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JEITA CP-3461B

**Design rule for Camera File system:
DCF Unified Version 2.0**

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Introduction

This document is a standard that edits and recompiles the “Design Rule for Camera File System DCF Unified Version” (JEITA CP-3461A + CIPA DC-009-2009) (hereinafter called “the DCF Standard Unified Version 2.0”) that was defined by JEITA and CIPA in ways that included incorporating the necessary portion of Annex F “Guidelines for Handling Exif/DCF” into the main text. Additionally, expressions that resulted in ambiguous interpretation were clarified and errors were corrected. In addition, specifications concerning FAT, application for devices with embedded memory, and 4. “DCF Media” were revised in order to respond to greater file capacity.

Revision History

Rev.	Date	Comment
1.0	October 1998	Published First Edition 1.0 <ul style="list-style-type: none"> ● Established file rules and file storage rules ● Established designation of sRGB ● Established thumbnail specifications
2.0	September 2003	Published Revision 2.0 <ul style="list-style-type: none"> ● Added DCF optional files (extended color space) ● Corrected misprints and omissions throughout the text
Unified Version 2.0	June 2009	Published Unified Version 2.0 <ul style="list-style-type: none"> ● Added CIPA-issued “Guidelines for Handling Exif/DCF” (CIPA DCG-004-2009) as Annex 6 ● Added explication of 2.0 as Annex 7 ● Corrected misprints and omissions throughout the text
2.0 (Edition 2010)	April 2010	Published Revision 2.0 (Edition 2010) <ul style="list-style-type: none"> ● Restructured the main standard text, guidelines, explications, etc., of DCF Unified Version 2.0 ● Clarified specification levels and revised the scope of application ● Revised items pertaining to file system ● Corrected misprints and omissions for the entire text

1. Scope

This standard specifies the file system to be used when handling image files and sound files that are prepared using a format that is in accordance with the Exif Standard with DCF media that were formatted by an FAT file system (FAT12, FAT16, FAT32, exFAT,) etc., that can guarantee their interoperability as media.

The standard applies to devices, recording media, and application software that handle image files and sound files when such files are handled as Exif/DCF files.

As devices mentioned above, the applicable items are devices with functions such as capturing, recording, displaying, editing, and printing of images.

Specifically, examples of capture/recording devices include DSC, DVC, and camera phones, etc. Examples of display/playback devices include image display devices such as DVT, digital photo frames, and car navigation systems. In addition, image storage devices include image storers and home servers. Image printing devices include printers.

As application software mentioned above, the applicable items are application software providing functions for editing, displaying, and recording metadata as well as importing and editing images.

2. Definitions

2.1. Definition of Terms

DCF	The standard specified in this document
Exif Standard	“Digital Still Camera Image File Format Standard (Exif) of the Japan Electronics and Information Technology Industries Association (JEITA)
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
DTV	Digital television
PC	Personal computer
DCF-compatible	Compliant with the DCF
DCF media	Removable memory recorded in compliance with the DCF or,

	removable and non-removable memory that a file system can access from an external device through IF (regardless of wired or wireless)
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 a FAT file system (FAT12, FAT16, FAT32, exFAT,) etc., excluding the dot and file extension
File extension	Three identifying characters used in a FAT file system (FAT12, FAT16, FAT32, exFAT,) etc., excluding 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
Compressed data	Data referred to in the JPEG Standard as “entropy coded data”
Tag	A field recording ancillary data about an image. Corresponds to “field” in TIFF
Tag information	A description of the tag contents
Exif/DCF Writer	A digital still camera (DSC) or other device or application software that can output an Exif/DCF file
Exif/DCF Editor	A device or application that edits (i.e., makes partial additions, changes, deletions) existing Exif/DCF files (Alternatively, image-editing application; includes some DTV, photo frames, and DSC)

Exif/DCF Reader	A device, such as a printer with a memory card slot, capable of directly reading an Exif/DCF file and printing or performing other output processing, as well as application software that uses Exif tags to perform image processing for output.(with playback function in conformity with the DCF Reader 1 and Reader 2 specifications described in 2.1 “Definition of Terms” of the DCF Standard)
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The following simple definitions, which are specified in detail in the DCF Standard, are provided in this standard for the reader's convenience.

DCF image directory	The directory directly under the root directory, created in accordance with the DCF directory rules
DCF directory	A directory for storing images under the DCF image root directory created in accordance with the DCF directory rules
DCF directory name	A directory name assigned in accordance with the DCF directory name conventions
DCF object	A group of files recorded in accordance with DCF
DCF file name	A file name assigned in accordance with the DCF file name 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 data structure specified in this 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 optional file	An image file stored directly under a DCF directory, having a DCF file name and the extension "JPG," and recorded in the DCF optional color space specified in this standard
DCF optional main image	The primary image in a DCF optional file
DCF extended image file	An image file stored directly under a DCF directory, having a DCF file name but an extension other than "JPG" or "THM" and its own data structure

DCF thumbnail file	A compressed file for storing the thumbnail image of a DCF extended image file
Protection	Setting the Read Only 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 displaying 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
DCF basic color space	The color space used in a DCF basic file, the widely used sRGB; its characteristics are indicated in IEC 61966-2-1: 2003
DCF optional color space	The color space used in a DCF optional file; its characteristics are indicated in Chapter 4 of this standard
Color space transformation	Processing for converting image data to the proper colors for playback when the color space assumed in recording differs from that used in the playback environment

2.2. Verbal forms for the expression of provisions

The keywords in this document are to be interpreted as described in ISO/IEC Directives 2.

(See [Directives2 Annex H](#) "Verbal forms for the expression of provisions".)

Requirement

Verbal forms	Equivalent expressions
Shall	is mandatory
shall not	

Recommendation

Verbal forms	Equivalent expressions
should	it is recommended that is recommended
should not	

Permission

Verbal forms	Equivalent expressions
may	is optional
need not	is not required

Possibility and capability

Verbal forms	Equivalent expressions
can	it is possible to
cannot	

2.3. Definition of characters used in directory and file names

When a directory or file using a one-byte code is created, such as FAT12, FAT16, or FAT32, only those ASCII characters that appear in Table 1 shall be used when creating the names of these files.

However, even for file systems, such as exFAT, that use only two-byte codes (such as Unicode) in directory and file names, only two-byte code characters that are equivalent to the ASCII characters shown in **Table 1** shall be used when creating these directories and files.

Moreover, if an existing directory or file name uses lower-case letters, they shall be treated as all the equivalent upper-case letters.

Table 1 Allowed characters

				b7	0	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	_		

When creating a directory or file with a one-byte code, follow the following rules:

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

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

3. Overview

3.1.DCF and recording media

DCF is intended to enable use of files 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.

3.2.Configuration of DCF specification

DCF consists of the three specifications shown in **Figure 1**.

- DCF media specification (**Chapter 4**) 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 5**) Based on the media specification in, **Chapter 4** the Writer specification stipulates the directory and file structure for recording data, and the file operations.
- Reader specifications (**Chapter 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 4**.

