



**Standard of the Camera & Imaging Products Association**

***CIPA DC- 008-Translation- 2010***

**Exchangeable image file format for digital still cameras:  
Exif Version 2.3**

**This translation has been made based on the original Standard (CIPA DC-008-2010). In the event of any doubts arising as the contents, the original Standard is to be the final authority.**

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**CIPA:**

DC-008-2010 Exchangeable image file format for digital still cameras:  
Exif Version 2.3

**JEITA:**

CP-3451B Exchangeable image file format for digital still cameras:  
Exif Version 2.3



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# Introduction

This document is a standard that adds the revisions shown in the following items to “Exchangeable image file format for digital still cameras Exif 2.21” (specifically, CIPA DCG-008-2009 and JEITA CP-3451A; hereinafter called the “Exif Unified Version 2.21”) that was defined by JEITA and CIPA.

1. Technical supplements of the main text, such as Annex G “Guidelines for Handling Exif/DCF” and Annex E “Exif Version 2.2 Explication,” have been merged. And this standard has been revised.
2. For corrections and additions to new tags and parameters, priority was given to those reflecting References that had defined tags and those for which conventional tags no longer applied due to technical advancements.
3. Conformance levels in implementation and ambiguous sections in the specification were clarified, and sections with inadequate explanations were supplemented.
4. Furthermore, the format and notations were revised to improve readability, and typographic errors were corrected.

Items that underwent additions and corrections of tag specifications for this revision as follows (all are optional):

- 1)[Exif IFD] Addition and modification of Sensitivity-related tags that correspond to methods for measuring sensitivity
  - For methods for measuring sensitivity, new sensitivity-related tags corresponding to SOS, REI, and ISO speed were established and parameters pertaining to these tags were added.
  - New sensitivity (SOS, REI, ISO speed) were expanded to LONG in response to higher sensitivity.
  - Methods for using sensitivity-related tags were added as Annex G.
- 2)[GPS IFD] Addition of methods for recording to GPS tags that apply to positioning methods other than GPS and guidelines for recording positioning errors
  - Positioning methods using mobile phone base stations and wireless LAN were added.
  - Recording of horizontal positioning errors was made possible.
- 3)[Exif IFD] Addition of body information tags and lens information tags
  - For body information, recording of owner and camera serial number was made possible.
  - For lens information, recording of lens specifications (focal length, f number, etc.) and manufacturer’s name was made possible.
- 4)[Exif audio file specifications] Audio sampling frequencies and a bit number were added
  - The frequencies 32,000 KHz, 48,000 KHz, 96,000 KHz, and 192,000 KHz were added.

- The bit number 24 bits was added.

5)[Exif IFD] Addition of light source parameters and changes to color temperature

- Parameters for light bulb-type fluorescent lights were added.
- Color temperature was changed in response to revision of JIS Z 9112 "classification of fluorescent lamps by chromaticity and color rendering property."

## Revision History

| Rev.                 | Date           | Comment   |
|----------------------|----------------|---|
| 1.0                  | October 1995   | Published First Edition 1.0 <ul style="list-style-type: none"> <li>● Established image data format definitions</li> <li>● Set definitions for structure of attribute information (tags)</li> <li>● Established basic tag definitions</li> </ul>   |
| 1.1                  | May 1997       | Published Revision 1.1 <ul style="list-style-type: none"> <li>● Added tags</li> <li>● Added operating specifications</li> </ul>   |
| 2.0                  | November 1997  | Published Revision 2.0 <ul style="list-style-type: none"> <li>● Added sRGB color space</li> <li>● Added GPS</li> <li>● Added compressed thumbnails and audio files</li> </ul>   |
| 2.1                  | December 1998  | Published Revision 2.1 <ul style="list-style-type: none"> <li>● Added DCF interoperability tags</li> </ul>  |
| 2.2                  | April 2002     | Published Revision 2.2 <ul style="list-style-type: none"> <li>● Applied ExifPrint               <ul style="list-style-type: none"> <li>- Developed tags for improving print quality (Photo contrast, sharpness, etc.)</li> </ul> </li> <li>● Added tags pertaining to positioning and GPS</li> </ul>  |
| 2.21                 | September 2003 | Published Revision 2.21 <ul style="list-style-type: none"> <li>● Added and corrected of Exif 2.2 content in line with revision of DCF 2.0               <ul style="list-style-type: none"> <li>- Added notation of tags for Gamma, ColorSpace, etc., that correspond to optional color space</li> <li>- Changed content of notation of flash tags and FileSource tags</li> </ul> </li> <li>● Added operational guidelines (flash tags, scene capture type, etc)</li> <li>● Corrected notation pertaining to image data pixel composition and pixel sampling</li> <li>● Corrected misprints and omissions throughout the text</li> </ul> |
| Unified Version 2.21 | September 2009 | Published Unified Version 2.21 <ul style="list-style-type: none"> <li>● Merged added/changed portion of Exif 2.21 to Exif 2.2</li> <li>● Corrected misprints and omissions throughout the text</li> <li>● Added "Guidelines for Handling Exif/DCF" issued by CIPA (CIPA DCG-004-2009) as Annex G</li> <li>● Added explication of 2.2 as Annex H</li> <li>● Added explication of 2.21 as Annex I</li> </ul>  |



|     |            |  |
|-----|------------|--|
| 2.3 | April 2010 | <p>Published Revision 2.3</p> <ul style="list-style-type: none"><li>● Restructured the main standard text, guidelines, explications, etc., of Exif Unified Version 2.21</li><li>● Added and revised tags<br/>(Sensitivity-related tags, GPS information, camera and lens information, items pertaining to sound files, and light-source color)</li><li>● Clarified specification levels and revised the scope of application</li><li>● Supplemented explanations and adjusted format for the entire text</li></ul> |
|-----|------------|--|

# 1. Scope

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

Formats specified in this standard are defined as folder structures that are based on Exif-JPEG and recording formats for memory. When formats are used as Exif/DCF files together with the DCF Standard, which guarantees interoperability among devices of different types, their scope shall cover devices, recording media, and application software that handle them. As devices mentioned above, the applicable items are devices with functions such as capturing, recording, displaying, editing, and printing images.

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

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

Specifically considered is application software that edits Exif/DCF tags and then saves them again or application software that adds metadata information undefined in the Exif Standard in Exif/DCF files and then saves it again.

## 2. Definitions

### 2.1 Definition of Terms

|                 |   |
|-----------------|---|
| DSC             | Digital still camera  |
| DVC             | Digital video camera  |
| DTV             | Digital television  |
| Primary image   | The main image data   |
| Thumbnail       | A small image used to index the primary image   |
| Compressed data | Data referred to in the JPEG Standard as “entropy coded data”   |
| Tag             | A field recording ancillary data about an image. Corresponds to “field” in TIFF   |
| Tag information | A description of the tag contents   |
| Exif            | An abbreviation of “Exchange image file format,” used here as the general term for this standard and earlier versions of this standard  |
| DCF             | An abbreviation of “Design rule for Camera File System”; it defines folder structures based on Exif-JPEG and formats for recording in memory, and is the camera file system standard that guarantees interoperability among devices of different types. |
| DCF media       | Removable memory recorded in compliance with the DCF or, removable and non-removable memory that a file system can access from an external device through IF (regardless of wired or wireless)  |

|                 |   |
|-----------------|---|
| Exif/DCF Writer | A digital still camera (DSC) or other device or application software that can output an Exif/DCF file   |
| Exif/DCF Editor | A device or application that edits (i.e., makes partial additions, changes, deletions) existing Exif/DCF files<br><br>(Alternatively, image-editing application; includes some DTV, photo frames, and DSC)  |
| Exif/DCF Reader | A device, such as a printer with a memory card slot, capable of directly reading an Exif/DCF file and printing or performing other output processing, as well as application software that uses Exif tags to perform image processing for output. (with playback function in conformity with the DCF Reader 1 and Reader 2 specifications described in 2.1 “Definition of Terms” of the DCF Standard) |

The following definitions also apply to this standard:

- “.H” appended to a numerical value means it is hexadecimal notation.
- Unless otherwise indicated, other numerical values are given in decimal notation.

## 2.2 Verbal forms for the expression of provisions

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

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

### Requirement

| Verbal forms | Equivalent expressions |
|--------------|------------------------|
| shall        | is mandatory           |
| shall not    | it is not allowed      |

### Recommendation

| Verbal forms | Equivalent expressions                   |
|--------------|--|
| should       | it is recommended that<br>is recommended |
| should not   |  |

### Permission

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

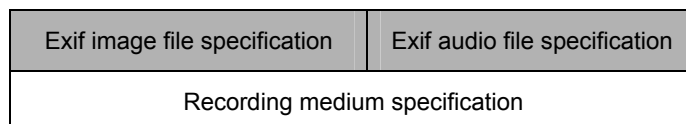
### Possibility and capability

| Equivalent expressions | Equivalent expressions |
|------------------------|------------------------|
| can                    | it is possible to      |
| can not                |                        |

## 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 [Design rule for Camera File system](#) 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 can be 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  $\mu$ -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 shall read the files it recorded itself. In a personal computer environment, the basic requirement is that dedicated software shall read all the images, audio and attribute information recorded in conformance with this standard (see **Figure 2**).

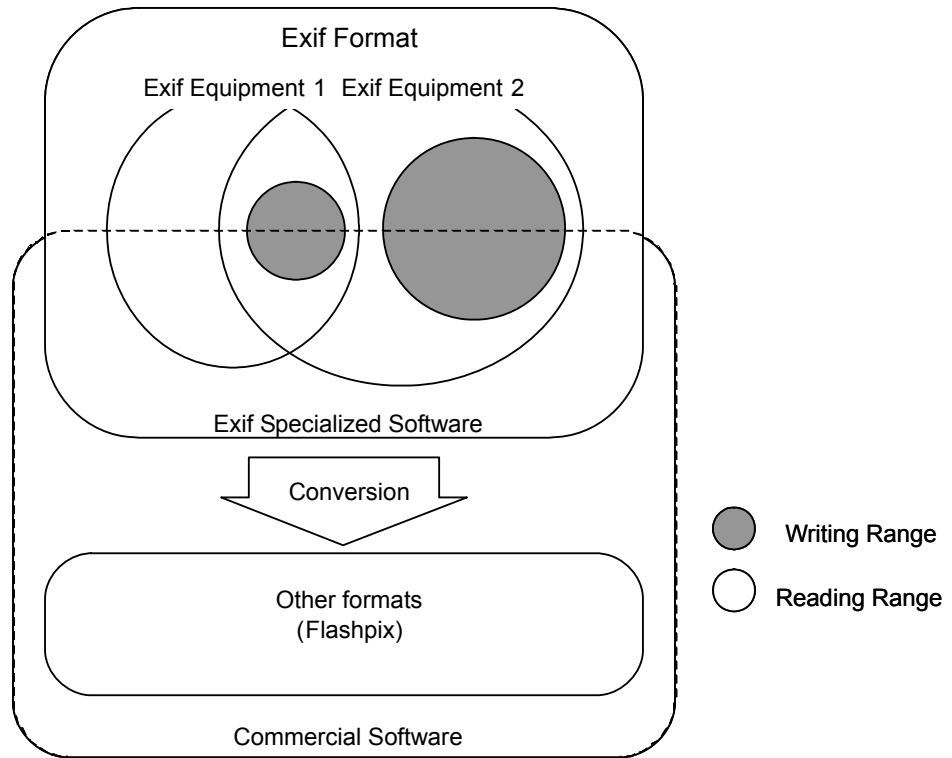


Figure 2 Compatibility Concepts



### 3.6 Workflow for editing an image with application software

Figure 3 shows the workflow when an Exif/DCF file is edited using an application. DSCs in this figure are examples of image capture/playback devices. Consideration is also given to the use of other devices such as a TV or printer.

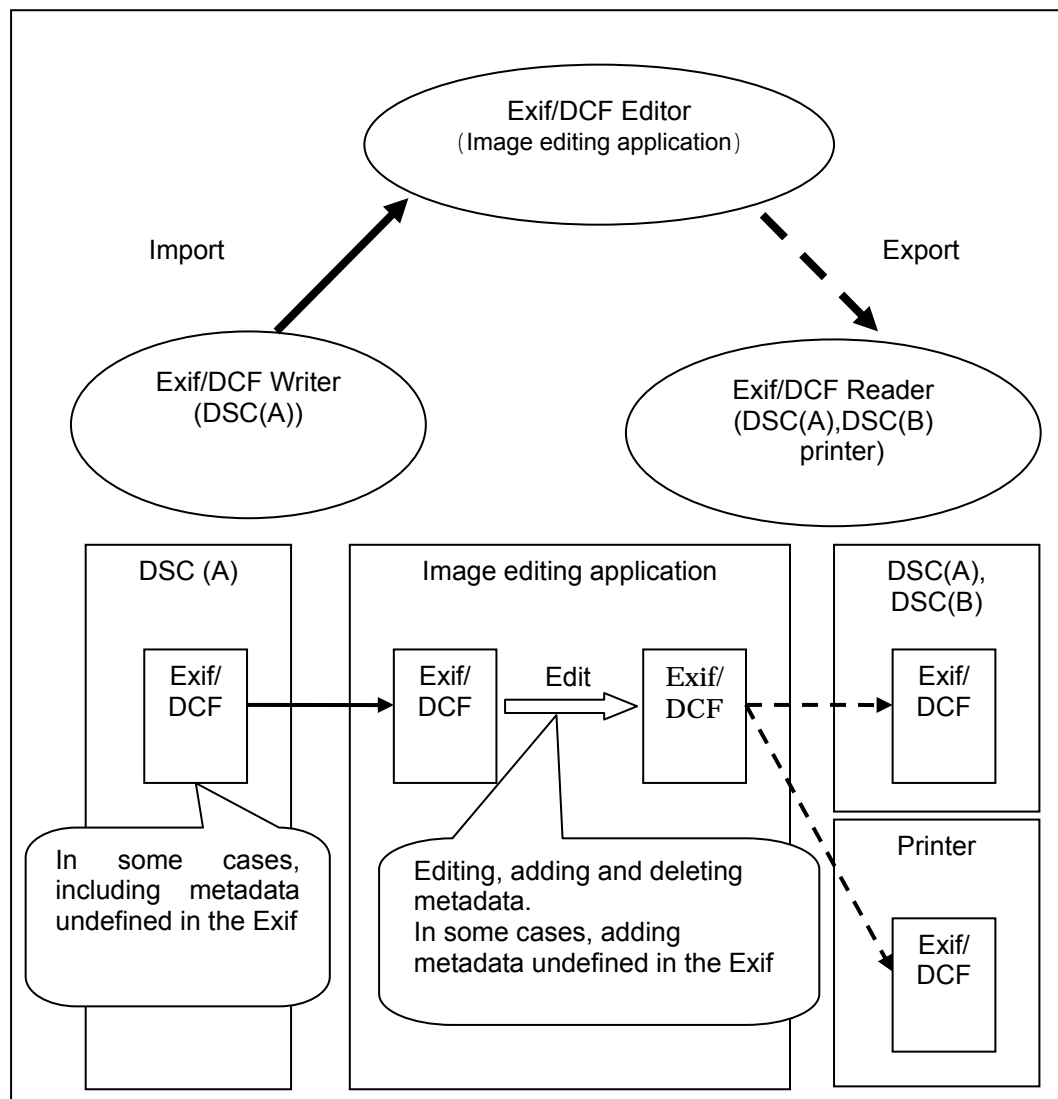


Figure 3 Editing images with application software

### 3.6.1 Actions

In this workflow, the following cases are considered:

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

## 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:

- 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 shall be 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

When uncompressed data is used, 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. When compressed data is used, the combination shall be 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 4** shows typical pixel sampling for image width  $w$  and height  $h$ . In the case of Y:Cb:Cr = 4:2:2, co-sited is recommended for the sake of improved image quality on TV systems. For Y:Cb:Cr = 4:2:0, centered is recommended according to the TIFF default which is most common format of the personal computer applications.

