not DCF objects

No specification is made.

5. Reader 1 specification

5.1. Directories (common to Reader 1 and 2)

5.1.1. Playback

(A) Playback scope

A reader shall detect the directories on a DCF medium, and shall play the files in them according to the specifications in 5.2 and 5.3. No specification is made regarding the playback of other directories, except that if they exist, they shall not hinder the playing of images in DCF directories.

(B) Playback method

The order of playback is not specified.

5.1.2. Deletion

A user attempting to delete a protected directory shall be presented with a warning to this effect. When an entire removable medium is initialized (formatted), the handling of directory protection is left up to the specifications for individual equipment.

5.2. Files

5.2.1. Playback

(A) Playback scope

A Reader shall play the DCF basic files in the DCF directories detected as in 5.1.1 (A). If a DCF basic main image cannot be played because the pixel size exceeds the playback capability, etc., the corresponding DCF basic thumbnail shall be playable (thumbnail substitute playback).

No specification is made regarding the playback of DCF extended image files. If a DCF basic file and DCF extended image file exist in the same object, normally the DCF basic file is to be given playback priority. It is preferable that a DCF thumbnail file be playable. The playability of other files is not specified.

If the number of objects on the DCF media exceeds the upper limit set in product specifications, that limitation shall be explained in the manual or displayed on the product as a warning to the user, etc.

(B) Playback method (common to Reader 1 and 2)

No specification is made regarding the layout of the playback display or the order of playback.

(C) DCF basic file identification (common to Reader 1 and 2)

A Reader capable of reading other image files besides DCF basic files shall make it possible for the user to recognize whether a played image is a DCF basic file or not. The purpose of this stipulation is to enable users to know whether an image being played by a Reader is a DCF basic file playable on other Reader products as well. The capability of distinguishing main image playback from thumbnail substitute playback is not specified. The thinking on Reader playback status and DCF basic file identification is indicated in Figure 5-1.
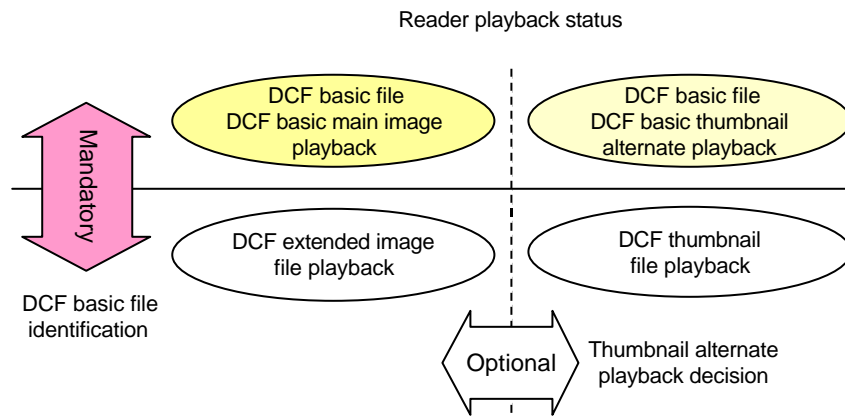

Figure 5-1: Playback status and DCF basic file identification

The recognition of a DCF file is made based on the following indication.

- The initial identification code in the APP1 data field is "Exif" and the *InteroperabilityIndex* tag in the *Interoperability IFD* is "R98".

(D) Handling of color-related tags (common to Reader 1 and 2)

If a color-related tag other than the ColorSpace tag is found in a DCF basic file, it is ignored. The tags shown in Table 5-1 are meant by color-related tags.

Table 5-1: Ignored color-related tags

Field Name	Tag no.
TransferFunction	301
WhitePoint	318
PrimaryChromaticities	319
YCbCrCoefficients	529
ReferenceBlackWhite	532

5.2.2. Deletion (common to Reader 1 and 2)

(A) DCF objects

All DCF objects, that is all DCF basic files, DCF extended image files, DCF thumbnail files and other files with DCF file names, are deleted, moved and copied in object units (see 7.4). Copying is treated in the same way as recording a new file. Moving is treated as a combination of copying and deletion. It is possible, with the Reader user's express intention, to delete, move, or copy one or some of the files in an object. A protected object shall not be deleted without presenting the user with a warning to that effect.