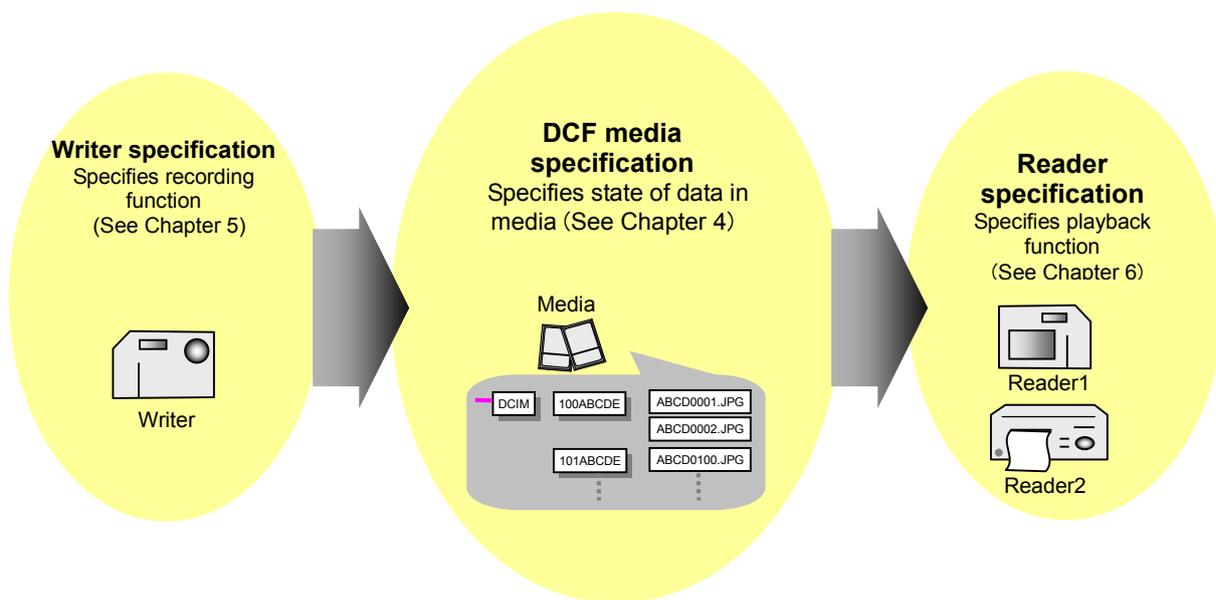


Figure 1 DCF standards

3.3.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 read and display the corresponding DCF basic thumbnail.
- Level 2 If a device is classified in Level 2, then it shall 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, shall implement level 2 compatibility, for which a supported pixel count specification is defined.

3.4. Classification of functions

The functions of DCF-compatible equipment are classified into Writer, Reader 1, and Reader 2 functions as shown in **Table 2**. 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 **3.5**.)

Table 2 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 specifications for Reader 1.	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 specifications for Reader 2.	Equipped with Level 2 playback compatibility. Assumed here are printers and other equipment whose main function is main image playback. Playback here means display and printing. Includes move, copy and delete functions.

3.5. Categories of DCF-compatible equipment

The categories of DCF-compatible equipment are the four types shown in **Table 3**. The products given are only examples and are not intended to specify the equipment.

Table 3 Categories of DCF-compatible equipment

	Recording				Playback						Typical Products
	A	B	C	D	A		B		C	D	
					Main image	Thumb	Main image	Thumb			
Category 1 (Writer only)	M	O	O	O	N		N		N	O ^(a)	Record-only DSC, scanner, etc
Category 2 (Writer + Reader 1)	M	O	O	O	T		T ^(c)		O	O	DSC with simple playback function, etc
Category 3 (Writer + Reader 2)	M	O	O	O	M	O	O ^(d)	O	O	O	DSC with playback function; printer/player with recording function; application software, etc.
Category 4 (Reader 2)	N	N	N	O ^(b)	M	O	O ^(d)	O	O	O	Printer, player, print service, etc

A: DCF basic files

B: DCF optional files

C: DCF objects other than DCF basic files and DCF optional files

D: Other files

M: Mandatory function

O: Optional function

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

T: Thumbnail substitute playback function is Mandatory, if a main image is not able to be displayed

Note^(a) Having a function for image playback but having neither Reader 1 nor Reader 2 functionality shall be prohibited.

^(b) Being a Reader with an image recording function but not having a Writer function shall be prohibited

^(c) Preferably playback should be made using color space transformation processing. In the absence of a color space transformation capability, playback shall be made in the sRGB color space.

^(d) Preferably playback should be made using color space transformation.

3.6. Workflow for editing an image with application software

Figure 2 shows the workflow when an Exif/DCF file is edited using an application. DSCs in this figure are examples of image capture/playback devices. Consideration is also given to the use of other devices such as a TV or printer.

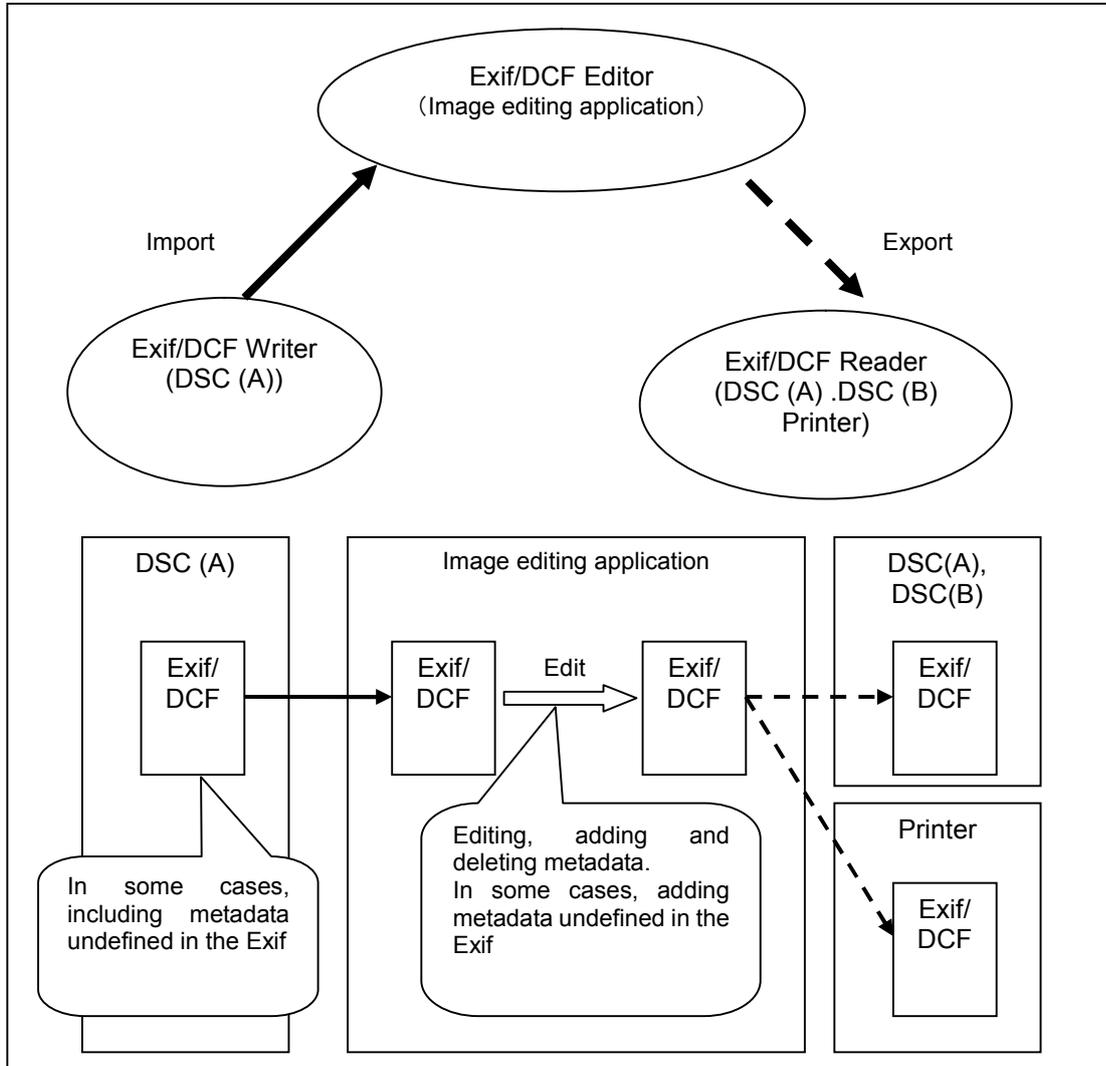


Figure 2 Editing images with application software

3.6.1 Actions

In this workflow, the following cases are considered:

1. Recording an image use an Exif/DCF writer (in some cases, recording metadata is undefined in the Exif).
2. Importing the image into an Exif/DCF editor and editing it (in some cases, adding metadata that is undefined in the Exif at this time).
3. Exporting the image that was edited in the above-mentioned Exif/DCF editor to an Exif/DCF reader. At this time, there are cases in which the Exif/DCF reader can correspond to 6. "Reader Specifications" in this standard, and cases when it cannot.
4. Viewing the image with an Exif/DCF reader.

4. DCF Media Standard

4.1. Large-capacity memory media

There are some file systems because that media capacity has been increasing. File systems used in DCF media are defined in 4.1.1

4.1.1 File system

The file system used in DCF media having a capacity of over 2 GByte is operated by such as FAT32 and exFAT. Interoperability should be enriched by adopting an appropriate file system within the specified range of the DCF standard depending on such conditions as capacity when selecting the file system to be used in DCF media.

4.2. Directory definition

The following are defined here.

- Directory structure
- Directory name

4.2.1 DCF image root directory

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

4.2.2 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 shall consist only of the upper-case alphanumeric characters shown in **Table 1**.

The conventions of DCF directory names are illustrated in **Table 4**.

Table 4 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 FAT (FAT12, FAT16, FAT32, exFAT) file systems 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.

4.2.3 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.

4.2.4 Directory example

A typical DCF directory is shown in **Figure 3**.

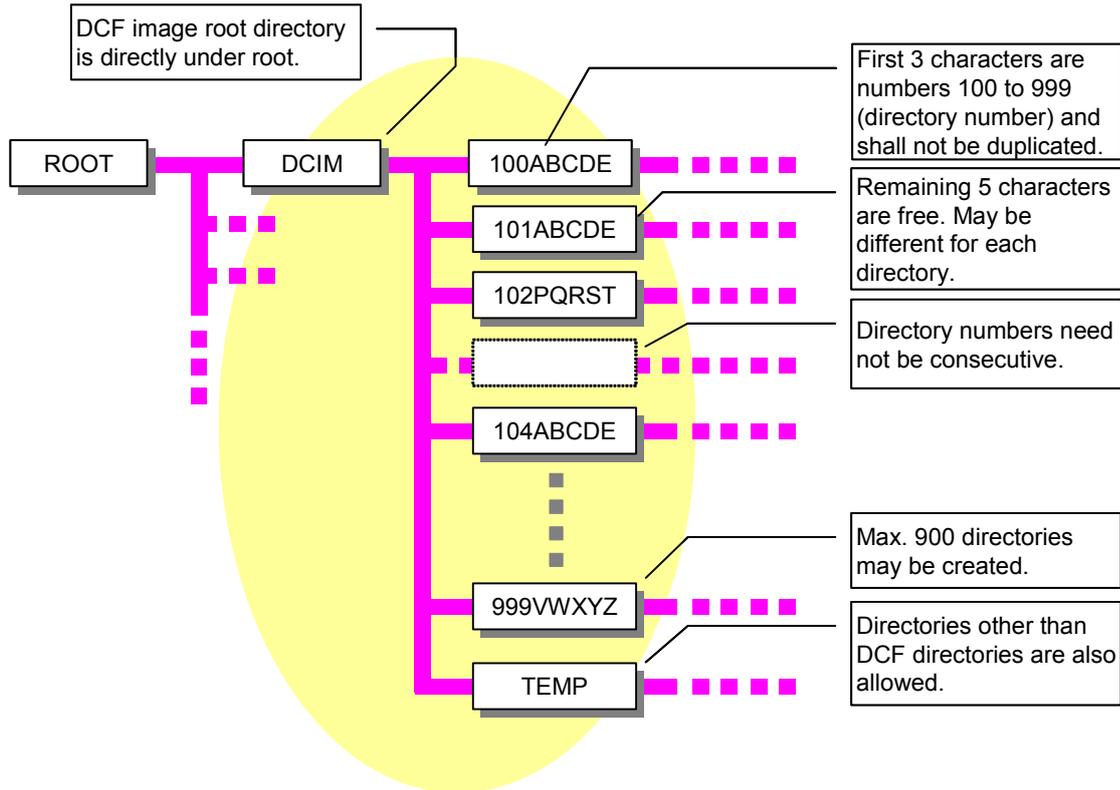


Figure 3 Typical DCF directory

4.3. File definition

4.3.1 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**
- 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 **4.3.2**.

The DCF file naming conventions are illustrated in **Table 5**.

Table 5 DCF file naming example (excluding extension)

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

4.3.2 DCF objects

DCF objects are file groups defined as follows.

4.3.2.1 Purpose of DCF objects

Of the files stored on DCF media, objects are 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 convenience of users.

4.3.2.2 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.

4.3.2.3 Files included in objects

DCF defines files included in DCF objects. Files with other extensions and data structures not specified in DCF may also be included in a DCF object.

a) DCF basic file

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

b) DCF optional file

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

c) DCF extended image file

- A file with a DCF file name but having an extension and data structure other than "JPG" or "THM".
- The data structure is not specified.

d) 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 below.

e) 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 optional 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 DCF optional file and DCF thumbnail file in the same object.
- A DCF basic file and DCF optional 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 and DCF optional files.
- A file with the extension "THM" having a data format other than that of a DCF thumbnail file.

4.3.2.4 Object file attributes

The Read Only attribute of the FAT (FAT12, FAT16, FAT32, exFAT) file systems 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.

4.3.2.5 Object operation

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

4.4. DCF basic files

4.4.1 Purpose

Image files conforming to Exif Ver. 2 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.

4.4.2 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". The character "_" shall not be used as the first character of a file name.

4.4.3 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.

4.4.4 Data structure of a DCF basic main image

4.4.4.1 Data structure

Exif compressed format (JPEG format) is mandatory as a Data structure of DCF basic file,

The pixel composition and sampling may be either YCbCr 4:2:2 or YCbCr 4:2:0.

4.4.4.2 Data compression

The compression ratio of DCF main basic images is not specified. The JPEG data structure shall be 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.

4.4.4.3 Pixel count

The number of pixels is not specified.

4.4.4.4 Image aspect ratio

The image aspect ratio is not specified.

4.4.5 Attribute information

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

4.4.5.1 Exif tag structure

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

4.4.5.2 Information about shooting conditions and camera

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 will 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 will 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 IFD, 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

4.4.5.3 DCF basic file 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 shall be "R98". The tag including end code is 4 Bytes. Note that this differs from the value (THM) defined for DCF thumbnail files in **section 4.6.4**.

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

■ **InteroperabilityVersion** (Interoperability IFD, mandatory)

This tag shall record the Interoperability version. Since the file content shall be equivalent to ExifR98, the value shall be the 4-Byte ASCII "0100" meaning Version 1.00. This shall not be 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

4.4.5.4 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

4.4.6 DCF basic thumbnail data structure

4.4.6.1 Image data format

The thumbnail data structure shall be in accord with the Exif compressed thumbnail specification.