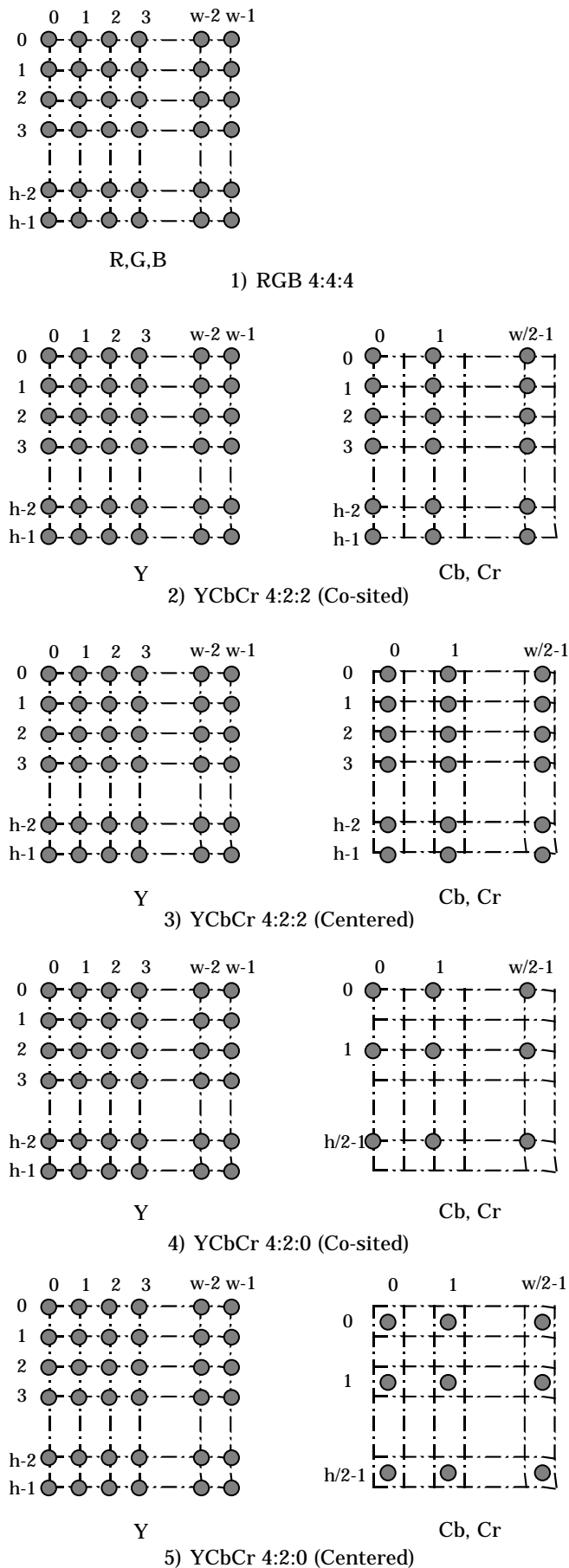
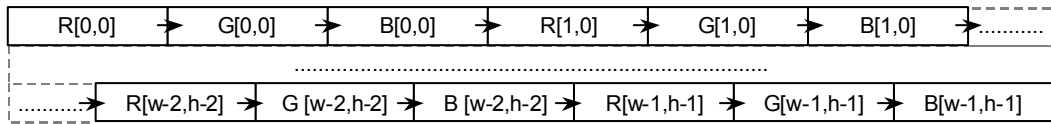


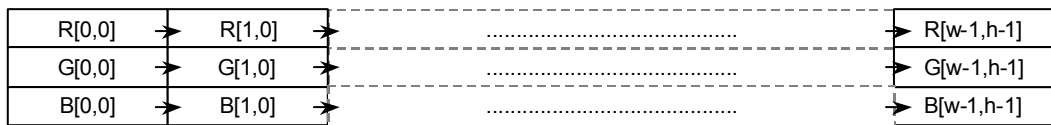
Figure 4 Pixel Composition and Pixel Sampling

### 4.4.4 Image Data Arrangement

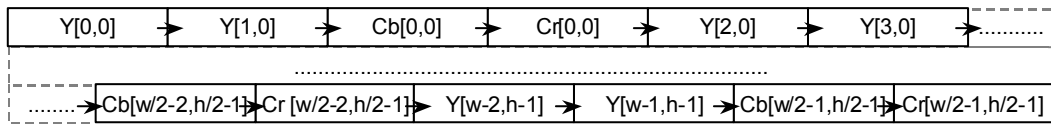
Image datand one screen shall consist of lines traced from top to bottom. JPEG compressed data shall consist of blocks configured of pixels traced in similar sequence. **Figure 5** shows the various data arrangements for recording in files images with pixels of width w and height h.



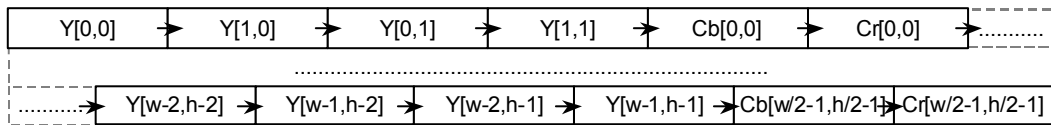
1) Uncompressed RGB Chunky (4:4:4)



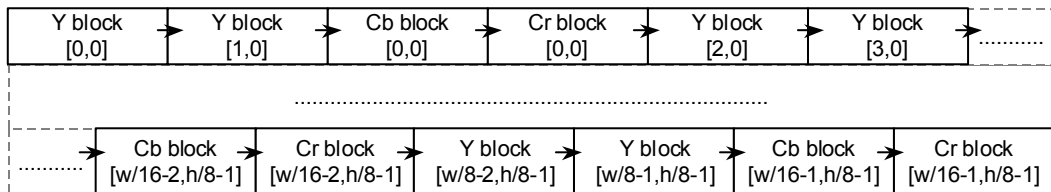
2) Uncompressed RGB Planar (4:4:4)



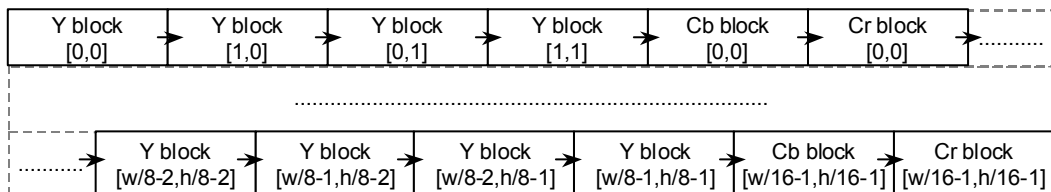
3) Uncompressed YCbCr Chunky (4:2:2)



4) Uncompressed YCbCr Chunky (4:2:0)



5) Compressed JPEG Block-Interleave (4:2:2)



6) Compressed JPEG Block-Interleave (4:2:0)

**Figure 5 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.

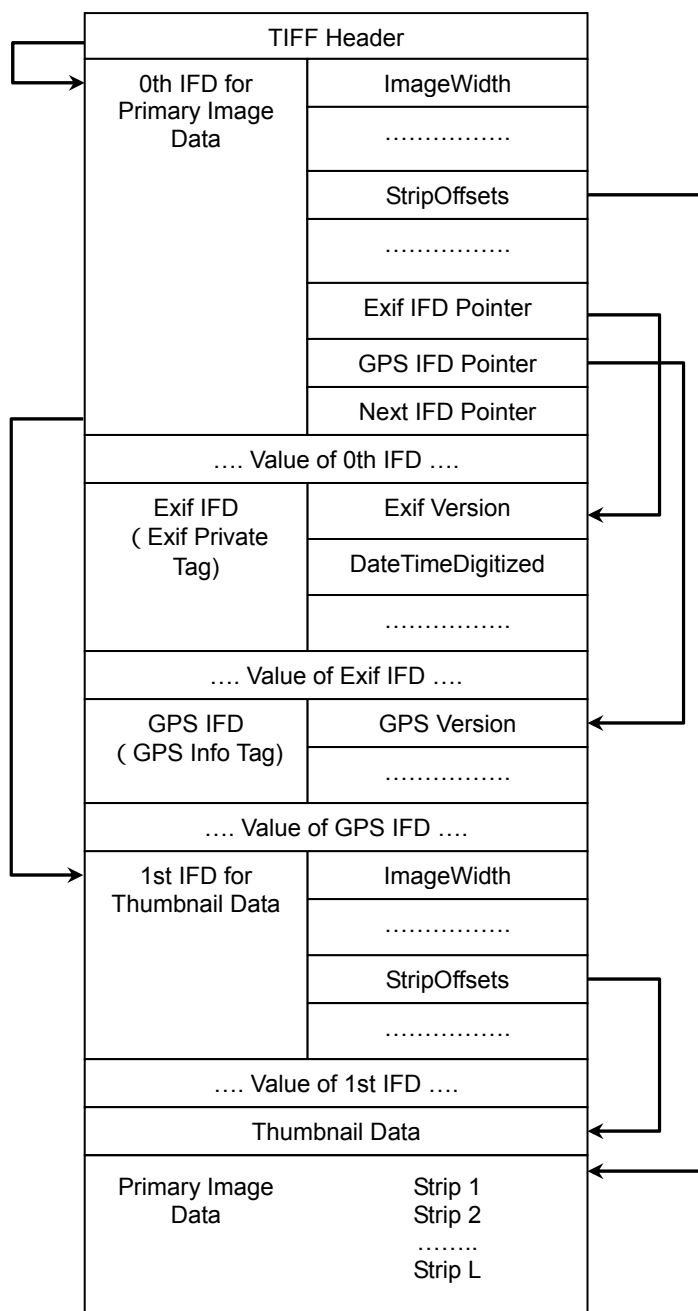
### 4.5.2 Basic Structure of Uncompressed RGB Data

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 6**). 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 6 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 shall terminate with 00000000.H.

On the IFD description method see **section 4.6.2**.

Table 1 TIFF Headers

| Name          | Size (Bytes) | Value  |
|---------------|--------------|--|
| Byte Order    | 2            | Either "II" (4949.H) (little endian) or "MM" (4D4D.H) (big endian) depending on the CPU of the machine doing the recording shall be written. |
| 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;

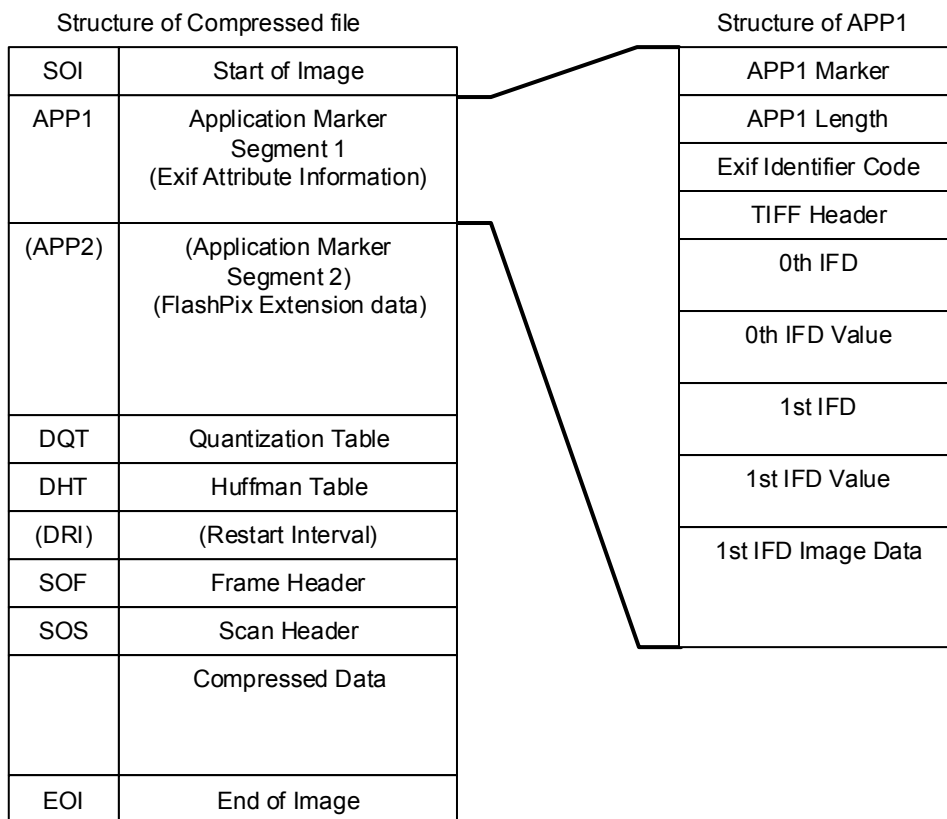
- RGB-YCbCr color transformation matrix coefficients (YCbCrCoefficients),
- Chrominance subsampling information (YCbCrSubSampling),
- Information on matching/nonmatching of chrominance and luminance samples (YCbCrPositioning).

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 shall be recorded in conformance with the JPEG DCT format specified in [ISO/IEC 10918-1](#), with the Application Market Segment (APP1) inserted. APP1 shall be recorded immediately after the SOI marker indicating the beginning of the file (see **Figure 7**). 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/DCF readers should be designed skip over unknown APPn and COM.



**Figure 7 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 may record 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 shall be used to record data exceeding 64 KBytes. For details see **section 4.7.3**.

### 4.5.5 Application marker segments

The basic structure of JPEG compressed data in Exif adopts a configuration based on marker segments compliant with the "Baseline DCT format of JPEG."

In the JPEG standard on which the Exif standard is based, the use of the APPn (Reserved for application segments) and COM (Comment) marker is not restricted. In the Exif standard (See **section 4.5.4**), it is written, "APPn other than APP1 and APP2 or COM segments are not used". However, there is no mention of prohibited use of undefined APPn markers. Therefore, undefined APPn markers can be optionally used for recording by vendors or trade groups. In this case, compliance with the following rules is recommended in order to maintain reproduction compatibility with the Exif devices. In this guideline, marker segments of JPEG compressed data should be recorded in accordance with the order shown in **Table 2** and should be interpreted as described in the table.

That is, it is possible to optionally record multiple APPn (n is a value from zero to 15) markers immediately after APP1 and APP2 defined in the Exif standard.

The bracketed marker segment names show optional marker segments in the Exif standard.

**Table 2 Marker segments of JPEG compressed data in Exif**

| No | Name of marker           | Specification in the Exif standard   |
|----|--------------------------|--|
| 1  | SOI                      | Recording this marker is mandatory. It shall be recorded in this position at the beginning of all markers.   |
| 2  | APP1                     | Exif Attribute Information<br>Recording this marker is mandatory. It shall be recorded in this position immediately after SOI.   |
| 3  | (APP2)                   | Flashpix Extension data<br>Recording this marker is optional. Multiple APP2 markers can be optionally recorded in any order.<br>It shall be recorded in this position, if necessary. |
| 4  | (APPn)                   | Recording this marker is optional.<br>Multiple markers can be recorded, as necessary.  |
| 5  | DQT, DHT, (DRI), SOF     | Other marker groups defined in Exif<br>Only the DRI marker is optional.<br>Recording the rest of the markers is mandatory.<br>Their recording order may be changeable.               |
| 6  | SOS<br>(compressed data) | If the DRI marker is recorded, the RSTm marker shall be inserted as well.  |
| 7  | EOI                      | Recording this marker is mandatory. It shall be recorded in this position.   |

The following **Figure 8** shows an example structure of JPEG compressed data when undefined data in the Exif standard is added.

In this case, the added segments are assumed as APPx, APPy and APPz (x, y and z are optional numbers from zero to 15).

|        |  |
|--------|--|
| SOI    | Start of Image   |
| APP1   | Application marker segment 1<br>(for Exif Attribute Information) |
| (APP2) | Application marker segment 2<br>(for Flashpix Extension data)    |
| (APPx) | Application marker segment x<br>(data 1 undefined in Exif)       |
| (APPy) | Application marker segment y<br>(data 2 undefined in Exif)       |
| (APPz) | Application marker segment z<br>(data 3 undefined in Exif)       |
| DQT    | Quantization Table   |
| DHT    | Huffman Table  |
| (DRI)  | (Restart Interval)   |
| SOF    | Frame Header   |
| SOS    | Scan Header  |
|        | Compressed<br>Data   |
| EOI    | End of Image   |

**Figure 8 Structure of JPEG compressed data with added APPn in Exif (Example)**

#### 4.5.6 How to deal with APPn markers undefined in the Exif standard

Exif/DCF writers should record only the minimum for vendors when recording APPn markers undefined in the Exif standard. Especially, metadata for which the content is inconsistent with that of metadata written in the Exif standard should not be recorded.

Even if APPn markers are undefined in the Exif standard and incomprehensible, Exif/DCF editors should not delete them, in consideration that the necessary information is recorded. Moreover,

Exif/DCF editors should add only the minimum for vendors when adding APPn markers undefined in the Exif standard. Especially, metadata for which the content is inconsistent with that of metadata written in the Exif standard should not be added.

When adding APPn markers, because the volume becomes quite large, current devices might not be able to handle the file itself. In other cases, the large volume might affect the performance of the device. Such cases should be kept in mind. For example, when an Exif/DCF editor uses optional APPn to add unique information to the file created by an Exif/DCF writer, the file size increases by the amount of added information. Even if the additional information is small, because the file size increases, some Exif/DCF readers might not properly handle the file itself due to the regulation in the specifications of the device. Other Exif/DCF readers might be affected in terms of performance. Therefore, it is necessary to take into account such cases.

Exif/DCF readers should be implemented to operate without interruption even if APPn markers undefined in the Exif standard have been recorded. It is recommended that Exif/DCF readers be designed to skip over unknown APP markers in the Exif standard (see **section 4.5.4**).

#### 4.5.7 Recording data other than the primary image

The JPEG standard defines data formats such as compressed image data format and it does not mention file formats. Therefore, it is possible to add information other than the primary image by separately defining the structure of an image file.

For example, the file formats for recording multiple images and for information other than images are considered. If there is a standard specification, specific methods for implementation and handling should comply with the standard specification.

In Exif/DCF editors, when APP markers compliant with a standard specification are used to manage the start address of an image with offset in files, it should be considered that the start address of the image might be changed by adding the APPn markers.

In Exif/DCF writers, when data is recorded using a unique method that does not comply with a standard specification, it should be kept in mind that the data might be changed or deleted when used with other Exif/DCF writers or editors.

Moreover, Exif/DCF readers should be implemented to operate without interruption even if certain kinds of data have been recorded after EOI of the primary image defined in the Exif standard. Specifically, unknown data after EOI of the primary image should be skipped. (see **section 4.7.1**)

#### 4.5.8 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. It is optional to record thumbnails 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 shall not be recorded as JPEG compressed data (see **Table 3**).

