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Exchangeable image file format for digital still cameras: Exif Version 2.2

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Standard of Japan Electronics and Information Technology Industries Association

Exchangeable image file format for digital still cameras: Exif Version 2.2

1 Scope

This standard specifies the formats to be used for images, sound and tags in digital still cameras and in other systems handling the image and sound files recorded by digital still cameras.

NOTE－Reference documents that are indispensable for this standard are listed as Normative References in this document.

2 Definition of Terms

(1) Primary image — The main image data

(2) Thumbnail — A small image used to index the primary image.

(3) Compressed data — Data referred to in the JPEG standard as "entropy coded data."

(4) Exif — An abbreviation of Exchangeable image file format, used here as the general term for this standard and earlier versions of this standard.

(5) writer — A digital still camera (DSC) or other device or application software that can output an Exif file.

(6) reader — A device, such as a printer with memory card slot, capable of directly reading an Exif file and printing or performing other output processing, as well as application software that uses Exif tags to perform image processing for output.

(7) tag — A field recording ancillary data about an image.

(8) tag information — A description of the tag contents.

3 General

3.1 Format Structure

This standard consists of the Exif image file specification and the Exif audio file specification (see Figure 1). The recording medium specification shall conform to the standard for the particular medium used and is not specified here. Recommendations on implementation are given in Annex D for directory and file naming.

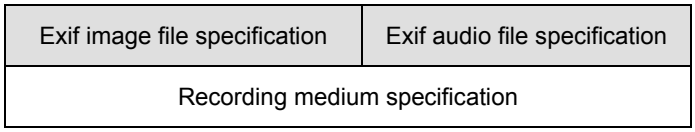

Figure 1 Format structure

3.2 Exif Image File Specification

The Exif image file specification stipulates the method of recording image data in files, and specifies the following items:

- Structure of image data files,
- Tags used by this standard,
- Definition and management of format versions.

Features of the Exif image file specification include the following.

The file-recording format is based on existing formats. Compressed files are recorded as JPEG (ISO/IEC 10918-1) with application marker segments (APP1 and APP2) inserted. Uncompressed files are recorded in TIFF Rev. 6.0 format. The use of existing formats means files recorded using a DSC or related system can be read directly by commercial applications, and makes possible the use of functions for viewing and manipulating the images.

Related attribute information for both compressed and uncompressed files is stored in the tag information format defined in TIFF Rev. 6.0. Information specific to the camera system and not defined in TIFF is stored in private tags registered for Exif. The Exif image file specification also specifies the method for recording thumbnails. The reason for using the TIFF Rev. 6.0 tag format in the compressed file APP1 segment is to facilitate exchange of attribute data between Exif compressed and uncompressed files.

Compressed files can record extended data exceeding 64 Kbytes by dividing it into multiple APP2 segments. The APP2 segment is used when recording Flashpix extensions.

Details of the Exif image file specification are given in Chapter 4 of this document.

3.3 Exif Audio File Specification

The Exif audio file specification stipulates the method of writing audio data in files, and specifies the following items:

- Structure of audio data files,
- Chunks,
- Definition and management of format versions.

Features of the Exif audio file specification include the following.

Files are recorded using the existing RIFF WAVE Form Audio File format. As data formats, PCM and μ-Law PCM (conforming to ITU-T G.711) are used for uncompressed audio data, and IMA-ADPCM for compressed audio data. As with the image files specification, the aim is to enable direct reading, playback and manipulation of the files using the functions in commercial applications.

Related attribute information is stored as an *INFO list* in the case of general attributes, and as Exif-specific chunks in the case of attributes specific to Exif. The Exif-specific chunks are newly provided to enable necessary information to be added by making use of chunk extensibility. The recording of data in an Exif-specific chunk is done in the same way as for an *INFO list*.

Details of the Exif audio file specification are given in Chapter 5 of this document.

3.4 Relation between Image and Audio File Specification

This standard includes specifications not only for an image file format but also for an audio file format enabling the recording of audio as a supplementary function.

Also specified in this standard is the relational information indicating the relation between image files and audio files.

Mapping between image files and audio files can be done in various ways; but the Exif standard specifies only the simplest mapping, with others left up to the implementation.

3.5 Presupposed Systems and Compatibility

The image systems presupposed by this standard consist of three elements as follows:

- Equipment: Imaging devices such as cameras, printers and filing equipment,
- Commercial software: Off-the-shelf image processing software running on personal computers,
- Specialized software: Dedicated (system-specific) image processing software running on personal computers.

Image file compatibility on these systems is achieved as follows. The DSC or other system writes data to files in the format specified in this standard. A basic condition of equipment with a playback function is that it be able to read the files it recorded itself. In a personal computer environment, the basic requirement is that dedicated software be able to read all the images, audio and attribute information recorded in conformance with this standard (see Figure 2).

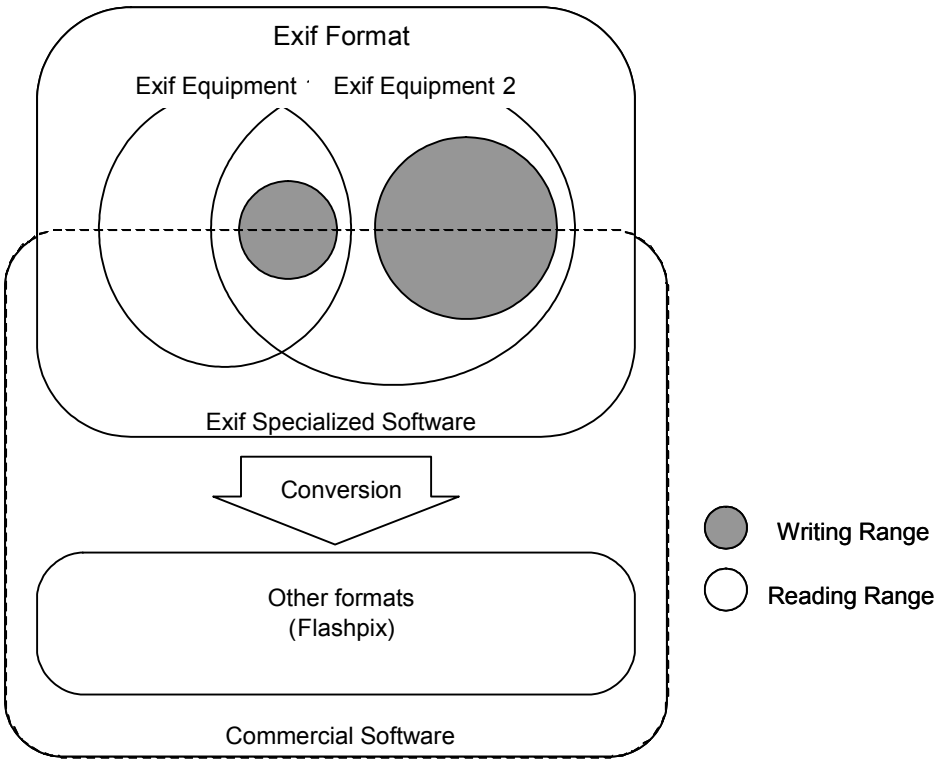

Figure 2 Compatibility Concepts

4 Exif Image File Specification

4.1 Outline of the Exif Image File Specification

This chapter gives details of the image file specification, covering the following items:

- Format version definition,
- Specifications relating to image data,
- Basic structure of image data,
- Tags,
- JPEG marker segments,
- Specifications on data recording.

4.2 Format Version

The version of the format specified here is recorded as 4 bytes (see section 4.6.5). The address bytes are recorded as A1, A2, B1, and B2, starting with the lowest number. A1 and A2 store the upper part of the standard version, with the lower part stored in B1 and B2. When changes are made to the version number of this standard, the following rules apply.

- When the changes are such that data readers can properly recognize conventional information and skip the data that was recorded using newly added functions, the lower part of the version (B1, B2) is changed.
- When there is a possibility that a data reader implementing the old standard may operate incorrectly due to the new specifications, the upper part of the version (A1, A2) is changed.

Players should be able to play back files of versions earlier than the supported standard.

4.3 Definition of Glossary

Terms and notation are used as follows in this standard:

- "Tag" is used as a synonym of "field",
- ".H" appended to a numerical value means it is hexadecimal notation,
- Unless otherwise indicated, other numerical values are given in decimal notation,
- The initial IFD in a file is the "0th IFD," with the next IFD being called the 1st IFD,

4.4 Specifications Relating to Image Data

4.4.1 Number of Pixels

There is no limit on number of pixels of the primary image when it is recorded as either uncompressed or JPEG compressed data. Note that when recording as JPEG compressed data images for which the number of lines (*ImageLength*) or number of samples/line (*ImageWidth*) is not a multiple of 8 or 16, the method of recording is as stipulated in section 4.8.1. The above specification applies similarly to thumbnails.

4.4.2 Pixel Aspect

Image data is recorded as square pixels with a pixel aspect ratio of 1:1. This specification is applied similarly to thumbnails.

4.4.3 Pixel Composition and Sampling

The combination of pixel composition and pixel sampling for image data shall be RGB 4:4:4 and either Y:Cb:Cr = 4:2:2 or Y:Cb:Cr = 4:2:0. The pixel composition of image data shall also be 8 bits each. This specification is applied similarly to thumbnails.

As sampling points on the elements making up pixels, the Y and Cb,Cr sampling points may be either co-sited or centered. Figure 3 shows typical pixel sampling for image width w and height h. In the case of Y:Cb:Cr = 4:2:2, spatial co-siting is recommended for the sake of improved image quality on TV systems. For Y:Cb:Cr = 4:2:0, spatial centering is recommended as per the TIFF default and is most common format of the personal computer applications.

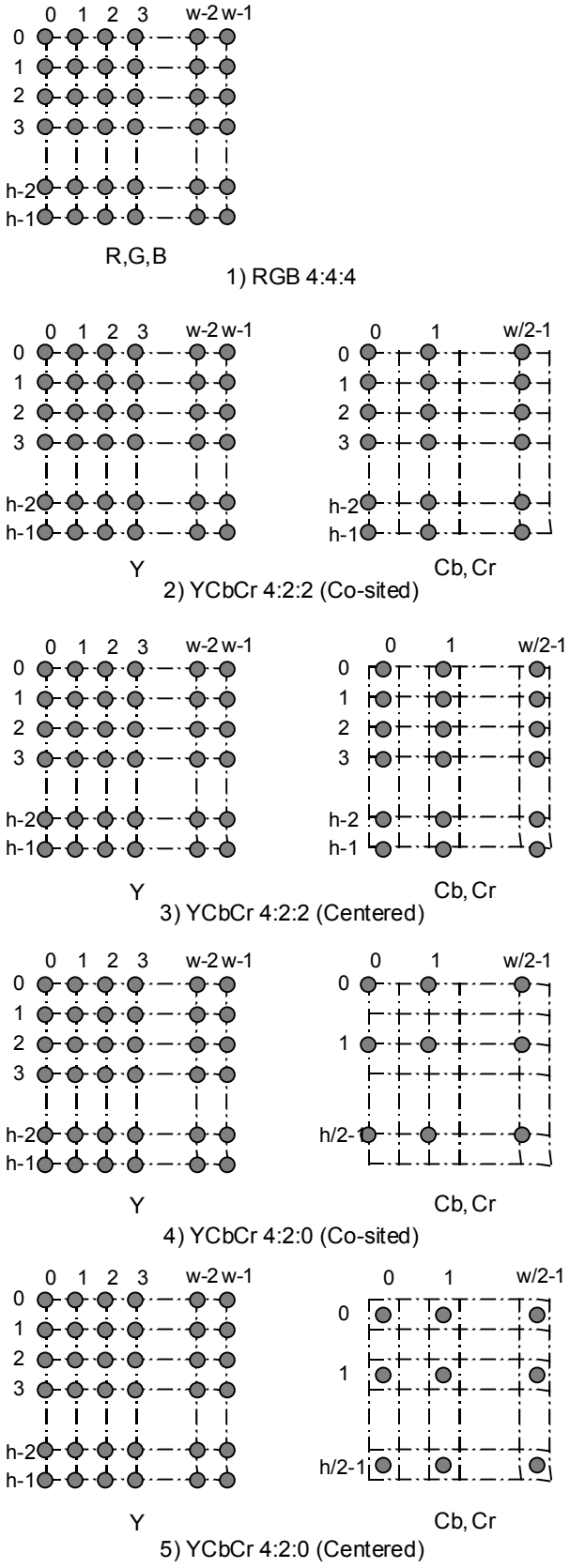

Figure 3 Pixel Composition and Pixel Sampling

4.4.4 Image Data Arrangement

Image data shall be arranged as follows. Uncompressed data shall consist of pixels with each line traced from left to right, and one screen shall consist of lines traced from top to bottom. JPEG compressed data shall consist of blocks configured of pixels traced in similar sequence. Figure 4 shows the various data arrangements for recording in files images with pixels of width w and height h.

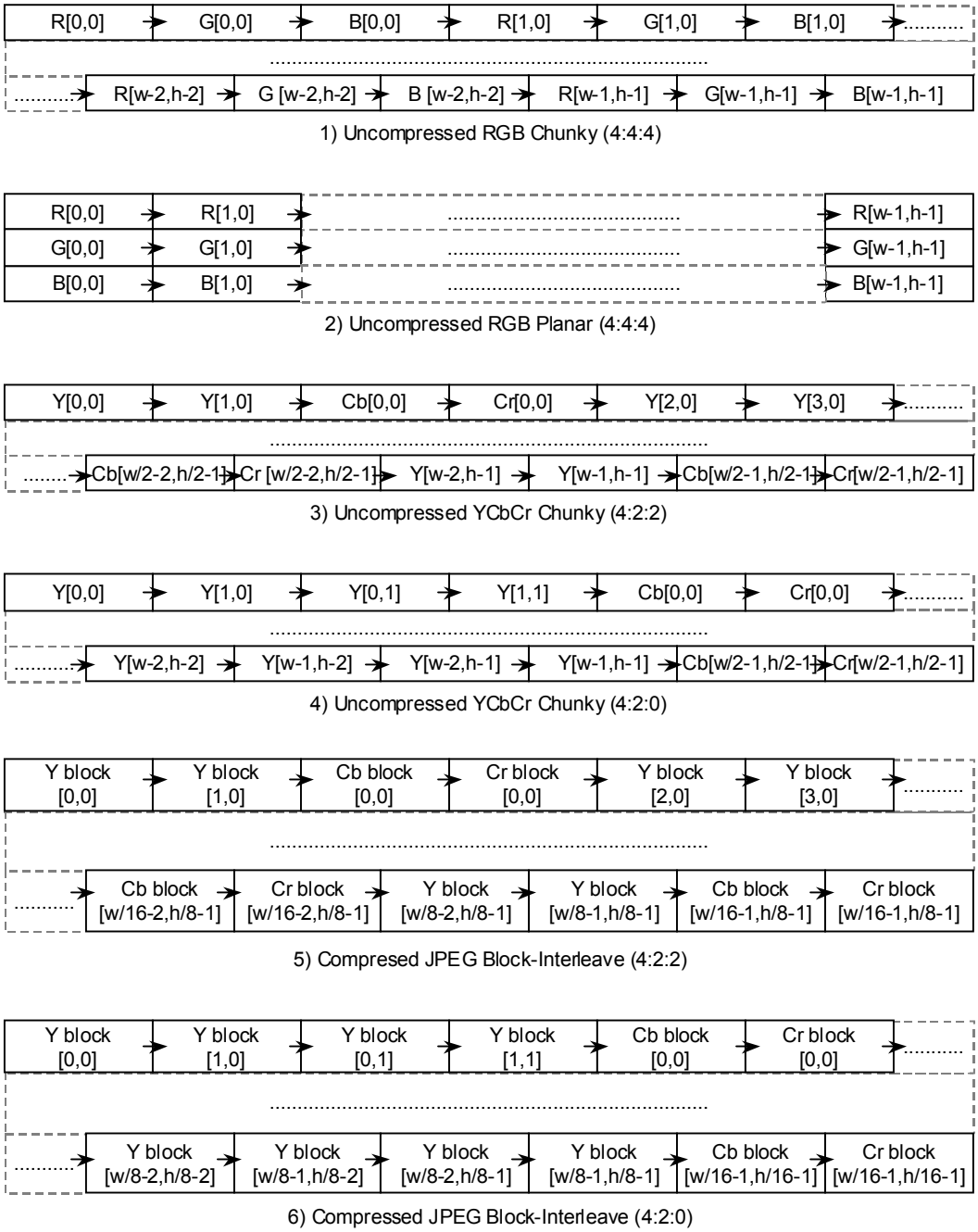

Figure 4 Data Arrangement

4.5 Basic Structure of Image Data

4.5.1 Basic Structure of Primary Image Data

Image data employs following existing image formats, depending on the image data type:

- RGB uncompressed data: Baseline TIFF Rev. 6.0 RGB Full Color Images,
- YCbCr uncompressed data: TIFF Rev. 6.0 Extensions YCbCr Images,
- JPEG compressed data: JPEG Baseline ADCT.

For compressed data, the attribute information required by the DSC application shall be recorded in APP1. Data writing in APP1 shall be compatible with TIFF. The use of a common method of storing attribute information for both compressed and uncompressed data results in a simpler format, while the ability to add private tags for additional information takes advantage of the extensibility of the tag mechanism.

4.5.2 Basic Structure of Uncompressed RGB Data

Uncompressed RGB data is recorded in conformance with Baseline TIFF Rev. 6.0 RGB Full Color Color Images.

Attribute information is recorded in tags specified in TIFF Rev. 6.0. Attribute information specific to Exif is recorded using private tags reserved in TIFF for this standard. The private tags point to sets of this attribute information (Exif IFD).

Files are structured as follows (see Figure 5). As in the TIFF standard, the recording location of each IFD value is not specified:

- File Header,
- 0th IFD,
- 0th IFD Value,
- 1st IFD,
- 1st IFD Value,
- 1st (Thumbnail) Image Data,
- 0th (Primary) Image Data.

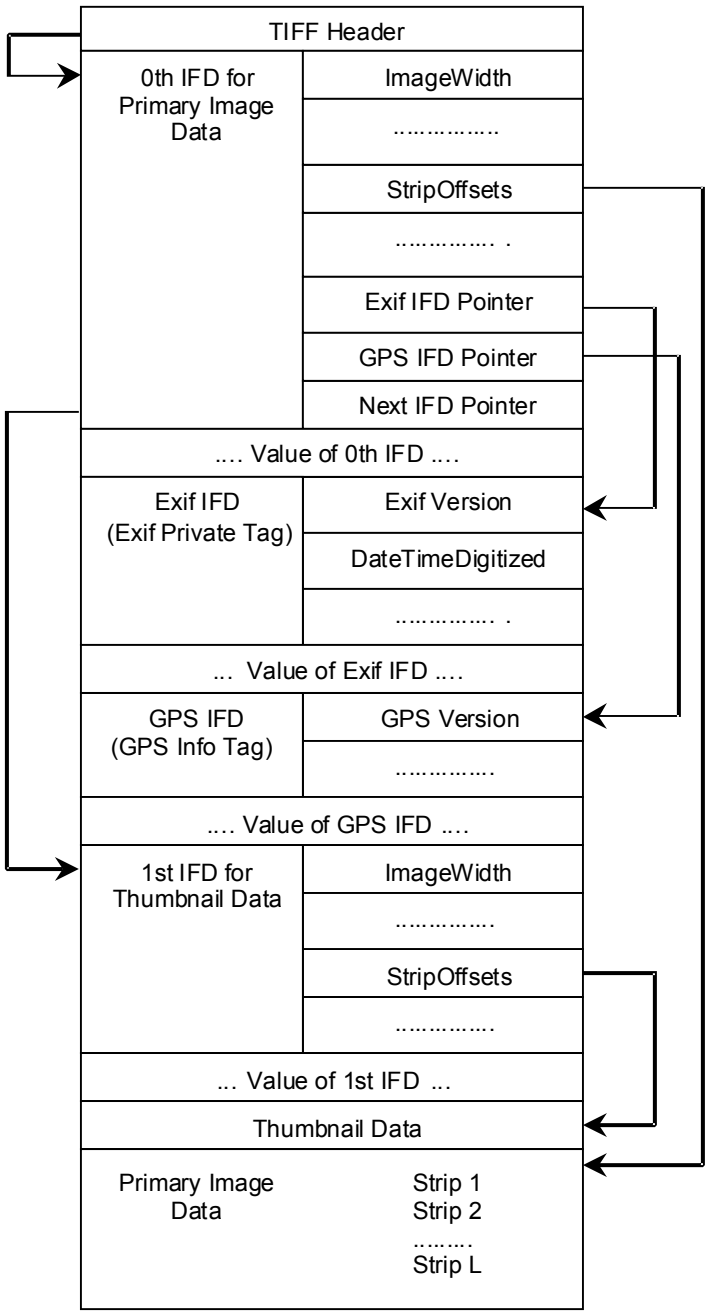

Figure 5 Basic Structure of Uncompressed Data Files

File Headers are 8 bytes as defined in the TIFF standard, with the Offset of IFD indicating the start address of the 0th IFD (see Table 1).

The 0th IFD Offset of Next IFD indicates the start address of the 1st IFD (thumbnail images). When the 1st IFD is not recorded, the 0th IFD Offset of Next IFD terminates with 00000000.H.

On the IFD description method see section 4.6.2.