The pixel composition and sampling shall be YCbCr 4:2:2. The reason for limiting to one choice here is to ensure Level 1 playback compatibility. The color space used for a thumbnail image shall be sRGB as with main image.

4.4.6.2 Compressed data

The JPEG data structure shall be as specified in Exif. As in the Exif specification, no restart marker shall be

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.

4.4.6.3 Number of pixels

The number of pixels for thumbnail recording shall be 160 horizontal pixels by 120 vertical pixels, chosen as a size large enough to enable the image to be recognized. Any other pixel size shall not be used.

4.4.6.4 Layout

If the DCF basic main image has an aspect ratio different from that of the DCF basic thumbnail, the difference shall be adjusted by padding. The recommended method for recording thumbnail images is as follows.

- Padding data: black (RGB all 0)
- Image position: centered
- Relation to main image: conform to the field angle of the main image to the extent possible, without cutting out part of the image.

4.4.7 Image data format in DCF basic files

The DCF basic main image format is summarized in **Table 6**. The DCF basic thumbnail data format is summarized in **Table 7**.

Table 6 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 7 DCF Basic Thumbnail Data Format

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

4.5. DCF optional files

4.5.1 Purpose

A DCF optional file is used when an image is to undergo extensive processing, notably in professional uses such as commercial printing. The image data uses the DCF optional color space.

4.5.2 Directory, file names and extensions

A DCF optional 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". The character "_" shall always be used as the first character of the file name. Typical file name: "_ABC0001.JPG"

4.5.3 Data structure of a DCF optional file main image

4.5.3.1 Data structure

The only supported data format for DCF optional main image data is Exif compressed format (JPEG format). The pixel composition and sampling is either YCbCr 4:2:2 or YCbCr 4:2:0.

4.5.3.2 Data compression

The compression ratio of image data is not specified. The JPEG data structure shall be 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.

4.5.3.3 Pixel count

The number of pixels is not specified.

4.5.3.4 Image aspect ratio

The image aspect ratio is not specified.

4.5.4 Attribute information

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

4.5.4.1 Exif tag structure

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

4.5.4.2 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)

Tag data is the same as for DCF basic files (see 4.4.5.).

Model (0th IFD, mandatory)

Tag data is the same as for DCF basic files (see 4.4.5.).

DateTimeOriginal (Exif IFD, mandatory)

Tag data is the same as for DCF basic files (see 4.4.5.).

DateTimeDigitized (Exif IF, mandatory)

Tag data is the same as for DCF basic files (see 4.4.5.).

4.5.4.3 DCF optional file identifying information

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

■ InteroperabilityIndex (Interoperability IFD, mandatory)

The value shall be "R03". The tag including end code is 4 Bytes.

Tag	=	1 (1.H)
Type	=	ASCII
Count	=	4
Default	=	"R03"

■ InteroperabilityVersion (Interoperability IFD, mandatory)

This tag shall record the version of the InteroperabilityIndex value. The value shall be the 4-Byte ASCII "0100" meaning Version 1.00. This shall not be 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 optional file, in which case it indicates that file's own format (Exif JPEG Ver. 2, 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 optional 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 optional 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

4.5.4.4 Color space

The DCF optional color space is used in a DCF optional file, and its characteristics are defined using the WhitePoint tag, PrimaryChromaticities tag, YCbCrCoefficients tag, and Gamma tag.

■ **ColorSpace** (Exif IFD, mandatory)

This tag records Uncalibrated, indicating non-use of the sRGB color space.

Tag = 40961 (A001.H)

Type = SHORT

Value = FFFF.H (Uncalibrated)

Count = 1

■ **WhitePoint** (0th IFD, mandatory)

This tag indicates the chromaticities of reference whitepoint. Information shall be recorded as follows in a

DCF optional file.

Tag = 318 (13E.H)
 Type = RATIONAL
 Count = 2
 Value = 139.H / 3E8.H 149.H / 3E8.H

The above values are for chromaticities of (X, Y) = (0.313, 0.329).

■ **PrimaryChromaticities** (0th IFD, mandatory)

This tag indicates the chromaticities of the three primary colors. Information shall be recorded as follows in a DCF optional file.

Tag = 319 (13F.H)
 Type = RATIONAL
 Count = 6
 Value = 40.H / 64.H 21.H / 64.H 15.H / 64.H 47.H / 64.H F.H / 64.H 6.H / 64.H

The above values are for the following chromaticities.

R chromaticities: (X, Y) = (0.64, 0.33)

G chromaticities: (X, Y) = (0.21, 0.71)

B chromaticities: (X, Y) = (0.15, 0.06)

■ **YCbCrCoefficients** (0th IFD, mandatory)

This tag indicates the color transform matrix coefficients for going from RGB to YCbCr image data. Information shall be recorded as follows in a DCF optional file.

Tag = 529 (211.H)
 Type = RATIONAL
 Count = 3
 Value = 12B.H / 3E8.H 24B.H / 3E8.H 72.H / 3E8.H

The above values correspond to the following coefficients.

0.299, 0.587, 0.114

■ **Gamma** (Exif IFD, mandatory)

This tag indicates a gamma compensation coefficient used by the transformation function in playback. Information shall be recorded as follows in a DCF optional file.

Tag = 42240 (A500.H)
 Type = RATIONAL
 Count = 1
 Value = 16.H / 0A.H

The above value is for a gamma compensation coefficient of 2.2.

4.5.5 DCF optional file thumbnail data structure

4.5.5.1 Image data format

The thumbnail data structure shall be in accord with the Exif compressed thumbnail specification. The pixel composition and sampling shall be YCbCr 4:2:2. The color space used for a thumbnail image shall be the same DCF optional color space used with main images.

4.5.5.2 Compressed data

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

4.5.5.3 Number of pixels

The number of pixels for thumbnail recording shall be 160 horizontal pixels by 120 vertical pixels, chosen as a size large enough to enable the image to be recognized. Any other pixel size shall not be used.

4.5.5.4 Layout

If the main image has an aspect ratio different from that of the thumbnail image, the difference shall be adjusted by padding. The recommended method for recording thumbnail images is as follows.

- Padding data: black (RGB all 0)
- Image position: centered
- Relation to main image: conform to the field angle of the main image to the extent possible, without cutting out part of the image.

4.5.6 Image data format in DCF optional files

The DCF optional file main image format is summarized in **Table 8**. The DCF optional file thumbnail data format is summarized in **Table 9**.

Table 8 DCF Optional File 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	DCF optional color space

Table 9 DCF Optional File Thumbnail Data Format

Compression	Number of pixels	Aspect ratio	Chrominance sampling	Compression ratio	Huffman Table	Color space
Compressed (JPEG)	160 x 120 (fixed)	4:3 (fixed)	4:2:2 (fixed)	Not specified	Typical	DCF optional color space

4.6.DCF thumbnail files

4.6.1 Purpose

DCF extended image files recorded with proprietary functions often cannot be displayed 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 is better to be noted carefully that even if DCF thumbnail files are used, this does not guarantee playback equivalent to DCF basic file level 2 compatibility.