If a DCF object contains a file with the Hidden attribute, that file is also treated as part of the object. The Hidden flag may be ignored.

When an entire removable medium is initialized (formatted), the handling of protection is left up to the specifications for individual equipment.

(B) Files that are not DCF objects

No specification is made.

5.3. Directory number and file number display (common to Reader 1 and 2)

A Reader with number display function shall also have a function for displaying the directory numbers and file numbers of DCF basic files, and for enabling the user to designate any images with the numbers. The purpose is to allow users to designate DCF basic files on DCF media without using the full path name.

The display rules are as follows.

- Show the directory number on the left and the file number on the right, separating them with a hyphen.

- Details such as zero suppression or padding are not specified.

- Directory numbers and file numbers may be displayed at all times or only when called up by an operation of some kind.

- Other methods of displaying image numbers may be used alongside this method.

The directory numbers and file numbers of DCF extended image files may also be displayed if desired.

An example of directory number and file number display is given in Table 5-2.

Table 5-2: Typical directory number and file number display

	Directory number				File number			
Example 1	1	0	2	-	0	0	1	5
Example 2	1	0	2	-			1	5
Example 3	1	0	2	-	1	5		

6. Reader 2 specification

6.1. Directories

6.1.1. Playback

This is as specified for Reader 1 in 5.1.1.

6.1.2. Deletion

This is as specified for Reader 1 in 5.1.2.

6.2. Files

6.2.1. Playback

(A) Playback scope

The Reader shall be capable of detecting DCF basic files in the DCF directories detected as in 6.1.1 and playing them within the range of pixel number described below. If a DCF basic main image is outside the range of pixel number, the corresponding DCF basic thumbnail may be played instead.

No specification is made regarding the playing of DCF extended image files. If an object contains both a DCF basic file and DCF extended image file, priority is normally given to DCF basic file playback. The playability of other files is not specified.

If the number of objects on the DCF media exceeds the upper limit set in product specifications, that limitation shall be explained in the manual or displayed on the product as a warning to the user, etc.

(B) Playback method

This is as specified for Reader 1 in 5.2.1.

(C) Supported pixel count specification

The supported pixel count specification indicates the maximum and minimum DCF basic main image size that shall be playable on a Reader 2 device. Reader 2 shall be able to play DCF basic main images within the range shown in Table 6-1.

Table 6-1: Range of Pixel Number

	Pixel Ranges				
Horizontal pixel range	160	$<=$	X	$<=$	1800
	and				
Vertical pixel range	120	$<=$	Y	$<=$	1200

(Pixels)

(D) DCF basic file identification

This is as specified for Reader 1 in 5.2.1.

(E) Handling of color-related tags

This is as specified for Reader 1 in 5.2.1.

6.2.2. Deletion

This is as specified for Reader 1 in 5.2.2.

6.3.   Directory number and file number display

This is as specified for Reader 1 in 5.3.