Table 1 TIFF Headers

Name	Size (Bytes)	Value
Byte Order	2	Written as either "II" (4949.H) (little endian) or "MM" (4D4D.H) (big endian) depending on the CPU of the machine doing the recording.
42	2	002A.H (fixed)
Offset of IFD	4	0th IFD offset. If the TIFF header is followed immediately by the 0th IFD, it is written as 00000008.H.

4.5.3 Basic Structure of YCbCr Uncompressed Data

YCbCr uncompressed data is recorded in conformance with TIFF Rev. 6.0 Extensions YcbCr Images. Tags for the following information are available for YCbCr uncompressed data in addition to the attribute information for RGB uncompressed data;

- RGB-YCbCr color transformation matrix coefficients (*YCbCrCoefficients*),
- Chrominance subsampling information (*YCbCrSubSampling*),
- Information on matching/nonmatching of chrominance and luminance samples (*YCbCrPositioning*).

The method of recording other attribute information is the same as for uncompressed RGB data (see section 4.5.2).

4.5.4 Basic Structure of JPEG Compressed Data

Compressed data files are recorded in conformance with the JPEG DCT format specified in ISO/IEC 10918-1, with the Application Market Segment (APP1) inserted. APP1 is recorded immediately after the SOI marker indicating the beginning of the file (see Figure 6). Multiple APP2 may be recorded as necessary, starting immediately after APP1. APPn other than APP1 and APP2 or COM segments are not used by Exif. However Exif readers should be designed skip over unknown APPn and COM.

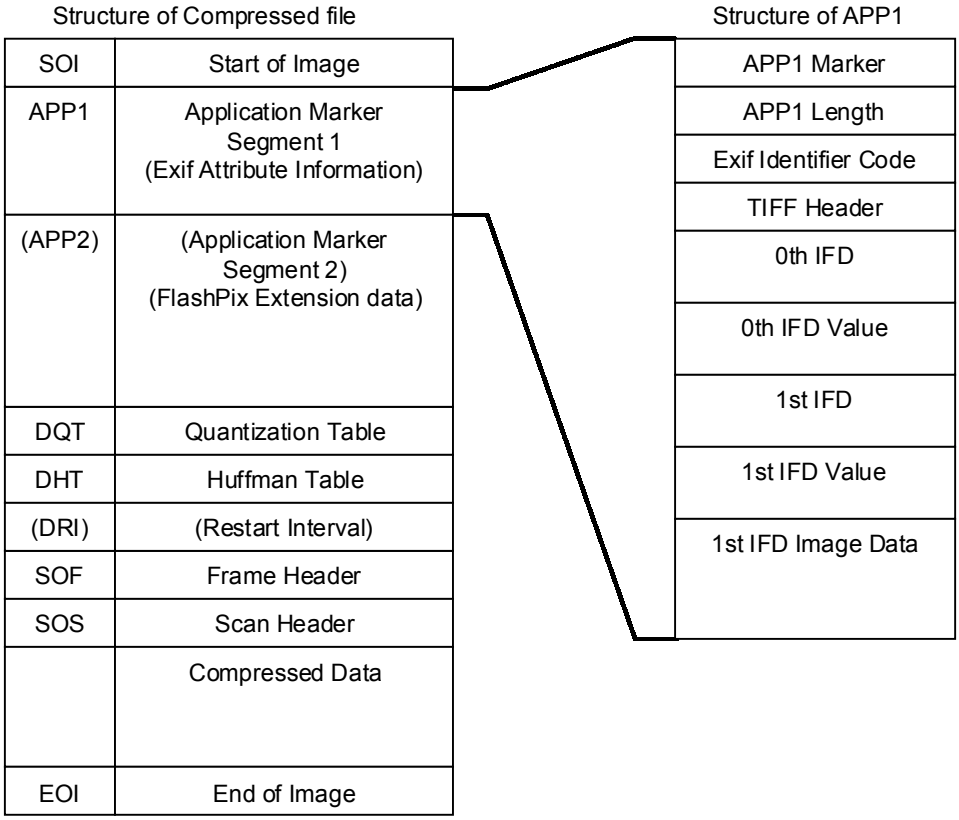

Figure 6 Basic Structure of Compressed Data Files

Interoperability, APP1 consists of the APP1 marker, Exif identifier code, and the attribute information itself. The size of APP1 including all these elements shall not exceed the 64 Kbytes specified in the JPEG standard.

Attribute information is stored in TIFF structure including a File Header, with a maximum of two IFD (0th IFD, 1st IFD). The 0th IFD records attribute information concerning the compressed image (primary image). The 1st IFD may be used to record a thumbnail image. For details see section 4.7.2.

APP2 consists of the APP2 marker, FPXR (Flashpix Ready) identifier code, and contents list for Flashpix extension recording, or stream data. A string of multiple APP2 marker segments may be used to record data exceeding 64 Kbytes. For details see section 4.7.3.

4.5.5 Basic Structure of Thumbnail Data

Thumbnail data is recorded in the 1st IFD similarly to primary images, using two existing image formats.

No limit is placed on the size of thumbnail images. Thumbnails are not mandatory, but it is recommended that they be recorded if possible, unless hardware or other restrictions preclude this.

Thumbnail data does not necessarily have to adopt the same data structure as that used for primary images. If, however, the primary images are recorded as uncompressed RGB data or as uncompressed YCbCr data, thumbnail images cannot be recorded as JPEG compressed data (see Table 2).

Table 2 Combinations of primary image and thumbnail data structures

		Primary Image	
		Uncompressed	Compressed
Thumbnail	Uncompressed	Possible	Possible
	Compressed	Not possible	Possible

When thumbnails are recorded in uncompressed format, they are to be recorded in the 1st IFD in conformance with Baseline TIFF Rev. 6.0 RGB Full Color Images or TIFF Rev. 6.0 Extensions YCbCr Images.

An Exif-specific recording method is used to record compressed thumbnails.

In this case the *Compression* tag value is set to "6" and tags in the 1st IFD (*JPEGInterchangeFormat*, *JPEGInterchangeFormatLength*) are used to designate the location and size. The images are recorded at the designated location as a JPEG stream (from SOI to EOI) conforming to the JPEG Baseline DCT format. No APPn marker, COM marker, nor restart marker is recorded in the JPEG stream (see Figure 7). To avoid duplicate definitions, the 1st IFD is not used to record a tag indicating a TIFF image or information recorded elsewhere as a JPEG marker segment.

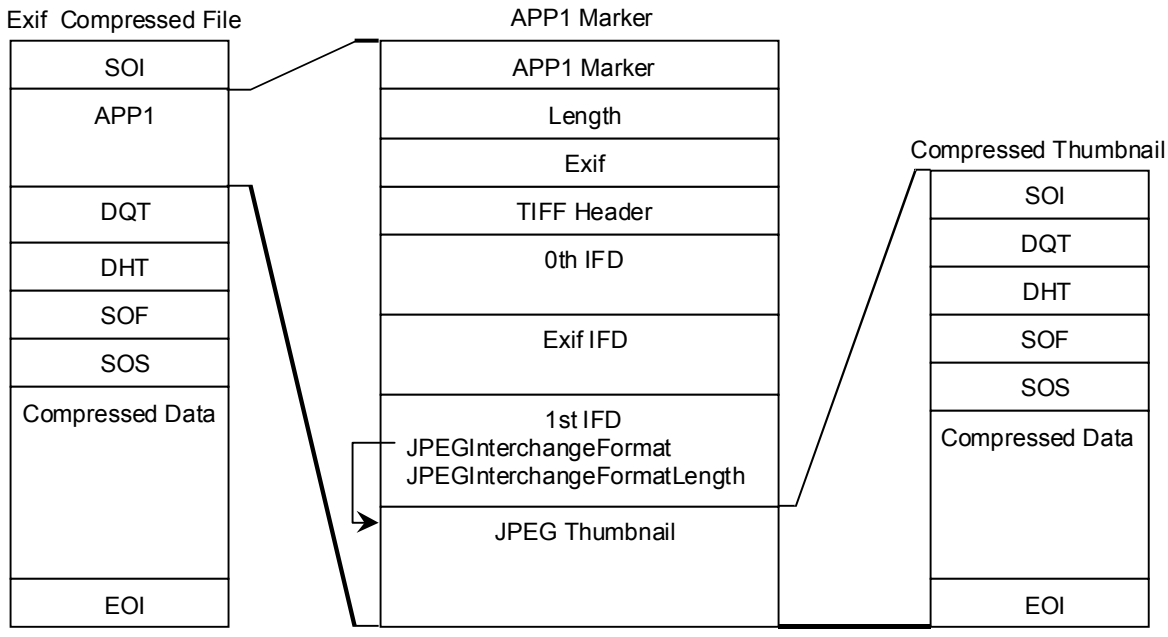

Figure 7 Structure of Exif file with compressed thumbnail

4.6 Tags

4.6.1 Features of Attribute Information

RGB data conforms to Baseline TIFF Rev. 6.0 RGB Full Color Images, and YCbCr data to TIFF Rev. 6.0 Extensions YCbCr Images. Accordingly, the parts that follow the TIFF structure shall be recorded in conformance to the TIFF standard. In addition to the attribute information indicated as mandatory in the TIFF standard, this Exif standard adds the TIFF optional tags that can be used in a DSC or other system, Exif-specific tags for recording DSC-specific attribute information, and GPS tags for recording position information. There are also Exif-original specifications not found in the TIFF standard for compressed recording of thumbnails.

Recording of compressed data differs from uncompressed data in the following respects:

- When the primary image data is recorded in compressed form, there is no tag indicating the primary image itself or its address (pointer),
- When thumbnail data is recorded in compressed form, address and size are designated using Exif-specific tags,
- Tags that duplicate information given in the JPEG Baseline are not recorded (for either primary images or thumbnails).
- Information relating to compression can be recorded using the tags for this purpose.

4.6.2 IFD Structure

The IFD used in this standard consists of a 2-byte count (number of fields), 12-byte field Interoperability arrays, and 4-byte offset to the next IFD, in conformance with TIFF Rev. 6.0.

Each of the 12-byte field Interoperability consists of the following four elements respectively.

Bytes 0-1	Tag
Bytes 2-3	Type
Bytes 4-7	Count
Bytes 8-11	Value Offset

Each element is explained briefly below. For details see TIFF Rev. 6.0.

Tag

Each tag is assigned a unique 2-byte number to identify the field. The tag numbers in the Exif 0th IFD and 1st IFD are all the same as the TIFF tag numbers.

Type

The following types are used in Exif:

1 = BYTE	An 8-bit unsigned integer.,
2 = ASCII	An 8-bit byte containing one 7-bit ASCII code. The final byte is terminated with NULL.,
3 = SHORT	A 16-bit (2-byte) unsigned integer,
4 = LONG	A 32-bit (4-byte) unsigned integer,
5 = RATIONAL	Two LONGs. The first LONG is the numerator and the second LONG expresses the denominator.,
7 = UNDEFINED	An 8-bit byte that can take any value depending on the field definition,
9 = SLONG	A 32-bit (4-byte) signed integer (2's complement notation),
10 = SRATIONAL	Two SLONGs. The first SLONG is the numerator and the second SLONG is the denominator.

Count

The number of values. It should be noted carefully that the count is not the sum of the bytes. In the case of one value of SHORT (16 bits), for example, the count is '1' even though it is 2 bytes.

Value Offset

This tag records the offset from the start of the TIFF header to the position where the value itself is recorded. In cases where the value fits in 4 bytes, the value itself is recorded. If the value is smaller than 4 bytes, the value is stored in the 4-byte area starting from the left, i.e., from the lower end of the byte offset area. For example, in big endian format, if the type is SHORT and the value is 1, it is recorded as 00010000.H.

Note that field Interoperability shall be recorded in sequence starting from the smallest tag number. There is no stipulation regarding the order or position of tag value (Value) recording.

4.6.3 Exif-specific IFD

A. Exif IFD

Exif IFD is a set of tags for recording Exif-specific attribute information. It is pointed to by the offset from the TIFF header (Value Offset) indicated by an Exif private tag value.

Exif IFD Pointer

Tag = 34665 (8769.H)
Type = LONG
Count = 1
Default = none

A pointer to the Exif IFD. Interoperability, Exif IFD has the same structure as that of the IFD specified in TIFF. Ordinarily, however, it does not contain image data as in the case of TIFF.

B. GPS IFD

GPS IFD is a set of tags for recording GPS information. It is pointed to by the offset from the TIFF header (Value Offset) indicated by a GPS private tag value.

GPS Info IFD Pointer

Tag = 34853 (8825.H)
Type = LONG
Count = 1
Default = none

A pointer to the GPS Info IFD. The Interoperability structure of the GPS Info IFD, like that of Exif IFD, has no image data.

C. Interoperability IFD

Interoperability IFD is composed of tags which stores the information to ensure the Interoperability and pointed by the following tag located in Exif IFD.

Interoperability IFD Pointer

Tag = 40965 (A005.H)
Type = LONG
Count = 1
Default = None

The Interoperability structure of Interoperability IFD is same as TIFF defined IFD structure but does not contain the image data characteristically compared with normal TIFF IFD.

4.6.4 TIFF Rev. 6.0 Attribute Information

Table 3 lists the attribute information used in Exif, including the attributes given as mandatory in Baseline TIFF Rev. 6.0 RGB Full Color Images and TIFF Rev. 6.0 Extensions YCbCr Images, as well as the optional TIFF tags used by DSC and other systems. The contents are explained below.

Table 3 TIFF Rev. 6.0 Attribute Information Used in Exif

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags relating to image data structure					
Image width	ImageWidth	256	100	SHORT or LONG	1
Image height	ImageLength	257	101	SHORT or LONG	1
Number of bits per component	BitsPerSample	258	102	SHORT	3
Compression scheme	Compression	259	103	SHORT	1
Pixel composition	PhotometricInterpretation	262	106	SHORT	1
Orientation of image	Orientation	274	112	SHORT	1
Number of components	SamplesPerPixel	277	115	SHORT	1
Image data arrangement	PlanarConfiguration	284	11C	SHORT	1
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	SHORT	2
Y and C positioning	YCbCrPositioning	531	213	SHORT	1
Image resolution in width direction	XResolution	282	11A	RATIONAL	1
Image resolution in height direction	YResolution	283	11B	RATIONAL	1
Unit of X and Y resolution	ResolutionUnit	296	128	SHORT	1
B. Tags relating to recording offset					
Image data location	StripOffsets	273	111	SHORT or LONG	*S
Number of rows per strip	RowsPerStrip	278	116	SHORT or LONG	1
Bytes per compressed strip	StripByteCounts	279	117	SHORT or LONG	*S
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	LONG	1
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	LONG	1
C. Tags relating to image data characteristics					
Transfer function	TransferFunction	301	12D	SHORT	3 * 256
White point chromaticity	WhitePoint	318	13E	RATIONAL	2
Chromaticities of primaries	PrimaryChromaticities	319	13F	RATIONAL	6
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	RATIONAL	3
Pair of black and white reference values	ReferenceBlackWhite	532	214	RATIONAL	6
D. Other tags					
File change date and time	DateTime	306	132	ASCII	20
Image title	ImageDescription	270	10E	ASCII	Any
Image input equipment manufacturer	Make	271	10F	ASCII	Any
Image input equipment model	Model	272	110	ASCII	Any
Software used	Software	305	131	ASCII	Any
Person who created the image	Artist	315	13B	ASCII	Any
Copyright holder	Copyright	33432	8298	ASCII	Any

*S Chunky format: StripsPerImage

Planar format: SamplesPerImage * StripsPerImage

StripsPerImage = floor((ImageLength + RowsPerStrip -1)/ RowsPerStrip)

A. Tags relating to image data structure

ImageWidth

The number of columns of image data, equal to the number of pixels per row. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 256 (100.H)
Type = SHORT or LONG
Count = 1
Default = none

ImageLength

The number of rows of image data. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 257 (101.H)
Type = SHORT or LONG
Count = 1
Default = none

BitsPerSample

The number of bits per image component. In this standard each component of the image is 8 bits, so the value for this tag is 8. See also *SamplesPerPixel*. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 258 (102.H)
Type = SHORT
Count = 3
Default = 8 8 8

Compression

The compression scheme used for the image data. When a primary image is JPEG compressed, this designation is not necessary and is omitted. When thumbnails use JPEG compression, this tag value is set to 6.

Tag = 259 (103.H)
Type = SHORT
Count = 1
Default = none
1 = uncompressed
6 = JPEG compression (thumbnails only)
Other = reserved

PhotometricInterpretation

The pixel composition. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 262 (106.H)
Type = SHORT
Count = 1
Default = none
2 = RGB
6 = YCbCr
Other = reserved

Orientation

The image orientation viewed in terms of rows and columns.

Tag = 274 (112.H)
Type = SHORT
Count = 1
Default = 1

1	=	The 0th row is at the visual top of the image, and the 0th column is the visual left-hand side.
2	=	The 0th row is at the visual top of the image, and the 0th column is the visual right-hand side.
3	=	The 0th row is at the visual bottom of the image, and the 0th column is the visual right-hand side.
4	=	The 0th row is at the visual bottom of the image, and the 0th column is the visual left-hand side.
5	=	The 0th row is the visual left-hand side of the image, and the 0th column is the visual top.
6	=	The 0th row is the visual right-hand side of the image, and the 0th column is the visual top.
7	=	The 0th row is the visual right-hand side of the image, and the 0th column is the visual bottom.
8	=	The 0th row is the visual left-hand side of the image, and the 0th column is the visual bottom.
Other	=	reserved

SamplesPerPixel

The number of components per pixel. Since this standard applies to RGB and YCbCr images, the value set for this tag is 3. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 277 (115.H)
Type = SHORT
Count = 1
Default = 3

PlanarConfiguration

Indicates whether pixel components are recorded in chunky or planar format. In JPEG compressed files a JPEG marker is used instead of this tag. If this field does not exist, the TIFF default of 1 (chunky) is assumed.

Tag = 284 (11C.H)
Type = SHORT
Count = 1

1	=	chunky format
2	=	planar format
Other	=	reserved

YCbCrSubSampling

The sampling ratio of chrominance components in relation to the luminance component. In JPEG compressed data a JPEG marker is used instead of this tag.

Tag = 530 (212.H)
Type = SHORT
Count = 2

[2, 1]	=	YCbCr4:2:2
[2, 2]	=	YCbCr4:2:0
Other	=	reserved

YCbCrPositioning

The position of chrominance components in relation to the luminance component. This field is designated only for

JPEG compressed data or uncompressed YCbCr data. The TIFF default is 1 (centered); but when Y:Cb:Cr = 4:2:2 it is recommended in this standard that 2 (co-sited) be used to record data, in order to improve the image quality when viewed on TV systems. When this field does not exist, the reader shall assume the TIFF default. In the case of Y:Cb:Cr = 4:2:0, the TIFF default (centered) is recommended. If the reader does not have the capability of supporting both kinds of *YCbCrPositioning*, it shall follow the TIFF default regardless of the value in this field. It is preferable that readers be able to support both centered and co-sited positioning.

Tag = 531 (213.H)
Type = SHORT
Count = 1
Default = 1
1 = centered
2 = co-sited
Other = reserved

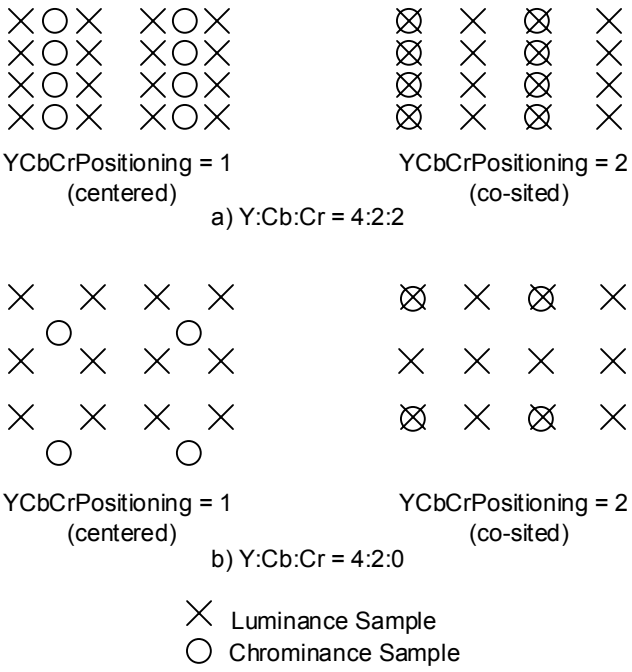

Figure 8 YCbCrPositioning

XResolution

The number of pixels per *ResolutionUnit* in the *ImageWidth* direction. When the image resolution is unknown, 72 [dpi] is designated.

Tag = 282 (11A.H)
Type = RATIONAL
Count = 1
Default = 72

YResolution

The number of pixels per *ResolutionUnit* in the *ImageLength* direction. The same value as *XResolution* is designated.

Tag = 283 (11B.H)
Type = RATIONAL
Count = 1

Default = 72

ResolutionUnit

The unit for measuring *XResolution* and *YResolution*. The same unit is used for both *XResolution* and *YResolution.* If the image resolution in unknown, 2 (inches) is designated.

Tag = 296 (128.H)
Type = SHORT
Count = 1
Default = 2
2 = inches
3 = centimeters
Other = reserved

B. Tags relating to recording offset

StripOffsets

For each strip, the byte offset of that strip. It is recommended that this be selected so the number of strip bytes does not exceed 64 Kbytes. With JPEG compressed data this designation is not needed and is omitted. See also *RowsPerStrip* and *StripByteCounts*.