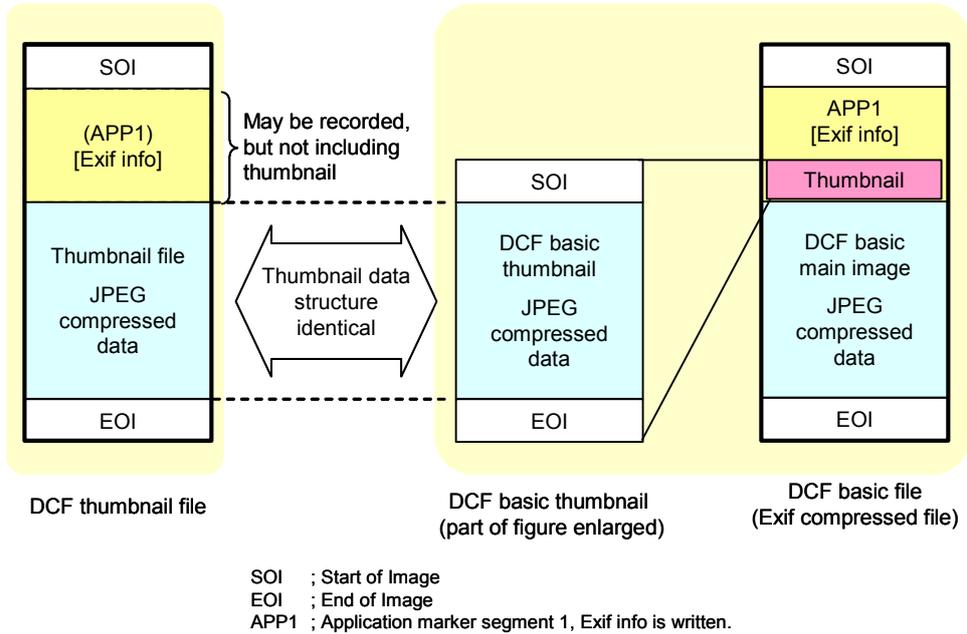
4.6.2 Directory, file name and extension

DCF thumbnail files are 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.

4.6.3 Image data structure

4.6.3.1 Data format

The data structure of a DCF thumbnail file shall be 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 4**. The pixel composition and sampling shall be YCbCr 4:2:2, as with DCF basic files specified at **4.4.4**.

Figure 4 DCF thumbnail file structure

4.6.3.2 Compressed data specification

This is the same as that for DCF basic files specified at **4.4.4**.

4.6.3.3 Pixel count

This is the same as that for DCF basic files specified at **4.4.4**.

4.6.3.4 Image aspect ratio

This is the same as that for DCF basic files specified at **4.4.4**.

4.6.4 Attribute information

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

4.6.4.1 Exif tag structure

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

4.6.4.2 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 4.4.5.).

Model (0th IFD, mandatory when attribute information is recorded)

The contents are the same as for DCF basic files (see 4.4.5.).

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

The contents are the same as for DCF basic files (see 4.4.5.).

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

The contents are the same as for DCF basic files (see 4.4.5.).

4.6.4.3 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 shall be "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"

■ InteroperabilityVersion

(Interoperability IFD, mandatory when attribute information is recorded)

This tag shall record the Interoperability version. The value here shall be the 4-Byte ASCII "0100" meaning Version 1.00. This shall not be 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

4.6.4.4 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 4.4.5.).

4.6.5 DCF thumbnail file data structure

The thumbnail data specifications for DCF thumbnail files are summarized in **Table 10**.

Table 10 DCF thumbnail file data format

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

4.7. Tag requirement levels

Some of the optional tags specified in the Exif standard are mandatory in DCF. This level difference is shown for the 0th IFD, Exif IFD and Interoperability IFD in, **Table 11**, **Table 12** and **Table 13** respectively.

Table 11 0th IFD requirement level

Field Name	Tag No.		Requirement Level			Remarks
	Dec	Hex	DCF basic	DCF optional	Thumbnail	
Make	271	10F	M	M	C	R
Model	272	110	M	M	C	R
WhitePoint	318	13E	N	M	N	O
PrimaryChromaticities	319	13F	N	M	N	O
YCbCrCoefficients	529	211	N	M	N	O

Table 12 Exif IFD requirement level

Field Name	Tag No.		Requirement Level			Remarks
	Dec	Hex	DCF basic	DCF optional	Thumbnail	
DateTimeOriginal	36867	9003	M	M	C	O
DateTimeDigitized	36868	9004	M	M	C	O
Interoperability IFD Pointer	40965	A005	M	M	C	O
Gamma	42240	A500	N	M	N	O

Table 13 Interoperability IFD requirement level

Field Name	Tag No.		Requirement Level			Remarks
	Dec	Hex	DCF basic	DCF optional	Thumbnail	
InteroperabilityIndex	1	1	M	M	C	O
InteroperabilityVersion	2	2	M	M	C	--
RelatedImageFileFormat	4096	1000	O	O	O	--
RelatedImageWidth	4097	1001	O	O	O	--
RelatedImageLength	4098	1002	O	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 if possible)
- O : Optional (recorded if required by particular equipment)
- N : Prohibited
- : Not specified

4.8. File structure example

An example of the file structure in a DCF directory is shown in **Figure 5**.