7. Other precautions

7.1. Naming directories under the DCF image root directory

The method by which a Writer adds a new directory to media containing directories that do not follow the DCF specifications, on a PC or the like as in Figure 7-1, is specified here along with the Reader playback method in such cases.
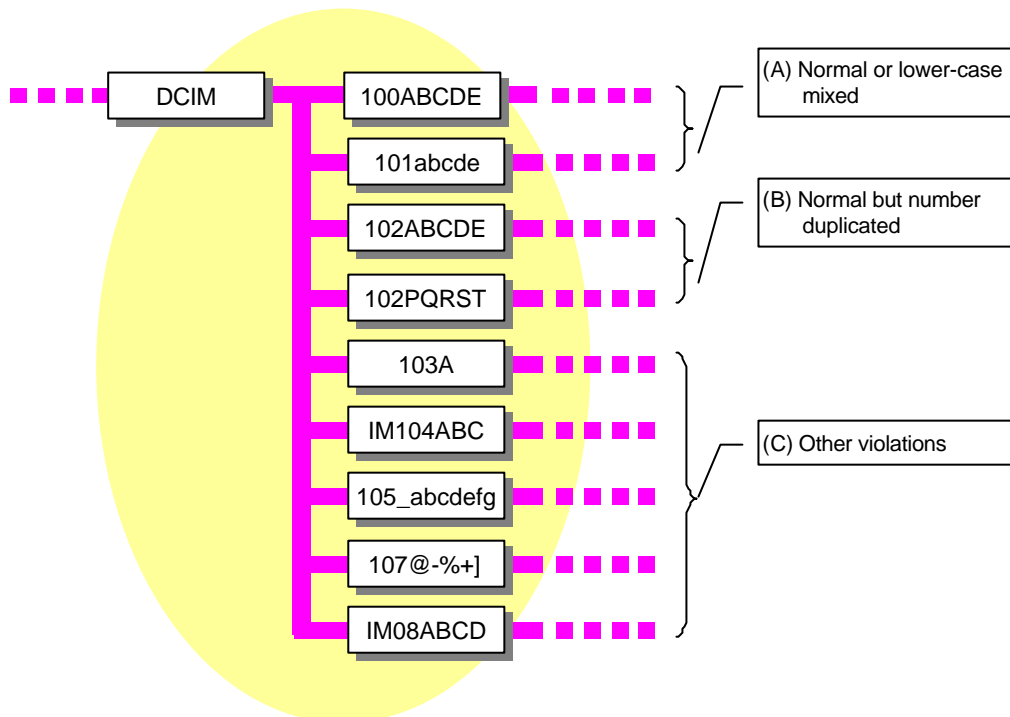

Figure 7-1: Directory naming precautions

(A)   When lower-case letters are used in a directory name

If lower-case letters are used in the free characters of a directory name but the name is otherwise compliant with DCF directory naming conventions, it shall be treated as a DCF directory without distinguishing case. A Writer may add files to such a directory, and may create new directories so long as the directory number is not duplicated. A Reader shall treat the directory as a DCF directory without distinguishing case.

(B)   When directory numbers are duplicated across DCF directories

Directories with duplicate directory numbers are all treated as non-DCF directories. New DCF objects shall not be recorded in such a directory. A Reader may play the files in such a directory, but the directory numbers and file numbers shall not be displayed. It shall also be made apparent to the user that files in such directories are not DCF basic files. When a Writer creates a new directory, it shall not be allowed to duplicate the directory number of such directories.

(C)   Handling of directories that are not DCF directories

A directory that is not a normal DCF directory and that does not fall under cases (A) or (B) above may be completely ignored. A Writer shall not add DCF objects to such a directory. A Reader may play the files in such a directory, but the directory numbers and file numbers shall not be displayed. It shall also be made apparent to the user that files in such directories are not DCF basic files.

7.2.   Naming of files in a DCF directory

The method by which a Writer adds a new object to a directory containing files with names that do not follow the DCF specifications, on a PC or the like as in Figure 7-1, is specified here along with the method by which a Reader plays DCF objects in such cases.
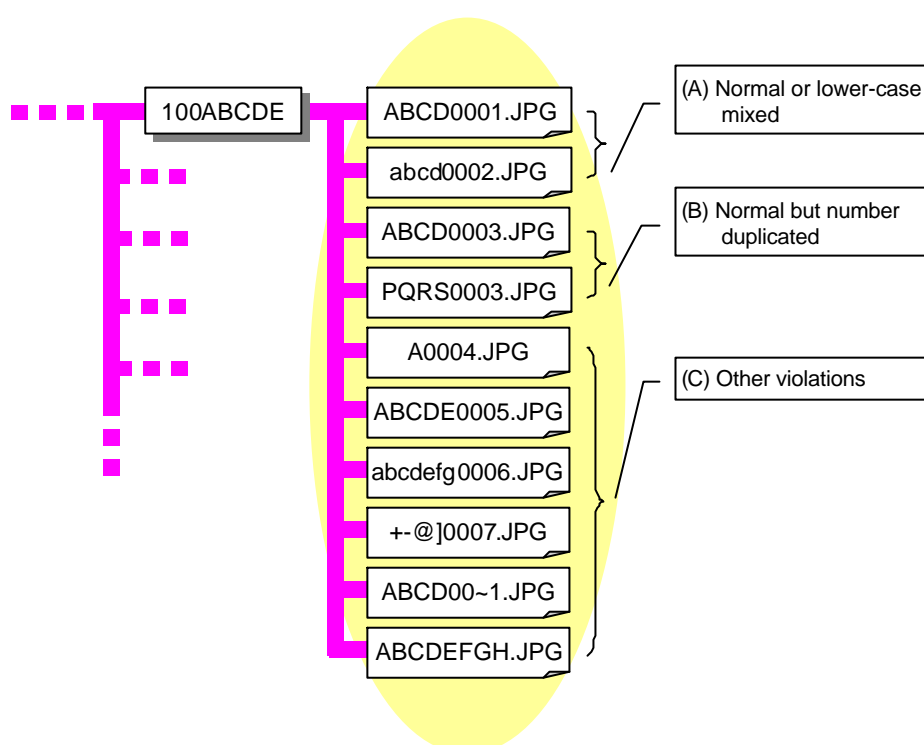