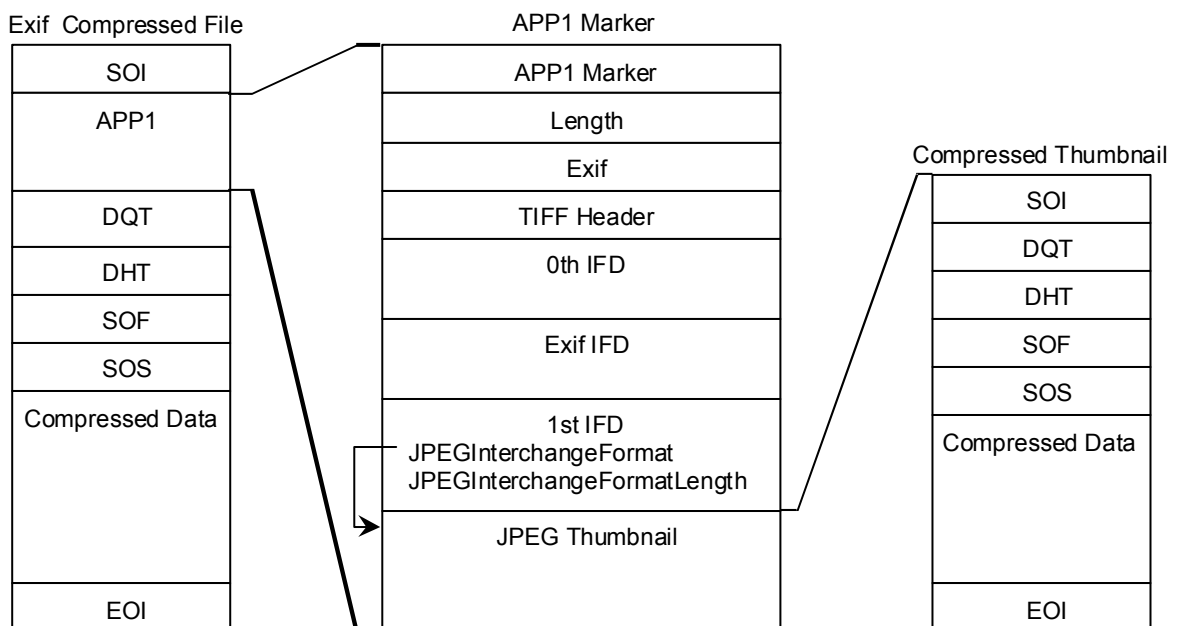
**Table 3 Combinations of primary image and thumbnail data structures**

|           |              |               |            |
|-----------|--------------|---------------|------------|
|           |              | 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 (JPEG Interchange Format, JPEG Interchange Format Length) 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. APPn marker, COM marker, nor restart marker shall not be recorded in the JPEG stream (see **Figure 9**). 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 9 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.<br>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 may 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 information such as 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 store 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 4** 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 4 TIFF Rev. 6.0 Attribute Information Used in Exif**

| Tag Name  | Field Name                  | Tag ID |      | Type          | Count   |
|---|-----------------------------|--------|------|---------------|---------|
|   |                             | Dec    | Hex  |               |         |
| <b>A. Tags relating to image data structure</b>       |                             |        |      |               |         |
| 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>B. Tags relating to recording offset</b>           |                             |        |      |               |         |
| 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       |
| <b>C. Tags relating to image data characteristics</b> |                             |        |      |               |         |
| 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       |
| <b>D. Other tags</b>                                  |                             |        |      |               |         |
| 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, this tag shall not be used because a JPEG marker is used instead of it.

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

**■ ImageLength**

The number of rows of image data. In JPEG compressed data, this tag shall not be used because a JPEG marker is used instead of it.

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, this tag shall not be used because a JPEG marker is used instead of it.

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. So, this tag shall not be recorded. 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, this tag shall not be used because a JPEG marker is used instead of it.

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  |

**Recording orientation**

**Table 5** shows the relationship between the total number of columns and total number of rows of coded image data that is stored in an Exif image file and an Exif tag.

**Table 5 Relationship between column count/row count of coded image data and Exif tag**

|              | When uncompressed RGB and YCbCr data<br>(See 4.6.5.A) | When compressed JPEG data<br>(See 4.6.5.C) |
|--------------|---|--|
| Column count | ImageWidth tag  | PixelXDimension                            |
| Row count    | ImageLength tag                                       | PixelYDimension                            |

**Figure 10** shows the pixel arrangement of coded image data that is stored in an Exif image file. It should be noted that the notation “(3,2)” in the figure indicates the pixel location “third column, second row.” (See **section 4.4.4** for details)

|    | C0    | C1    | C2    | C3    |
|----|-------|-------|-------|-------|
| R0 | (0,0) | (1,0) | (2,0) | (3,0) |
| R1 | (0,1) | (1,1) | (2,1) | (3,1) |
| R2 | (0,2) | (1,2) | (2,2) | (3,2) |

**Figure 10 Data array of an Exif image file**

Figure 11 shows the orientation of an image display on a display device. The notation “visual top” refers to the upper edge of the displayed image when looking directly at the screen from its front. Likewise, the notations “visual left-hand,” “visual right-hand,” and “visual bottom” refer to the left edge, right edge, and bottom edge of the screen, respectively.

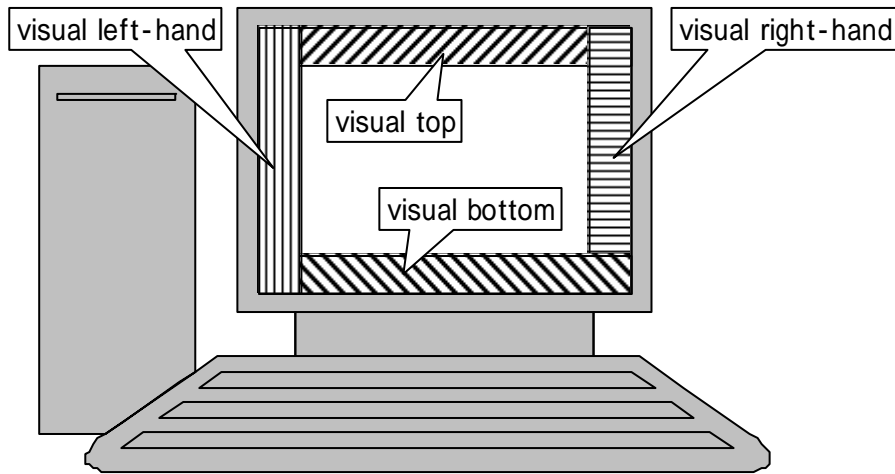
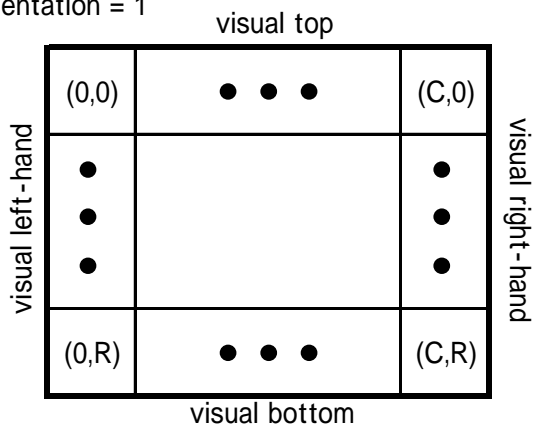


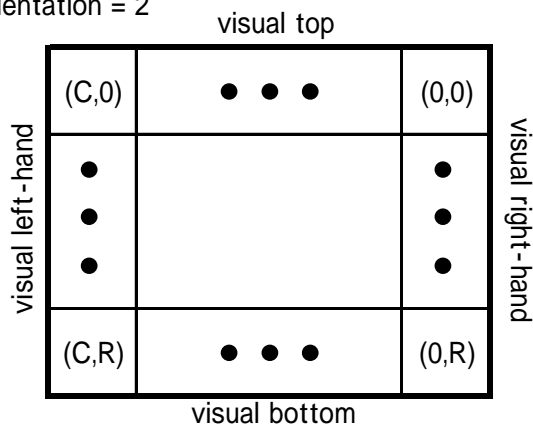
Figure 11 Orientation of an image display on a display device

Figure 12 shows the relationship between coded image data that is stored in an Exif image file and orientation of the image display on a display screen according to the orientation tag.

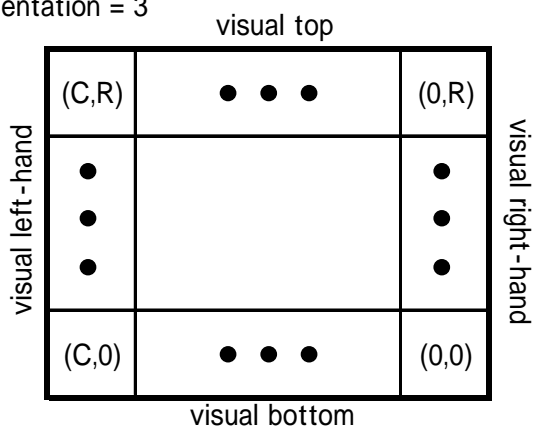
Orientation = 1



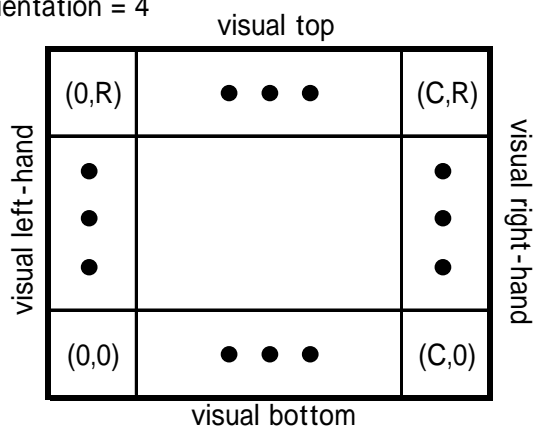
Orientation = 2



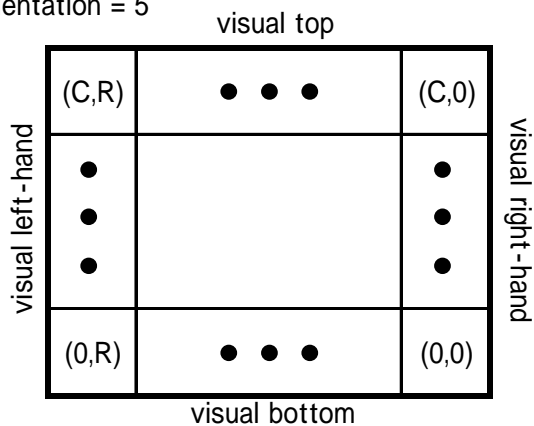
Orientation = 3



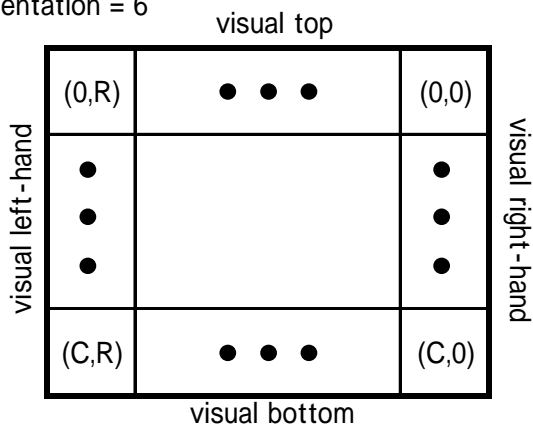
Orientation = 4

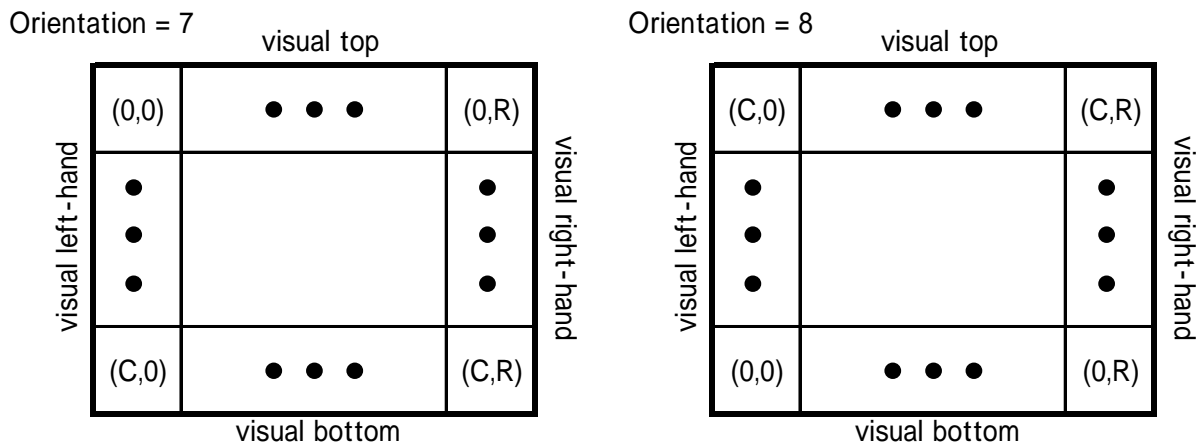


Orientation = 5



Orientation = 6





The notation “(C,R)” indicates the pixel location in coded image data that is stored in the Exif image file; it refers to the “C column number and R row number.”

(0,0) = (smallest column number, largest row number)

(C,R) = (smallest column number, largest row number)

**Figure 12 Relationship between image data and orientation on a display screen according to an orientation tag**

- Orientation = 1 is created when it is expected that 0th row of the coded image data stored in the Exif image file and the visual top of the display screen, and 0th column and visual left, will each be matched for display.
- Orientation = 2 is Orientation = 1 that has been reversed
- Orientation = 3 is Orientation = 6 that has been turned 90 degrees clockwise
- Orientation = 4 is Orientation = 3 that has been reversed
- Orientation = 5 is Orientation = 8 that has been reversed
- Orientation = 6 is Orientation = 1 that has been turned 90 degrees clockwise
- Orientation = 7 is Orientation = 6 that has been reversed
- Orientation = 8 is Orientation = 3 that has been turned 90 degrees clockwise

Table 6 shows the relationship between the orientation tag and rotation processing that should be conducted when displaying coded image data that is stored on an Exif image file on a screen.

**Table 6 Relationship between the orientation tag and rotation processing to display image data on a screen**

|   |  |          |          |          |
|---|--|----------|----------|----------|
| Image data and rotation orientation on the display screen match | Each rotation of 90 degrees clockwise<br>→ |          |          |          |
|   | <b>1</b>                                   | <b>6</b> | <b>3</b> | <b>8</b> |
| Horizontal reversal<br>↓  | <b>2</b>                                   | <b>7</b> | <b>4</b> | <b>5</b> |

(The integers 1 to 8 in the table are orientation tag values)

■ **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, this tag shall not be used because a JPEG marker is used instead of it.

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 data, this tag shall not be used because a JPEG marker is used instead of it. 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. So, this tag shall not be recorded

Tag = 530 (212.H)

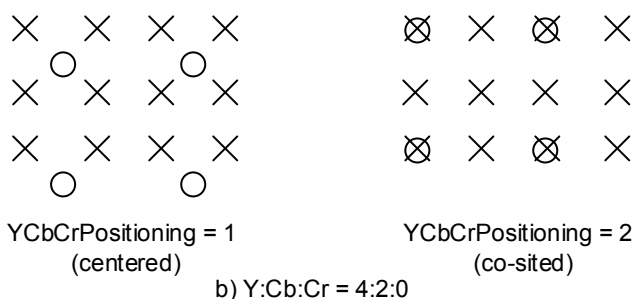
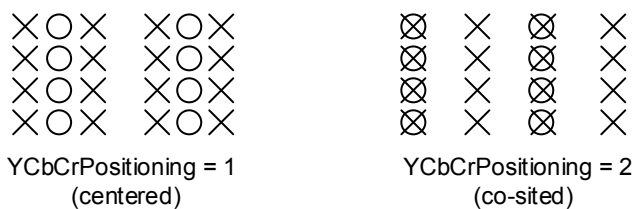


- Type = SHORT
- Count = 2
- [2, 1] = YCbCr4:2:2
- [2, 2] = YCbCr4:2:0
- Other = reserved

■ 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 Exif/DCF 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 can support both centered and co-sited positioning.

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



X Luminance Sample  
 O Chrominance Sample

Figure 13 YcbCrPositioning

■ XResolution

The number of pixels per ResolutionUnit in the ImageWidth direction. When the image resolution is

unknown, 72 [dpi] shall be 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 shall be 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 is unknown, 2 (inches) shall be 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. In the case of JPEG compressed data, this designation is not necessary. So, this tag shall not be recorded. 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. In the case of JPEG compressed data, this designation is not necessary. So, this tag shall not be recorded. 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. In the case of JPEG compressed data, this designation is not

necessary. So, this tag shall not be recorded..

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 shall not be 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 need not be used , 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 need not be used, 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 need not be used, 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 D**, "Color Space Guidelines," is used as the default.

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

#### ■ 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 (":") should be filled with blank characters, or else the Interoperability field should 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 is possible to be added 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 or 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 7** and **Table 8** followed by an explanation of the contents.