Tag = 273 (111.H)
Type = SHORT or LONG
Count = StripsPerImage (when PlanarConfiguration = 1)
= SamplesPerPixel * StripsPerImage (when PlanarConfiguration = 2)
Default = none

RowsPerStrip

The number of rows per strip. This is the number of rows in the image of one strip when an image is divided into strips. With JPEG compressed data this designation is not needed and is omitted. See also *RowsPerStrip* and *StripByteCounts*.

Tag = 278 (116.H)
Type = SHORT or LONG
Count = 1
Default = none

StripByteCounts

The total number of bytes in each strip. With JPEG compressed data this designation is not needed and is omitted.

Tag = 279 (117.H)
Type = SHORT or LONG
Count = StripsPerImage (when PlanarConfiguration = 1)
SamplesPerPixel * StripsPerImage (when PlanarConfiguration = 2)
Default = none

JPEGInterchangeFormat

The offset to the start byte (SOI) of JPEG compressed thumbnail data. This is not used for primary image JPEG data.

Tag = 513 (201.H)

Type = LONG
Default = none

JPEGInterchangeFormatLength

The number of bytes of JPEG compressed thumbnail data. This is not used for primary image JPEG data. JPEG thumbnails are not divided but are recorded as a continuous JPEG bitstream from SOI to EOI. APPn and COM markers should not be recorded. Compressed thumbnails shall be recorded in no more than 64 Kbytes, including all other data to be recorded in APP1.

Tag = 514 (202.H)
Type = LONG
Default = none

C. Tags Relating to Image Data Characteristics

TransferFunction

A transfer function for the image, described in tabular style. Normally this tag is not necessary, since color space is specified in the color space information tag (*ColorSpace*).

Tag = 301 (12D.H)
Type = SHORT
Count = 3 * 256
Default = none

WhitePoint

The chromaticity of the white point of the image. Normally this tag is not necessary, since color space is specified in the color space information tag (*ColorSpace*).

Tag = 318 (13E.H)
Type = RATIONAL
Count = 2
Default = none

PrimaryChromaticities

The chromaticity of the three primary colors of the image. Normally this tag is not necessary, since color space is specified in the color space information tag (*ColorSpace*).

Tag = 319 (13F.H)
Type = RATIONAL
Count = 6
Default = none

YCbCrCoefficients

The matrix coefficients for transformation from RGB to YCbCr image data. No default is given in TIFF; but here the characteristics given in Annex E, "Color Space Guidelines," is used as the default.

Tag = 529 (211.H)
Type = RATIONAL
Count = 3
Default = See Annex E

ReferenceBlackWhite

The reference black point value and reference white point value. No defaults are given in TIFF, but the values below are given as defaults here. The color space is declared in a color space information tag, with the default being the value that gives the optimal image characteristics Interoperability these conditions.

Tag	=	532 (214.H)	
Type	=	RATIONAL	
Count	=	6	
Default	=	[0, 255, 0, 255, 0, 255]	(when PhotometricInterpretation is RGB)
		[0, 255, 0, 128, 0, 128]	(when PhotometricInterpretation is YCbCr)

D. Other Tags

DateTime

The date and time of image creation. In this standard it is the date and time the file was changed. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") may be filled with blank characters, or else the Interoperability field may be filled with blank characters. The character string length is 20 bytes including NULL for termination. When the field is left blank, it is treated as unknown.

Tag	=	306 (132.H)
Type	=	ASCII
Count	=	20
Default	=	none

ImageDescription

A character string giving the title of the image. It may be a comment such as "1988 company picnic" or the like. Two-byte character codes cannot be used. When a 2-byte code is necessary, the Exif Private tag *UserComment* is to be used.

Tag	=	270 (10E.H)
Type	=	ASCII
Count	=	Any
Default	=	none

Make

The manufacturer of the recording equipment. This is the manufacturer of the DSC, scanner, video digitizer or other equipment that generated the image. When the field is left blank, it is treated as unknown.

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

Model

The model name or model number of the equipment. This is the model name of number of the DSC, scanner, video digitizer or other equipment that generated the image. When the field is left blank, it is treated as unknown.

Tag	=	272 (110.H)
Type	=	ASCII
Count	=	Any

Default = none

Software

This tag records the name and version of the software or firmware of the camera or image input device used to generate the image. The detailed format is not specified, but it is recommended that the example shown below be followed. When the field is left blank, it is treated as unknown.

Ex.) "Exif Software Version 1.00a"

Tag = 305 (131h)
Type = ASCII
Count = Any
Default = none

Artist

This tag records the name of the camera owner, photographer or image creator. The detailed format is not specified, but it is recommended that the information be written as in the example below for ease of Interoperability. When the field is left blank, it is treated as unknown.

Ex.) "Camera owner, John Smith; Photographer, Michael Brown; Image creator, Ken James"

Tag = 315 (13Bh)
Type = ASCII
Count = Any
Default = none

Copyright

Copyright information. In this standard the tag is used to indicate both the photographer and editor copyrights. It is the copyright notice of the person or organization claiming rights to the image. The Interoperability copyright statement including date and rights should be written in this field; e.g., "Copyright, John Smith, 19xx. All rights reserved." In this standard the field records both the photographer and editor copyrights, with each recorded in a separate part of the statement. When there is a clear distinction between the photographer and editor copyrights, these are to be written in the order of photographer followed by editor copyright, separated by NULL (in this case, since the statement also ends with a NULL, there are two NULL codes) (see example 1). When only the photographer copyright is given, it is terminated by one NULL code (see example 2). When only the editor copyright is given, the photographer copyright part consists of one space followed by a terminating NULL code, then the editor copyright is given (see example 3). When the field is left blank, it is treated as unknown.

Ex. 1) When both the photographer copyright and editor copyright are given.
Photographer copyright + NULL[00.H] + editor copyright + NULL[00.H]

Ex. 2) When only the photographer copyright is given.
Photographer copyright + NULL[00.H]

Ex. 3) When only the editor copyright is given.
Space[20.H]+ NULL[00.H] + editor copyright + NULL[00.H]

Tag = 33432 (8298.H)
Type = ASCII
Count = Any
Default = none

4.6.5 Exif IFD Attribute Information

The attribute information (field names and codes) recorded in the Exif IFD is given in Table 4 and Table 5 followed by an explanation of the contents.

Table 4 Exif IFD Attribute Information (1)

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags Relating to Version					
Exif version	ExifVersion	36864	9000	UNDEFINED	4
Supported Flashpix version	FlashpixVersion	40960	A000	UNDEFINED	4
B. Tag Relating to Image Data Characteristics					
Color space information	ColorSpace	40961	A001	SHORT	1
C. Tags Relating to Image Configuration					
Meaning of each component	ComponentsConfiguration	37121	9101	UNDEFINED	4
Image compression mode	CompressedBitsPerPixel	37122	9102	RATIONAL	1
Valid image width	PixelXDimension	40962	A002	SHORT or LONG	1
Valid image height	PixelYDimension	40963	A003	SHORT or LONG	1
D. Tags Relating to User Information					
Manufacturer notes	MakerNote	37500	927C	UNDEFINED	Any
User comments	UserComment	37510	9286	UNDEFINED	Any
E. Tag Relating to Related File Information					
Related audio file	RelatedSoundFile	40964	A004	ASCII	13
F. Tags Relating to Date and Time					
Date and time of original data generation	DateTimeOriginal	36867	9003	ASCII	20
Date and time of digital data generation	DateTimeDigitized	36868	9004	ASCII	20
DateTime subseconds	SubSecTime	37520	9290	ASCII	Any
DateTimeOriginal subseconds	SubSecTimeOriginal	37521	9291	ASCII	Any
DateTimeDigitized subseconds	SubSecTimeDigitized	37522	9292	ASCII	Any
G. Tags Relating to Picture-Taking Conditions					
See Table 5					
H. Other Tags					
Unique image ID	ImageUniqueID	42016	A420	ASCII	33

Table 5 Exif IFD Attribute Information (2)

G. Tags Relating to Picture-Taking Conditions					
Exposure time	ExposureTime	33434	829A	RATIONAL	1
F number	FNumber	33437	829D	RATIONAL	1
Exposure program	ExposureProgram	34850	8822	SHORT	1
Spectral sensitivity	SpectralSensitivity	34852	8824	ASCII	Any
ISO speed rating	ISOSpeedRatings	34855	8827	SHORT	Any
Optoelectric conversion factor	OECF	34856	8828	UNDEFINED	Any
Shutter speed	ShutterSpeedValue	37377	9201	SRATIONAL	1
Aperture	ApertureValue	37378	9202	RATIONAL	1
Brightness	BrightnessValue	37379	9203	SRATIONAL	1
Exposure bias	ExposureBiasValue	37380	9204	SRATIONAL	1
Maximum lens aperture	MaxApertureValue	37381	9205	RATIONAL	1
Subject distance	SubjectDistance	37382	9206	RATIONAL	1
Metering mode	MeteringMode	37383	9207	SHORT	1
Light source	LightSource	37384	9208	SHORT	1
Flash	Flash	37385	9209	SHORT	1
Lens focal length	FocalLength	37386	920A	RATIONAL	1
Subject area	SubjectArea	37396	9214	SHORT	2 or 3 or 4
Flash energy	FlashEnergy	41483	A20B	RATIONAL	1
Spatial frequency response	SpatialFrequencyResponse	41484	A20C	UNDEFINED	Any
Focal plane X resolution	FocalPlaneXResolution	41486	A20E	RATIONAL	1
Focal plane Y resolution	FocalPlaneYResolution	41487	A20F	RATIONAL	1
Focal plane resolution unit	FocalPlaneResolutionUnit	41488	A210	SHORT	1
Subject location	SubjectLocation	41492	A214	SHORT	2
Exposure index	ExposureIndex	41493	A215	RATIONAL	1
Sensing method	SensingMethod	41495	A217	SHORT	1
File source	FileSource	41728	A300	UNDEFINED	1
Scene type	SceneType	41729	A301	UNDEFINED	1
CFA pattern	CFAPattern	41730	A302	UNDEFINED	Any
Custom image processing	CustomRendered	41985	A401	SHORT	1
Exposure mode	ExposureMode	41986	A402	SHORT	1
White balance	WhiteBalance	41987	A403	SHORT	1
Digital zoom ratio	DigitalZoomRatio	41988	A404	RATIONAL	1
Focal length in 35 mm film	FocalLengthIn35mmFilm	41989	A405	SHORT	1
Scene capture type	SceneCaptureType	41990	A406	SHORT	1
Gain control	GainControl	41991	A407	RATIONAL	1
Contrast	Contrast	41992	A408	SHORT	1
Saturation	Saturation	41993	A409	SHORT	1
Sharpness	Sharpness	41994	A40A	SHORT	1
Device settings description	DeviceSettingDescription	41995	A40B	UNDEFINED	Any
Subject distance range	SubjectDistanceRange	41996	A40C	SHORT	1

A. Tags Relating to Version

ExifVersion

The version of this standard supported. Nonexistence of this field is taken to mean nonconformance to the standard (see section 4.2). Conformance to this standard is indicated by recording "0220" as 4-byte ASCII. Since the type is UNDEFINED, there is no NULL for termination.

Tag = 36864 (9000.H)
Type = UNDEFINED
Count = 4
Default = "0220"

FlashpixVersion

The Flashpix format version supported by a FPXR file. If the FPXR function supports Flashpix format Ver. 1.0, this is indicated similarly to *ExifVersion* by recording "0100" as 4-byte ASCII. Since the type is UNDEFINED, there is no NULL for termination.

Tag = 40960(A000.H)
Type = UNDEFINED
Count = 4
Default = "0100"
0100 = Flashpix Format Version 1.0
Other = reserved

B. Tag Relating to Color Space

ColorSpace

The color space information tag (*ColorSpace*) is always recorded as the color space specifier.

Normally sRGB (=1) is used to define the color space based on the PC monitor conditions and environment. If a color space other than sRGB is used, Uncalibrated (=FFFF.H) is set. Image data recorded as Uncalibrated can be treated as sRGB when it is converted to Flashpix. On sRGB see Annex E.

Tag = 40961 (A001.H)
Type = SHORT
Count = 1
1 = sRGB
FFFF.H = Uncalibrated
Other = reserved

C. Tags Relating to Image Configuration

PixelXDimension

Information specific to compressed data. When a compressed file is recorded, the valid width of the meaningful image shall be recorded in this tag, whether or not there is padding data or a restart marker. This tag should not exist in an uncompressed file. For details see section 2.8.1 and Annex F.

Tag = 40962 (A002.H)
Type = SHORT or LONG
Count = 1
Default = none

PixelYDimension

Information specific to compressed data. When a compressed file is recorded, the valid height of the meaningful image shall be recorded in this tag, whether or not there is padding data or a restart marker. This tag should not exist in an uncompressed file. For details see section 2.8.1 and Annex F. Since data padding is unnecessary in the vertical direction, the number of lines recorded in this valid image height tag will in fact be the same as that recorded in the SOF.

Tag = 40963 (A003.H)
Type = SHORT of LONG
Count = 1

ComponentsConfiguration

Information specific to compressed data. The channels of each component are arranged in order from the 1st component to the 4th. For uncompressed data the data arrangement is given in the *PhotometricInterpretation* tag. However, since *PhotometricInterpretation* can only express the order of Y,Cb and Cr, this tag is provided for cases when compressed data uses components other than Y, Cb, and Cr and to enable support of other sequences.

Tag = 37121 (9101.H)
Type = UNDEFINED
Count = 4
Default = 4 5 6 0 (if RGB uncompressed)
1 2 3 0 (other cases)

0 = does not exist
1 = Y
2 = Cb
3 = Cr
4 = R
5 = G
6 = B
Other = reserved

CompressedBitsPerPixel

Information specific to compressed data. The compression mode used for a compressed image is indicated in unit bits per pixel.

Tag = 37122 (9102.H)
Type = RATIONAL
Count = 1
Default = none

D. Tags Relating to User Information

MakerNote

A tag for manufacturers of Exif writers to record any desired information. The contents are up to the manufacturer, but this tag should not be used for any other than its intended purpose.

Tag = 37500 (927C.H)
Type = UNDEFINED
Count = Any
Default = none

UserComment

A tag for Exif users to write keywords or comments on the image besides those in *ImageDescription*, and without the character code limitations of the *ImageDescription* tag.

Tag	=	37510 (9286.H)
Type	=	UNDEFINED
Count	=	Any
Default	=	none

The character code used in the *UserComment* tag is identified based on an ID code in a fixed 8-byte area at the start of the tag data area. The unused portion of the area is padded with NULL ("00.H"). ID codes are assigned by means of registration. The designation method and references for each character code are given in Table 6 . The value of Count N is determined based on the 8 bytes in the character code area and the number of bytes in the user comment part. Since the TYPE is not ASCII, NULL termination is not necessary (see Figure 9).

Table 6 Character Codes and their Designation

Character Code	Code Designation (8 Bytes)	References
ASCII	41.H, 53.H, 43.H, 49.H, 49.H, 00.H, 00.H, 00.H	ITU-T T.50 IA5
JIS	4A.H, 49.H, 53.H, 00.H, 00.H, 00.H, 00.H, 00.H	JIS X208-1990
Unicode	55.H, 4E.H, 49.H, 43.H, 4F.H, 44.H, 45.H, 00.H	Unicode Standard
Undefined	00.H, 00.H, 00.H, 00.H, 00.H, 00.H, 00.H, 00.H	Undefined

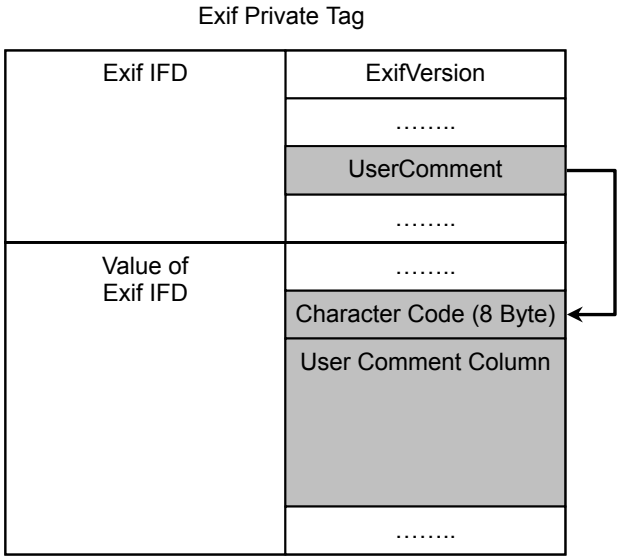

Figure 9　User Comment Tag

The ID code for the *UserComment* area may be a Defined code such as JIS or ASCII, or may be Undefined. The Undefined name is *UndefinedText*, and the ID code is filled with 8 bytes of all "NULL" ("00.H"). An Exif reader that reads the *UserComment* tag shall have a function for determining the ID code. This function is not required in Exif readers that do not use the *UserComment* tag (see Table 7).

Table 7 Implementation of Defined and Undefined Character Codes

ID Code	Exif Reader Implementation
Defined (JIS, ASCII, etc.)	Determines the ID code and displays it in accord with the reader capability.
Undefined (all NULL)	Depends on the localized PC in each country. (If a character code is used for which there is no clear specification like Shift-JIS in Japan, Undefined is used.) Although the possibility of unreadable characters exists, display of these characters is left as a matter of reader implementation.

When a *UserComment* area is set aside, it is recommended that the ID code be ASCII and that the following user comment part be filled with blank characters [20.H].

E. Tag Relating to Related File

RelatedSoundFile

This tag is used to record the name of an audio file related to the image data. The only relational information recorded here is the Exif audio file name and extension (an ASCII string consisting of 8 characters + '.' + 3 characters). The path is not recorded. Stipulations on audio are given in section 0. File naming conventions are given in section 0.

When using this tag, audio files shall be recorded in conformance to the Exif audio format. Writers are also allowed to store the data such as Audio within APP2 as Flashpix extension stream data.

Audio files shall be recorded in conformance to the Exif audio format.

The mapping of Exif image files and audio files is done in any of the three ways shown in Table 8. If multiple files are mapped to one file as in [2] or [3] of this table, the above format is used to record just one audio file name. If there are multiple audio files, the first recorded file is given.

In the case of [3] in Table 8, for example, for the Exif image file "DSC00001.JPG" only "SND00001.WAV" is given as the related Exif audio file.

When there are three Exif audio files "SND00001.WAV", "SND00002.WAV" and "SND00003.WAV", the Exif image file name for each of them, "DSC00001.JPG," is indicated. By combining multiple relational information, a variety of playback possibilities can be supported. The method of using relational information is left to the implementation on the playback side. Since this information is an ASCII character string, it is terminated by NULL.

Table 8 Mapping between Image and Audio Files

	Relationship	Exif Image File	Exif Audio File
[1]	1 to 1	DSC00001.JPG	SND00001.WAV
[2]	Plural to 1	DSC00001.JPG DSC00002.JPG DSC00003.JPG	SND00001.WAV
[3]	1 to plural	DSC00001.JPG	SND00001.WAV SND00002.WAV SND00003.WAV

When this tag is used to map audio files, the relation of the audio file to image data shall also be indicated on the audio file end.

Tag	=	40964 (A004.H)
Type	=	ASCII
Count	=	13
Default	=	none

F. Tags Relating to Date and Time

DateTimeOriginal

The date and time when the original image data was generated. For a DSC the date and time the picture was taken are recorded. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") may be filled with blank characters, or else the Interoperability field may be filled with blank characters. The character string length is 20 bytes including NULL for termination. When the field is left blank, it is treated as unknown.

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

DateTimeDigitized

The date and time when the image was stored as digital data. If, for example, an image was captured by DSC and at the same time the file was recorded, then the DateTimeOriginal and DateTimeDigitized will have the same contents. The format is "YYYY:MM:DD HH:MM:SS" with time shown in 24-hour format, and the date and time separated by one blank character [20.H]. When the date and time are unknown, all the character spaces except colons (":") may be filled with blank characters, or else the Interoperability field may be filled with blank characters. The character string length is 20 bytes including NULL for termination. When the field is left blank, it is treated as unknown.

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

SubsecTime

A tag used to record fractions of seconds for the *DateTime* tag.

Tag	=	37520 (9290.H)
Type	=	ASCII
Count	=	Any
Default	=	none

SubsecTimeOriginal

A tag used to record fractions of seconds for the *DateTimeOriginal* tag.

Tag	=	37521 (9291.H)
Type	=	ASCII
N	=	Any
Default	=	none

SubsecTimeDigitized

A tag used to record fractions of seconds for the *DateTimeDigitized* tag.

Tag	=	37522 (9292.H)
Type	=	ASCII
N	=	Any
Default	=	none

Note—Recording subsecond data (*SubsecTime*, *SubsecTimeOriginal*, *SubsecTimeDigitized*)

The tag type is ASCII and the string length including NULL is variable length. When the number of valid digits is up to the second decimal place, the subsecond value goes in the Value position. When it is up to four decimal places, an address value is Interoperability, with the subsecond value put in the location pointed to by that address. (Since the count of ASCII type field Interoperability is a value that includes NULL, when the number of valid digits is up to four decimal places the count is 5, and the offset value goes in the Value Offset field. See section 2.6.2.) Note that the subsecond tag differs from the *DateTime* tag and other such tags already defined in TIFF Rev. 6.0, and that both are recorded in the Exif IFD.

Ex.: September 9, 1998, 9:15:30.130 (the number of valid digits is up to the third decimal place)

DateTime	1996:09:01 09:15:30 [NULL]
SubSecTime	130 [NULL]

If the string length is longer than the number of valid digits, the digits are aligned with the start of the area and the rest is filled with blank characters [20.H]. If the subsecond data is unknown, the Interoperability area can be filled with blank characters.