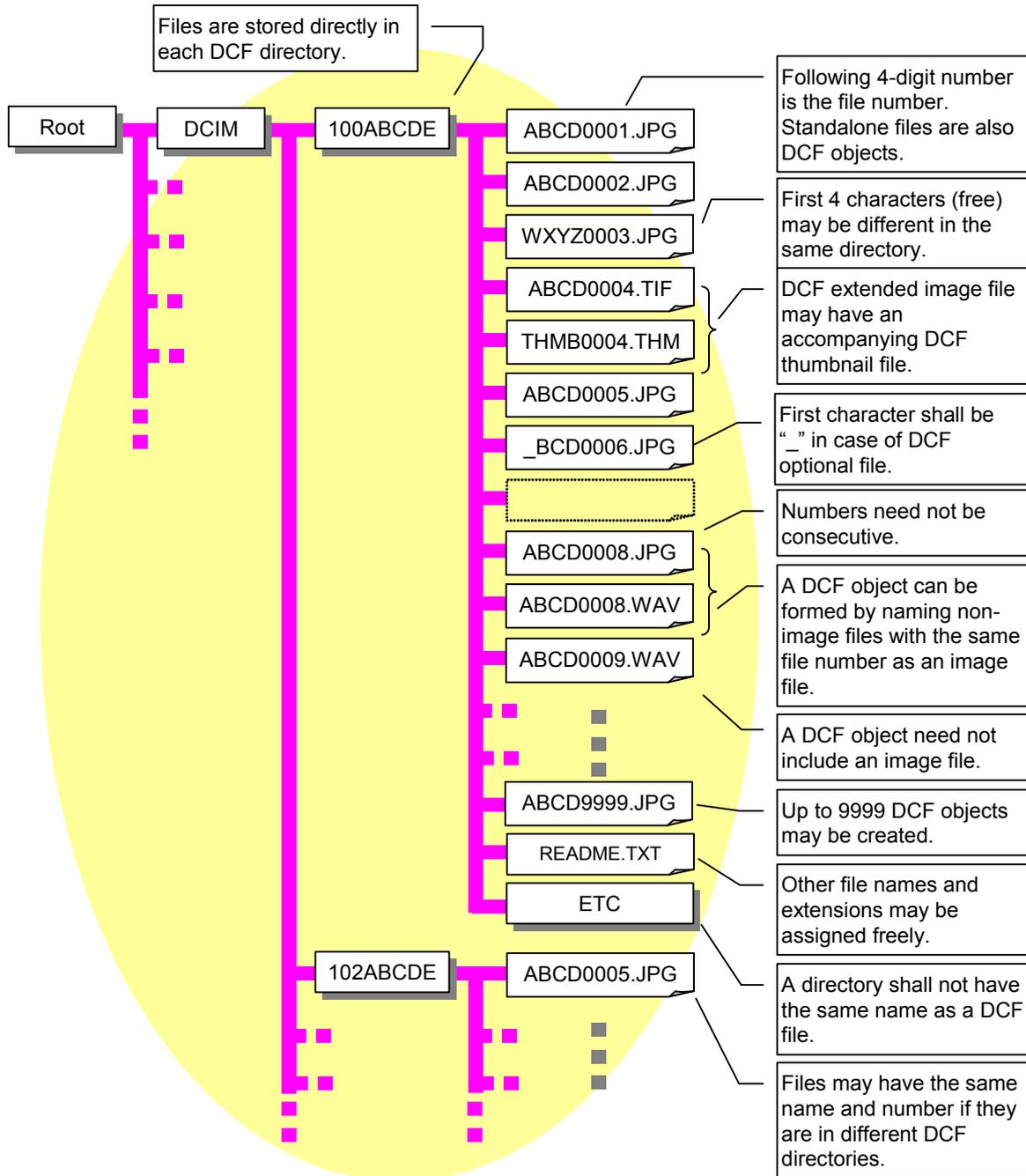


Figure 5 Typical file structure in a DCF directory

5. Writer Specification

5.1. Directories

5.1.1 Creating directories

5.1.1.1 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.

5.1.1.2 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.

5.1.1.3 Other directories

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

It is likewise optional 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.

5.1.2 Deleting directories

It is optional for deletion of a specific DCF directory to result in a directory number discontinuity. A user attempting to delete a protected directory should 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 Creating files

5.2.1.1 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 optional files or DCF extended image files may be recorded as well, for the sake of proprietary functions. Note, however, that no image file without a DCF file name shall be recorded in a DCF directory.

5.2.1.2 DCF thumbnail files

A thumbnail file may be recorded along with a DCF extended image file to form a DCF object.

5.2.1.3 Other files making up a DCF object

Other files besides DCF basic files, DCF optional files, DCF extended image files, and DCF thumbnail files may be given DCF file names 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.

5.2.1.4 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.

5.2.2 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 and DCF optional files shall not be duplicated. DCF basic files and DCF optional 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 **Chapter 6**), which may result in a different file being displayed than the one intended by the Writer user. For this reason, it should avoid recording a DCF basic file and DCF extended 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.

5.2.3 Deleting files

5.2.3.1 DCF objects

All DCF objects, that is, all DCF basic files, DCF optional files, DCF extended image files, DCF thumbnail files and other files with DCF file names, shall be deleted, moved and copied in object units (see **7.4.**).

Copying shall be treated in the same way as recording a new file. Moving shall be 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 should 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 removable memory is initialized (formatted), the handling of protection is left up to the specifications for individual equipment.

5.2.3.2 Files that are not DCF objects

No specification is made.

6. Reader Specification

6.1. Directories (common to Reader 1 and 2)

6.1.1 Playback

6.1.1.1 Playback scope

A reader shall detect the directories on a DCF medium, and shall display the files in them according to the specifications in 6.2. No specification is made regarding the playback of other directories, except that if they exist, they shall not hinder the displaying of images located in DCF directories.

6.1.1.2 Playback method

The order of playback is not specified.

6.1.2 Deletion

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

6.2. Files

6.2.1 Playback

6.2.1.1 Reader 1 playback scope

Reader 1 shall display the DCF basic files and DCF optional files in a DCF directory detected as in 6.1.1.1. Playback of the main image in a DCF basic file is recommended; but if the main image cannot be displayed because the pixel count exceeds the playback capability, etc., the corresponding thumbnail shall be displayable (thumbnail substitute playback).

It is recommended that Reader 1 be able to perform the necessary color space transformation processing for playback of the main image in a DCF optional file; but if Reader 1 lacks that capability, it shall at least be capable of thumbnail substitute playback without color space transformation. Reader 1 may also display main images without color space transformation processing.

6.2.1.2 Reader 2 playback scope

Reader 2 shall be able to detect the DCF basic files in a DCF directory as in 6.1.1.1 and shall be able to display the DCF basic main images within the range of the supported pixel count specification explained in 6.2.1.4 below. If a DCF basic main image is outside the supported pixel count and cannot be displayed, the corresponding DCF basic thumbnail may be displayed instead.

It is preferable that Reader 2 be able to detect a DCF optional file in a DCF directory and to display a DCF optional main image within the range of the supported pixel count specification. If Reader 2 lacks the capability for color space transformation processing, displaying of main images without that processing is allowable.

6.2.1.3 DCF extended image files (common to Reader 1 and 2)

No specification is made regarding DCF extended image file playback. If the same object contains both a DCF basic file and DCF extended file, as a rule priority should be given to playback of the DCF basic file.

The priority of other file playback is not specified.

6.2.1.4 Supported pixel count specification

The supported pixel count specification indicates the maximum and minimum DCF basic main image size that shall be displayable on a Reader 2 device. Reader 2 shall be able to display DCF basic main images within the range shown in **Table 14**.

Table 14 Displayable pixel count range

	Pixel count ranges				
	Minimum		Maximum		
Horizontal pixel range	160	<=	X	<=	1800
	and				
Vertical pixel range	120	<=	Y	<=	1200

(Pixels)

6.2.2 Playback method (common to Reader 1 and 2)

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

6.2.3 DCF optional files and color space transformation

The relation of DCF optional file playback and the Reader 1 and 2 color space transformation capability is shown in **Table 15**.

Table 15 DCF optional files and color space transformation capability

Image data	Color space transformation	Reader1	Reader2
Main image	No	Optional	Optional
	Yes	Optional	Optional
Thumbnail (substitute playback)	No	Mandatory (if color space transformation not possible)	Optional
	Yes	Optional	Optional

6.2.4 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 should be ignored. The tags shown in **Table 16** are meant by color-related tags.

Table 16 Ignored color-related tags

Field Name	IFD	Tag no
TransferFunction	0th IFD	301
WhitePoint	0th IFD	318
PrimaryChromaticities	0th IFD	319
YCbCrCoefficients	0th IFD	529
ReferenceBlackWhite	0th IFD	532
Gamma	Exif IFD	42240

In the case of DCF optional files, the tags listed in **Table 17** can be referenced to find out the recorded color space characteristics. See 7.5 on the method of identifying DCF optional files.

Table 17 Referenced color-related tags

Field Name	IFD	Tag no
WhitePoint	0th IFD	318
PrimaryChromaticities	0th IFD	319
YCbCrCoefficients	0th IFD	529
Gamma	Exif IFD	42240

6.2.5 Deletion (common to Reader 1 and 2)

6.2.5.1 DCF objects

All DCF objects, that is, all DCF basic files, DCF optional files, DCF extended image files, DCF thumbnail

files and other files with DCF file names, shall be deleted, moved and copied in object units (see 7.4). Copying shall be treated in the same way as recording a new file. Moving shall be treated as a combination of copying and deletion. It is optional, with the Reader user's express intention, to delete, move, or copy one or some of the files in an object. A protected object should 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 removable memory is initialized (formatted), the handling of protection is left up to the specifications for individual equipment.

6.2.5.2 Files that are not DCF objects

No specification is made.

6.3. 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 DCF optional files, and for enabling the user to designate any images with the numbers. The purpose is to allow users to designate DCF basic files and DCF optional 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 some kind of operations.
- 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 18**.

Table 18 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			

7. Other Points to Note

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 6**, is specified here along with the Reader playback method in such cases.