**Table 7 Exif IFD Attribute Information (1)**

| Tag Name   | Field Name              | Tag ID |      | Type          | Count |
|--|-------------------------|--------|------|---------------|-------|
|  |                         | Dec    | Hex  |               |       |
| <b>A. Tags Relating to Version</b>                   |                         |        |      |               |       |
| Exif version   | ExifVersion             | 36864  | 9000 | UNDEFINED     | 4     |
| Supported Flashpix version                           | FlashpixVersion         | 40960  | A000 | UNDEFINED     | 4     |
| <b>B. Tag Relating to Image Data Characteristics</b> |                         |        |      |               |       |
| Color space information                              | ColorSpace              | 40961  | A001 | SHORT         | 1     |
| Gamma  | Gamma                   | 42240  | A500 | RATIONAL      | 1     |
| <b>C. Tags Relating to Image Configuration</b>       |                         |        |      |               |       |
| 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     |
| <b>D. Tags Relating to User Information</b>          |                         |        |      |               |       |
| Manufacturer notes                                   | MakerNote               | 37500  | 927C | UNDEFINED     | Any   |
| User comments  | UserComment             | 37510  | 9286 | UNDEFINED     | Any   |
| <b>E. Tag Relating to Related File Information</b>   |                         |        |      |               |       |
| Related audio file                                   | RelatedSoundFile        | 40964  | A004 | ASCII         | 13    |
| <b>F. Tags Relating to Date and Time</b>             |                         |        |      |               |       |
| 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   |
| <b>G. Tags Relating to Picture-Taking Conditions</b> |                         |        |      |               |       |
| See <b>Table 8</b>                                   |                         |        |      |               |       |
| <b>H. Other Tags</b>                                 |                         |        |      |               |       |
| Unique image ID                                      | ImageUniqueID           | 42016  | A420 | ASCII         | 33    |
| Camera Owner Name                                    | CameraOwnerName         | 42032  | A430 | ASCII         | Any   |
| Body Serial Number                                   | BodySerialNumber        | 42033  | A431 | ASCII         | Any   |
| Lens Specification                                   | LensSpecification       | 42034  | A432 | RATIONAL      | 4     |
| Lens Make  | LensMake                | 42035  | A433 | ASCII         | Any   |
| Lens Model   | LensModel               | 42036  | A434 | ASCII         | Any   |
| Lens Serial Number                                   | LensSerialNumber        | 42037  | A435 | ASCII         | Any   |

Table 8 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         |
| Photographic Sensitivity                      | PhotographicSensitivity   | 34855 | 8827 | SHORT     |  | Any         |
| Optoelectric conversion factor                | OEFCF                     | 34856 | 8828 | UNDEFINED |  | Any         |
| Sensitivity Type                              | SensitivityType           | 34864 | 8830 | SHORT     |  | 1           |
| Standard Output Sensitivity                   | StandardOutputSensitivity | 34865 | 8831 | LONG      |  | 1           |
| Recommended ExposureIndex                     | RecommendedExposureIndex  | 34866 | 8832 | LONG      |  | 1           |
| ISO Speed                                     | ISO Speed                 | 34867 | 8833 | LONG      |  | 1           |
| ISO Speed Latitude yyy                        | ISO SpeedLatitudeyyy      | 34868 | 8834 | LONG      |  | 1           |
| ISO Speed Latitude zzz                        | ISO SpeedLatitudezzz      | 34869 | 8835 | LONG      |  | 1           |
| 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**). In accordance with conformance to this standard, this tag shall be recorded like "0230" as 4-byte ASCII. Since the type is UNDEFINED, it shall not be terminated with NULL.

Tag = 36864 (9000.H)  
 Type = UNDEFINED  
 Count = 4  
 Default = "0230"

### ■ 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, it shall not be terminated with NULL.

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

## B. Tags Relating to ColorSpace

### ■ 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 may be treated as sRGB when it is converted to Flashpix. On sRGB see

#### Annex D.

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

### ■ Gamma

Indicates the value of coefficient gamma. The formula of transfer function used for image reproduction is expressed as follows.

$$(\text{Reproduced value}) = (\text{Input value})^{\text{gamma}}$$

Both reproduced value and input value indicate normalized value, whose minimum value is 0 and

maximum value is 1.

Tag = 42240 (A500.H)  
 Type = RATIONAL  
 Count = 1  
 Default = None

### 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 shall not exist in an uncompressed file. For details see **section 4.8.1** 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 shall not exist in an uncompressed file. For details see **section 4.8.1** 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 or 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/DCF writers to record any desired information. The contents are up to the manufacturer, but this tag shall not be used for any other than its intended purpose.

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

■ **UserComment**

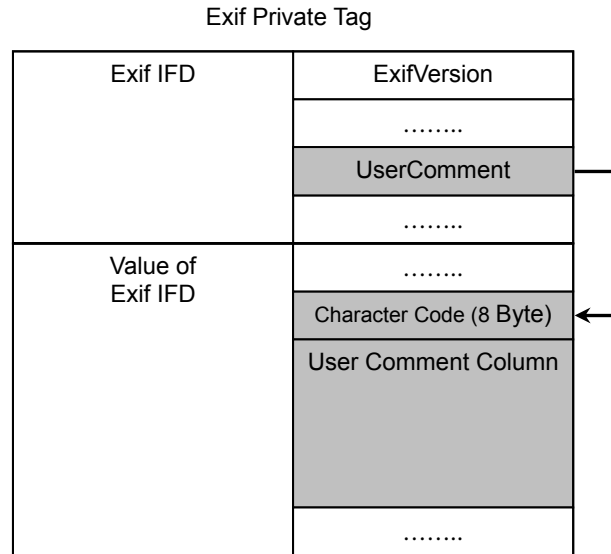
A tag for Exif users to write keywords or comments on the image besides those in ImageDescription, and without the character code limitations of the ImageDescription tag.

- 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 shall be 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 9**. 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 14**).

**Table 9 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 14 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/DCF reader that reads the UserComment tag shall have a function for determining the ID code. This function is not required in Exif/DCF readers that do not use the UserComment tag (see **Table 10**).

**Table 10 Implementation of Defined and Undefined Character Codes**

| ID Code                       | Exif/DCF reader Implementation  |
|-------------------------------|---|
| Defined<br>(JIS, ASCII, etc.) | Determines the ID code and displays it in accord with the Exif/DCF reader capability.   |
| Undefined<br>(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 Exif/DCF 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 5.6.3 "ere1"**. File naming conventions are given in **section 5.7.1**.

When using this tag, audio files shall be recorded in conformance to the Exif audio format. Writers can also 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 11**. If multiple files are mapped to one file as in [2] or [3] of this **Table 11**, the above format shall be used to record just one audio file name. If there are multiple audio files, the first recorded file shall be given. In the case of [3] in **Table 11**, 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 shall be terminated by NULL.

**Table 11 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<br>DSC00002.JPG<br>DSC00003.JPG | SND00001.WAV                                 |
| [3] | 1 to plural  | DSC00001.JPG                                 | SND00001.WAV<br>SND00002.WAV<br>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 (":") should be filled with blank characters, or else the Interoperability field should 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 (":") should be filled with blank characters, or else the Interoperability field should 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 4.6.2.**) 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 1998:09:01 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 should 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           |

#### ■ PhotographicSensitivity

This tag indicates the sensitivity of the camera or input device when the image was shot. More specifically, it indicates one of the following values that are parameters defined in ISO 12232: standard output sensitivity (SOS), recommended exposure index (REI), or ISO speed. Accordingly, if a tag corresponding to a parameter that is designated by a SensitivityType tag is recorded, the values of the tag and of this PhotographicSensitivity tag are the same. However, if the value is 65535 (the maximum value of SHORT) or higher, the value of this tag shall be 65535. When recording this tag, the SensitivityType tag should also be recorded. In addition, while "Count = Any", only 1 count should be used when recording this tag.

Note that this tag was referred to as "ISOSpeedRatings" in versions of this standard up to Version 2.21.

See **Annex G** for use of sensitivity-related tags.

|         |   |                |
|---------|---|----------------|
| 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 15**.



| 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 15 OECF Description

Table 12 gives a simple example.

Table 12 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          |

■ SensitivityType

The SensitivityType tag indicates which one of the parameters of ISO12232 is the PhotographicSensitivity tag. Although it is an optional tag, it should be recorded when a PhotographicSensitivity tag is recorded. Value = 4, 5, 6, or 7 may be used in case that the values of plural parameters are the same. See Annex G for use of sensitivity-related tags.

Tag = 34864 (8830.H)

Type = SHORT

Count = 1

Value = 0: Unknown

1: Standard output sensitivity (SOS)

2: Recommended exposure index (REI)

3: ISO speed

4: Standard output sensitivity (SOS) and recommended exposure index (REI)

5: Standard output sensitivity (SOS) and ISO speed

6: Recommended exposure index (REI) and ISO speed

7: Standard output sensitivity (SOS) and recommended exposure index (REI) and ISO speed

Other: Reserved

Default = None

■ StandardOutputSensitivity

This tag indicates the standard output sensitivity value of a camera or input device defined in ISO 12232. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded. See **Annex G** for use of sensitivity-related tags.

Tag = 34865 (8831.H)  
Type = LONG  
Count = 1  
Default = None

#### ■ RecommendedExposureIndex

This tag indicates the recommended exposure index value of a camera or input device defined in ISO 12232. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded. See **Annex G** for use of sensitivity-related tags.

Tag = 34866 (8832.H)  
Type = LONG  
Count = 1  
Default = None

#### ■ ISO Speed

This tag indicates the ISO speed value of a camera or input device that is defined in ISO 12232. When recording this tag, the PhotographicSensitivity and SensitivityType tags shall also be recorded. See **Annex G** for use of sensitivity-related tags.

Tag = 34867 (8833.H)  
Type = LONG  
Count = 1  
Default = None

#### ■ ISOSpeedLatitudeyyy

This tag indicates the ISO speed latitude yyy value of a camera or input device that is defined in ISO 12232.

However, this tag shall not be recorded without ISOSpeed and ISOSpeedLatitudezzz.

See **Annex G** for use of sensitivity-related tags.

Tag = 34868 (8834.H)  
Type = LONG  
Count = 1  
Default = None

#### ■ ISOSpeedLatitudezzz

This tag indicates the ISO speed latitude zzz value of a camera or input device that is defined in ISO

12232.

However, this tag shall not be recorded without ISOSpeed and ISOSpeedLatitudeyyy.

See **Annex G** for use of sensitivity-related tags..

Tag = 34869 (8835.H)

Type = LONG

Count = 1

Default = None

See **Annex G** for use of sensitivity-related tags.

#### ■ 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
- 255 = other
- Other = reserved

#### ■ LightSource

The kind of light source.

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

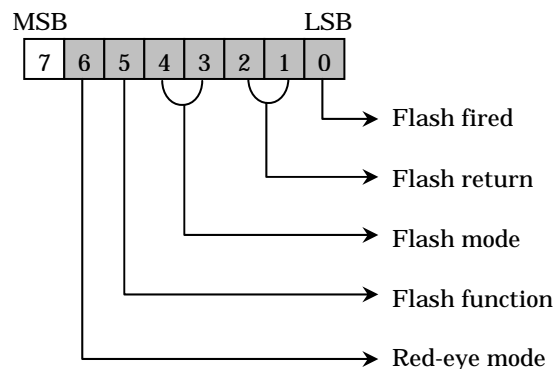
- 0 = unknown
- 1 = Daylight
- 2 = Fluorescent
- 3 = Tungsten (incandescent light)
- 4 = Flash
- 9 = Fine weather

- 10 = Cloudy weather
- 11 = Shade
- 12 = Daylight fluorescent (D 5700 - 7100K)
- 13 = Day white fluorescent (N 4600 - 5500K)
- 14 = Cool white fluorescent (W 3800 - 4500K)
- 15 = White fluorescent (WW 3250 - 3800K)
- 16 = Warm white fluorescent (L 2600 - 3250K)
- 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 16**).

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



**Figure 16 Bit Coding of the Flash Tag**

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

#### ■ 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 17**.)

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 18**.)

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.

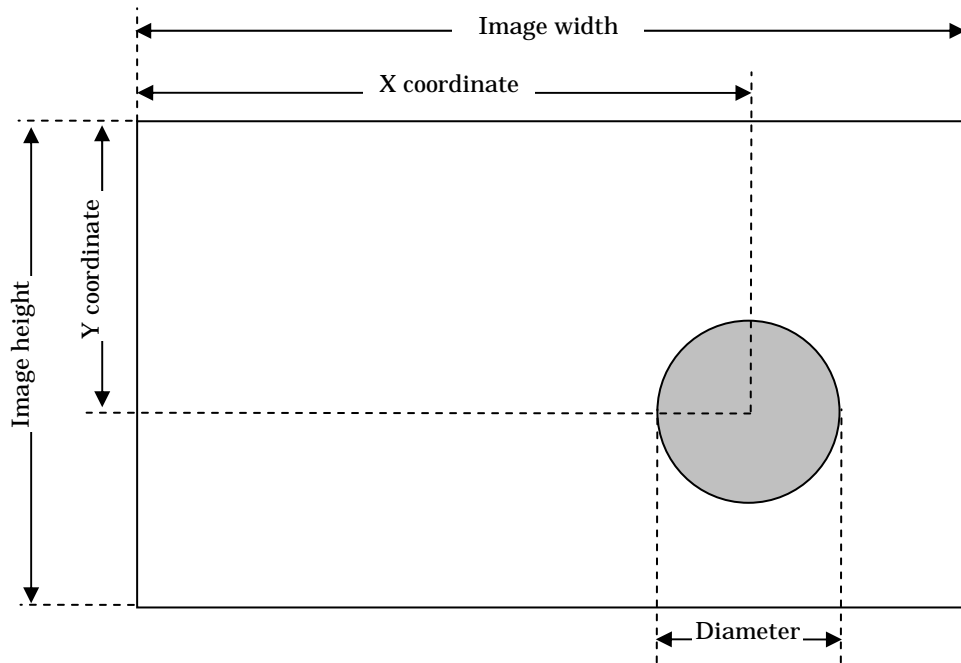


Figure 17 Circular area designation

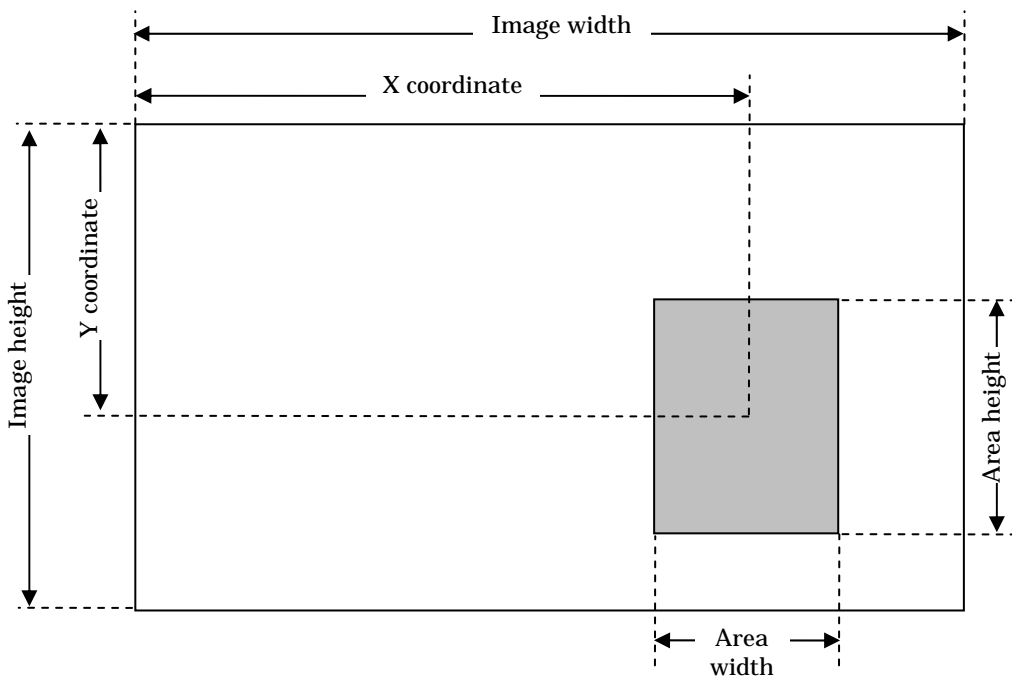


Figure 18 Rectangular area designation

■ **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 19**.

| 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 19 Spatial Frequency Response Description**

Table 13 gives a simple example.

**Table 13 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 always shall be set to 3.

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

|       |   |                             |
|-------|---|-----------------------------|
| 0     | = | others                      |
| 1     | = | scanner of transparent type |
| 2     | = | scanner of reflex type      |
| 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 20 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 20 CFA Pattern Description

The relation of color filter color to CFA value is shown in Table 14.

Table 14 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 21**

|   |   |   |   |       |
|---|---|---|---|-------|
| G | R | G | R | ..... |
| B | G | B | G | ..... |
| G | R | G | R | ..... |
| B | G | B | G | ..... |
| : | : | : | : |       |

**Figure 21 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 Exif/DCF 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 may 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 Exif/DCF reader.

|       |   |                |
|-------|---|----------------|
| Tag   | = | 41995 (A40B.H) |
| Type  | = | UNDEFINED      |
| Count | = | Any            |

Default = None

The information is recorded in the format shown in **Figure 22**. 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 10646-1](#).

| 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 22** 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

**■ CameraOwnerName**

This tag records the owner of a camera used in photography as an ASCII string.

Tag = 42032 (A430.H)  
Type = ASCII  
Count = ANY  
Default = None

**■ BodySerialNumber**

This tag records the serial number of the body of the camera that was used in photography as an ASCII string.

Tag = 42033 (A431.H)  
Type = ASCII  
Count = ANY  
Default = None

**■ LensSpecification**

This tag notes minimum focal length, maximum focal length, minimum F number in the minimum focal length, and minimum F number in the maximum focal length, which are specification information for the lens that was used in photography. When the minimum F number is unknown, the notation is 0/0.

Tag = 42034 (A432.H)  
Type = RATIONAL  
Count = 4  
Default = None

Value 1 := Minimum focal length (unit: mm)  
Value 2 := Maximum focal length (unit: mm)  
Value 3 := Minimum F number in the minimum focal length  
Value 4 := Minimum F number in the maximum focal length

**■ LensMake**

This tag records the lens manufacturer as an ASCII string.

Tag = 42035 (A433.H)  
Type = ASCII  
Count = Any  
Default = None

**■ LensModel**

This tag records the lens's model name and model number as an ASCII string.



Tag = 42036 (A434.H)  
 Type = ASCII  
 Count = Any  
 Default = None

■ **LensSerialNumber**

This tag records the serial number of the interchangeable lens that was used in photography as an ASCII string.

Tag = 42037 (A435.H)  
 Type = ASCII  
 Count = ANY  
 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 15**, followed by an explanation of the contents.