Examples when subsecond data is 0.130 seconds:

Ex. 1) '1','3','0',[NULL]

Ex. 2) '1','3','0',[20.H],[NULL]

Ex. 3) '1','3','0', [20.H], [20.H], [20.H], [20.H], [20.H], [NULL]

Example when subsecond data is unknown:

Ex. 4) [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [20.H], [NULL]

G. Tags Relating to Picture-Taking Conditions

ExposureTime

Exposure time, given in seconds (sec).

Tag	=	33434 (829A.H)
Type	=	RATIONAL
Count	=	1
Default	=	none

FNumber

The F number.

Tag	= 33437 (829D.H)
Type	= RATIONAL
Count	= 1
Default	= none

ExposureProgram

The class of the program used by the camera to set exposure when the picture is taken. The tag values are as follows.

Tag = 34850 (8822.H)
Type = SHORT
Count = 1
Default = 0

0	=	Not defined
1	=	Manual
2	=	Normal program
3	=	Aperture priority
4	=	Shutter priority
5	=	Creative program (biased toward depth of field)
6	=	Action program (biased toward fast shutter speed)
7	=	Portrait mode (for closeup photos with the background out of focus)
8	=	Landscape mode (for landscape photos with the background in focus)
Other	=	reserved

SpectralSensitivity

Indicates the spectral sensitivity of each channel of the camera used. The tag value is an ASCII string compatible with the standard developed by the ASTM Technical committee.

Tag = 34852 (8824.H)
Type = ASCII
Count = Any
Default = none

ISOSpeedRatings

Indicates the ISO Speed and ISO Latitude of the camera or input device as specified in ISO 12232.

Tag = 34855 (8827.H)
Type = SHORT
Count = Any
Default = none

OECF

Indicates the Opto-Electric Conversion Function (OECF) specified in ISO 14524. *OECF* is the relationship between the camera optical input and the image values.

Tag = 34856 (8828.H)
Type = UNDEFINED
Count = ANY
Default = none

When this tag records an *OECF* of m rows and n columns, the values are as in Figure 10.

Length	Type	Meaning
2	SHORT	Columns = n
2	SHORT	Rows = m
Any	ASCII	0th column item name (NULL terminated)
:	:	:
Any	ASCII	n-1th column item name (NULL terminated)
8	SRATIONAL	OECF value [0,0]
:	:	:
8	SRATIONAL	OECF value [n-1,0]
8	SRATIONAL	OECF value [0,m-1]
:	:	:
8	SRATIONAL	OECF value [n-1,m-1]

Figure 10 OECF Description

Table 9 gives a simple example.

Table 9 Example of Exposure and RGB Output Level

Camera log Aperture	R Output Level	G Output Level	B Output Level
-3.0	10.2	12.4	8.9
-2.0	48.1	47.5	48.3
-1.0	150.2	152.0	149.8

ShutterSpeedValue

Shutter speed. The unit is the APEX (Additive System of Photographic Exposure) setting (see Annex C).

Tag = 37377 (9201.H)
Type = SRATIONAL
Count = 1
Default = none

ApertureValue

The lens aperture. The unit is the APEX value.

Tag = 37378 (9202.H)
Type = RATIONAL
Count = 1
Default = none

BrightnessValue

The value of brightness. The unit is the APEX value. Ordinarily it is given in the range of -99.99 to 99.99. Note that if the numerator of the recorded value is FFFFFFFF.H, Unknown shall be indicated.

Tag = 37379 (9203.H)
Type = SRATIONAL
Count = 1
Default = none

ExposureBiasValue

The exposure bias. The unit is the APEX value. Ordinarily it is given in the range of –99.99 to 99.99.

Tag = 37380 (9204.H)
Type = SRATIONAL
Count = 1
Default = none

MaxApertureValue

The smallest F number of the lens. The unit is the APEX value. Ordinarily it is given in the range of 00.00 to 99.99, but it is not limited to this range.

Tag = 37381 (9205.H)
Type = RATIONAL
Count = 1
Default = none

SubjectDistance

The distance to the subject, given in meters. Note that if the numerator of the recorded value is FFFFFFFF.H, Infinity shall be indicated; and if the numerator is 0, Distance unknown shall be indicated.

Tag = 37382 (9206.H)
Type = RATIONAL
Count = 1
Default = none

MeteringMode

The metering mode.

Tag = 37383 (9207.H)
Type = SHORT
Count = 1
Default = 0

0	=	unknown
1	=	Average
2	=	CenterWeightedAverage
3	=	Spot
4	=	MultiSpot
5	=	Pattern
6	=	Partial
Other	=	reserved
255	=	other

LightSource

The kind of light source.

Tag = 37384 (9208.H)
Type = SHORT
Count = 1
Default = 0

0	=	unknown

1	=	Daylight
2	=	Fluorescent
3	=	Tungsten (incandescent light)
4	=	Flash
9	=	Fine weather
10	=	Cloudy weather
11	=	Shade
12	=	Daylight fluorescent (D 5700 – 7100K)
13	=	Day white fluorescent (N 4600 – 5400K)
14	=	Cool white fluorescent (W 3900 – 4500K)
15	=	White fluorescent (WW 3200 – 3700K)
17	=	Standard light A
18	=	Standard light B
19	=	Standard light C
20	=	D55
21	=	D65
22	=	D75
23	=	D50
24	=	ISO studio tungsten
255	=	other light source
Other	=	reserved

Flash

This tag indicates the status of flash when the image was shot. Bit 0 indicates the flash firing status, bits 1 and 2 indicate the flash return status, bits 3 and 4 indicate the flash mode, bit 5 indicates whether the flash function is present, and bit 6 indicates "red eye" mode (see Figure 11).

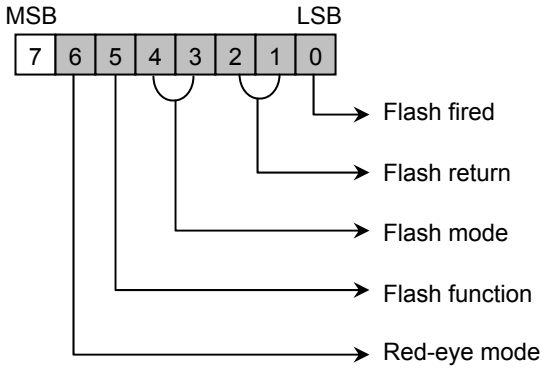

Figure 11 Bit Coding of the Flash Tag

Tag	=	37385 (9209.H)
Type	=	SHORT
Count	=	1

Values for bit 0 indicating whether the flash fired.

0b	=	Flash did not fire.
1b	=	Flash fired.

Values for bits 1 and 2 indicating the status of returned light.

00b	=	No strobe return detection function
01b	=	reserved
10b	=	Strobe return light not detected.
11b	=	Strobe return light detected.

Values for bits 3 and 4 indicating the camera's flash mode.

00b	=	unknown
01b	=	Compulsory flash firing
10b	=	Compulsory flash suppression
11b	=	Auto mode

Values for bit 5 indicating the presence of a flash function.

0b	=	Flash function present
1b	=	No flash function

Values for bit 6 indicating the camera's red-eye mode.

0b	=	No red-eye reduction mode or unknown
1b	=	Red-eye reduction supported

Resulting Flash tag values.

0000.H	=	Flash did not fire.
0001.H	=	Flash fired.
0005.H	=	Strobe return light not detected.
0007.H	=	Strobe return light detected.
0009.H	=	Flash fired, compulsory flash mode
000D.H	=	Flash fired, compulsory flash mode, return light not detected
000F.H	=	Flash fired, compulsory flash mode, return light detected
0010.H	=	Flash did not fire, compulsory flash mode
0018.H	=	Flash did not fire, auto mode
0019.H	=	Flash fired, auto mode
001D.H	=	Flash fired, auto mode, return light not detected
001F.H	=	Flash fired, auto mode, return light detected
0020.H	=	No flash function
0041.H	=	Flash fired, red-eye reduction mode
0045.H	=	Flash fired, red-eye reduction mode, return light not detected
0047.H	=	Flash fired, red-eye reduction mode, return light detected
0049.H	=	Flash fired, compulsory flash mode, red-eye reduction mode
004D.H	=	Flash fired, compulsory flash mode, red-eye reduction mode, return light not detected
004F.H	=	Flash fired, compulsory flash mode, red-eye reduction mode, return light detected
0059.H	=	Flash fired, auto mode, red-eye reduction mode
005D.H	=	Flash fired, auto mode, return light not detected, red-eye reduction mode
005F.H	=	Flash fired, auto mode, return light detected, red-eye reduction mode
Other	=	reserved

SubjectArea

This tag indicates the location and area of the main subject in the overall scene.

Tag	=	37396 (9214.H)
Type	=	SHORT
Count	=	2 or 3 or 4
Default	=	none

The subject location and area are defined by Count values as follows.

Count = 2	Indicates the location of the main subject as coordinates. The first value is the X coordinate and the second is the Y coordinate.
Count = 3	The area of the main subject is given as a circle. The circular area is expressed as center coordinates and diameter. The first value is the center X coordinate, the second is the center Y coordinate, and the third is the diameter. (See Figure 12.)
Count = 4	The area of the main subject is given as a rectangle. The rectangular area is expressed as center coordinates and area dimensions. The first value is the center X coordinate, the second is the center Y coordinate, the third is the width of the area, and the fourth is the height of the area. (See Figure 13.)

Note that the coordinate values, width, and height are expressed in relation to the upper left as origin, prior to rotation processing as per the Rotation tag.

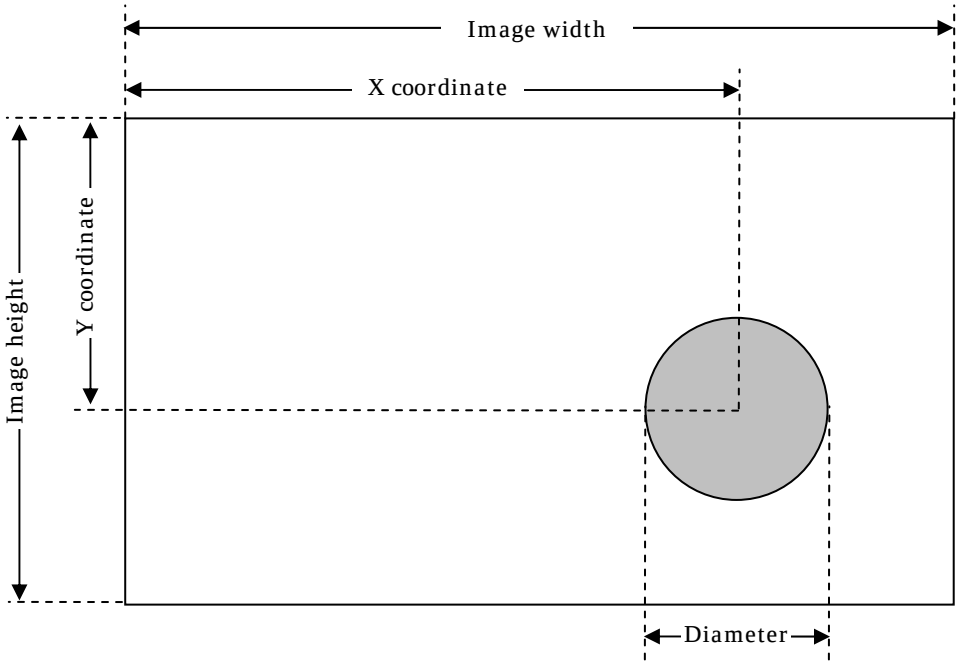

Figure 12 Circular area designation

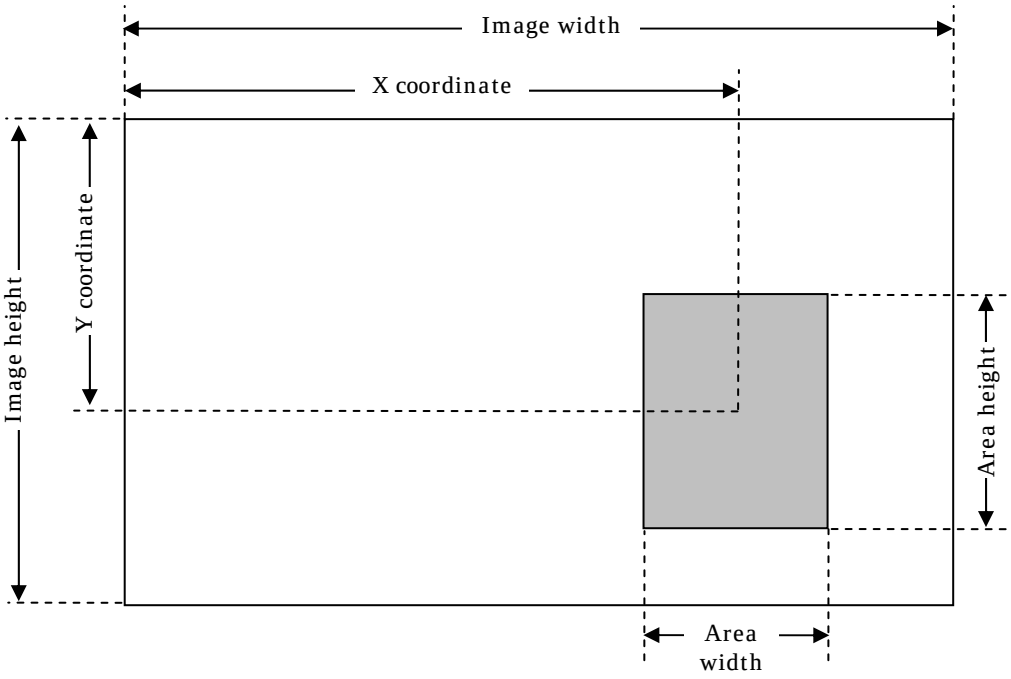

Figure 13 Rectangular area designation

FocalLength

The actual focal length of the lens, in mm. Conversion is not made to the focal length of a 35 mm film camera.

Tag	=	37386 (920A.H)
Type	=	RATIONAL
Count	=	1
Default	=	none

FlashEnergy

Indicates the strobe energy at the time the image is captured, as measured in Beam Candle Power Seconds (BCPS).

Tag = 41483 (A20B.H)
Type = RATIONAL
Count = 1
Default = none

SpatialFrequencyResponse

This tag records the camera or input device spatial frequency table and SFR values in the direction of image width, image height, and diagonal direction, as specified in ISO 12233.

Tag = 41484 (A20CH)
Type = UNDEFINED
Count = ANY
Default = none

When the spatial frequency response for m rows and n columns is recorded, the values are as shown in Figure 14.

Length	Type	Meaning
2	SHORT	Columns = n
2	SHORT	Rows = m
Any	ASCII	0th column item name (NULL terminated)
:	:	:
Any	ASCII	n-1th column item name (NULL terminated)
8	RATIONAL	SFR value [0,0]
:	:	:
8	RATIONAL	SFR value [n-1,0]
8	RATIONAL	SFR value [0,m-1]
:	:	:
8	RATIONAL	SFR value [n-1,m-1]

Figure 14 Spatial Frequency Response Description

Table 10 gives a simple example.

Table 10 Example of Spatial Frequency Response

Spatial Frequency (lw/ph)	Along Image Width	Along Image Height
0.1	1.00	1.00
0.2	0.90	0.95
0.3	0.80	0.85

FocalPlaneXResolution

Indicates the number of pixels in the image width (X) direction per *FocalPlaneResolutionUnit* on the camera focal plane.

Tag = 41486 (A20E.H)
Type = RATIONAL
Count = 1
Default = none

FocalPlaneYResolution

Indicates the number of pixels in the image height (Y) direction per *FocalPlaneResolutionUnit* on the camera focal plane.

Tag = 41487 (A20F.H)
Type = RATIONAL
Count = 1
Default = none

FocalPlaneResolutionUnit

Indicates the unit for measuring *FocalPlaneXResolution* and *FocalPlaneYResolution*. This value is the same as the *ResolutionUnit*.

Tag = 41488 (A210.H)
Type = SHORT
Count = 1
Default = 2 (inch)

Note on use of tags concerning focal plane resolution

These tags record the actual focal plane resolutions of the main image which is written as a file after processing instead of the pixel resolution of the image sensor in the camera. It should be noted carefully that the data from the image sensor is resampled.

These tags are used at the same time as a FocalLength tag when the angle of field of the recorded image is to be calculated precisely.

SubjectLocation

Indicates the location of the main subject in the scene. The value of this tag represents the pixel at the center of the main subject relative to the left edge, prior to rotation processing as per the *Rotation* tag. The first value indicates the X column number and second indicates the Y row number.

Tag = 41492 (A214.H)
Type = SHORT
Count = 2
Default = none

When a camera records the main subject location, it is recommended that the SubjectArea tag be used instead of this tag.

ExposureIndex

Indicates the exposure index selected on the camera or input device at the time the image is captured.

Tag = 41493 (A215.H)
Type = RATIONAL
Count = 1
Default = none

SensingMethod

Indicates the image sensor type on the camera or input device. The values are as follows.

Tag = 41495 (A217.H)
Type = SHORT
Count = 1
Default = none
1 = Not defined
2 = One-chip color area sensor
3 = Two-chip color area sensor

4 = Three-chip color area sensor
5 = Color sequential area sensor
7 = Trilinear sensor
8 = Color sequential linear sensor
Other = reserved

FileSource

Indicates the image source. If a DSC recorded the image, this tag value of this tag always be set to 3, indicating that the image was recorded on a DSC.

Tag = 41728 (A300.H)
Type = UNDEFINED
Count = 1
Default = 3
3 = DSC
Other = reserved

SceneType

Indicates the type of scene. If a DSC recorded the image, this tag value shall always be set to 1, indicating that the image was directly photographed.

Tag = 41729 (A301.H)
Type = UNDEFINED
Count = 1
Default = 1
1 = A directly photographed image
Other = reserved

CFAPattern

Indicates the color filter array (CFA) geometric pattern of the image sensor when a one-chip color area sensor is used. It does not apply to all sensing methods.

Tag = 41730 (A302.H)
Type = UNDEFINED
Count = ANY
Default = none

Figure 15 shows how a CFA pattern is recorded for a one-chip color area sensor when the color filter array is repeated in m x n (vertical x lateral) pixel units.

Length	Type	Meaning
2	SHORT	Horizontal repeat pixel unit = n
2	SHORT	Vertical repeat pixel unit = m
1	BYTE	CFA value [0.0]
:	:	:
1	BYTE	CFA value [n-1.0]
1	BYTE	CFA value [0.m-1]
:	:	:
1	BYTE	CFA value [n-1.m-1]

Figure 15 CFA Pattern Description

The relation of color filter color to CFA value is shown in Table 11.

Table 11 Color Filter Color and CFA Value

Filter Color	CFA Value
RED	00.H
GREEN	01.H
BLUE	02.H
CYAN	03.H
MAGENTA	04.H
YELLOW	05.H
WHITE	06.H

For example, when the CFA pattern values are {0002.H, 0002.H, 01.H, 00.H, 02.H, 01.H}, the color filter array is as shown in Figure 16.

G	R	G	R	.....
B	G	B	G	.....
G	R	G	R	.....
B	G	B	G	.....
:	:	:	:	

Figure 16 Color Filter Array

CustomRendered

This tag indicates the use of special processing on image data, such as rendering geared to output. When special processing is performed, the reader is expected to disable or minimize any further processing.

Tag = 41985 (A401.H)
Type = SHORT
Count = 1
Default = 0
0 = Normal process
1 = Custom process
Other = reserved

ExposureMode

This tag indicates the exposure mode set when the image was shot. In auto-bracketing mode, the camera shoots a series of frames of the same scene at different exposure settings.

Tag = 41986 (A402.H)
Type = SHORT
Count = 1
Default = none
0 = Auto exposure
1 = Manual exposure
2 = Auto bracket
Other = reserved

WhiteBalance

This tag indicates the white balance mode set when the image was shot.

Tag = 41987 (A403.H)
Type = SHORT
Count = 1
Default = none
0 = Auto white balance
1 = Manual white balance
Other = reserved

DigitalZoomRatio

This tag indicates the digital zoom ratio when the image was shot. If the numerator of the recorded value is 0, this indicates that digital zoom was not used.

Tag = 41988 (A404.H)
Type = RATIONAL
Count = 1
Default = none

FocalLengthIn35mmFilm

This tag indicates the equivalent focal length assuming a 35mm film camera, in mm. A value of 0 means the focal length is unknown. Note that this tag differs from the FocalLength tag.

Tag = 41989 (A405.H)
Type = SHORT
Count = 1
Default = none

SceneCaptureType

This tag indicates the type of scene that was shot. It can also be used to record the mode in which the image was shot. Note that this differs from the scene type (SceneType) tag.

Tag = 41990 (A406.H)
Type = SHORT
Count = 1
Default = 0
0 = Standard
1 = Landscape
2 = Portrait
3 = Night scene
Other = reserved

GainControl

This tag indicates the degree of overall image gain adjustment.

Tag = 41991 (A407.H)
Type = SHORT
Count = 1
Default = none
0 = None

1 = Low gain up
2 = High gain up
3 = Low gain down
4 = High gain down
Other = reserved

Contrast

This tag indicates the direction of contrast processing applied by the camera when the image was shot.

Tag = 41992 (A408.H)
Type = SHORT
Count = 1
Default = 0
0 = Normal
1 = Soft
2 = Hard
Other = reserved

Saturation

This tag indicates the direction of saturation processing applied by the camera when the image was shot.