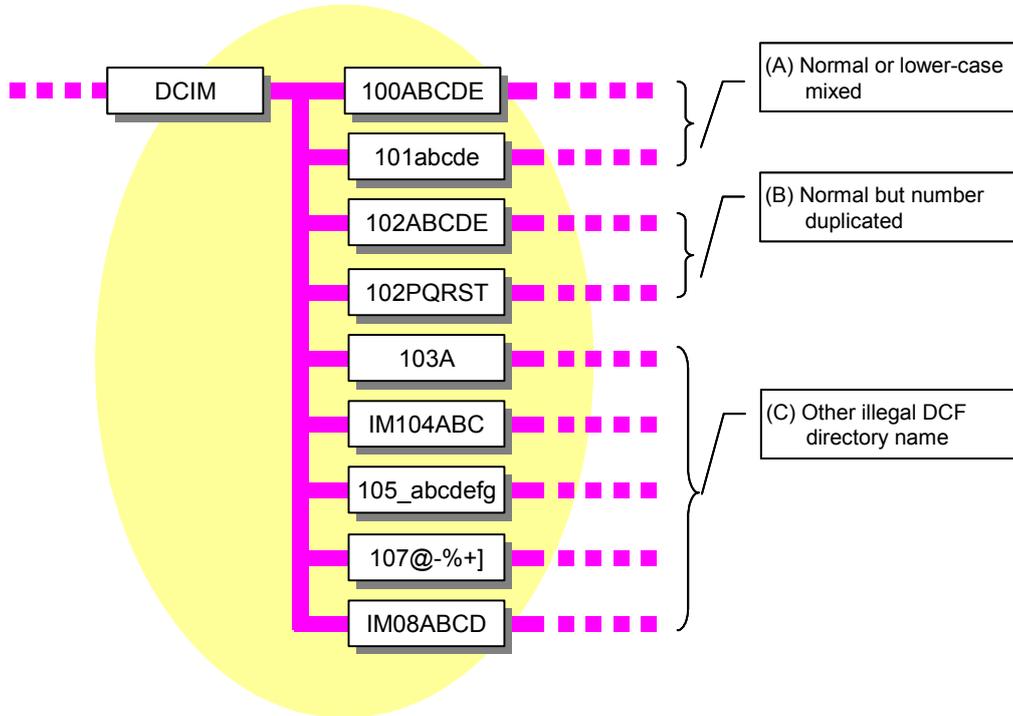


Figure 6 Directory naming precautions

7.1.1 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.

7.1.2 When directory numbers are duplicated across DCF directories

Directories with duplicate directory numbers shall be all treated as non-DCF directories. New DCF objects shall not be recorded in such a directory. A Reader may display 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 directory numbers.

7.1.3 Handling of directories that are not DCF directories

A Reader or Writer may completely ignore a directory that is not a normal DCF directory and that does not fall under cases 7.1.1 or 7.1.2 above. A Reader may display 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**, is specified here along with the method by which a Reader displays DCF objects in such cases.

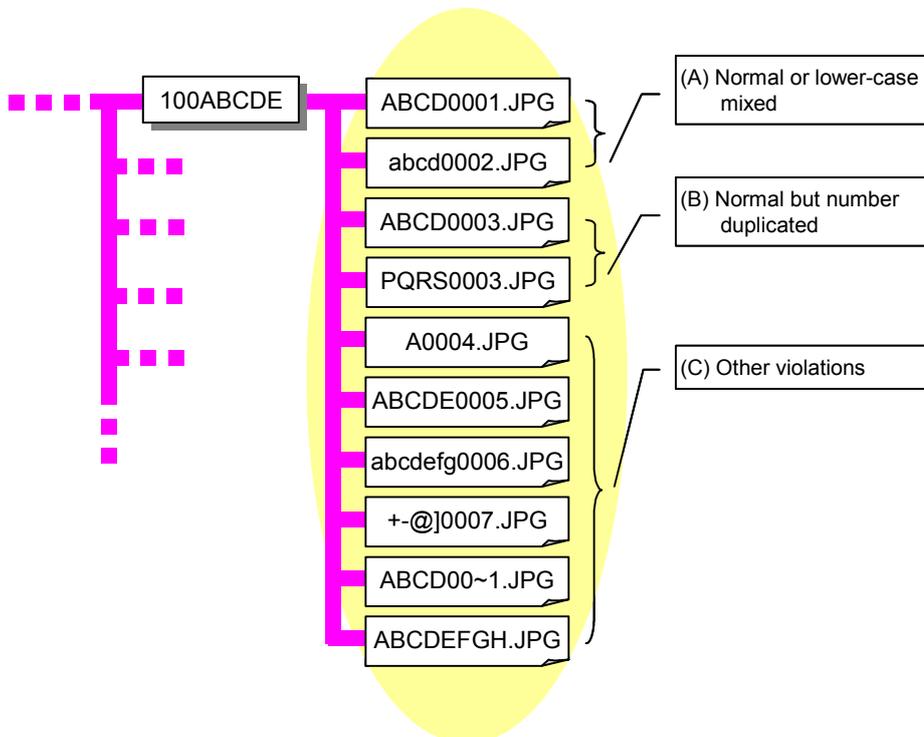


Figure 7 File naming precautions

7.2.1 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 shall be treated as a DCF object without distinguishing case.

7.2.2 When file numbers are duplicated across DCF basic files or DCF optional files

If file numbers are duplicated across DCF basic files or DCF optional files, a Reader may display the 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 or DCF optional files. When a Writer creates a new DCF object, it shall not be allowed to duplicate the file numbers.

7.2.3 Handling of files without DCF file names

A file without a normal DCF file name that does not fall under cases 7.2.1 or 7.2.2 above may be completely ignored. A Reader may display 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 and time tags

The Exif standard specifies the following three date and time 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 or DCF optional 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 optional to update the DateTimeOriginal and DateTimeDigitized tags as well.

When a DCF basic file or DCF optional file is created not on a DSC but on a PC or the like, and the capture date and time are impossible to 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 may record 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 or DCF optional 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 or DCF optional 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 Read Only attribute shall 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, should be designed to operate so that if even one file in a DCF object has the Read Only 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 should not perform operations involving only some of the files at one time, regardless of the Writer or Reader user's intention.

7.5. Identification of DCF optional files

A DCF optional file is identified based on the InteroperabilityIndex tag value and the color space-related tags specified in **Chapter 4**. A Reader shall use these tags to determine whether a file is a DCF optional file. In the case of a noncompliant file such as one missing a mandatory color space-related tag or having a recorded value that differs from the specifications, the InteroperabilityIndex value may be used. If both the Gamma and TransferFunction tags are present, precedence should be given to the Gamma tag.

8. References

The standards listed below comprise a part of this standard through their appearance as quotations or references. If a quoted or referenced standard provides the publish date (or, in the case of JIS, the year that the standard came into effect), only that version composes a part of this standard; any later revised versions, amendments, or supplements are not used. If the publish date (or year of coming into effect) is not added, the latest version (including amendments and supplements) is used.