**Table 15 GPS Attribute Information**

| Tag Name                               | Field Name           | Tag ID |     | Type      | Count |
|--|----------------------|--------|-----|-----------|-------|
|  |                      | Dec    | Hex |           |       |
| <b>A. Tags Relating to GPS</b>         |                      |        |     |           |       |
| 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     |
| Horizontal positioning error           | GPSHPositioningError | 31     | 1F  | RATIONAL  | 1     |

**A. Tags Relating to GPS****■ GPSTagID**

Indicates the version of GPSInfoFD. The version is given as 2.3.0.0. This tag is mandatory when GPSInfo tag is present. Note that the GPSTagID tag is written as a different byte than the Exif Version tag.

Tag = 0 (0.H)  
 Type = BYTE  
 Count = 4  
 Default = 2.3.0.0  
 2.3.0.0 = Version 2.3  
 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

**■ GPSTimeStamp**

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 may 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. Originally it was defined for GPS, but it may be used for recording a measure mode to record the position information provided from a mobile base station or wireless LAN as well as GPS.

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     |

#### ■ GPSTrackDirectionRef

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

#### ■ GPSTagDirection

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

#### ■ GPSTDestLongitudeRef

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

#### ■ GPSTDestLongitude

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

#### ■ GPSTDestBearingRef

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

#### ■ GPSTDestBearing

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

#### ■ GPSTDestDistanceRef

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

Tag = 25 (19.H)  
 Type = ASCII

|         |   |                |
|---------|---|----------------|
| Count   | = | 2              |
| Default | = | 'K'            |
| 'K'     | = | Kilometers     |
| 'M'     | = | Miles          |
| 'N'     | = | Nautical miles |
| Other   | = | reserved       |

#### ■ GPSTestDistance

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 9, Table 10**), 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      |

Although this tag was originally defined for GPS use, it may record positional information obtained from mobile phone base stations and wireless LAN in addition to GPS. When recording information that was gathered using the above-mentioned methods, this tag and related tags may be used as shown in the following examples.

When data from a mobile phone base station (cell-id) is used to calculate positional information:

- To record the string "CELLID" in GPSProcessingMethod as ASCII
- To record a GPSMeasureMode tag (in the case of CELLID, normally "2")

When wireless LAN data is used to calculate positional information:

- To record the string "WLAN" in GPSProcessingMethod as ASCII
- To record a GPSMeasureMode tag (in the case of wireless LAN, normally "2")

When GPS satellite data is used to calculate positional information:

- To record the string "GPS" in GPSProcessingMethod as ASCII



- To record a GPSPMeasureMode tag (in the case of GPS, normally "2" or "3")

When more than one of the above-mention methods are used to calculate positional information (hybrid method):

- A method using the pertinent strings "CELLID," "WLAN," and/or "GPS" is listed by opening space in the GPSPProcessingMethod tag. At this time, the method that most contributed to the measurement is listed first
- The measurement mode that most contributed to calculation of positional information is recorded in GPSPMeasureMode

When positional information (Exif GPS IFD:1-6) was entered manually:

- To record the string "MANUAL" in the GPSPProcessingMethod tag as ASCII
- A GPSPMeasureMode tag is not recorded

#### ■ GPSPAreaInformation

A character string recording the name of the GPS area. The first byte indicates the character code used (**Table 9**, **Table 10**), 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

#### ■ GPSPDateStamp

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

#### ■ GPSPDifferential

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

**■ GPSHPositioningError**

This tag indicates horizontal positioning errors in meters.

Tag = 31 (1F.H)  
Type = RATIONAL  
Count = 1  
Default = None

**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, GPSPLatitudeRef 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 **Table 16**. The meaning is explained below.

**Table 16 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 (Exif R 98) 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.

"R03" = Indicates a file conforming to DCF Option 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 17**, **Table 18**, **Table 19** and **Table 20**.

**Table 17 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  | O            | O      | O   | O          |
| 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          |

M : Mandatory (shall be recorded)

R : Recommended

O : Optional

N : It is not allowed to record

J : It is not allowed to record (included in JPEG marker)

Table 18 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          |
| Photographic Sensitivity                   | PhotographicSensitivity      | 34855  | 8827 | O            | O      | O   | O          |
| Optoelectric coefficient                   | OEFCF                        | 34856  | 8828 | O            | O      | O   | O          |
| Sensitivity Type                           | SensitivityType              | 34864  | 8830 | O            | O      | O   | O          |
| Standard Output Sensitivity                | StandardOutputSensitivity    | 34865  | 8831 | O            | O      | O   | O          |
| Recommended Exposure Index                 | RecommendedExposureIndex     | 34866  | 8832 | O            | O      | O   | O          |
| ISO Speed                                  | ISO Speed                    | 34867  | 8833 | O            | O      | O   | O          |
| ISO Speed Latitude yyy                     | ISO SpeedLatitudeyyy         | 34868  | 8834 | O            | O      | O   | O          |
| ISO Speed Latitude zzz                     | ISO SpeedLatitudezzz         | 34869  | 8835 | 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          |
| Camera Owner Name                          | CameraOwnerName              | 42032  | A430 | O            | O      | O   | O          |

|                    |                   |       |      |   |   |   |   |
|--------------------|-------------------|-------|------|---|---|---|---|
| BodySerial Number  | BodySerialNumber  | 42033 | A431 | O | O | O | O |
| Lens Specification | LensSpecification | 42034 | A432 | O | O | O | O |
| Lens Make          | LensMake          | 42035 | A433 | O | O | O | O |
| Lens Model         | LensModel         | 42036 | A434 | O | O | O | O |
| Lens Serial Number | LensSerialNumber  | 42037 | A435 | O | O | O | O |
| Gamma              | Gamma             | 42240 | A500 | O | O | O | O |

**Notation**

M : Mandatory (shall be recorded)

R : Recommended

O : Optional

N : It is not allowed to record

J : It is not allowed to record (included in JPEG marker)

**Table 19 Tag Support Levels (3) - 0th IFD GPS Info Tags -**

| Tag Name                               | Field Name           | Tag ID |     | Uncompressed |        |     | Compressed |
|--|----------------------|--------|-----|--------------|--------|-----|------------|
|  |                      | 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          |
| Horizontal positioning error           | GPSHPositioningError | 31     | 1F  | O            | O      | O   | O          |

**Notation**

M : Mandatory (shall be recorded)

R : Recommended

O : Optional

N : It is not allowed to record

J : It is not allowed to record (included in JPEG marker)

**Table 20 Tag Support Levels (4) - 0th IFD Interoperability Tag –**

| Tag Name                        | Field Name            | Tag ID |     | Uncompressed |        |     | Comp<br>-ressed |
|---------------------------------|-----------------------|--------|-----|--------------|--------|-----|-----------------|
|                                 |                       | 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 : It is not allowed to record

J : It is not allowed to record (included in JPEG marker)

**B. Thumbnail (1st IFD) Support Levels**

The support levels of thumbnail (1st IFD) tags are shown in **Table 21**.

**Table 21 Tag Support Levels (5) - 1st IFD TIFF Tag -**

| 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   | 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 (shall be recorded)
- R : Recommended
- O : Optional
- N : It is not allowed to record
- J : It is not allowed to record (included in JPEG marker)

**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/DCF 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 22**.

**Table 22 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 23**).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning       |
|-------------------------|---------------|---------------|
| +00                     | FF            | Marker Prefix |
| +01                     | D8            | SOI           |

**Figure 23 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 24**). 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<br>(Hex) | Code<br>(Hex) | Meaning                                   |
|-------------------------|---------------|---|
| +00                     | FF            | Marker Prefix                             |
| +01                     | DB            | DQT                                       |
| +02                     | 00<br>C5      | Length of field<br>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 24 DQT Structure (with three quantization tables)

**C. Huffman table definition (DHT: Define Huffman Table)**

DHT is a marker code defining a Huffman table.

In this standard a single component shall have a Huffman table consisting of a set of DC and AC, and each component shall be mapped to one or another of the Huffman tables defined by DHT. All Huffman tables shall be recorded in one DHT marker segment; recording of multiple DHT markers is not allowed.

A Huffman table may have any values, or the JPEG reference values can be used as the base table (see **Figure 25**).

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<br>(Hex) | Code<br>(Hex) | Meaning  |
|-------------------------|---------------|--|
| +00                     | FF            | Marker Prefix  |
| +01                     | C4            | DHT  |
| +02                     | 01<br>A2      | Length of field<br>$2+(1+16+12+1+16+162)*2$<br>= 418 Bytes |
| +04                     | 00            | Table number Y-DC : 00                                     |
| +05                     | :             | DHT parameter  |
|                         | :             |  |
|                         | :             |  |
| +21                     | 10            | Table number Y-AC : 10                                     |
| +22                     | :             | DHT parameter  |
|                         | :             |  |
|                         | :             |  |
| +D4                     | 01            | Table number C-DC : 01                                     |
| +D5                     | :             | DHT parameter  |
|                         | :             |  |
|                         | :             |  |
| +F1                     | 11            | Table number C-AC : 11                                     |
| +F2                     | :             | DHT parameter  |
|                         | :             |  |
|                         | :             |  |

Figure 25 DHT Structure

**D. Restart Interoperability definition (DRI: Define Restart Interoperability)**

DRI is a marker defining the Interoperability at which restart markers are inserted (see **Figure 26**). The recording of DRI and insertion of restart markers are optional. If restart markers are inserted, DRI shall be recorded and its values shall be 4 MCU (Minimum Coding Unit), i.e., 64 pixel units, regardless of whether 4:2:2 or 4:2:0 is used for color sampling (see **Annex F**). Only one DRI shall be recorded.

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<br>(Hex) | Code<br>(Hex) | Meaning                              |
|-------------------------|---------------|--------------------------------------|
| +00                     | FF            | Marker Prefix                        |
| +00                     | DD            | DRI                                  |
| +02                     | 00            | Length of field<br>$2+2 = 4$ (Bytes) |
| +04                     | XX            | 00                                   |
|                         | YY            | 04                                   |

Figure 26 DRI Structure

**E. Frame header (SOF: Start of Frame)**

SOF is a marker code indicating the start of a frame segment and giving various parameters for that frame (see **Figure 27**).

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<br>(Hex) | Code<br>(Hex) | Meaning                           |
|-------------------------|---------------|-----------------------------------|
| +00                     | FF            | Marker Prefix                     |
| +00                     | C0            | SOF                               |
| +02                     | 00            | Length of field                   |
|                         | 11            | 2+1+2+2+1+2*3 = 17 (Bytes)        |
| +04                     | 08            | Data precision (bits)             |
| +05                     | XX            | Vertical lines                    |
|                         | YY            | XXYY (Hex) lines                  |
| +07                     | WW            | Horizontal lines                  |
|                         | ZZ            | WWZZ (Hex) pixels                 |
| +09                     | 03            | Components                        |
| +0A                     | 01            | Component number (1:Y)            |
| +0B                     | 21or22        | H0 = 2, V0 = 1(4:2:2) or 2(4:2:0) |
| +0C                     | 00            | Quantization designation          |
| +0D                     | 02            | Component number (2:Cb)           |
| +0E                     | 11            | H1 = 1, V1 = 1                    |
| +0F                     | 01            | Quantization designation          |
| +10                     | 03            | Component number (3:Cr)           |
| +11                     | 11            | H2 = 1, V2 = 1                    |
| +12                     | 02            | Quantization designation          |

Figure 27 SOF Structure

**F. Scan header (SOS: Start of Scan)**

SOS is a marker code giving various scan-related parameters (see **Figure 28**).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning                                   |
|-------------------------|---------------|---|
| +00                     | FF            | Marker Prefix                             |
| +00                     | DA            | SOS                                       |
| +02                     | 00<br>0C      | Length of field<br>2+1+3*2+3 = 12 (Bytes) |
| +04                     | 03            | Components in scan                        |
| +05                     | 01            | Component selector Y : 01                 |
| +06                     | 00            | Huffman table selector Y : 00             |
| +07                     | 02            | Component selector Cb : 02                |
| +08                     | 11            | Huffman table selector C : 11             |
| +09                     | 03            | Component selector Cr : 03                |
| +0A                     | 11            | Huffman table selector C : 11             |
| +0B                     | 00            | Scan start position in block              |
| +0C                     | 3F            | Scan end position in block                |
| +0D                     | 00            | Successive approximation<br>Bit position  |

**Figure 28 SOS Structure**

**G. Compressed data**

Compressed data is byte data block Interoperability at the required ratio of Y:Cb:Cr and Huffman encoded. An EOB (End of Block) is inserted in each block when the last value of its DCT coefficient is 0. If restart marker insertion is defined in DRI, restart markers are inserted at 4 MCU Interoperability.

**H. End of compressed data (EOI : End of Image)**

EOI is a marker code indicating the end of Interoperability coded data, and is paired with SOI (see **Figure 29**). No specification is made regarding data arrays that come after EOI.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning       |
|-------------------------|---------------|---------------|
| +00                     | FF            | Marker Prefix |
| +01                     | D9            | EOI           |

**Figure 29 EOI Structure**

**4.7.2 Interoperability Structure of APP1 in Compressed Data**

APP1 consists of an APP1 marker indicating that it is an application area, a length code indicating its size, and primary image attribute information patterned after the TIFF structure. The APP1 segment cannot record more than 64 KBytes, a limitation that shall be kept in mind when recording thumbnail images. APP1 also records attribute information for JPEG compressed images. The features of this marker segment are described below.

**A. Order of APP1 recording**

APP1 shall be recorded immediately after the SOI marker indicating the start of the file (see **Figure 7**).

**B. APP1 Interoperability structure**

APP1 consists of an APP1 marker, Exif ID code and the attribute information itself (see **Figure 30**).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning               |
|-------------------------|---------------|-----------------------|
| +00                     | FF            | Marker Prefix         |
| +01                     | E1            | APP1                  |
| +02                     |               | Length of field       |
| +04                     | 45            | 'E'                   |
| +05                     | 78            | 'x'                   |
| +06                     | 69            | 'i'                   |
| +07                     | 66            | 'f'                   |
| +08                     | 00            | NULL                  |
| +09                     | 00            | Padding               |
| +0A                     |               | Attribute information |

**Figure 30 Basic Structure of APP1 Marker Segment**

**C. Exif ID code**

The Exif ID code indicates that the APP1 segment Interoperability is Exif format. After a 4-Byte code, 00.H is recorded in 2 Bytes. The reason for recording this code is to avoid duplication with other applications making use of JPEG application marker segments (APPn).

**D. Attribute information**

Attribute information can be recorded in 2 IFDs (0th IFD, 1st IFD) following the TIFF structure, including the File Header. The 0th IFD records compressed image attributes (the image itself). The 1st IFD may be used for thumbnail images.

**E. TIFF header**

The TIFF header in APP1 constitutes 8 Bytes of data, including the byte order and the Offset of IFD indicating the first IFD. The Offset is referenced to the address of the first byte of the Byte Order. For example, the Offset of IFD address in the TIFF Header is 4 (see **Table 1**).

**F. Relation to JPEG marker segments**

Attribute information is recorded in essentially the same format as that used to record uncompressed data attribute information. In order to avoid duplication, however, attribute information recorded in a JPEG marker segment shall not be recorded in APP1.

**4.7.3 Interoperability Structure of APP2 in Compressed Data**

APP2 consists of an APP2 marker indicating that it is an application area, a length code indicating its size, and Flashpix (see **Annex F**) extensions. If there is no need to record extensions, this marker segment may be omitted.

There are two kinds of APP2 marker segments for recording Flashpix extensions.

One is a Contents List Segment recording a storage and stream list making up the extended data. One file contains only one contents list segment.

The second is a Stream Data Segment storing the data for each of the streams listed in the Contents List Segment. If necessary, there may be two or more APP2 marker segments for storing stream data. In addition there is an APP2 segment reserved for Flashpix use, which is specified in the Flashpix standard.

The contents of data that can be recorded as stream data is left for future specification. It may include one or more Audio data.

**A. Order of APP2 recording.**

APP2 segments shall follow after the APP1 segment, in the order of Contents List Segment and Stream Data Segments. If there are two or more stream data segments, their order is as given in the contents list (see **Figure 7**).

**B. APP2 Interoperability structure**

APP2 consists of an APP2 marker, ID code (FPXR), and Contents List or Stream Data (see **Figure 31**).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning                            |
|-------------------------|---------------|------------------------------------|
| +00                     | FF            | Marker Prefix                      |
| +01                     | E2            | APP2                               |
| +02                     |               | Length of field                    |
| +04                     | 46            | 'F'                                |
| +05                     | 50            | 'P'                                |
| +06                     | 58            | 'X'                                |
| +07                     | 52            | 'R'                                |
| +08                     | 00            | NULL                               |
| +09                     | 00            | Version                            |
| +0A                     |               | Contents List<br>or<br>Stream Data |

**Figure 31 Basic Structure of APP2 Marker Segment**

**C. FPXR ID code**

The FPXR ID code indicates that the APP2 segment contains FPXR data. It is a 4-byte code followed by 00.H recorded in 1 Byte. The reason for recording this code is to avoid duplication with other applications making use of JPEG application marker segments (APPn). The subsequent byte gives the version number (00.H).

**D. Contents list structure**

The contents list segment lists the storages and streams to be created when the file is converted to a Flashpix image file. The first two bytes give the number of Interoperability.

The Interoperability fields on the contents list are as follows.

- Entity size

Indicates the size of the stream, or else FFFFFFFF.H (in the case of a storage). It is recorded in big endian format.

- Default value

A fixed value not set explicitly in the stream data segment but used as the default for each byte.