Tag = 41993 (A409.H)
Type = SHORT
Count = 1
Default = 0
0 = Normal
1 = Low saturation
2 = High saturation
Other = reserved

Sharpness

This tag indicates the direction of sharpness processing applied by the camera when the image was shot.

Tag = 41994 (A40A.H)
Type = SHORT
Count = 1
Default = 0
0 = Normal
1 = Soft
2 = Hard
Other = reserved

DeviceSettingDescription

This tag indicates information on the picture-taking conditions of a particular camera model. The tag is used only to indicate the picture-taking conditions in the reader.

Tag = 41995 (A40B.H)
Type = UNDEFINED
Count = Any
Default = none

The information is recorded in the format shown in Figure 17. The data is recorded in Unicode using SHORT type for the number of display rows and columns and UNDEFINED type for the camera settings. The Unicode (UCS-2) string including Signature is NULL terminated. The specifics of the Unicode string are as given in ISO/IEC 10464-1.

Length	Type	Meaning
2	SHORT	Display columns
2	SHORT	Display rows
Any	UNDEFINED	Camera setting-1
Any	UNDEFINED	Camera setting-2
:	:	:
Any	UNDEFINED	Camera setting-n

Figure 17 Format used to record picture-taking conditions

SubjectDistanceRange

This tag indicates the distance to the subject.

Tag = 41996 (A40C.H)
Type = SHORT
Count = 1
Default = none
0 = unknown
1 = Macro
2 = Close view
3 = Distant view
Other = reserved

H. Other tags

ImageUniqueID

This tag indicates an identifier assigned uniquely to each image. It is recorded as an ASCII string equivalent to hexadecimal notation and 128-bit fixed length.

Tag = 42016 (A420.H)
Type = ASCII
Count = 33
Default = none

4.6.6 GPS Attribute Information

The attribute information (field names and codes) recorded in the GPS Info IFD is given in Table 12, followed by an explanation of the contents.

Table 12 GPS Attribute Information

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Tags Relating to GPS					
GPS tag version	GPSVersionID	0	0	BYTE	4
North or South Latitude	GPSLatitudeRef	1	1	ASCII	2
Latitude	GPSLatitude	2	2	RATIONAL	3
East or West Longitude	GPSLongitudeRef	3	3	ASCII	2
Longitude	GPSLongitude	4	4	RATIONAL	3
Altitude reference	GPSAltitudeRef	5	5	BYTE	1
Altitude	GPSAltitude	6	6	RATIONAL	1
GPS time (atomic clock)	GPSTimeStamp	7	7	RATIONAL	3
GPS satellites used for measurement	GPSSatellites	8	8	ASCII	Any
GPS receiver status	GPSStatus	9	9	ASCII	2
GPS measurement mode	GPSMeasureMode	10	A	ASCII	2
Measurement precision	GPSDOP	11	B	RATIONAL	1
Speed unit	GPSSpeedRef	12	C	ASCII	2
Speed of GPS receiver	GPSSpeed	13	D	RATIONAL	1
Reference for direction of movement	GPSTrackRef	14	E	ASCII	2
Direction of movement	GPSTrack	15	F	RATIONAL	1
Reference for direction of image	GPSImgDirectionRef	16	10	ASCII	2
Direction of image	GPSImgDirection	17	11	RATIONAL	1
Geodetic survey data used	GPSMapDatum	18	12	ASCII	Any
Reference for latitude of destination	GPSDestLatitudeRef	19	13	ASCII	2
Latitude of destination	GPSDestLatitude	20	14	RATIONAL	3
Reference for longitude of destination	GPSDestLongitudeRef	21	15	ASCII	2
Longitude of destination	GPSDestLongitude	22	16	RATIONAL	3
Reference for bearing of destination	GPSDestBearingRef	23	17	ASCII	2
Bearing of destination	GPSDestBearing	24	18	RATIONAL	1
Reference for distance to destination	GPSDestDistanceRef	25	19	ASCII	2
Distance to destination	GPSDestDistance	26	1A	RATIONAL	1
Name of GPS processing method	GPSProcessingMethod	27	1B	UNDEFINED	Any
Name of GPS area	GPSAreaInformation	28	1C	UNDEFINED	Any
GPS date	GPSDateStamp	29	1D	ASCII	11
GPS differential correction	GPSDifferential	30	1E	SHORT	1

A. Tags Relating to GPS

GPSVersionID

Indicates the version of *GPSInfoIFD*. The version is given as 2.2.0.0. This tag is mandatory when *GPSInfo* tag is present. Note that the GPSVersionID tag is written as a different byte than the Exif Version tag.

Tag = 0 (0.H)
Type = BYTE
Count = 4
Default = 2.2.0.0
2.2.0.0 = Version 2.2
Other = reserved

GPSLatitudeRef

Indicates whether the latitude is north or south latitude. The ASCII value 'N' indicates north latitude, and 'S' is south latitude.

Tag = 1 (1.H)

Type = ASCII
Count = 2
Default = none
'N' = North latitude
'S' = South latitude
Other = reserved

GPSLatitude

Indicates the latitude. The latitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes and seconds, a typical format would be dd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1,mmmm/100,0/1.

Tag = 2 (2.H)
Type = RATIONAL
Count = 3
Default = none

GPSLongitudeRef

Indicates whether the longitude is east or west longitude. ASCII 'E' indicates east longitude, and 'W' is west longitude.

Tag = 3 (3.H)
Type = ASCII
Count = 2
Default = none
'E' = East longitude
'W' = West longitude
Other = reserved

GPSLongitude

Indicates the longitude. The longitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes and seconds, a typical format would be ddd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1,mmmm/100,0/1.

Tag = 4 (4.H)
Type = RATIONAL
Count = 3
Default = none

GPSAltitudeRef

Indicates the altitude used as the reference altitude. If the reference is sea level and the altitude is above sea level, 0 is given. If the altitude is below sea level, a value of 1 is given and the altitude is indicated as an absolute value in the GPSAltitude tag. The reference unit is meters. Note that this tag is BYTE type, unlike other reference tags.

Tag = 5 (5.H)
Type = BYTE
Count = 1
Default = 0

0 = Sea level
1 = Sea level reference (negative value)
Other = reserved

GPSAltitude

Indicates the altitude based on the reference in *GPSAltitudeRef*. Altitude is expressed as one RATIONAL value. The reference unit is meters.

Tag = 6 (6.H)
Type = RATIONAL
Count = 1
Default = none

GPSTimeStamp

Indicates the time as UTC (Coordinated Universal Time). TimeStamp is expressed as three RATIONAL values giving the hour, minute, and second.

Tag = 7 (7.H)
Type = RATIONAL
Count = 3
Default = none

GPSSatellites

Indicates the GPS satellites used for measurements. This tag can be used to describe the number of satellites, their ID number, angle of elevation, azimuth, SNR and other information in ASCII notation. The format is not specified. If the GPS receiver is incapable of taking measurements, value of the tag shall be set to NULL.

Tag = 8 (8.H)
Type = ASCII
Count = Any
Default = none

GPSStatus

Indicates the status of the GPS receiver when the image is recorded. 'A' means measurement is in progress, and 'V' means the measurement is Interoperability.

Tag = 9 (9.H)
Type = ASCII
Count = 2
Default = none
'A' = Measurement in progress
'V' = Measurement Interoperability
Other = reserved

GPSMeasureMode

Indicates the GPS measurement mode. '2' means two-dimensional measurement and '3' means three-dimensional measurement is in progress.

Tag = 10 (A.H)
Type = ASCII
Count = 2

Default = none
'2' = 2-dimensional measurement
'3' = 3-dimensional measurement
Other = reserved

GPSDOP

Indicates the GPS DOP (data degree of precision). An HDOP value is written during two-dimensional measurement, and PDOP during three-dimensional measurement.

Tag = 11 (B.H)
Type = RATIONAL
Count = 1
Default = none

GPSSpeedRef

Indicates the unit used to express the GPS receiver speed of movement. 'K' 'M' and 'N' represents kilometers per hour, miles per hour, and knots.

Tag = 12 (C.H)
Type = ASCII
Count = 2
Default = 'K'
'K' = Kilometers per hour
'M' = Miles per hour
'N' = Knots
Other = reserved

GPSSpeed

Indicates the speed of GPS receiver movement.

Tag = 13 (D.H)
Type = RATIONAL
Count = 1
Default = none

GPSTrackRef

Indicates the reference for giving the direction of GPS receiver movement. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 14 (E.H)
Type = ASCII
Count = 2
Default = 'T'
'T' = True direction
'M' = Magnetic direction
Other = reserved

GPSTrack

Indicates the direction of GPS receiver movement. The range of values is from 0.00 to 359.99.

Tag = 15 (F.H)

Type = RATIONAL
Count = 1
Default = none

GPSImgDirectionRef

Indicates the reference for giving the direction of the image when it is captured. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 16 (10.H)
Type = ASCII
Count = 2
Default = 'T'
'T' = True direction
'M' = Magnetic direction
Other = reserved

GPSImgDirection

Indicates the direction of the image when it was captured. The range of values is from 0.00 to 359.99.

Tag = 17 (11.H)
Type = RATIONAL
Count = 1
Default = none

GPSMapDatum

Indicates the geodetic survey data used by the GPS receiver. If the survey data is restricted to Japan, the value of this tag is 'TOKYO' or 'WGS-84'. If a *GPS Info* tag is recorded, it is strongly recommended that this tag be recorded.

Tag = 18 (12.H)
Type = ASCII
Count = Any
Default = none

GPSDestLatitudeRef

Indicates whether the latitude of the destination point is north or south latitude. The ASCII value 'N' indicates north latitude, and 'S' is south latitude.

Tag = 19 (13.H)
Type = ASCII
Count = 2
Default = none
'N' = North latitude
'S' = South latitude
Other = reserved

GPSDestLatitude

Indicates the latitude of the destination point. The latitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If latitude is expressed as degrees, minutes and seconds, a typical format would be dd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be dd/1,mmmm/100,0/1.

Tag = 20 (14.H)
Type = RATIONAL
Count = 3
Default = none

GPSDestLongitudeRef

Indicates whether the longitude of the destination point is east or west longitude. ASCII 'E' indicates east longitude, and 'W' is west longitude.

Tag = 21 (15.H)
Type = ASCII
Count = 2
Default = none
'E' = East longitude
'W' = West longitude
Other = reserved

GPSDestLongitude

Indicates the longitude of the destination point. The longitude is expressed as three RATIONAL values giving the degrees, minutes, and seconds, respectively. If longitude is expressed as degrees, minutes and seconds, a typical format would be ddd/1,mm/1,ss/1. When degrees and minutes are used and, for example, fractions of minutes are given up to two decimal places, the format would be ddd/1,mmmm/100,0/1.

Tag = 22 (16.H)
Type = RATIONAL
Count = 3
Default = none

GPSDestBearingRef

Indicates the reference used for giving the bearing to the destination point. 'T' denotes true direction and 'M' is magnetic direction.

Tag = 23 (17.H)
Type = ASCII
Count = 2
Default = 'T'
'T' = True direction
'M' = Magnetic direction
Other = reserved

GPSDestBearing

Indicates the bearing to the destination point. The range of values is from 0.00 to 359.99.

Tag = 24 (18.H)
Type = RATIONAL
Count = 1
Default = none

GPSDestDistanceRef

Indicates the unit used to express the distance to the destination point. 'K', 'M' and 'N' represent kilometers, miles and knots.

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Tag = 25 (19.H)
Type = ASCII
Count = 2
Default = 'K'
'K' = Kilometers
'M' = Miles
'N' = Knots
Other = reserved

GPSDestDistance

Indicates the distance to the destination point.

Tag = 26 (1A.H)
Type = RATIONAL
Count = 1
Default = none

GPSProcessingMethod

A character string recording the name of the method used for location finding. The first byte indicates the character code used (Table 6、Table 7), and this is followed by the name of the method. Since the Type is not ASCII, NULL termination is not necessary.

Tag = 27 (1B.H)
Type = UNDEFINED
Count = Any
Default = none

GPSAreaInformation

A character string recording the name of the GPS area. The first byte indicates the character code used (Table 6、Table 7), and this is followed by the name of the GPS area. Since the Type is not ASCII, NULL termination is not necessary.

Tag = 28 (1C.H)
Type = UNDEFINED
Count = Any
Default = none

GPSDateStamp

A character string recording date and time information relative to UTC (Coordinated Universal Time). The format is "YYYY:MM:DD." The length of the string is 11 bytes including NULL.

Tag = 29 (1D.H)
Type = ASCII
Count = 11
Default = none

GPSDifferential

Indicates whether differential correction is applied to the GPS receiver.

Tag = 30 (1E.H)
Type = SHORT

Count = 1
Default = none
0 = Measurement without differential correction
1 = Differential correction applied
Other = reserved

Note－When the tag Type is ASCII, it shall be terminated with NULL.

It shall be noted carefully that since the value count includes the terminator NULL, the total count is the number of data+1. For example, *GPSLatitudeRef* cannot have any values other than Type ASCII 'N' or 'S'; but because the terminator NULL is added, the value of N is 2.

4.6.7 Interoperability IFD Attribute Information

The attached information(field name, code) stored in Interoperability IFD is listed in and the meaning will be explained also.

Table 13 Interoperability IFD Attribute Information

Tag Name	Field Name	Tag ID		Type	Count
		Dec	Hex		
A. Attached Information Related to Interoperability					
	Interoperability Identification InteroperabilityIndex	1	1	ASCII	Any

A. Tags Relating to Interoperability

The rules for Exif image files defines the description of the following tag. Other tags stored in Interoperability IFD may be defined dependently to each Interoperability rule.

InteroperabilityIndex

Indicates the identification of the Interoperability rule. The following rules are defined. Four bytes used including the termination code (NULL).

Tag = 1 (1.H)
Type = ASCII
Count = Any
Default = none
"R98" = Indicates a file conforming to R98 file specification of Recommended Exif Interoperability Rules (ExifR98) or to DCF basic file stipulated by Design Rule for Camera File System.
"THM" = Indicates a file conforming to DCF thumbnail file stipulated by Design rule for Camera File System.

4.6.8 Tag Support Levels

The tags and their support levels are given here.

A. Primary Image (0th IFD) Support Levels

The support levels of primary image (0th IFD) tags are given in Table 14, Table 15, Table 16 and Table 17.

Table 14 Tag Support Levels (1) - 0th IFD TIFF Tags -

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Image width	ImageWidth	256	100	M	M	M	J
Image height	ImageLength	257	101	M	M	M	J
Number of bits per component	BitsPerSample	258	102	M	M	M	J
Compression scheme	Compression	259	103	M	M	M	J
Pixel composition	PhotometricInterpretation	262	106	M	M	M	N
Image title	ImageDescription	270	10E	R	R	R	R
Manufacturer of image input equipment	Make	271	10F	R	R	R	R
Model of image input equipment	Model	272	110	R	R	R	R
Image data location	StripOffsets	273	111	M	M	M	N
Orientation of image	Orientation	274	112	R	R	R	R
Number of components	SamplesPerPixel	277	115	M	M	M	J
Number of rows per strip	RowsPerStrip	278	116	M	M	M	N
Bytes per compressed strip	StripByteCounts	279	117	M	M	M	N
Image resolution in width direction	XResolution	282	11A	M	M	M	M
Image resolution in height direction	YResolution	283	11B	M	M	M	M
Image data arrangement	PlanarConfiguration	284	11C	O	M	O	J
Unit of X and Y resolution	ResolutionUnit	296	128	M	M	M	M
Transfer function	TransferFunction	301	12D	R	R	R	R
Software used	Software	305	131	O	O	O	O
File change date and time	DateTime	306	132	R	R	R	R
Person who created the image	Artist	315	13B	O	O	O	O
White point chromaticity	WhitePoint	318	13E	O	O	O	O
Chromaticities of primaries	PrimaryChromaticities	319	13F	O	O	O	O
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	N	N	N	N
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	N	N	N	N
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	N	N	O	O
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	N	N	M	J
Y and C positioning	YCbCrPositioning	531	213	N	N	M	M
Pair of black and white reference values	ReferenceBlackWhite	532	214	O	O	O	O
Copyright holder	Copyright	33432	8298	O	O	O	O
Exif tag	Exif IFD Pointer	34665	8769	M	M	M	M
GPS tag	GPSInfo IFD Pointer	34853	8825	O	O	O	O

Notation
M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : Not recorded
J : Included in JPEG marker and so not recorded

Table 15 Tag Support Levels (2) - 0th IFD Exif Private Tags –

Tag Name	Field Name	Tag ID		Uncompressed			Compressed
		Dec	Hex	Chunky	Planar	YCC	
Exposure time	ExposureTime	33434	829A	R	R	R	R
F number	FNumber	33437	829D	O	O	O	O
Exposure program	ExposureProgram	34850	8822	O	O	O	O
Spectral sensitivity	SpectralSensitivity	34852	8824	O	O	O	O
ISO speed ratings	ISOSpeedRatings	34855	8827	O	O	O	O
Optoelectric coefficient	OECF	34856	8828	O	O	O	O
Exif Version	ExifVersion	36864	9000	M	M	M	M
Date and time original image was generated	DateTimeOriginal	36867	9003	O	O	O	O
Date and time image was made digital data	DateTimeDigitized	36868	9004	O	O	O	O
Meaning of each component	ComponentsConfiguration	37121	9101	N	N	N	M
Image compression mode	CompressedBitsPerPixel	37122	9102	N	N	N	O
Shutter speed	ShutterSpeedValue	37377	9201	O	O	O	O
Aperture	ApertureValue	37378	9202	O	O	O	O
Brightness	BrightnessValue	37379	9203	O	O	O	O
Exposure bias	ExposureBiasValue	37380	9204	O	O	O	O
Maximum lens aperture	MaxApertureValue	37381	9205	O	O	O	O
Subject distance	SubjectDistance	37382	9206	O	O	O	O
Metering mode	MeteringMode	37383	9207	O	O	O	O
Light source	LightSource	37384	9208	O	O	O	O
Flash	Flash	37385	9209	R	R	R	R
Lens focal length	FocalLength	37386	920A	O	O	O	O
Subject area	SubjectArea	37396	9214	O	O	O	O
Manufacturer notes	MakerNote	37500	927C	O	O	O	O
User comments	UserComment	37510	9286	O	O	O	O
DateTime subseconds	SubSecTime	37520	9290	O	O	O	O
DateTimeOriginal subseconds	SubSecTimeOriginal	37521	9291	O	O	O	O
DateTimeDigitized subseconds	SubSecTimeDigitized	37522	9292	O	O	O	O
Supported Flashpix version	FlashpixVersion	40960	A000	M	M	M	M
Color space information	ColorSpace	40961	A001	M	M	M	M
Valid image width	PixelXDimension	40962	A002	N	N	N	M
Valid image height	PixelYDimension	40963	A003	N	N	N	M
Related audio file	RelatedSoundFile	40964	A004	O	O	O	O
Interoperability tag	Interoperability IFD Pointer	40965	A005	N	N	N	O
Flash energy	FlashEnergy	41483	A20B	O	O	O	O
Spatial frequency response	SpatialFrequencyResponse	41484	A20C	O	O	O	O
Focal plane X resolution	FocalPlaneXResolution	41486	A20E	O	O	O	O
Focal plane Y resolution	FocalPlaneYResolution	41487	A20F	O	O	O	O
Focal plane resolution unit	FocalPlaneResolutionUnit	41488	A210	O	O	O	O
Subject location	SubjectLocation	41492	A214	O	O	O	O
Exposure index	ExposureIndex	41493	A215	O	O	O	O
Sensing method	SensingMethod	41495	A217	O	O	O	O
File source	FileSource	41728	A300	O	O	O	O
Scene type	SceneType	41729	A301	O	O	O	O
CFA pattern	CFAPattern	41730	A302	O	O	O	O
Custom image processing	CustomRendered	41985	A401	O	O	O	O
Exposure mode	ExposureMode	41986	A402	R	R	R	R
White balance	WhiteBalance	41987	A403	R	R	R	R
Digital zoom ratio	DigitalZoomRatio	41988	A404	O	O	O	O
Focal length in 35 mm film	FocalLengthIn35mmFilm	41989	A405	O	O	O	O
Scene capture type	SceneCaptureType	41990	A406	R	R	R	R
Gain control	GainControl	41991	A407	O	O	O	O
Contrast	Contrast	41992	A408	O	O	O	O
Saturation	Saturation	41993	A409	O	O	O	O
Sharpness	Sharpness	41994	A40A	O	O	O	O
Device settings description	DeviceSettingDescription	41995	A40B	O	O	O	O
Subject distance range	SubjectDistanceRange	41996	A40C	O	O	O	O
Unique image ID	ImageUniqueID	42016	A420	O	O	O	O

Notation
M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : Not recorded
J : Included in JPEG marker and so not recorded

Table 16 Tag Support Levels (3) - 0th IFD GPS Info Tags -

Tag Name	Field Name	Tag ID		Uncompressed			Comp-r essed
		Dec	Hex	Chunky	Planar	YCC	
GPS tag version	GPSVersionID	0	0	O	O	O	O
North or South Latitude	GPSLatitudeRef	1	1	O	O	O	O
Latitude	GPSLatitude	2	2	O	O	O	O
East or West Longitude	GPSLongitudeRef	3	3	O	O	O	O
Longitude	GPSLongitude	4	4	O	O	O	O
Altitude reference	GPSAltitudeRef	5	5	O	O	O	O
Altitude	GPSAltitude	6	6	O	O	O	O
GPS time (atomic clock)	GPSTimeStamp	7	7	O	O	O	O
GPS satellites used for measurement	GPSSatellites	8	8	O	O	O	O
GPS receiver status	GPSStatus	9	9	O	O	O	O
GPS measurement mode	GPSMeasureMode	10	A	O	O	O	O
Measurement precision	GPSDOP	11	B	O	O	O	O
Speed unit	GPSSpeedRef	12	C	O	O	O	O
Speed of GPS receiver	GPSSpeed	13	D	O	O	O	O
Reference for direction of movement	GPSTrackRef	14	E	O	O	O	O
Direction of movement	GPSTrack	15	F	O	O	O	O
Reference for direction of image	GPSImgDirectionRef	16	10	O	O	O	O
Direction of image	GPSImgDirection	17	11	O	O	O	O
Geodetic survey data used	GPSMapDatum	18	12	O	O	O	O
Reference for latitude of destination	GPSDestLatitudeRef	19	13	O	O	O	O
Latitude of destination	GPSDestLatitude	20	14	O	O	O	O
Reference for longitude of destination	GPSDestLongitudeRef	21	15	O	O	O	O
Longitude of destination	GPSDestLongitude	22	16	O	O	O	O
Reference for bearing of destination	GPSDestBearingRef	23	17	O	O	O	O
Bearing of destination	GPSDestBearing	24	18	O	O	O	O
Reference for distance to destination	GPSDestDistanceRef	25	19	O	O	O	O
Distance to destination	GPSDestDistance	26	1A	O	O	O	O
Name of GPS processing method	GPSProcessingMethod	27	1B	O	O	O	O
Name of GPS area	GPSAreaInformation	28	1C	O	O	O	O
GPS date	GPSDateStamp	29	1D	O	O	O	O
GPS differential correction	GPSDifferential	30	1E	O	O	O	O

Table 17 Tag Support Levels (4) - 0th IFD Interoperability Tag -

Tag Name Field Name		Tag ID		Uncompressed			Comp-r essed
		Dec	Hex	Chunky	Planar	YCC	
Interoperability Identification	InteroperabilityIndex	1	1	N	N	N	O

Notation
M : Mandatory (shall be recorded)
R : Recommended
O : Optional
N : Not recorded
J : Included in JPEG marker and so not recorded

B. Thumbnail (1st IFD) Support Levels

The support levels of thumbnail (1st IFD) tags are shown in Table 18.