Figure 7-2: File naming precautions

(A)   When lower-case letters are used in the file name

If lower-case letters are used in the four free characters of a file name or in the extension, but otherwise the file is named in accord with DCF file naming conventions, it is treated as a DCF object without distinguishing case.

(B)   When file numbers are duplicated across DCF basic files

Basic files with duplicate numbers are all treated as not DCF basic files. A Reader may play such files, but the directory numbers and file numbers shall not be displayed. It shall also be made apparent to the user that the files are not DCF basic files. When a Writer creates a new DCF object, it shall not be allowed to duplicate the file numbers.

(C) Handling of files without DCF file names

A file without a normal DCF file name that does not fall under cases (A) or (B) above may be completely ignored. A Reader may play such files, but the directory numbers and file numbers shall not be displayed. It shall also be made apparent to the user that the files are not DCF basic files.

7.3.   Updating of tag data when saving

7.3.1. Handling of date tags

The Exif standard specifies the following three date tags.

- *DateTimeOriginal*
- *DateTimeDigitized*
- *DateTime*

DateTime records the date and time of file updating, like a file time stamp. *DateTimeOriginal* records the date and time when an image was shot, and *DateTimeDigitized* has the date and time when digital data was created. On a DSC, in many cases these three are identical.

If a DCF basic file is saved again at a time after the image was originally captured, it is recommended that only the *DateTime* tag be updated and not the *DateTimeOriginal* or *DateTimeDigitized* tags. If, however, the image is processed in a way that invalidates the date and time of original image capture, it is allowable to update the *DateTimeOriginal* and *DateTimeDigitized* tags as well.

When a DCF basic file is created not on a DSC but on a PC or the like, and the capture date and time cannot be determined, the *DateTimeOriginal* tag may have the date and time left blank (filled with space characters), as indicated in the Exif standard.

7.3.2. Handling of *Make*, *Model*, and *Software* tags

The Exif standard specifies the following three tags for recording information about equipment and applications.

- *Make*
- *Model*
- *Software*

The *Make* tag records the equipment or application vendor name, and *Model* gives the model name. *Software* may be used to record the name of software used in equipment (embedded software) or for the application software name.

If any of these tags is updated when a DCF basic file is saved, it is recommended that only the *Software* tag be changed and the *Make* and *Model* tags be left as is. If, however, the image is processed in such a way as to invalidate the equipment information of the original image, the *Make* and *Model* tags may also be updated.

When a DCF basic file is created not on a DSC but on a PC or the like, *Make* and *Model* may be used to record the software name.

7.4. DCF object bulk operations

Write-protecting a DCF object requires that the ReadOnly attribute be assigned to all the files in the DCF object. If file attributes are changed on a PC or the like, it is conceivable that only some of the files in a DCF object will be protected.

A Writer or Reader, respecting the DCF object configuration, is designed to operate so that if even one file in a DCF object has the ReadOnly attribute, all files in that object are considered protected.

If an object consists of a very large number of files such that bulk operations (copying, moving, deleting) are not practical, a Writer or Reader shall not perform operations involving only some of the files at one time, regardless of the Writer or Reader user's intention.

Annex A   DCF applicable media

DCF applies to the media shown in Table A.

As necessary, this list will be expanded to other media in the future.