- Storage/Stream name

The name of the storage and stream added for transformation to Flashpix. It is given as the full path name from the Flashpix source image object root storage. "/" represents a directory separator and shall be the first character of the property value. This name is a 16-bit character string from the Unicode code page, with NULL termination. It is recorded in little endian format.

- Entity class ID

The storage ClassID, given only in the case of a storage Interoperability. It is written as 16-bytes in little endian format.



The data structure of the Contents List Segment is given in **Figure 32**.

| Address Offset<br>(Hex)            | Bytes<br>(Hex)    | Code<br>(Hex) | Meaning                  |
|------------------------------------|-------------------|---------------|--------------------------|
| +00                                | 1                 | FF            | Marker Prefix            |
| +01                                | 1                 | E2            | APP2                     |
| +02                                | 2                 |               | Length of field          |
| +04                                | 4                 |               | "FPXR"                   |
| +08                                | 1                 | 00            | NULL                     |
| +09                                | 1                 | 00            | Version                  |
| +0A                                | 1                 | 01            | Contents List            |
| +0B                                | 2                 |               | Interoperability Count   |
| +0C                                | 4                 |               | Entity size 1            |
| +11                                | 1                 |               | Default value 0          |
| +12                                | m <sub>0</sub>    |               | Storage or Stream name 0 |
| +12+m <sub>0</sub>                 | (n <sub>0</sub> ) |               | (Entity Class ID 0)      |
| +12+m <sub>0</sub> +n <sub>0</sub> | 4                 |               | Entity size 1            |
| :                                  | 1                 |               | Default value 1          |
| :                                  | m <sub>1</sub>    |               | Storage or Stream name 1 |
| :                                  | (n <sub>1</sub> ) |               | (Entity Class ID 1)      |
| :                                  | :                 | :             | :                        |
| :                                  | :                 | :             | :                        |
| :                                  | 4                 |               | Entity size l            |
| :                                  | 1                 |               | Default value l          |
| :                                  | m <sub>l</sub>    |               | Storage or Stream name l |
| :                                  | (n <sub>l</sub> ) |               | (Entity Class ID l)      |

**Figure 32 Contents List Segment Structure**

**E. Stream Data Segment structure**

A stream data segment records part or all of the stream listed in the contents list segment. Because of the 64-KByte size limit of a JPEG marker segment, a stream longer than this shall be recorded in two or more stream data segments. Instead of writing stream data directly in multiple stream data segments, the segments may be filled based on a fixed default. A stream data segment can contain the following data.

- Index into Contents Lists
  - The order of Interoperability recorded in a contents list segment starting from 0.
- Offset into the full Flashpix stream
  - The offset to the first byte of stream data in the Flashpix stream.
- Stream Data
  - The actual data stream recorded as extended data in the transformation to Flashpix. The length of this data is indicated by the length code in the stream data segment.

The data structure of a Stream Data Segment is given in **Figure 33**.

| Address Offset<br>(Hex) | Bytes<br>(Hex) | Code<br>(Hex) | Meaning                   |
|-------------------------|----------------|---------------|---------------------------|
| +00                     | 1              | FF            | Marker Prefix             |
| +01                     | 1              | E2            | APP2                      |
| +02                     | 2              |               | Length of field           |
| +04                     | 4              |               | "FPXR"                    |
| +08                     | 1              | 00            | NULL                      |
| +09                     | 1              | 00            | Version                   |
| +0A                     | 1              | 02            | Stream Data               |
| +0B                     | 2              | N             | Index to Contents List    |
| +0C                     | 4              | (Offset)      | Offset to Flashpix stream |
| +11                     | Variable       | (value)       | Stream Data               |

**Figure 33 Stream Data Segment Structure**

**F. Reserved Segment (Reserved for future use by the Flashpix format)**

This marker segment is reserved for future use. An example is given in **Figure 34**.

| Address Offset<br>(Hex) | Bytes<br>(Hex) | Code<br>(Hex) | Meaning               |
|-------------------------|----------------|---------------|-----------------------|
| +00                     | 1              | FF            | Marker Prefix         |
| +01                     | 1              | E2            | APP2                  |
| +02                     | 2              |               | Length of field       |
| +04                     | 4              |               | "FPXR"                |
| +08                     | 1              | 00            | NULL                  |
| +09                     | 1              | 00            | Version               |
| +0A                     | 1              | 03            | Reserved for Flashpix |
| +0B                     | :              | :             |                       |
|                         | :              | :             |                       |

**Figure 34 Structure of Data Segment Reserved for Flashpix**

## 4.8 Data Description

### 4.8.1 Stipulations on Compressed Image Size

The JPEG format is adopted for compressed images. Since JPEG compresses images in blocks of 8 x 8 pixels, preferably the pixel number set as the width and height of the image should be exact multiples of the MCU (multiples of 16 for width, and multiples of 8 for height if Y:Cb:Cr = 4:2:2, or 16 if Y:Cb:Cr = 4:2:0). It is not required, however, that all image data be fit within this range. If a restart marker is inserted every 4 MCU for the sake of transformation to Flashpix, the width of the image shall be an exact multiple of 4 MCU (64 pixels). There is no such restriction on height.

Specifications on inserting data to adjust the recorded image size relative to the valid image size, or padding, are given below.

#### A. Image size recording procedure in the Exif/DCF writer

An Exif/DCF writer shall record a compressed image with the image width information and height information set in accord with the stipulations below, and padded as necessary. When the image is padded in the direction of width, the padding data shall be appended at the right edge. Padding in the direction of height shall be appended at the bottom edge.

The data used for padding is not specified.

[Stipulations on image width]

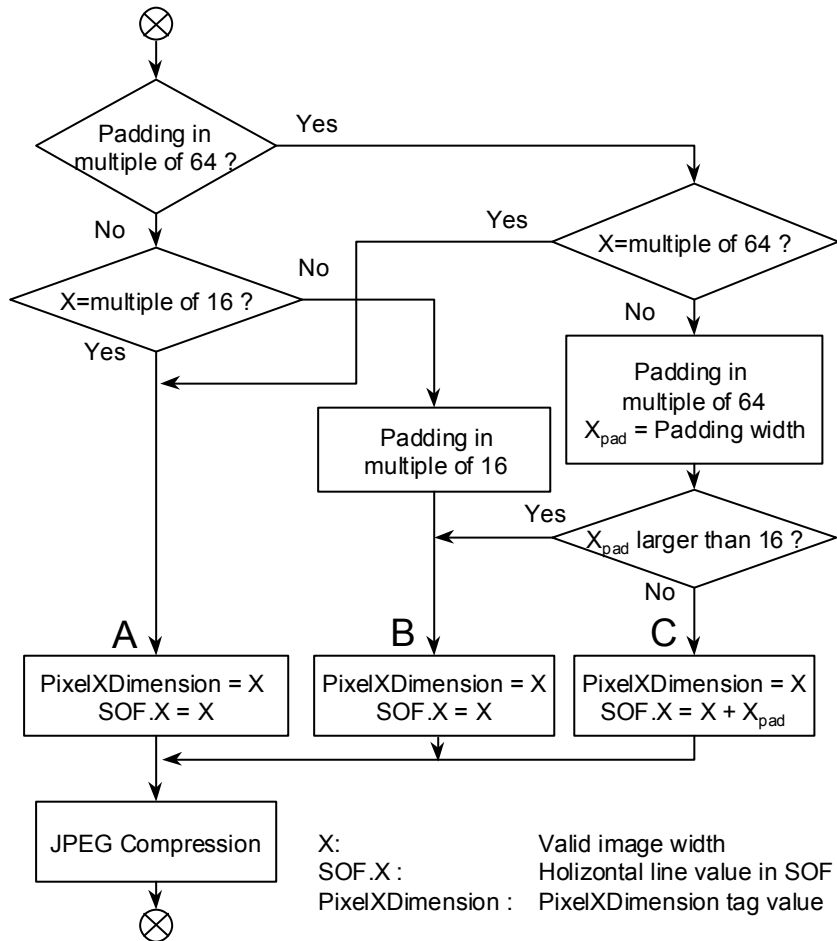
Image width information consists of the valid image width tag (PixelXDimension), SOF marker information, and JPEG compressed data. Of these three, the recording of a valid image width tag is mandatory.

Image width is padded to the right in the following cases. The value used for padding is not specified.

- When the image width is not an exact multiple of 16 and the JPEG block has unused capacity to be filled.
- When the image width is not a multiple of 64 and the insufficiency shall be made up in order to insert restart markers.

The method of describing the various image width data with and without padding is given in **Figure 35**.

It shall be noted carefully that the value of SOF is used in some cases to describe the valid image width, and in others to describe the image width after padding.



**Figure 35 Image Data Width Description**

**Table 23** gives examples of information recorded in the direction of image width and padding data width, for each of cases A, B, and C of **Figure 35**.

**Table 23 Typical Width Direction Information and Padding Data**

|   | Valid Image Width | PixelXDimension | SOF Information | Compressed Data | Padding Width |
|---|-------------------|-----------------|-----------------|-----------------|---------------|
| A | 640               | 640             | 640             | 640             | 0             |
| B | 634               | 634             | 634             | 640             | 6 (< 1MCU)    |
| C | 620               | 620             | 640             | 640             | 20 (> 1MCU)   |

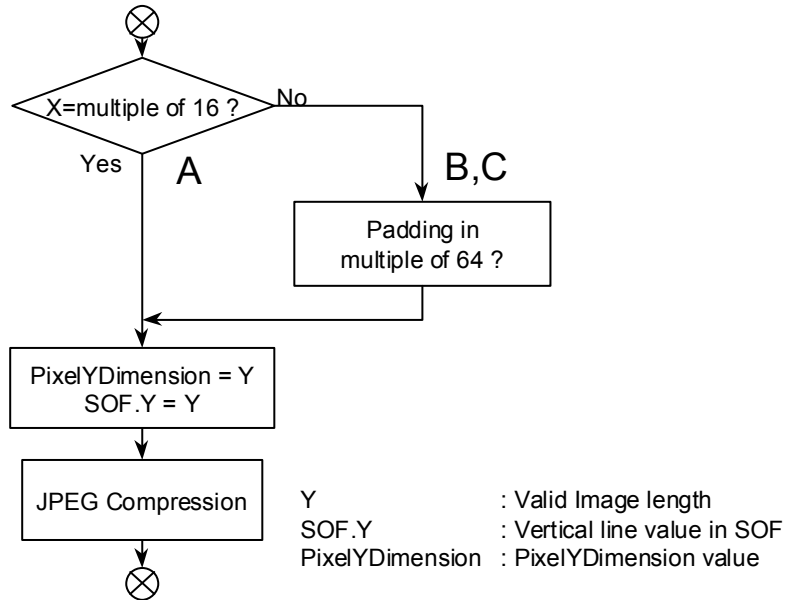
[Stipulations on image height]

Image height information consists of the valid image height tag (PixelYDimension), SOF marker information, and JPEG compressed data. Of these three, the recording of a valid image height tag is mandatory.

The image height is padded in the following case. The padding value is not specified.

When the image height is not an exact multiple of 16 and the JPEG block has unused capacity to be filled.

Insertion of a restart marker does not require padding. The method of recording the various image height data with and without padding is given in **Figure 36**. The SOF marker always has the same value as the effective image height tag.



**Figure 36 Image Data Height Description**

**Table 24** gives examples of information recorded in the direction of image height and padding data height, for each of cases A, B, and C of **Figure 36**.

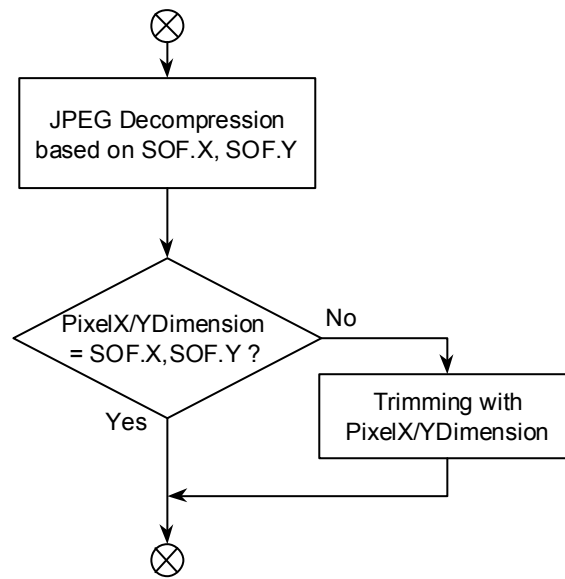
**Table 24 Typical Height Direction Information and Padding Data (when Y:Cb:Cr = 4:2:2)**

|   | Valid Image Height | Valid Image Height Tag | SOF Information | Compressed Data | Padding Height |
|---|--------------------|------------------------|-----------------|-----------------|----------------|
| A | 480                | 480                    | 480             | 480             | 0              |
| B | 474                | 474                    | 474             | 480             | 6 (< 1MCU)     |
| C | 460                | 460                    | 460             | 464             | 4 (< 1MCU)     |

**B. Image size reproduction procedure in the Exif/DCF reader**

It is recommended that the Exif/DCF reader (and in particular, dedicated software) follow the procedureshown in **Figure 37** for reproducing images. First it expands the image based on the SOF information.

Next it trims the image on the right and lower edges in accord with information in the valid image width tag and height tag, and reproduces the valid image data. If the SOF information and the valid imagewidth and height tag information are the same, trimming is unnecessary.



**Figure 37 Procedure for Image Data Reproduction**

Some off-the-shelf software lacks a function for handling valid image width and height tags. If the valid image width differs from the number of horizontal pixels recorded in the SOF, padding data may be displayed. The padding data values should be chosen with this possibility in mind.

## 4.8.2 Stipulations on Thumbnails

### A. Exif/DCF writer

The recording of thumbnail images is an optional specification of the Exif/DCF reader. It is therefore allowable to have Exif files with and without thumbnails. For details see **section 4.5.8**

### B. Exif/DCF reader

This format shall be designed so that the primary image will be reproduced intact whether or not thumbnail images are recorded in the file. It is assumed that even when functions are provided for viewing images on the camera or player, for viewing the process of image transfer from camera to PC, or for using thumbnails as an index display in the camera software or other image software, there will still be cases where the file is viewed without thumbnails. The creation and displaying of thumbnails should therefore be performed or not at the discretion of the user.

## 4.8.3 File Name Stipulations

### A. Exif/DCF writer

The file name and characters used for file names are not specified, other than to stipulate the use of ASCII alphanumerics. (File names in Japanese or other character sets are not to be used.) File names shall be 8 characters or fewer, not including the extension. (Long file names are not to be used.) The file name extensions are ".JPG" for compressed data files and ".TIF" for uncompressed data files.

## 4.8.4 Byte Order Stipulations

### A. Exif/DCF reader

It is recommended that the Exif/DCF reader be able to reproduce Exif files recorded in both little endian and big endian formats.

## 5. Exif Audio File Specification

### 5.1 Outline of the Exif Audio File Specification

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

- Format version definition,
- Specifications relating to audio data,
- Basic structure of audio data,
- Chunks,
- File naming conventions.

### 5.2 Format Version

The version of the format specified here is recorded as 4 bytes (see **section 5.6.3**). The address bytes are recorded as A1, A2, B1, 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.

### 5.3 Definition of Terms

Terms and notation are used as follows in this section:

- Text enclosed in " " is a character string, and "Z means a character string ending in NULL (00.H),

### 5.4 Specifications Relating to Audio Data

#### 5.4.1 Sampling Frequency

The sampling frequency shall be any of 8.000 KHz, 11.025 KHz, 22.050 KHz, 32.000 KHz, 44.100 KHz, 48.000 KHz, 96.000 KHz or 192.000KHz. Only 8.000Hz shall be used for  $\mu$ -LAW PCM in accord with ITU-T G.711. IMA-ADPCM shall be 8.000 KHz, 11.025 KHz, 22.050 KHz, or 44.100 KHz, which are recommended by the IMA (Interactive Multimedia Association).

#### 5.4.2 Bit Size

The bit size shall be 8 bits, 16 bits or 24 bits. Only 8 bits shall be used for  $\mu$ -LAW PCM in accord with ITU-T G.711; and only 4 bits shall be used for IMA-ADPCM in accord with the IMA (Interoperability Multimedia Association) specification.



### 5.4.3 Channels

The number of channels shall be either monaural or stereo (2 ch).

### 5.4.4 Compression Schemes

The following three compressions schemes are specified here:

- Uncompressed audio data: PCM ,
- Uncompressed audio data:  $\mu$ -Law PCM (conforming to ITU-T G.711),
- Compressed data: IMA-ADPCM.

## 5.5 Basic Structure of Audio Data

Exif audio files are based on the RIFF WAVE Form Audio File format adopted as a Windows(tm) standard audio file format, with the addition of various DSC attribute information as needed. Exif audio files are data-compatible with WAVE Form Audio files and can be played on accessories supplied with Windows(tm).

Of the general attribute information required by DSC applications, the common attributes are recorded on an INFO list, and the Exif-specific attributes are recorded in Exif chunks. The Exif chunks are provided to enable the addition of information as necessary, taking advantage of chunk extensibility. The method of recording data in the Exif-specific chunks is patterned after that for the INFO list.

### 5.5.1 Basic Structure of WAVE Form Audio Files

The WAVE Form Audio File format is based on the RIFF (Resource Interoperability File Format) tagged file structure.

A RIFF file consists of basic data blocks called chunks.