Table 18 Tag Support Levels (5) - 1st IFD TIFF Tag –

Tag Name	Field Name	Tag ID		Uncompressed			Comp-ressed
		Dec	Hex	Chunky	Planar	YCC	
Image width	ImageWidth	256	100	M	M	M	J
Image height	ImageLength	257	101	M	M	M	J
Number of bits per component	BitsPerSample	258	102	M	M	M	J
Compression scheme	Compression	259	103	M	M	M	M
Pixel composition	PhotometricInterpretation	262	106	M	M	M	J
Image title	ImageDescription	270	10E	O	O	O	O
Manufacturer of image input equipment	Make	271	10F	O	O	O	O
Model of image input equipment	Model	272	110	O	O	O	O
Image data location	StripOffsets	273	111	M	M	M	N
Orientation of image	Orientation	274	112	O	O	O	O
Number of components	SamplesPerPixel	277	115	M	M	M	J
Number of rows per strip	RowsPerStrip	278	116	M	M	M	N
Bytes per compressed strip	StripByteCounts	279	117	M	M	M	N
Image resolution in width direction	XResolution	282	11A	M	M	M	M
Image resolution in height direction	YResolution	283	11B	M	M	M	M
Image data arrangement	PlanarConfiguration	284	11C	O	M	O	J
Unit of X and Y resolution	ResolutionUnit	296	128	M	M	M	M
Transfer function	TransferFunction	301	12D	O	O	O	O
Software used	Software	305	131	O	O	O	O
File change date and time	DateTime	306	132	O	O	O	O
Person who created the image	Artist	315	13B	O	O	O	O
White point chromaticity	WhitePoint	318	13E	O	O	O	O
Chromaticities of primaries	PrimaryChromaticities	319	13F	O	O	O	O
Offset to JPEG SOI	JPEGInterchangeFormat	513	201	N	N	N	M
Bytes of JPEG data	JPEGInterchangeFormatLength	514	202	N	N	N	M
Color space transformation matrix coefficients	YCbCrCoefficients	529	211	N	N	O	O
Subsampling ratio of Y to C	YCbCrSubSampling	530	212	N	N	M	J
Y and C positioning	YCbCrPositioning	531	213	N	N	O	O
Pair of black and white reference values	ReferenceBlackWhite	532	214	O	O	O	O
Copyright holder	Copyright	33432	8298	O	O	O	O
Exif tag	Exif IFD Pointer	34665	8769	O	O	O	O
GPS tag	GPSInfo IFD Pointer	34853	8825	O	O	O	O

Notation
M : Mandatory (must be recorded)
R : Recommended
O : Optional
N : Not recorded
J : Included in JPEG marker and so not recorded

4.7 JPEG Marker Segments Used in Exif

In addition to the compressed data (Interoperability coded data), a compressed file contains one each of the marker segments APP1, DQT, DHT, SOF and SOS. The compressed data begins with an SOI and ends with an EOI marker. A restart marker (DRI, RSTm) may be inserted optionally. Another option is to have two or more APP2 marker segments. APPn other than APP1 and APP2 or COM segments are not used by Exif. However Exif readers should be designed skip over unknown APPn and COM.

APP1 shall be recorded immediately after SOI, and if there is an APP2 it follows after APP1. DQT, DHT, DRI and SOF come after APP2 and before SOS, in any order.

The marker segments used in Exif are listed in Table 18.

Table 18 Marker Segments

	Marker Name	Marker Code	Description
SOI	Start of Image	FFD8.H	Start of compressed data
APP1	Application Segment 1	FFE1.H	Exif attribute information
APP2	Application Segment 2	FFE2.H	Exif extended data
DQT	Define Quantization Table	FFDB.H	Quantization table definition
DHT	Define Huffman Table	FFC4.H	Huffman table definition
DRI	Define Restart Interoperability	FFDD.H	Restart Interoperability definition
SOF	Start of Frame	FFC0.H	Parameter data relating to frame
SOS	Start of Scan	FFDA.H	Parameters relating to components
EOI	End of Image	FFD9.H	End of compressed data

The data structures of markers defined in JPEG Baseline DCT and used in Exif compressed files, as well as the APP1 and APP2 data structures defined specifically for this standard, are explained below.

4.7.1 JPEG Marker Segments

The data structure of JPEG marker segments other than APP1 and APP2 is noted below.

A. Start of compressed data (SOI: Start of Image)

SOI is a marker code indicating the start of compressed data (see Figure 18).

Address Offset (Hex)	Code (Hex)	Meaning
+00	FF	Marker Prefix
+01	D8	SOI

Figure 18 SOI Structure

B. Quantization table definition (DQT: Define Quantization Table)

DQT is a marker code defining a quantization table.

As many as three kinds of tables may be recorded with a precision of 8 bits (Pq=0). All quantization tables shall be defined in one DQT marker segment; recording of multiple DQT markers is not allowed. The table may have any values (see Figure 19). DQT, DHT, DRI and SOF may line up in any order, but shall be recorded after APP1 (or APP2 if any) and before SOS.

Address Offset (Hex)	Code (Hex)	Meaning
+00	FF	Marker Prefix
+01	DB	DQT
+02	00 C5	Length of field 2+(1+64)*3=197 (Bytes)
+04	00	Y: Pq=0, Nq=0
+05	: : : :	Quantization table Y:Q0 : : Quantization table Y:Q63
+45	01	Cb: Pq=0, Nq=1
+46	: : : :	Quantization table Cb:Q0 : : Quantization table Cb:Q63
+86	02	Cr: Pq=0, Nq=1
+87	: : : :	Quantization table Cr:Q0 : : Quantization table Cr:Q63

Figure 19 DQT Structure (with three quantization tables)

	ICRD-ck	005A	ckID	ICRD	49435244
		005E	ckSize		0B000000
		0062	ckData	(August 11, 1997)	"1997-08-11"0000
	IART-ck	006E	ckID	IART	49415254
		0072	ckSize		0E000000
		0076	ckData	(creator)	"Hanako Yamada"00
	ICOP-ck	0084	ckID	ICOP	49434F50
		0088	ckSize		17000000
		008C	ckData	(copyright)	"Copyright XYZ on 1997."0000
exif-LIST		00E2	ckID	LIST	4C495354
		00E6	ckSize		94000000
		00EA	listType	exif	65786966
	ever-ck	00A4	ckID	LIST	4C495354
		00A8	ckSize		78000000
		00AC	listType	exif	65786966
	erel-ck	00BC	ckID	erel	6572656C
		00C0	ckSize		0D000000
		00C4	ckData	(relation to Exif image file)	"DSC00001.JPG"0000
	etim-ck	00D2	ckID	etim	6574696D
		00D6	ckSize		0D000000
		00DA	ckData	(15:14:13.135)	"15:14:13.135"0000
	ecor-ck	00E8	ckID	ecor	65636F72
		00EC	ckSize		1E000000
		00F0	ckSize	(equipment manufacturer)	"DSC Interoperability Corporation"00
	emdl-ck	010E	ckID	emdl	656D646C
		0112	ckSize		0D000000
		0116	ckData	(equipment model)	"DSC Camera-2"0000
data-ck					
		0124	ckID	data	64617461
		0128	ckSize		008C0000
		012C	ckData		.....

(Total bytes = 35840)

Annex C

APEX Units

The camera information in this standard conforms to the APEX (Additive System of Photographic Exposure) unit system. APEX is a convenient unit for expressing exposure (Ev). The relation of APEX to other units is essentially as follows.

b) ApertureValue (Av) = 2 $\log_2$ (F number)

c) ShutterSpeedValue (Tv) = - $\log_2$ (exposure time)

d) BrightnessValue (Bv) = $\log_2$ (B/NK)Note that: B:cd/cm^2, N,K: constant

Film sensitivity (not used in this standard) is expressed as follows.

e) Film sensitivity (Sv) = $\log_2$ (ASA / 3.125)

Using these values, exposure (Ev) is calculated as follows.

f) Ev = Av + Tv = Bv + Sv

The table below gives examples of values actually used as camera information.

Table 48 Typical APEX Values

ApertureValue (APEX)	F-Number
0	1
1	1.4
2	2
3	2.8
4	4
5	5.6
6	8
7	11
8	16
9	22
10	32

ShutterSpeed Value (APEX)	ExposureTime (second)
-5	30
-4	15
-3	8
-2	4
-1	2
0	1
1	1/2
2	1/4
3	1/8
4	1/15
5	1/30
6	1/60
7	1/125
8	1/250
9	1/500
10	1/1000
11	1/2000

BrightnessValue (APEX)	foot lambert
-2	1/4
-1	1/2
0	1
1	2
2	4
3	8
4	15
5	30

Annex D

Recommended Implementation Examples

See the DCF Standard (JEIDA-49-2).

Annex E

Color Space Guidelines

sRGB defines standard monitor color characteristics and viewing environment. The images taken and processed by a DSC should be designed on the premise of being reproduced and viewed in accord with those definitions.

In reality, the recorded data is often saved in a YCC color space because of JPEG compression. It is therefore necessary to clarify the relationship between the above sRGB color space and YCC color space. A definition of this relationship is to be found in the sYCC standard (for which standardization is being advanced in the IEC), and the present standard uses this as reference. One result of referring to the sYCC standard is that colors outside the sRGB color space are included.

Annex F

Notes on Conversion to Flashpix

The data recording method in this standard makes it possible to convert from Exif to Flashpix format with no loss of image quality, and retaining all attribute information. A file that is thus designed from the start for conversion to Flashpix is called a Flashpix-Ready (FPXR) file.

There are three main Flashpix-Ready functions:

g) All Exif tag information is mapped to the Flashpix Image Info Property Set,

h) APP2 extended data can be converted to Flashpix extensions,

i) JPEG images can be converted to the Flashpix tile structure without image quality loss, making use of restart markers.

Figure 53 illustrates the conversion process.

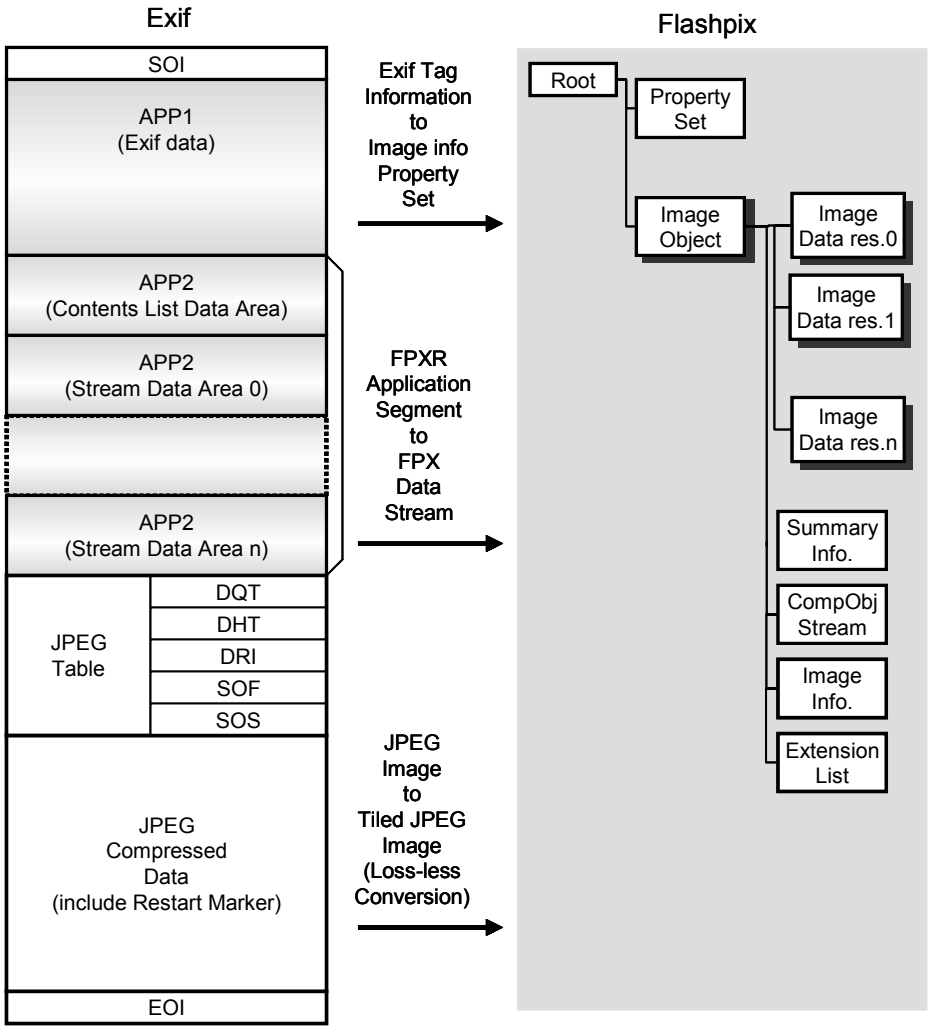

Figure 53 Conversion from Exif to Flashpix

F.1 Converting Image Data

Flashpix compressed image data consists of JPEG-compressed 64 x 64-pixel tiles. Converting JPEG images without restart markers to Flashpix images requires that the JPEG data be expanded and re-compressed, which can lead to image quality loss. By inserting restart markers at 64-pixel Interoperability, Flashpix images of the maximum resolution can be generated simply by rearranging the JPEG-compressed data.

Figure 54 shows how compressed data is rearranged using restart markers.

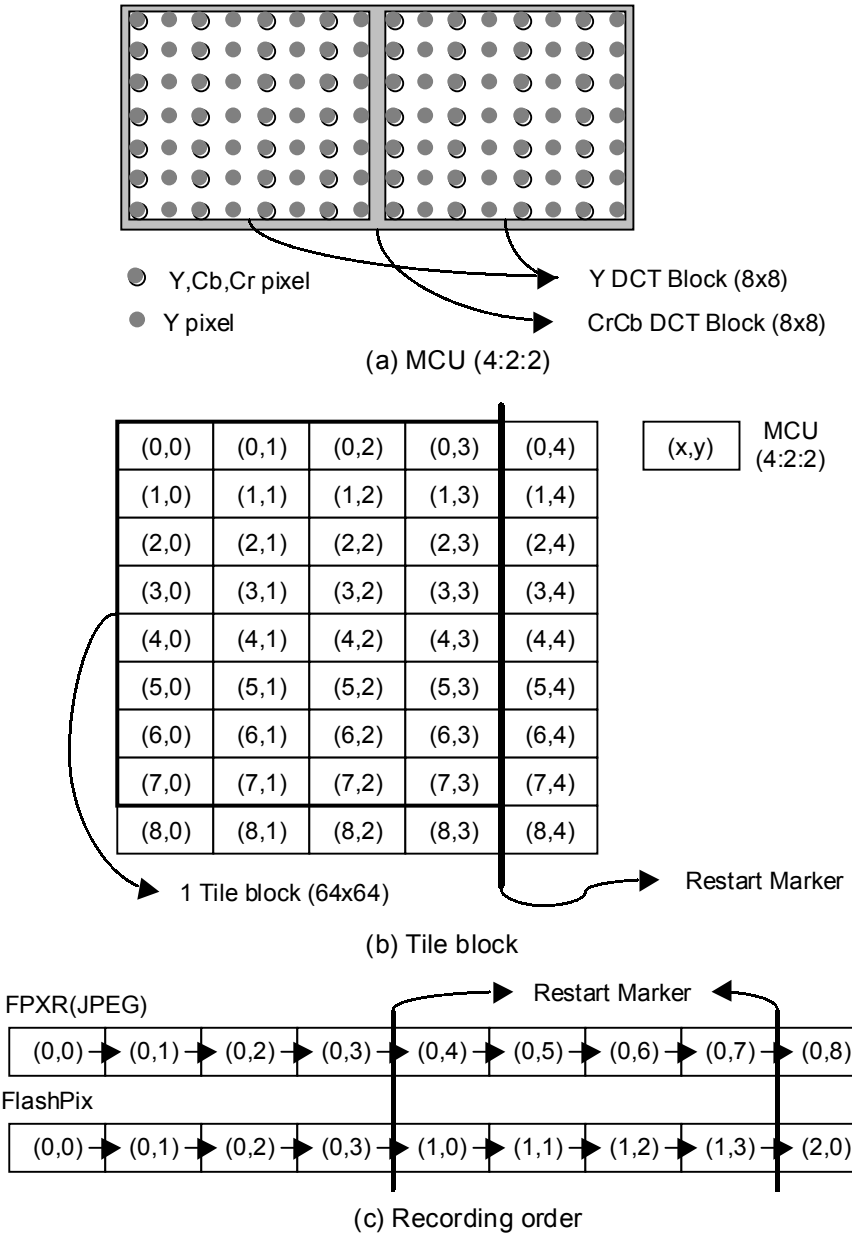

Figure 54 Conversion to Flashpix Using Restart Markers

Recording of restart markers is optional, and conversion to Flashpix is possible without them; but conversion without restart markers may result in some image quality loss and require a longer processing time.

In order for restart markers to be inserted at 64-pixel Interoperability, the image data width shall be an exact multiple of 64. Therefore the valid image width is recorded as tag information (*PixelXDimension*), and the JPEG compressed data is recorded with the valid image padded to the right to make it an exact multiple of 64 (see section 4.8.1).

As in the Flashpix standard, padding is used where necessary to achieve exact multiples of 64; and when converting to Flashpix, the padding data on the right can be treated in the same way as valid image data.

If the image height is not an exact multiple of 64, Exif files are not padded; so when converting to Flashpix it is necessary to pad the bottom edge of the image.

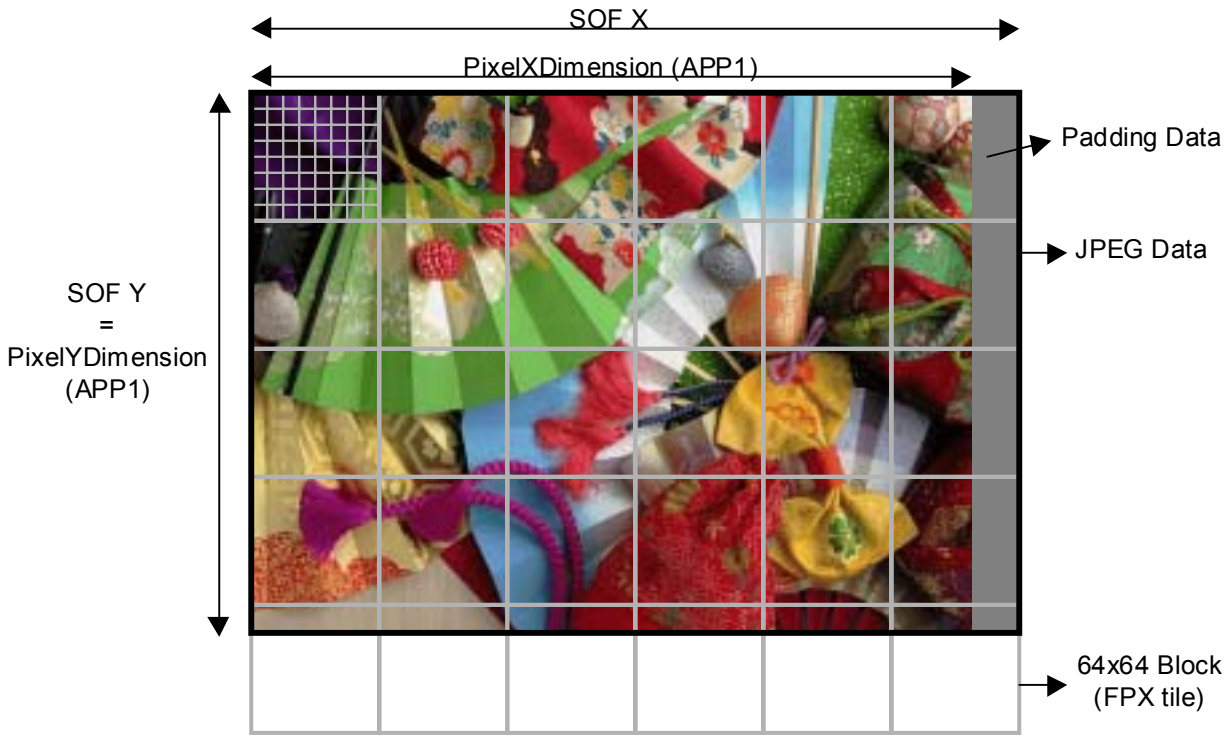

Figure 55 Image Size Restrictions

F.2 Converting Tag Data

When Exif attribute information is converted to Flashpix, a one-to-one conversion can be made to the Property Set used to record Flashpix attributes. The rules for converting from each kind of Exif tag to the Flashpix PropertySet are given in the tables below (conversion of GPS Info tags is to be determined later).