Table A DCF applicable media

Name	Issued by	Contact
PC Card ATA	JEIDA	http://www.pc-card.gr.jp/
	PCMCIA	http://www.pc-card.com/
SmartMedia	SSFDC Forum	http://www.ssfdc.or.jp/
CompactFlash	CompactFlash Association	http://www.compactflash.org/
Memory Stick	Sony Corporation	http://www.world.sony.com/MS/
SD Card	SD Card Association	http://www.sdcard.org

Please contact the issuer for specifications and use conditions of these media.

Annex B   Data validation

A. Validation method

Validation testing is performed by the makers of DCF-compatible equipment and applications themselves. The contact for information on procedures is given below.

Japan Electronic Industry Development Association
Kikai Shinko Kaikan, 5-8, Shiba-koen 3-chome, Minato-ku, Tokyo
TEL 03-3433-1923
http://www.jeida.or.jp/

B. Compatibility testing policy

Storage media may be distributed as necessary to companies supporting DCF. The companies to which media distribution is made shall perform any necessary compatibility testing with their own products and return a report to the distributing agency.

Annex C   Relation to JPEG and Exif standards

The Exif standard covers the following.

- Image file format

- Audio file format

- Recommended conventions for directory and file naming

- Color space guidelines

The Exif standard specifies requirement levels as mandatory, recommended, and optional for each item relating to image and audio file recording methods. For example, thumbnail recording is optional, and leeway is permitted in thumbnail format. The directory and file naming conventions in the Exif standard are given in the form of administrative examples.

The DCF standard specifies administrative rules, which add further stipulations to the Exif standard for the sake of playback compatibility. The file format in DCF is based on the Exif standard. The relationship among JPEG, Exif and DCF standards is summarized in Figure C-1. See chapters 3 and following for details.

Standard name / Specification	JPEG		Exif Ver. 2		DCF
Compressed image file format	JPEG Baseline specification		Marker segment restrictions / Pixel sampling restrictions		Exif Ver. 2.1 conformant / Typical Huffman Table used
	JPEG extended specification				
Thumbnail image format			JPEG 4:2:2		Size 160x120 fixed / Typical Huffman Table used
			JPEG 4:2:0		
			TIFF		
Image attribute information			Camera information		Some mandatory items
			Color space information		Limited to sRGB
			Other information		Exif Ver. 2.1 conformant
FlashPix Ready function			Specified		Exif Ver. 2.1 conformant
Directory and file naming			Recommended examples (specified only in outline)		Specified in detail
Writer and reader specifications					Writer and reader conditions specified in detail
Uncompressed image file format			TIFF Rev. 6.0 conformant (with some restrictions added)		
Audio file format			WAV format (with some restrictions added)		
Object specification					Related files specified as objects

Figure C-1   Relation of DCF to Exif and JPEG standards

Digital Still Camera Technical Committee

Chair	Motokazu	Ohkawa	High-tech VISUAL PROMOTION CENTER
Members	Harumi	Aoki	Asahi optical Co., Ltd.
	Nobuaki	Sakurada	Canon Inc.
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	Takashi	Toyoshima	OLYMPUS OPTICAL CO., LTD
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	Toshiharu	Kobayashi	Sony Corporation
	Toshinori	Unno	Taiko Denki Co., Ltd.
	Hiroaki	Matsubara	TOSHIBA CORPORATION
	Ohara	Minoru	TOSHIBA CORPORATION
	Masahiko	Shimizu	Tokyo Electron Device Ltd.
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Shogo	Ida	I. B. M. Japan Ltd.
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Sugio	Makishima	FUJI PHOTO FILM CO., LTD.
Hiroshi	Tanaka	FUJI PHOTO FILM CO., LTD.
Mikio	Watanabe	FUJI PHOTO FILM CO., LTD.
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Yasuhiro	Morimoto	Minolta Co., Ltd.
Hirokazu	Naruto	Minolta Co., Ltd.
Hiroki	Fukuoka	RICHO COMPANY, LTD.
Yoshiro	Tomisaki	Japan Electronic Industry Development Association
Hisanori	Tatae	Japan Electronic Industry Development Association
Hiroshi	Suzuki	Japan Electronic Industry Development Association