#### (1) Chunk

Using C language syntax, a chunk may be defined as a structure, like that in Equation 1. The chunk structure may also be expressed in graphical form as in **Figure 38**.

```
typedef struct {
    unsigned long    ckID;// 4-character code
    unsigned long    ckSize; // Size of member <ckData>
    unsigned char    ckData[ckSize]; // The data in the chunk
} CK;
-- - [Equation 1]
```

| Address Offset<br>(Hex) | Meaning          |
|-------------------------|------------------|
| +00                     | ckID (4 Bytes)   |
| +04                     | ckSize (4 Bytes) |
| +08                     | ckData[ckSize]   |

**Figure 38** Chunk Structure

**【Explanation】**

ckID (chunk ID, a 4-character code) consists of from one to four ASCII alphanumeric characters, left-justified and filled with blank characters if less than four characters in length. Blanks cannot be inserted between characters. This four-character code identifies the contents of the chunk data, described later. Software processing the chunk may be skipped if its chunk ID is unknown..

ckSize (chunk Size) is a 32-bit unsigned integer giving the size (bytes) of the ckData[ckSize] (chunk Data). This size does not include padding bytes following the ckID, ckSize itself and ckData. The byte order is little endian (LSB first, MSB last). In the case of RIFF files, values of more than one byte are all written in little endian order. If two or more chunks follow in sequence, the value of ckSize shall be read properly in order to know the start address (ckID) of the next chunk.

ckData[ckSize] (chunk Data) is the actual data included in that chunk, and may be recorded as binary data of either fixed length or variable length. The start of ckData is aligned with the RIFF file start position in word (16-bit) units. If the data size is an odd number of bytes, a padding byte with the value '0' is appended after the ckData. This padding byte is not included in the ckSize (chunk Size).

ckData[ckSize] (chunk Data) can itself have a particular structure rather than being a simple byte array. That is, ckData itself may include a chunk (sub-chunk). In other words, chunks may be arranged hierarchically. Only certain chunks are allowed to contain sub-chunks. These are the RIFF chunk and LIST chunk described later below. Generally two or more sub-chunks may be contained in these chunks.

All other chunks store only one binary data element in the ckData.

**(2) RIFF Form**

A "RIFF form" is a chunk with "RIFF" as its chunk ID (ckID); it is also used to mean a file format with the RIFF structure (RIFF file).

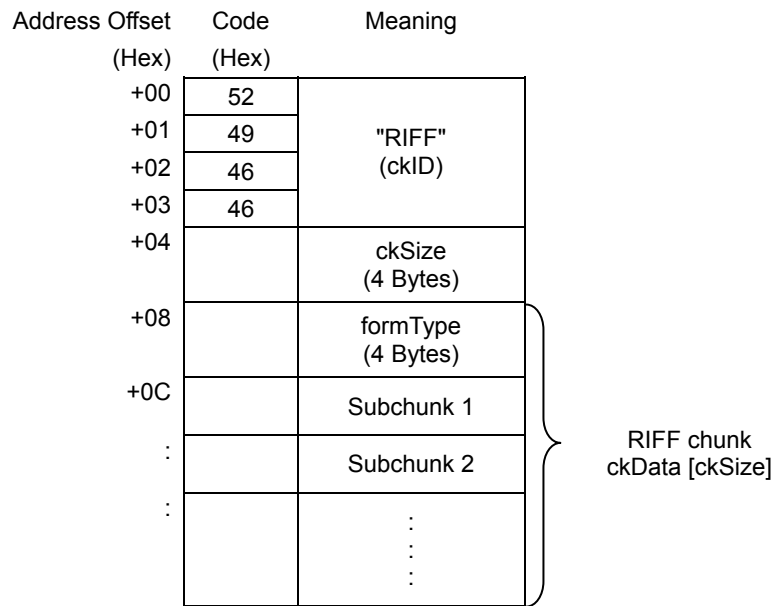
A "RIFF chunk" ckData (chunk data) consists of a 4-character code at the beginning called the formType (form type), followed by a sub-chunk.

A RIFF chunk is at the top of the chunk hierarchy. A RIFF form shall have this chunk, but may have only one. All other chunks are sub-chunks of the RIFF chunk.

A form type is generally a code identifying the data contents, among other things. It is also possible to tell from this code what kind of sub-chunk a chunk contains. A form type shall be registered. A registered form type is written in all upper-case letters.

Along with a form type, a chunk ID (ckID) shall also be registered. A chunk ID in all upper-case letters indicates a general-purpose chunk that may be used with various form types. A chunk ID used with a specific form type is written in all lower-case letters.

An illustration of the RIFF chunk is given in **Figure 39**.



**Figure 39 RIFF Chunk Structure**

**Note** Representative form types are given in **Table 25**. These are written in all upper-case letters because they are registered form types.

**Table 25 Representative Form Types**

| Form Type | Name                                      |
|-----------|---|
| PAL       | Palette file form                         |
| RDIB      | RIFF DIB (Device Independent Bitmap) form |
| RMID      | RIFF MIDI form                            |
| RMMP      | RIFF multimedia movie form                |
| WAVE      | WAVE Form Audio File format               |

**(3) WAVE Form Audio File Format**

The WAVE Form is one kind of RIFF form. It is a file for handling digitized sound data. The form type is WAVE, in upper-case letters.

The file extension for a WAVE Form Audio File is ".WAV".

The data structure of the WAVE Form Audio File format is shown in **Figure 40**.

As is evident from **Figure 40**, the chunk data (ckData [ckSize]) of a RIFF chunk generally consists of the formType ("WAVE"), fmt-ck (format chunk), fact-ck (fact chunk), and data-ck (data chunk). fmt-ck and data-ck are mandatory chunks, but fact-ck may be mandatory or not, depending on the format type (audio coding format) of the WAVE Form.

In addition to these, optional sub-chunks may be recorded and may store various attribute information. These optional sub-chunks are not shown in **Figure 40**.

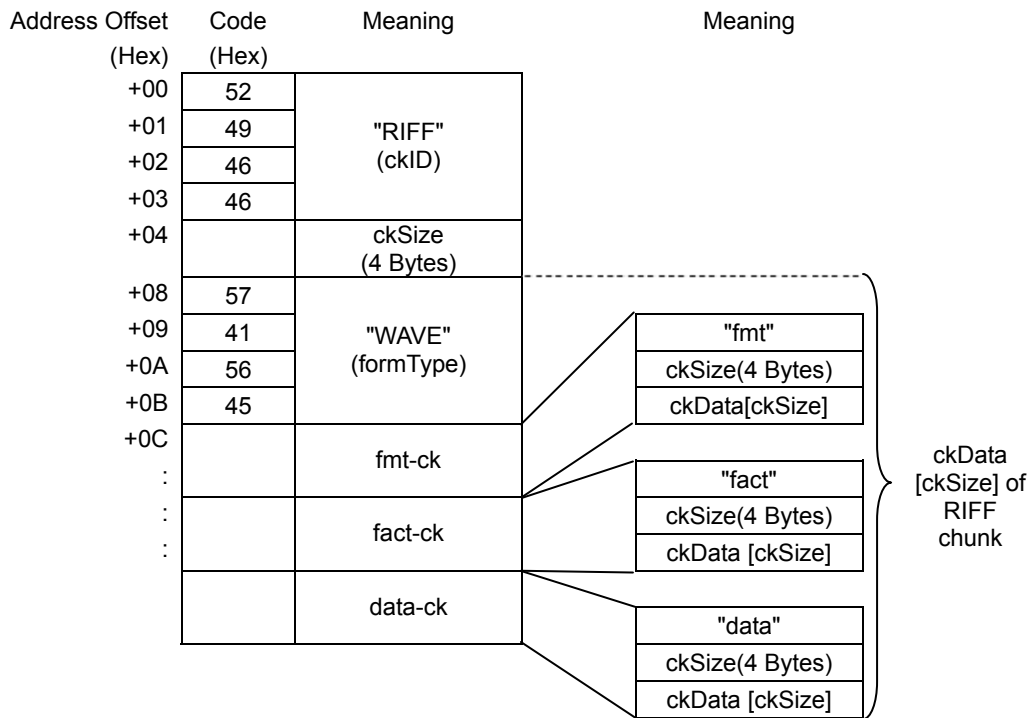


Figure 40 Data Structure of the WAVE Form Audio File Format

<fmt-ck>

fmt-ck (format chunk) contains format information designating the format of audio data included in the data-ck (data chunk) described later below. The ckID (chunk ID) of fmt-ck is "fmt."

"fmt " is 3 characters long, so a blank character (20.H) goes at the end.

fmt-ck is mandatory and shall always be recorded before data-ck.

Since fmt-ck has the chunk structure, ckSize and ckData[ckSize] are included as its members; but the contents of the ckData depend on the format type (audio coding format). This ckData consists of the structure given in Equation 2, and the byte array given in Equation 3.

```

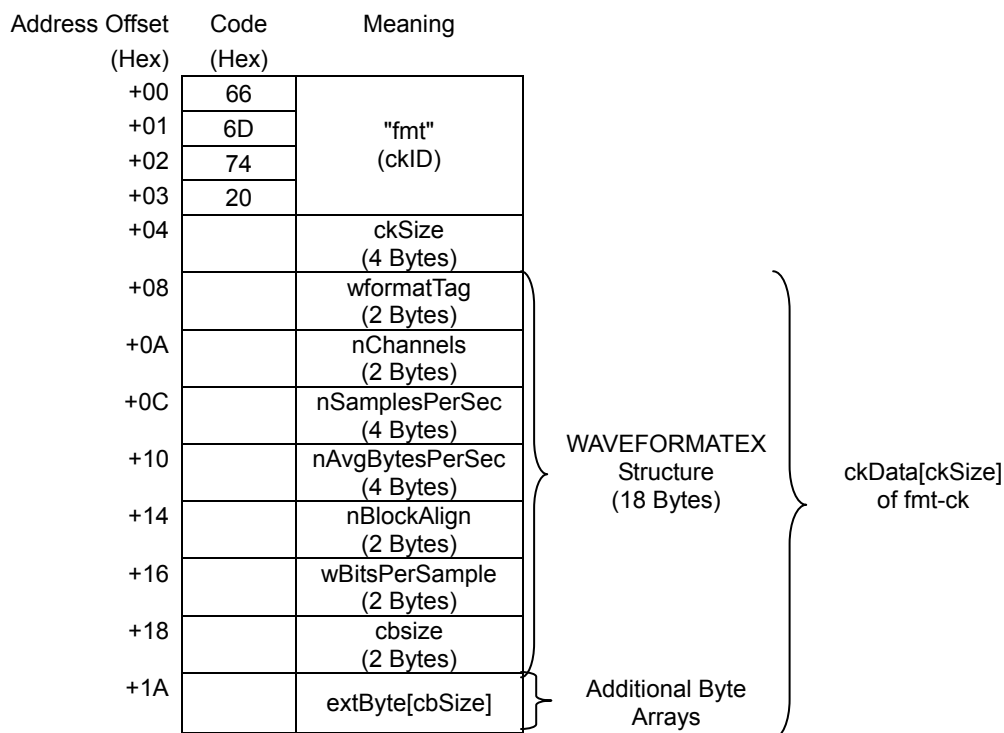
struct{
    unsigned int    wFormatTag;    // Format type
    unsigned int    nChannels; // Number of channels
    unsigned long   nSamplesPerSec; // Sampling rate
    unsigned long   nAvgBytesPerSec; // Average bytes per second
    unsigned int    nBlockAlign;    // Block alignment
    unsigned int    wBitsPerSample; // Bits per sample
    unsigned int    cbSize;    // Additional bytes
} WAVEFORMATEX;
---[Equation 2]
unsigned char    extByte[cbSize]; // Additional byte array ---[Equation 3]
    
```

The meaning of each member of the format information is given in **Table 26**.

**Table 26 Format Information Members**

| Member          | Description   |
|-----------------|---|
| wFormatTag      | An unsigned 16-bit integer indicating the format type (audio coding format) of the WAVE Form. Typical format types are given below.<br>PCM (Pulse Code Modulation) format: 0001.H<br>$\mu$ -Law format (ITU-T G.711): 0007.H<br>IMA-ADPCM (DVI-ADPCM) format: 0011.H  |
| nChannels       | An unsigned 16-bit integer indicating the number of channels. Monaural is 1 and stereo is 2.  |
| nSamplesPerSec  | An unsigned 32-bit integer indicating the sampling rate (samples per second). Audio is played in each channel at this rate.<br>In PCM format the common values of this member are 8.000KHz, 11.025KHz, 22.050KHz, 32.000KHz, 44.100KHz, 48.000KHz, 96.000KHz, and 192.000KHz.   |
| nAvgBytesPerSec | An unsigned 32-bit integer indicating the average bytes per second, a value transferred to the data in data-ck.<br>In PCM format, nAvgBytesPerSec is equivalent to the equation below.<br>$nSamplesPerSec * nBlockAlign$  |
| nBlockAlign     | An unsigned 16-bit integer indicating the (byte unit) block alignment in data-ck. In PCM format, nBlockAlign is equivalent to the equation below.<br>$nChannels * wBitsPerSample/8$   |
| wBitsPerSample  | An unsigned 16-bit integer indicating the bits per sample of each channel.<br>In PCM format, this value is 8, 16 or 24.<br>In the case of compressed sound data, when this value cannot be defined it becomes '0'.  |
| cbSize          | An unsigned 16-bit integer indicating the size (in bytes) of the additional format information extByte[cbSize] appended after the WAVEFORMATEX structure. This information is used to store attributes added in non-PCM formats. If additional information is not needed, it becomes '0'.<br>In PCM format, this member is not needed (the cbSize field itself is not necessary). |
| extByte[cbSize] | A byte array representing the additional format information appended after the WAVEFORMATEX structure.<br>The meaning of this information depends on the format type. If the value of cbSize is 0, this field does not exist.<br>In PCM format, both the cbSize field and extByte[cbSize] field are unnecessary.  |

The fmt-ck structure can be illustrated as in **Figure 41**.



**Figure 41** fmt-ck Structure

<fact-ck>

fact-ck (fact chunk) is used to store file-dependent information relating to the WAVE file contents. The ckID (chunk ID) of fact-ck is "fact".

It is assumed that fact-ck will be extended in the future to store information needed by WAVE files at that time, but currently only one information member is defined.

The information that can be stored in fact-ck at the present time is defined in Equation 4.

unsigned long dwSampleLength; // Sample length - - - [Equation 4]

**Table 27** fact-ck Member

| Member         | Description  |
|----------------|--|
| dwSampleLength | An unsigned 32-bit integer indicating the number of audio data samples (sample length).<br>When this information is combined with nSamplePerSec in fmt-ck, the data length can be expressed in seconds (recording time). |

Since the only information defined presently is dwSampleLength, the value of ckSize (chunk Size) for fact-ck is '00000004.H'; but ckSize may change in the future as information is added (in which case it will be larger than '00000004.H'). Programs shall be able to skip over fields they cannot Interoperability and go on to process the next chunk. For this reason the capability of correctly reading the value of ckSize is a necessary requirement.

The structure of fact-ck is illustrated in **Figure 42**. The value of ckSize is fixed at '00000004.H' (this value is used in Write processing).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning                     |
|-------------------------|---------------|-----------------------------|
| +00                     | 66            | "fact"<br>(ckID)            |
| +01                     | 61            |                             |
| +02                     | 63            |                             |
| +03                     | 74            |                             |
| +04                     | 04            | 00000004.H<br>(ckSize)      |
| +05                     | 00            |                             |
| +06                     | 00            |                             |
| +07                     | 00            | dwSampleLength<br>(4 Bytes) |
| +08                     |               |                             |

} ckData[ckSize]

**Figure 42 fact-ck Structure**

<data-ck>

data-ck (data chunk) is a chunk for storing audio data. Its ckID (chunk ID) is "data".

The ckData (chunk Data) of data-ck consists of the audio data only. In some cases the chunk is filled out with padding bytes.

The audio data is coded based on the format type. The information in fmt-ck is used when the audio data is played back.

The ckSize (chunk Size) of data-ck is the size of the coded audio data only. The structure of data-ck is illustrated in **Figure 43**.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning             |
|-------------------------|---------------|---------------------|
| +00                     | 64            | "data"<br>(ckID)    |
| +01                     | 61            |                     |
| +02                     | 74            |                     |
| +03                     | 61            |                     |
| +04                     |               | ckSize<br>(4 Bytes) |
| +08                     |               | ckData[ckSize]      |

} Size of audio data  
} Coded audio data

**Figure 43 data-ck Structure**

### 5.5.2 Basic Structure of PCM Audio Data

PCM audio data has linear quantization (A/D conversion) characteristics, and is not encoded for compression. It therefore does not need to be decompressed for playback, but can simply be played by reading it directly.

The basic structure of audio data when the format type is PCM (Pulse Code Modulation) format is shown in **Figure 44**.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning              |
|-------------------------|---------------|----------------------|
| +00                     | 52            | "RIFF"<br>(ckID)     |
| +01                     | 49            |                      |
| +02                     | 46            |                      |
| +03                     | 46            |                      |
| +04                     |               | ckSize<br>(4 Bytes)  |
| +08                     | 57            | "WAVE"<br>(formType) |
| +09                     | 41            |                      |
| +0A                     | 56            |                      |
| +0B                     | 45            |                      |
| +0C                     |               | fmt-ck<br>(24 Bytes) |
| +24                     |               | data-ck              |

} PCM format information  
(size is 24 Bytes fixed)

} PCM format audio data

**Figure 44 Basic Structure of PCM Format**



The specific values stored in fmt-ck in the case of PCM format are as shown in **Table 28**.