Table 49 Conversion between Exif Tags and Flashpix Property Set (1) (TIFF Tags)

Exif			FPX		
Field Name	Tag Code		Property Set	Group	Name
	Dec	Hex			
ImageWidth	256	100	-	-	-
ImageLength	257	101	-	-	-
BitsPerSample	258	102	-	-	-
Compression	259	103	-	-	-
PhotometricInterpretation	262	106	-	-	-
ImageDescription	270	10E	Image Info	Content Description	Caption text
Make	271	10F	Image Info	Camera Information	Camera manufacturer name
Model	272	110	Image Info	Camera Information	Camera model name
StripOffsets	273	111	-	-	-
Orientation	274	112	Transform	-	Spatial Orientation
SamplesPerPixel	277	115	-	-	-
RowsPerStrip	278	116	-	-	-
StripByteCounts	279	117	-	-	-
XResolution	282	11A	Image Contents	Primary description	Default display width
YResolution	283	11B	Image Contents	Primary description	Default display height
PlanarConfiguration	284	11C	-	-	-
ResolutionUnit	296	128	Image Contents	Primary description	Display height/width units
TransferFunction	301	12D	-	-	-
Software	305	131	Image Info	File source	Software Name
DateTime	306	132	Ignore	Ignore	Ignore
Artist	315	13B	Image Info	Intellectual Property	Authorship
WhitePoint	318	13E	-	-	-
PrimaryChromaticities	319	13F	-	-	-
YCbCrCoefficients	529	211	-	-	-
YCbCrSubSampling	530	212	-	-	-
YCbCrPositioning	531	213	Ignore	Ignore	Ignore
ReferenceBlackWhite	532	214	-	-	-
Copyright	33432	8298	Image Info	Intellectual Property	Copyright message
Exif IFD Pointer	34665	8769	-	-	-
GPS Info IFD Pointer	34853	8825	-	-	-

Table 50 Conversion between Exif Tags and Flashpix Property Set (2) (Exif Private Tags)

Exif			FPX		
Field Name	Tag Code		Property Set	Group	Name
	Dec	Hex			
ExposureTime	33434	829A	Image Info	Per Picture Camera Setting	Exposure time
FNumber	33437	829D	Image Info	Per Picture Camera Setting	F-number
ExposureProgram	34850	8822	Image Info	Per Picture Camera Setting	Exposure program
SpectralSensitivity	34852	8824	Image Info	Digital Camera Characterization	Spectral sensitivity
ISOSpeedRatings	34855	8827	Image Info	Digital Camera Characterization	ISO speed ratings
OECF	34857	8829	Image Info	Digital Camera Characterization	OECF
ExifVersion	36864	9000	-	-	-
DateTimeOriginal	36867	9003	Image Info	Content Description	Date of the original image
			Image Info	Per Picture Camera Setting	Capture date
DateTimeDigitized	36868	9004	Summary Info	-	Create date/time
ComponentsConfiguration	37121	9101	Ignore	Ignore	Ignore
CompressedBitsPerPixel	37122	9102	Ignore	Ignore	Ignore
ShutterSpeedValue	37377	9201	Image Info	Per Picture Camera Setting	Exposure time
ApertureValue	37378	9202	Image Info	Per Picture Camera Setting	F-number
BrightnessValue	37379	9203	Image Info	Per Picture Camera Setting	Brightness value
ExposureBiasValue	37380	9204	Image Info	Per Picture Camera Setting	Exposure bias value
MaxApertureValue	37381	9205	Image Info	Per Picture Camera Setting	Maximum aperture value
SubjectDistance	37382	9206	Image Info	Per Picture Camera Setting	Subject distance
MeteringMode	37383	9207	Image Info	Per Picture Camera Setting	Metering mode
LightSource	37384	9208	Image Info	Per Picture Camera Setting	Scene illuminant
Flash	37385	9209	Image Info	Per Picture Camera Setting	Flash
			Image Info	Per Picture Camera Setting	Flash return
FocalLength	37386	920A	Image Info	Per Picture Camera Setting	Focal length
MakerNote	37500	927C	-	-	-
UserComment	37510	9286	Image Info	Content description	Content description note
SubSecTime	37520	9290	Ignore	Ignore	Ignore
SubSecTimeOriginal	37521	9291	Image Info	Content Description	Date of the original image
			Image Info	Per Picture Camera Setting	Capture date
SubSecTimeDigitized	37522	9292	Summary Info	-	Create date/time
FlashpixVersion	40960	A000	-	-	-
ColorSpace	40961	A001	Image Contents	resolution description	Subimage color
PixelXDimension	40962	A002	Image Contents	Primary description	Highest resolution width
PixelYDimension	40963	A003	Image Contents	Primary description	Highest resolution height
RelatedSoundFile	40964	A004	-	-	-
FlashEnergy	41483	A20B	Image Info	Per Picture Camera Setting	Flash Energy
SpatialFrequencyResponse	41484	A20C	Image Info	Digital Camera Characterization	Spatial frequency response
FocalplaneXResolution	41486	A20E	Image Info	Digital Camera Characterization	Focal plane X resolution
FocalplaneYResolution	41487	A20F	Image Info	Digital Camera Characterization	Focal plane Y resolution
FocalplaneResolutionUnit	41488	A210	Image Info	Digital Camera Characterization	Focal plane resolution unit
SubjectLocation	41492	A214	Image Info	Per Picture Camera Setting	Subject location
ExposureIndex	41493	A215	Image Info	Per Picture Camera Setting	Exposure index
SensingMethod	41495	A217	Image Info	Digital Camera Characterization	Sensing method
FileSource	41728	A300	Image Info	File Source	File source
SceneType	41729	A301	Image Info	File Source	Scene type
CFAPattern	41730	A302	Image Info	Digital Camera Characterization	CFA pattern

Table 51 Conversion between Exif Tags and Flashpix Property Set (3) (GPS Info Tags)

Exif			FPX		
Field Name	Tag Code		Property Set	Group	Name
	Dec	Hex			
GPSVersionID	0	0	GPS Info extension	-	GPSVersionID
GPSLatitudeRef	1	1	GPS Info extension	-	GPSLatitudeRef
GPSLatitude	2	2	GPS Info extension	-	GPSLatitude
GPSLongitudeRef	3	3	GPS Info extension	-	GPSLongitudeRef
GPSLongitude	4	4	GPS Info extension	-	GPSLongitude
GPSAltitudeRef	5	5	GPS Info extension	-	GPSAltitudeRef
GPSAltitude	6	6	GPS Info extension	-	GPSAltitude
GPSTimeStamp	7	7	GPS Info extension	-	GPSTimeStamp
GPSSatellites	8	8	GPS Info extension	-	GPSSatellites
GPSStatus	9	9	GPS Info extension	-	GPSStatus
GPSMeasureMode	10	A	GPS Info extension	-	GPSMeasureMode
GPSDOP	11	B	GPS Info extension	-	GPSDOP
GPSSpeedRef	12	C	GPS Info extension	-	GPSSpeedRef
GPSSpeed	13	D	GPS Info extension	-	GPSSpeed
GPSTrackRef	14	E	GPS Info extension	-	GPSTrackRef
GPSTrack	15	F	GPS Info extension	-	GPSTrack
GPSImgDirectionRef	16	10	GPS Info extension	-	GPSImgDirectionRef
GPSImgDirection	17	11	GPS Info extension	-	GPSImgDirection
GPSMapDatum	18	12	GPS Info extension	-	GPSMapDatum
GPSDestLatitudeRef	19	13	GPS Info extension	-	GPSDestLatitudeRef
GPSDestLatitude	20	14	GPS Info extension	-	GPSDestLatitude
GPSDestLongitudeRef	21	15	GPS Info extension	-	GPSDestLongitudeRef
GPSDestLongitude	22	16	GPS Info extension	-	GPSDestLongitude
GPSDestBearingRef	23	17	GPS Info extension	-	GPSDestBearingRef
GPSDestBearing	24	18	GPS Info extension	-	GPSDestBearing
GPSDestDistanceRef	25	19	GPS Info extension	-	GPSDestDistanceRef
GPSDestDistance	26	1A	GPS Info extension	-	GPSDestDistance

F.3 Converting to Flashpix Extensions (APP2)

The extended data recorded in APP2 marker segments can be converted readily to Flashpix extensions.

First of all, Figure 56 shows the conversion process when APP2 is recorded as one Interoperability per stream of data.

An area with data size of 8000.H, Default value 00.H is allocated to the stream name "/¥005MyPropertySet" (¥005 means 005.H) in the Flashpix file Structured Storage structure, and the stream data recorded in APP2-2 is copied to offset 00000000.H, that is, the start of the allocated area.

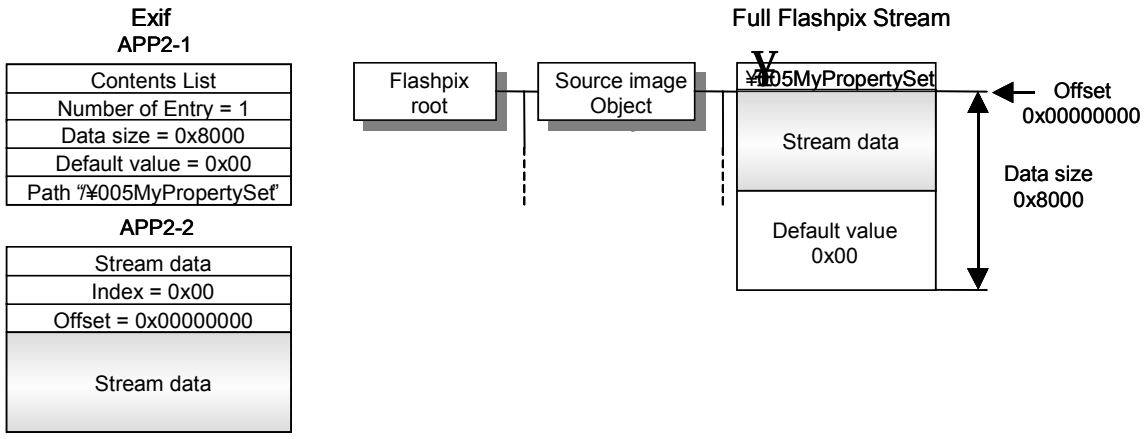

Figure 56 Conversion to Flashpix Extensions (1)

Next, Figure 57 shows the conversion process when one Interoperability per two streams of data is recorded in APP2.

This time an area with data size of 10000.H, Default value 00.H is allocated to the stream name "/¥005MyPropertySet" in the Flashpix file Structured Storage structure, and the stream data recorded in APP2-2 is copied to offset 00000000.H, that is, the start of the allocated area, while the stream data recorded in APP2-3 is copied starting from offset 00008000.H.

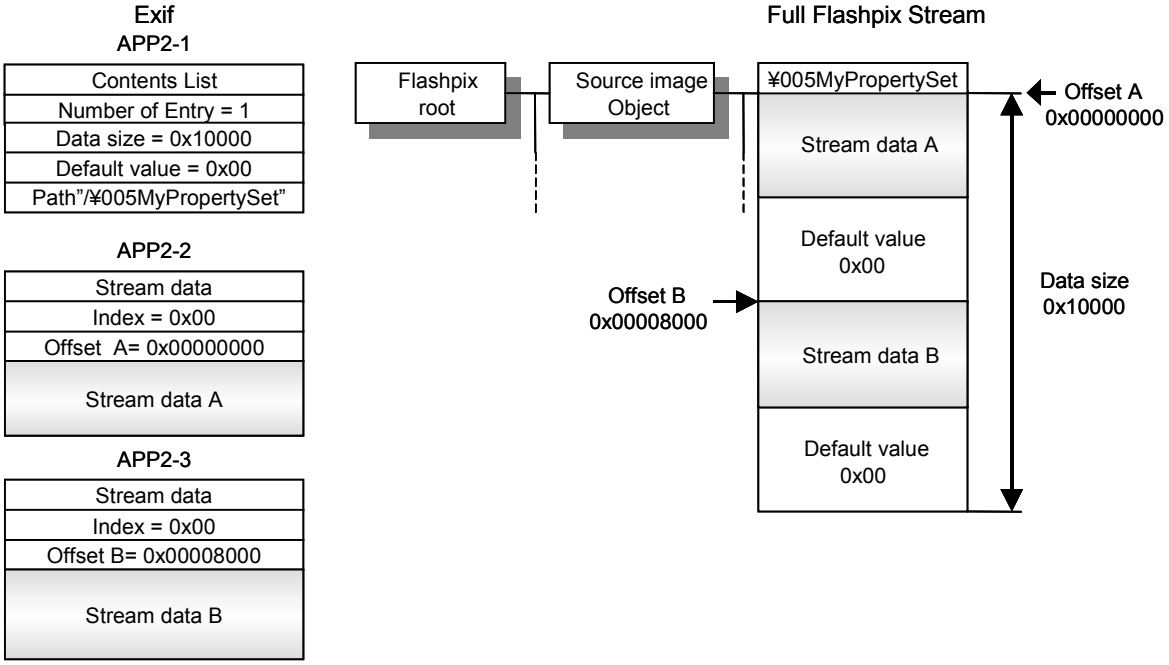

Figure 57 Conversion to Flashpix Extensions (2)

Finally, Figure 58 shows an example of conversion when 2 Interoperability per stream of data are recorded in APP2.

Here a data size of 8000.H, Default value 00.H is allocated to the stream name "MyPropertySet" Interoperability the storage name "¥005MyStorage" in the Flashpix file Structured Storage structure, and the stream data recorded in APP2-2 is copied to offset 00000000.H, that is, the start of the allocated area.

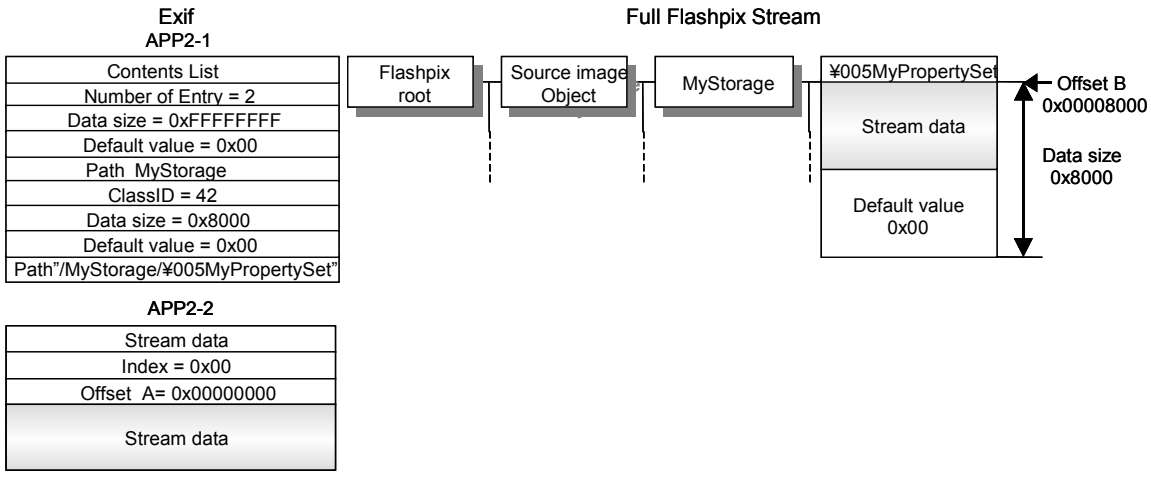

Figure 58 Conversion to Flashpix Extensions (3)

Explication of Exchangeable image file format for digital still cameras: Exif Version 2.2

This document provides explanatory information on the latest revision to the Exif Standard, Version 2.2. This document includes explanations referring to the definitions in the Exif Standard, reference material in relation to the standard, and information in relation to the development of the standard. This document is entirely informative and shall not be considered as an integral part of the Exif Standard.

1. Purpose of the Revised Edition

The digital still camera image file format standard, commonly referred to as Exif, is widely used as an international standard for digital still cameras (DSC), and in many other fields in addition to DSC. Recent technology advancements in both DSC resolution and print quality have brought demands for simpler, higher-quality printer output. The revised Exif Standard addresses these needs by adding new tags to record information considered to be useful for printer output processing, additional GPS information, and making other minor additions and changes to the existing Exif Standard Version 2.1.

2. History of Revisions

Exif Standard Version 1.0 was issued on October 1995 as a standard of the then Japan Electronics Industry Development Association (JEIDA). The most recent version, Exif Standard Version 2.1, was issued on July 1998 with additional tag information and recording format options. The DCF Standard, defining camera file system standards to enable image files to be exchanged among different recording media, was standardized in December 1998 as a companion to the Exif Standard. The main features defined in each of the Exif Standard versions are summarized below.

a) Exif Standard Version 1.0 — Specification of image data format, tag information structure and basic tag definitions.

b) Exif Standard Version 2.0 — Addition of sRGB color space, compressed thumbnails, and audio files.

c) Exif Standard Version 2.1 — Addition of interoperability tag.

d) DCF Standard Version 1.0 — Specification of directory structure, file naming, and image playback scope.

Thereafter the Japan Electronics and Information Technology Industries Association (JEITA), formed by the merger of JEIDA and the Electronic Industry Association of Japan (EIAJ), requested further deliberations by the Digital Still Camera Committee, a DSC Format WG of the Japan Camera Industry Association (JCIA). The first meeting was held on September 13, 2001 to determine the role, objectives and schedule of the committee. The committee resolved to follow the basic design principle of previous Exif Standards, which was based on monitor-oriented image quality design, though setting the primary objective of this revision to extended the tag definition to allow information useful when processing to be recorded by a DSC for printer output. This was to improve the image quality of printer output and other devices in addition to monitors. The committee further resolved to accept proposals to add tag information that were not necessarily in scope of the primary objective when there was a request. Given the strong desire to complete the revised standard at an early date, the timeline was set for

completing the main deliberations by the end of 2001 and issuing the standard by the end of February, 2002.

At the second meeting held on October 2, 2001, proposals were submitted by two member companies, followed by questions and answers. The third (October 24, 2001) and fourth (November 6, 2001) meetings were devoted to discussions on the two proposals. A new proposal was presented, incorporating the advantages of both proposals, at the fifth meeting on November 22, 2001, and this new proposal became the basis for detailed studies thereafter. Also at this meeting, the version number was resolved to be "Version 2.2", based on the nature of the revisions.

At the sixth meeting (December 11, 2001), the level of DSC writer support (i.e. Mandatory, Recommended, Optional) was resolved for the newly added tags and existing tags that can be used for the primary objectives of this revision were reexamined. At the seventh meeting (December 26, 2001), details of the DSC Format WG Specification draft were reviewed and revised as appropriate. It was further resolved to document guidelines, entitled "Guidelines for Implementing Exif 2.2 Tag Information", applicable to the new and existing tags that were deliberated for this version. These guidelines are appended as Chapter 0 to this Explication. Finally, at the eighth meeting, held January 21, 2002, details of the specification organization and guidelines were confirmed and approved.

3. Main Issues Arising in the Deliberations

3.1 Summary of the Discussions

The image quality produced by a DSC and those of a printer are based on vendor dependent technologies that are not suitable as being specified in a standard. Therefore, the goal of this standardization effort was to enable improved print quality when print processing is applied to an image data after being processed by each vendor's DSC. Previously, under some conditions, the user's expectations were not always met. To this end, a policy was adopted of having the DSC provide as much capture information as possible as an aid to improving print quality. Of the initial proposals, one was to record tag information mainly for print image processing, while the other took the approach of recording DSC capture information and having the printer interpret it. It was resolved by the committee to use the latter approach as the basis of deliberations thereafter, since it has more general applicability, though incorporate useful elements of the former proposal as appropriate.

3.2 Tag Information

In general, there are limits to the precision of the capture information that can be measured by a DSC. As such, if the information defined were to have strict values, suitable information may not always be obtained. Therefore, the definitions in this standard were made somewhat general so that various DSC models will be able to record its capture conditions.

4. Main Revisions

The tag information added for this revision are listed in section4.1. Existing tags that have undergone significant revision are given in section 4.2.