Exif	Exchangeable image file format for digital still cameras: CIPA DC-008 http://www.cipa.jp/index.html CP-3451 http://www.jeita.or.jp/
sRGB	Amd.1 Ed.1 to Multimedia systems and equipment Colour measurement and management Part 2-1: Colour Management Default RGB colour space sRGB (2003) IEC 61966-2-1-am1 ed1.0 http://www.iec.ch/
JPEG	"Information technology -- Digital compression and coding of continuous-tone still images: Requirements and guidelines", ISO/IEC 10918-1 http://www.iso.org/ http://www.iec.ch/
Directives2	ISO/IEC Directives, Part 2 "Rules for the structure and drafting of International Standards" http://www.iso.org/ http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3146825/4229629/4230450/4230456/ISO IEC Directives Part 2 Rules for the structure and drafting of International Standards 2004 5th edition pdf format .pdf?nodeid=4230517&vernum=0
FAT32	"FAT32 File System" Microsoft FAT32 Specification http://www.microsoft.com/iplicensing/productDetail.aspx?productTitle=FAT%20File%20System
exFAT	"exFAT File System". Microsoft exFAT Revision 1.00 File System Basic Specification http://www.microsoft.com/iplicensing/productDetail.aspx?productTitle=exFAT%20File%20System%20Licensing%20Program

Annex A Data Verification

1. Validation method

Validation testing is performed by the makers of DCF-compatible equipment and applications themselves.

Annex B Relation to JPEG and Exif Standards

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 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 8**. See **Chapter4** and following for details.

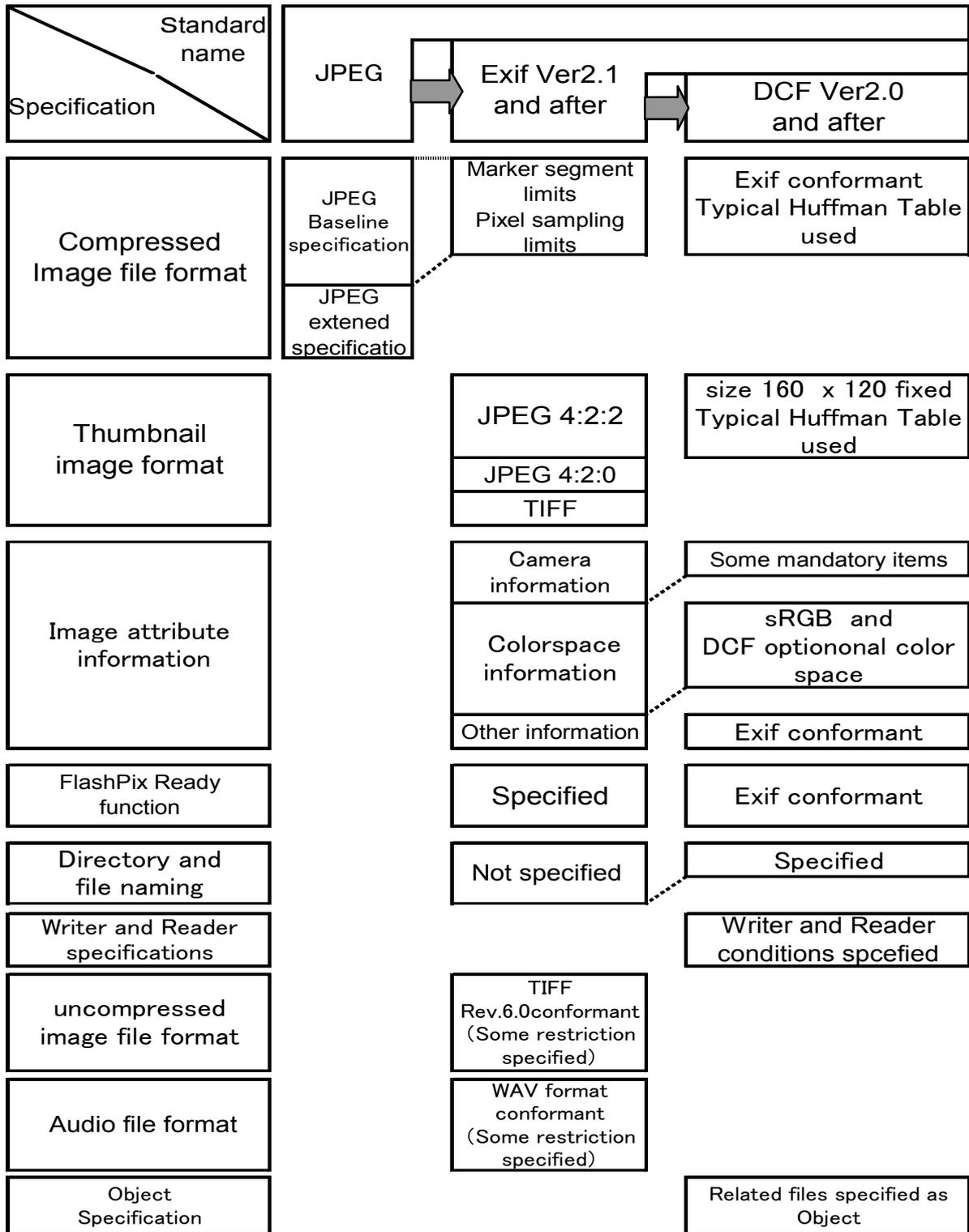


Figure 8 Relation of DCF to Exif and JPEG standards

Annex C Notes on Image File Playback

When displaying an image file, a Reader is ideal to make the user aware of whether the file being displayed is a DCF basic file or some other kind of image, so that the user can determine whether the image is displayable on another Reader as well.

The recommended method of making the user aware is either by indicating that the displayed image is a DCF basic file when a DCF basic file is being displayed, or by indicating that the displayed image is not a DCF basic file when an image file other than a DCF basic file is being displayed. **(Figure 9)** The method of distinguishing main image playback from thumbnail substitute playback is not specified but is optional.

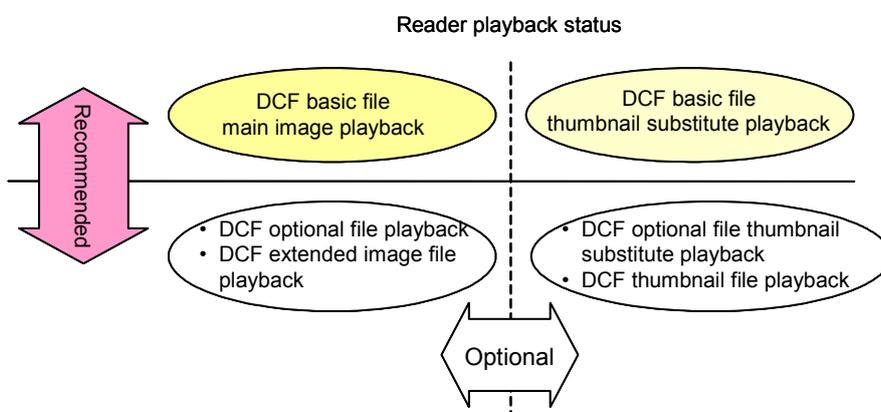


Figure 9 Playback status identification

Annex D Limits on DCF Object Operations

When there are limitations placed on the number of DCF objects that are able to handled or other device specifications that does not always limit the ability to perform operations on some DCF objects, the user shall be warned of these limitations, such as by indicating them in product manuals or by product display.

Annex E Notes on DCF Optional Color Space Use

1. Writer

A Writer capable of recording DCF optional files shall inform users, in manuals or by other means, of the significance of the optional color space, its functions and use.

The following are examples of such indication.

- It is applicable mainly for use in commercial printing, when images undergo extensive processing.
- It is intended for professional-use software.
- DCF basic files are geared to use in kiosks, print services, and home printers.

2. Reader

If a Reader displays DCF optional files without color space transformation processing, it is recommended that the user be warned of the possibility of incorrect color rendition.

Participating members

The bulk of the deliberations over the formulation of the standards described in this document was performed by the Exif/DCF Working Group.

The members of the Working Group are listed below.

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