4.1 Newly added tag information

a) SubjectArea

b) CustomRendered

c) ExposureMode

d) WhiteBalance

e) DigitalZoomRatio

f) FocalLengthIn35mmfilm

g) SceneCaptureType

h) GainControl

i) Contrast

j) Saturation

k) Sharpness

l) DeviceSettingDescription

m) SubjectDistanceRange

n) ImageUniqueID

o) GPSProcessingMethod

p) GPSAreaInformation

q) GPSDateStamp

r) GPSDifferential

4.2 Changed tag information

a) LightSource

b) Flash

5. Industrial Properties Rights

The companies listed below have declared that they hold the patent right(s) shown below, which include issued patents and pending patent applications, and have announced that they will grant a license to these patents under reasonable and non-discriminatory terms and conditions for products which conform to the JEITA standard "Exchangeable image file format for digital still cameras: Exif Version 2.2". Such licenses should be negotiated with each patent holder.

- Eastman Kodak Company	JAPAN	3072852, 1932572, 11-60620(pending application)
	US	6310647, 5983229, 5696850, 5164831, 4811042, 4652104, 09/950199(pending application)
	France	472699, 206070
	UK	472699, 206070
	Germany	69119847, 3686512
- FUJI PHOTO FILM CO., LTD.	JAPAN	2131338, 2625012, 2938875
- KYOCERA CORPORATION	JAPAN	3035391, 3103442, 3103437, 3124600
- Matsushita Electric Industrial Co., Ltd.	US	5581362
- OLYMPUS OPTICAL CO.,LTD.	JAPAN	7-2700888(application number)
- RICOH COMPANY, LTD.	JAPAN	9-61924(pending application)
- Sony Corporation	JAPAN	2001-046407(application number), 2001-228236(application number)

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. JEITA shall not be held responsible for any or all such patent rights.

6. The DCF Standard

The DCF Standard, as noted in Chapter 2, is closely tied to the Exif Standard. With this revision of the Exif Standard, applicable Exif versions noted in the DCF Standard shall be interpreted as below. The contents of the DCF Standard itself shall not change.

a) "Background to this standard recommendation"
Change to read "*1) Exif Version 2.1 Digital Still Camera Image File Format Standard (Exif) Version 2.1 and Exif Version 2.2 Digital Still Camera Image File Format Standard (Exif) Version 2.2, Japan Electronics and Information Technology Industries Association."

b) 1.3. Glossary, Exif Standard
Change to read "*1) Exif Version 2.1 Digital Still Camera Image File Format Standard (Exif) Version2.1 and Exif Version 2.2 Digital Still Camera Image File Format Standard (Exif) Version 2.2, Japan Electronics and Information Technology Industries Association."

c) 3.3.1. Purpose
Change to read "Exif Version 2.1 or Exif Version 2.2."

d) Annex C, Fig. C-1
Change to read "Exif Version2.1 conformant or Exif Version 2.2 conformant."

7. Guidelines for Implementing Exif 2.2 Tag Information

7.1 General

This chapter gives guidelines for implementing and using the tags defined by the Exif Standard that are of use in print processing (e.g. image retouching). Writers should record these tags as indicated in these guidelines. Readers can make use of the information recorded in Exif file tags in order to perform optimal image processing. Note that the output processing indicated here for readers are given for the sake of example. Examples of tag handling by application software are also given, in section 7.4 Application Software Guidelines.

Tag IDs and values are given in the explanations. For details, refer to the Exif Standard.

7.2 Definitions

Key terms used in this document are defined as follows.

a) Writer: A digital still camera (DSC) or other device or application software that can output an Exif file.

b) Reader: A device, such as a printer with memory card slot, capable of directly reading an Exif file and printing or performing other output processing, as well as application software that uses Exif tags to perform image processing for output.

c) Tag Information: A description of the tag contents. The tag definitions are given in the main specification.

7.3 Tag Use in Readers

Readers can make use of the information recorded as tags in an Exif file to perform optimal image processing. The following tags are useful for photo retouch processing and their use is to be encouraged whenever possible.

a) ExposureMode

b) WhiteBalance

c) Flash

d) SceneCaptureType

e) ExposureTime

f) CustomRendered

7.3.1 ExposureTime

Tag Information

Exposure time, given in seconds (sec).

[Reader]

－When exposure time is unusually long, the reader can assume the possibility of noise occurring.

－Other tags (brightness, shutter speed, gain control, captured scene type, etc.) may be used as supplementary information.

7.3.2 BrightnessValue

Tag Information

The value of brightness. The unit is the APEX value.

[Writer]

－The writer should record the brightness of the presumed main subject. When flash is used, the brightness level before firing should be recorded.

[Reader]

－The reader may judge the possibility of noise occurring from very low light conditions.

－This tag may be used to determine the weather conditions, etc., in daylight shooting.

7.3.3 LightSource

Tag Information

Indicates the kind of light source.

[Writer]

－The writer should record the light source as estimated by the writer based on white balance, etc., or as set by the user.

－This will sometimes differ from the actual light source used for shooting

[Reader]

－This information may be referred to when adjusting white balance.

7.3.4 Flash

Tag Information

This tag indicates the flash status when the picture was taken.

[Writer]

－The red-eye bit indicates whether the flash was fired for the purpose of red-eye reduction, including pre-flash.

[Reader]

－This tag can be used along with subject distance range (or subject distance), scene type and brightness to determine whether suitable exposure is possible.

7.3.5 SubjectArea

Tag Information

This tag indicates the location and area of the main subject in the overall scene.

[Writer]

－The writer should record a subject area that is large enough to enable the reader to determine the subject, preferably at least one percent of the total image area.

[Reader]

－A reader can refer to this information as the area for image optimization processing.

7.3.6 CustomRendered

Tag Information

This tag indicates the use of special processing on image data, such as rendering geared to output. When special processing is performed, the reader is expected to disable or minimize any further processing.

[Writer]

－For ordinary shooting this is set to 0 (normal process). If the writer applies special processing such as monochrome mode or sepia mode, and it is desired to prevent or minimize automatic adjustment by the reader, a value of 1 is set (custom process).

[Reader]

－When a value of 1 (custom process) is set, the reader determines that the image has already been specially processed, and should either disable or reduce any further processing in order to prevent double processing.

7.3.7 ExposureMode

Tag Information

This tag indicates the exposure mode set when the image was shot.

[Writer]

－If shutter speed and aperture were set by the user, the writer sets a value of 1 (manual exposure); if auto-bracketing was set, a value of 2 (auto bracket) is recorded.

－When exposure bias was set, it is up to the writer whether to record 0 (auto exposure) or 1 (manual exposure).

[Reader]

－When a value of 0 (auto exposure) is set, a reader should perform automatic adjustment of exposure settings.

－When a value of 1 (manual exposure) or 2 (auto bracketing) is set, the reader should either not perform automatic bias or should reduce the amount of bias.

7.3.8 WhiteBalance

Tag Information

This tag indicates the white balance set when the image was shot.

[Writer]

－If white balance is determined automatically, 0 (auto white balance) is recorded.

－If preset, custom setting, or while balance auto-bracketing is set, 1 (manual white balance) is recorded.

[Reader]

－If 0 (auto white balance) is recorded, color balance should be adjusted automatically. The reader may use the light source tag as additional information when performing the adjustment.

－If 1 (manual white balance) is indicated, either normal color balance should not be adjusted automatically or the adjustment level should be reduced.

7.3.9 DigitalZoomRatio

Tag Information

This tag indicates the digital zoom ratio when the image was shot.

[Reader]

－This information can be used as additional information for zoom processing when converting resolution.

7.3.10 FocalLengthIn35mmFilm

Tag Information

This tag indicates the equivalent focal length assuming a 35mm film camera.

[Writer]

－Digital zoom ratio is not taken into account.

[Reader]

－A reader can use this value along with subject distance to estimate the magnification.

7.3.11 SceneCaptureType

Tag Information

This tag indicates the type of scene that was shot. It can also be used to set the mode in which the image was shot.

[Writer]

－The writer records the shooting mode set by the user or the scene type determined by the writer.

－A value of 1 (landscape) indicates a mode suitable for shooting scenery, 2 (portrait) means a mode suitable for portrait photography, and 3(night scene) means a mode suitable for night scenes was set.

[Reader]

－The reader can use this information to perform image processing suitable for the type of scene that was shot.

－The reader should use this tag and the image analysis result, or other related tags, to prevent over-correction or processing that defeats the purpose of the recorded values.

－If the captured scene type as well as saturation, sharpness and contrast are recorded, it is up to the reader which of these to use.

－Processing examples are given in the table below for each objective.

Explication Table 1 Examples of Processing for Different Scene Types

	Processing Objective	Processing Example
Normal	To make the ordinary scenery look more attractive	Normal processing
Landscape	To make the landscape scenery look more attractive	Enhancement of contrast, saturation, and sharpness
Portrait	To make the subject look more attractive	Memory color correction of skin color
Night Scene	To make the night scene look more attractive	Inhibition of soft tone correction Noise reduction

7.3.12GainControl

Tag Information

This tag indicates the degree of overall image gain adjustment.

[Writer]

－The writer records the difference in gain in relation to the default (factory setting) sensitivity. The default sensitivity may differ for each writer.

－If there is more than one default value, this tag is not used.

[Reader]

－The reader can estimate the degree of noise occurrence in accord with the recorded value.

－Other tags (exposure time, shutter speed, brightness, captured scene type, etc.) may be used as supplementary information.

7.3.13 Contrast/Saturation/Sharpness

Tag Information

The Contrast tag indicates the direction of contrast processing applied by the camera when the image was shot.
The Saturation tag indicates the direction of saturation processing applied by the camera when the image was shot.
The Sharpness tag indicates the direction of sharpness processing applied by the camera when the image was shot.

[Writer]

－The writer records the difference in contrast, saturation and sharpness in relation to the default (factory setting) values.

－The defaults may differ for each writer.

[Reader]

－The reader should understand that the recorded values are for the purpose of print processing and should avoid over-correction or processing that defeats the purpose of the recorded values.

－Processing examples are given in the table below for each objective.

Explication Table 2 Examples of Processing to be Avoided by Readers

	Processing that goes against the intent of the recorded values	Duplicate processing
Contrast	Softening when hard contrast was intended	Excessive softening when soft contrast is recorded
Saturation	Lowering saturation when high saturation was intended	Raising saturation excessively when high saturation is recorded
Sharpness	Increasing sharpness when weak sharpness was intended	Increasing sharpness excessively when strong sharpness is recorded

7.3.14 SubjectDistanceRange

Tag Information

Indicates the distance range to the subject.

[Writer]

－This is the distance to the part of the scene determined by the writer to be the main subject. The means of measuring this and the precision are implementation dependent. The camera setting may be recorded.

－When the subject distance range cannot be determined, 0 (unknown) shall be recorded.

－When macro mode is set, 1 (macro) shall be recorded.

－Generally if the subject distance is 1 to 3 meters, 2 (close view) shall be recorded.

－If the subject is farther than close range, 3 (distant view) shall be recorded.

[Reader]

－This information can be used as information for processing images shot with flash.

－It can also be used as additional information about the SceneCaptureType.

7.4 Application Software Guidelines

These guidelines give examples of tag handling when Exif image files are edited in application software. The problem here is that when application software edits and saves an Exif file, in some cases the tag information is not recorded the way it should be. By developing applications to handle tags in accordance with these guidelines, program developers can ensure that Exif image files are treated suitably.

7.4.1 Tag handling by application software

Tags contain important information about the image data in a file. When application software processes an image and saves it as a new Exif image file, it is important that this Exif tag information be recorded properly along with the image. When a large amount of tag information is to be re-recorded, it can be copied from the original Exif file. Some of the tags, however, should be updated to reflect the changes made by the application software.

7.4.2 Tag handling examples

This section explains tag handling when the following representative processing is performed.

a) Rotation

b) Trimming

c) Image retouching (exposure bias, adjustment of white balance, brightness, contrast, sharpness, etc.)

d) Red-eye reduction (partial image retouching)

e) Special processing (sepia processing, monochrome processing or other processing affecting the entire image)

In sections 7.4.3 and following, the tags that can be copied unchanged and those that need to be updated are indicated. If multiple processing was performed (e.g., rotation plus trimming) and tag handling differs for each process, "Update tag value" takes precedence. If the changed Exif image file does not contain the tags listed here, the saved file after alteration should not include them either. Tag handling examples for each IFD are given in the following sections

7.4.3 0th IFD

The following tags should be copied unchanged.

—ImageDescription; ID= 270

—Make; ID= 271

—Model; ID= 272

—Xresolution; ID= 282

—Yresolution; ID= 283

—ResolutionUnit; ID= 296

—TransferFunction; ID= 301

—Artist; ID= 315

—WhitePoint; ID= 318

—PrimaryChromaticities; ID= 319

—YcbCrCoefficients; ID= 529

—ReferenceBlackWhite; ID= 532

—Copyright; ID= 33432

Examples of the preferred tag handling for each type of processing are given below.

Explication Table 3 0th IFD tag handling examples

Tag	Rotation	Trimming	Retouch	Red-eye	Special
Orientation ID=274	Set to 1	Set to 1	Set to 1	Set to 1	Set to 1
YCbCrPositioning ID= 531	Update value	Update value	Update value	Update value	Update value
Software ID=305	Change to name of used software	Change to name of used software	Change to name of used software	Change to name of used software	Change to name of used software
DateTime ID=306,	Changed to saved date and time	Changed to saved date and time	Changed to saved date and time	Changed to saved date and time	Changed to saved date and time

7.4.4 Exif IFD，Primary Image

The following tags should be copied unchanged.

－ExposureTime; ID= 33434

－Fnumber; ID= 33437

－ExposureProgram; ID= 34850

－SpectralSensitivity; ID= 34852

－ISOSpeedRatings; ID= 34855

－OECF; ID= 34856

－ExifVersion; ID= 36864

－DateTimeOrginal; ID= 36867

－DateTimeDigitized; ID= 36868

－ComponentsConfiguration; ID= 37121

－ShutterSpeedValue; ID= 37377

－ApertureValue; ID= 37378

－BrightnessValue; ID= 37379

－ExposureBiasValue; ID= 37380

－MaxApertureValue; ID= 37381

－SubjectDistance; ID= 37382

－MeteringMode; ID= 37383

－LightSource; ID= 37384

－Flash; ID= 37385

－FocalLength; ID= 37386

－MakerNotes; ID= 37500

－SubSecTimeOriginal; ID= 37521

－SubSecTimeDigitized; ID= 37522

－FlashPixVersion; ID= 40960

－ColorSpace; ID= 40961

－RelatedSoundFile; ID= 40964

－FlashEnergy; ID= 41483

－SpatialFrequencyResponse ; ID= 41484

－FocalPlaneX-Resolution; ID= 41486

－FocalPlaneY-Resolution; ID= 41487

－FocalPlane-ResolutionUnit; ID= 41488

－ExposureIndex; ID= 41493

－SensingMethod; ID= 41495

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—FileSource; ID= 41728

—SceneType; ID= 41729

—CFApattern; ID= 41730

—ExposureMode; ID= 41986

—WhiteBalance; ID= 41987

—DigitalZoomRatio; ID= 41988

—FocalLengthIn35mmFilm; ID= 441989

—SceneCaptureType; ID= 41990

—GainControl; ID= 41991

—Contrast; ID= 41992

—Saturation; ID= 41993

—Sharpness; ID= 41994

—DeviceSettingDescription; ID= 41995

—SubjectDistanceRange; ID= 41996

—ImageUniqueID; ID= 42016

Examples of the preferred tag handling for each type of processing are given below.

Explication Table 4 Exif IFD tag handling examples

Tag		Rotation	Trimming	Retouch	Red-eye	Special
CompressedBitsPerPixel ID=37122		Update value based on compression mode set when saved.	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"
PixelXDimension ID=40962		Update to width after rotation.	Update to width after trimming.	No change	No change	No change
PixelYDimension ID=40963		Update to height after rotation.	Update to height after trimming.	No change	No change	No change
SubsecTime ID=37520		If the writer can record this tag, update when saving.	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"
SubjectLocation ID=41492		Update to value after rotation	Update to value after trimming	No change	No change	No change
SubjectArea ID=37396		Update to value after rotation	Update to value after trimming	No change	No change	No change
CustomRendered ID=41985	value =0	No change	No change	Set to 1.	Set to 1. Can be left unchanged depending on size of affected area	Set to 1.
	value =1	No change	No change	No change. Preferably this processing should not be performed.	No change. Processing may be performed depending on size of area.	No change. Preferably this processing should not be performed.

7.4.5 InterOperability IFD

Tags in the InterOperability IFD should be copied unchanged.

7.4.6 GPS Info IFD

Tags in the GPS Info IFD should be copied unchanged.

7.4.7 1st IFD

The following tags should be copied unchanged.

－Compression; ID= 259

－ImageDescription; ID= 270

－Make; ID= 271

－Model; ID= 272

－TransferFunction; ID= 301

－Artist; ID= 306

－WhitePoint; ID= 318

－PrimaryChromaticities; ID= 319

－YCbCrCoefficients; ID= 529

－ReferenceBlackWhite; ID= 532

－Copyright; ID= 33432

Examples of the preferred tag handling for each type of processing are given below.

Explication Table 5 1st IFD tag handling examples

Tag	Rotation	Trimming	Retouch	Red-eye	Special
Orientation ID=274	Set to 1	Set to 1	Set to 1	Set to 1	Set to 1
YCbCrPositioning ID= 531	Update value	Update value	Update value	Update value	Update value
XResolution ID= 282	Adjust width resolution to primary image	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"
YResolution ID= 283,	Adjust height resolution to primary image	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"
ResolutionUnit ID= 296	Adjust resolution unit to primary image	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"
DateTime ID=306	Changed to date and time saved	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"	Same as "Rotation"

8. Logo Mark Guidelines

Software and other products conforming to the JEITA Exif Standard Version 2.2 can use the logo mark shown below. See the JEITA Web page below for details.

http://it.jeita.or.jp/perinfo/committee/pc/exif/logo/

9. Committee Organization for Preparing the Draft Standard

This standard was deliberated by the Digital Still Camera Committee, DSC Format WG of the Japan Camera Industry Association (JCIA). The draft standard was then presented to JEITA Technical Standardization Committee on AV & IT Storage-Systems and Equipment, and approved by that Committee in (February) 2002.

The committees involved in drafting the standard are as follows:

JEITA Technical Standardization Committee on AV & IT Storage Systems and Equipment

Chairman:	Tadashi Ezaki	Sony Corporation

JCIA Digital Still Camera Committee

Chairman:	Iwao Aizawa	KONICA CORPORATION

JCIA DSC Format WG

Chairman:	Mikio Watanabe	FUJI PHOTO FILM CO., LTD.
Co-Chairman:	Toshihisa Kuroiwa	NIKON CORPORATION
Member:	Naoki Yamagata	Asahi Optical Co., Ltd.
	Hitoshi Uwabu	Asahi Optical Co., Ltd.
	Hisashi Niwa	ImageLink, Inc.
	Tetsuya Toyoda	OLYMPUS OPTICAL CO.,LTD.
	Masaru Kawase	OLYMPUS OPTICAL CO.,LTD.
	Masahiro Higuchi	OLYMPUS OPTICAL CO.,LTD.
	Jun Hosoda	CASIO COMPUTER CO., LTD.
	Kyouichi Kawamoto	CASIO COMPUTER CO., LTD.
	Wataru Sakagami	CANON INC.
	Hideaki Kawamura	CANON INC.
	Noboru Miyashita	KYOCERA CORPORATION
	Koichi Settai	Kodak Japan Ltd.
	Keita Kimizuka	KONICA CORPORATION
	Yoshiaki Yamanaka	KONICA CORPORATION
	Nobuhide Dotsubo	SANYO Electric Co., Ltd.
	Masao Tamashima	SANYO Electric Co., Ltd.
	Takahiro Imai	SHARP CORPORATION
	Isao Edatsune	SEIKO EPSON CORPORATION
	Makoto Fujino	SEIKO EPSON CORPORATION
	Naoya Katoh	Sony Corporation
	Masahiko Nagumo	Sony Corporation
	Koichiro Ishigami	Sony Corporation
	Urato Aruga	CHINON INDUSTRIES INC.
	Yasuo Aoki	Digipri Corporation
	Tatsuro Abe	TOSHIBA CORPORATION
	Kiyoshige Shibazaki	NIKON CORPORATION
	Kazuhiko Takemura	FUJI PHOTO FILM CO., LTD.
	Hisayoshi Tsubaki	FUJI PHOTO FILM CO., LTD.
	Shigeo Sakaue	Matsushita Electric Industrial Co., Ltd.
	Kimiharu Akahoshi	Minolta Co., Ltd.
	Yuki Matsushima	RICOH COMPANY, LTD.

	Kenji Shiraishi	RICOH COMPANY, LTD.
	Takuma Mori	Hewlett-Packard Japan, Ltd
	Kaoru Watanabe	Hewlett-Packard Japan, Ltd
	Junichi Yamazaki	Hewlett-Packard Japan, Ltd
	Ikuko Sugo	Hewlett-Packard Japan, Ltd
	Hiroaki Sugiura	MITSUBISHI ELECTRIC CORPORATION
	Kazuyuki Ibe	JEITA
	Shigeo Kobayashi	JBMA
	Yasushi Nagao	Microsoft Co., Ltd.
Secretariat:	Tohru Nakamura	JCIA
	Motokazu Ohkawa	JCIA
	Shinichiro Tominaga	JCIA
	Noriko Shimmura	JCIA