**Table 28 PCM Format fmt-ck Information**

| PCM (Pulse Code Modulation) Format |   |
|------------------------------------|---|
| Members                            | Code  |
| ckSize (fmt-ck)                    | 00000010.H (16 Bytes, since cbSize is unnecessary)  |
| wFormatTag                         | 0001.H (PCM format)   |
| nChannels                          | The values of each mode are as follows.<br>0001.H (monaural) or 0002.H (stereo)   |
| nSamplesPerSec                     | The values of each mode are as follows.<br>00001F40.H (8.0 KHz)<br>00002B11.H (11.025 KHz)<br>00005622.H (22.05 KHz)<br>00007D00.H (32.0KHz)<br>0000AC44.H (44.10 KHz)<br>0000BB80.H (48.0KHz)<br>00017700.H (96.0KHz)<br>0002EE00.H (192.0KHz) |

|                        |  |
|------------------------|--|
| <p>nAvgBytesPerSec</p> | <p>The values of each mode are as follows.<br/>                     00001F40.H (8.0 KHz, 8-bit monaural)<br/>                     00003E80.H (8.0 KHz, 8-bit stereo)<br/>                     00003E80.H (8.0 KHz, 16-bit monaural)<br/>                     00007D00.H (8.0 KHz, 16-bit stereo)<br/>                     00005DC0.H (8.0KHz, 24-bit monaural)<br/>                     0000BB80.H (8.0KHz, 24-bit stereo)<br/>                     00002B11.H (11.025 KHz, 8-bit monaural)<br/>                     00005622.H (11.025 KHz, 8-bit stereo)<br/>                     00005622.H (11.025 KHz, 16-bit monaural)<br/>                     0000AC44.H (11.025 KHz, 16-bit stereo)<br/>                     00008133.H (11.025KHz, 24-bit monaural)<br/>                     00010266.H (11.025KHz, 24-bit stereo)<br/>                     00005622.H (22.05 KHz, 8-bit monaural)<br/>                     0000AC44.H (22.05 KHz, 8-bit stereo)<br/>                     0000AC44.H (22.05 KHz, 16-bit monaural)<br/>                     00015888.H (22.05 KHz, 16-bit stereo)<br/>                     00010266.H (22.05KHz, 24-bit monaural)<br/>                     000204CC.H (22.05KHz, 24-bit stereo)<br/>                     00007D00.H (32.0KHz, 8-bit monaural)<br/>                     0000FA00.H (32.0KHz, 8-bit stereo)<br/>                     0000FA00.H (32.0KHz, 16-bit monaural)<br/>                     0001F400.H (32.0KHz, 16-bit stereo)<br/>                     00017700.H (32.0KHz, 24-bit monaural)<br/>                     0002EE00.H (32.0KHz, 24-bit stereo)<br/>                     0000AC44.H (44.10 KHz, 8-bit monaural)<br/>                     00015888.H (44.10 KHz, 8-bit stereo)<br/>                     00015888.H (44.10 KHz, 16-bit monaural)<br/>                     0002B110.H (44.10 KHz, 16-bit stereo)<br/>                     000204CC.H (44.10KHz, 24-bit monaural)<br/>                     00040998.H (44.10KHz, 24-bit stereo)<br/>                     0000BB80.H (48.0KHz, 8-bit monaural)<br/>                     00017700.H (48.0KHz, 8-bit stereo)<br/>                     00017700.H (48.0KHz, 16-bit monaural)<br/>                     0002EE00.H (48.0KHz, 16-bit stereo)<br/>                     00023280.H (48.0KHz, 24-bit monaural)<br/>                     00046500.H (48.0KHz, 24-bit stereo)<br/>                     00017700.H (96.0KHz, 8-bit monaural)<br/>                     0002EE00.H (96.0KHz, 8-bit stereo)<br/>                     0002EE00.H (96.0KHz, 16-bit monaural)<br/>                     0005DC00.H (96.0KHz, 16-bit stereo)<br/>                     00046500.H (96.0KHz, 24-bit monaural)<br/>                     0008CA00.H (96.0KHz, 24-bit stereo)<br/>                     0002EE00.H (192.0KHz, 8-bit monaural)<br/>                     0005DC00.H (192.0KHz, 8-bit stereo)<br/>                     0005DC00.H (192.0KHz, 16-bit monaural)<br/>                     000BB800.H (192.0KHz, 16-bit stereo)<br/>                     0008CA00.H (192.0KHz, 24-bit monaural)<br/>                     00119400.H (192.0KHz, 24-bit stereo)</p> <p>Definition: nSamplesPerSec * nBlockAlign</p> |
| <p>nBlockAlign</p>     | <p>The values of each mode are as follows.<br/>                     0001.H (8-bit monaural)<br/>                     0002.H (8-bit stereo)<br/>                     0002.H (16-bit monaural)<br/>                     0004.H (16-bit stereo)<br/>                     0003.H (24-bit monaural)<br/>                     0006.H (24-bit stereo)</p> <p>Definition: nChannels * wBitsPerSample/8</p>   |
| <p>wBitsPerSample</p>  | <p>The values of each mode are as follows.<br/>                     0008.H (8bit) or 0010.H (16bit) or 0018.H (24bit)</p>  |
| <p>cbSize</p>          | <p>Not used</p>  |
| <p>extByte[cbSize]</p> | <p>Not used</p>  |

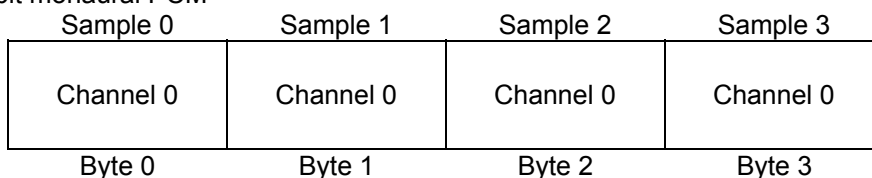
In the case of PCM format audio data, the data format of each sample is 8-bit or 16-bit integer. These sample data formats and their values are given in **Table 29**.

**Table 29 Sample Data Formats and Values**

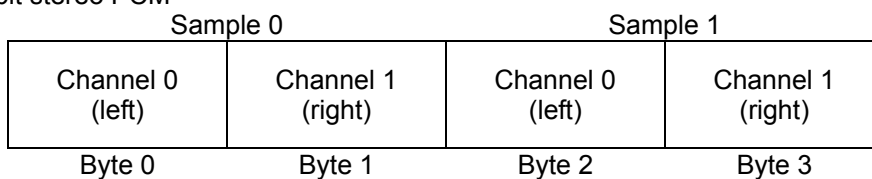
| Sample Size | Data Format      | Minimum             | Interoperability | Maximum             |
|-------------|------------------|---------------------|------------------|---------------------|
| 8-bit PCM   | Unsigned Integer | 0 (00.H)            | 128 (80.H)       | 255 (FF.H)          |
| 16-bit PCM  | Signed Integer   | -32768 (8000.H)     | 0 (0000.H)       | 32767 (7FFF.H)      |
| 24-bit PCM  | Signed Integer   | -8388608 (800000.H) | 0 (0000.H)       | 8388607 (7FFFFFF.H) |

The PCM format audio data contained in data-ck is packed as shown in **Figure 45**. Here the left-hand byte stores the lower address and the right-hand byte holds the upper address.

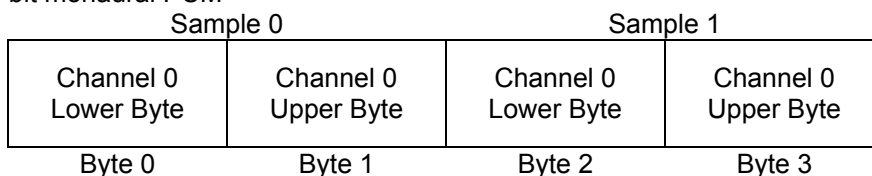
8-bit monaural PCM



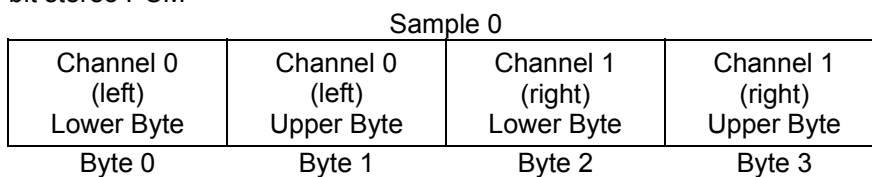
8-bit stereo PCM

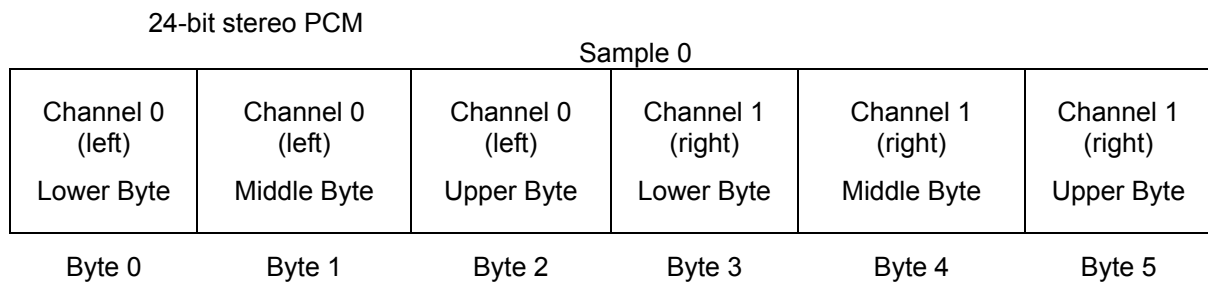
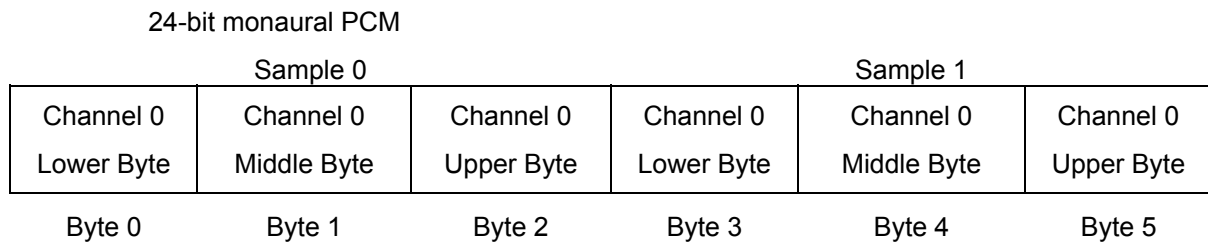


16-bit monaural PCM



16-bit stereo PCM





**Figure 45 Packing of PCM Audio Data**

### 5.5.3 Basic Structure of $\mu$ -Law Audio Data

Each of the audio data samples of  $\mu$ -Law audio data has nonlinear (logarithmic) quantization characteristics. For this reason 16 bits of data can be represented in an 8-bit size. In playback, either the data is first converted to linear 16-bit data and then put through a linear D/A converter, or else the analog signal is derived by going through an 8-bit nonlinear D/A converter with characteristics opposite the  $\mu$ -Law quantization characteristics. Details of the nonlinear quantization characteristics and of the conversion between 8-bit  $\mu$ -Law data and 16-bit linear data are given in the ITU-T G.711 standard.

When the format type is  $\mu$ -Law (ITU-T G.711) format, the basic structure is expressed as in **Figure 46**. The two differences from PCM format are the larger size of fmt-ck (the cbSize file exists) and the existence of fact-ck.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning               |   |
|-------------------------|---------------|-----------------------|---|
| +00                     | 52            | "RIFF"<br>(ckID)      |   |
| +01                     | 49            |                       |   |
| +02                     | 46            |                       |   |
| +03                     | 46            |                       |   |
| +04                     |               | ckSize<br>(4 Bytes)   |   |
| +08                     | 57            | "WAVE"<br>(formType)  |   |
| +09                     | 41            |                       |   |
| +0A                     | 56            |                       |   |
| +0B                     | 45            |                       |   |
| +0C                     |               | fmt-ck<br>(26 Bytes)  | } $\mu$ -Law format information (size is<br>26 Bytes fixed) |
| +26                     |               | fact-ck<br>(12 Bytes) |   |
| +32                     |               | data-ck               | } PCM format audio data                                     |

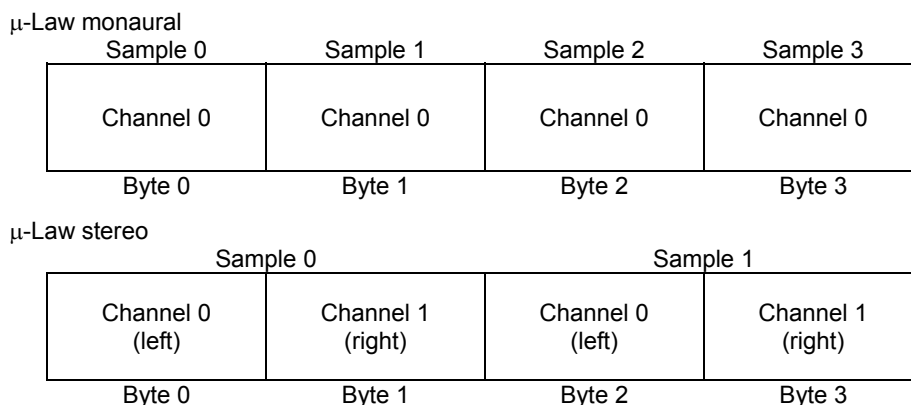
**Figure 46 Basic Structure of  $\mu$ -Law Format**

The specific values of the information stored in `fmt-ck` and `fact-ck` in the case of the  $\mu$ -Law format are given in **Table 30**.

**Table 30** `fmt-ck` and `fact-ck` Information in  $\mu$ -Law Format

| $\mu$ -Law (ITU-T G.711) Format |  |
|---------------------------------|--|
| Members                         | Code   |
| <code>ckSize(fmt-ck)</code>     | 00000012.H (18Bytes, WAVEFORMATEX only)  |
| <code>wFormatTag</code>         | 0007.H ( $\mu$ -Law format)  |
| <code>nChannels</code>          | The values of each mode are as follows.<br>0001.H (monaural) or 0002.H (stereo)  |
| <code>nSamplesPerSec</code>     | 00001F40.H (8.0KHz)  |
| <code>nAvgBytesPerSec</code>    | The values of each mode are as follows.<br>00001F40.H (8.0KHz, 8-bit monaural)<br>00003E80.H (8.0KHz, 8-bit stereo)<br>Definition: <code>nSamplesPerSec * nBlockAlign</code> |
| <code>nBlockAlign</code>        | The values of each mode are as follows.<br>0001.H (8bit monaural)<br>0002.H (8bit stereo)<br>Definition: <code>nChannels * wBitsPerSample/8</code>                           |
| <code>wBitsPerSample</code>     | 0008.H (8bit)  |
| <code>cbSize</code>             | 0000.H ( <code>extByte[cbSize]</code> does not exist)  |
| <code>extByte[cbSize]</code>    | Not used   |
| <code>dwSampleLength</code>     | It is recommended that the actual number of samples that can be played be recorded here.<br>Definition: <code>(ckSize_of_data-ck) / nBlockAlign</code>                       |

The  $\mu$ -Law audio data contained in `data-ck` is packed as shown in **Figure 47**. Here the left-hand bytestores the lower address and the right-hand byte holds the upper address.



**Figure 47** Packing of  $\mu$ -Law Audio Data

### 5.5.4 Basic Structure of IMA-ADPCM Audio Data

IMA-ADPCM audio data is 4-bit data obtained by compressing 16-bit linear PCM audio data. IMA-ADPCM, as seen in its other name DVI-ADPCM, uses a compression algorithm originally developed by the Intel DVI Group (DVI: Digital Video Interoperability). It was later adopted by the IMA (Interoperability Multimedia Association) as a standard audio data format.

Details of the IMA-ADPCM algorithm are given in the IMA Digital Audio Doc-Pac and other documents.

When the format type is IMA-ADPCM (DVI-ADPCM), the basic structure is as shown in **Figure 48**.

A fact-ck is recorded as with the  $\mu$ -Law format, but a difference from that format is the larger fmt-ck size (in addition to a cbSize field there is a wSamplesPerBlock field).

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning               |   |
|-------------------------|---------------|-----------------------|---|
| +00                     | 52            | "RIFF"<br>(ckID)      |   |
| +01                     | 49            |                       |   |
| +02                     | 46            |                       |   |
| +03                     | 46            |                       |   |
| +04                     |               | ckSize<br>(4 Bytes)   |   |
| +08                     | 57            | "WAVE"<br>(formType)  |   |
| +09                     | 41            |                       |   |
| +0A                     | 56            |                       |   |
| +0B                     | 45            |                       |   |
| +0C                     |               | fmt-ck<br>(28 Bytes)  | IMA-ADPCM format information (size is 28 Bytes fixed) |
| +28                     |               | fact-ck<br>(12 Bytes) |   |
| +34                     |               | data-ck               | PCM format audio data                                 |

**Figure 48 Basic Structure of IMA-ADPCM Format**

The specific values of the information stored in fmt-ck and fact-ck in the case of the IMA-ADPCM format are given in **Table 31** and **Table 32**.

**Table 31 IMA-ADPCM Format fmt-ck and fact-ck Information (1)**

| IMA-ADPCM (DVI-ADPCM) Format |   |
|------------------------------|---|
| Members                      | Code  |
| ckSize(fmt-ck)               | 00000014.H (20 Bytes)   |
| wFormatTag                   | 0011.H (IMA-ADPCM format)   |
| nChannels                    | 0001.H (monaural) or 0002.H (stereo)  |
| nSamplesPerSec               | The values of each mode are as follows.<br>00001F40.H (8.0 KHz)<br>00002B11.H (11.025 Hz)<br>00005622.H (22.050 Hz)<br>0000AC44.H (44.10 Hz)  |
| nAvgBytesPerSec              | The values of each mode are as follows.<br>00000FD7.H (8.0 KHz, 4-bit monaural)<br>00001FAE.H (8.0 KHz, 4-bit stereo)<br>000015D4.H (11.025 KHz, 4-bit monaural)<br>00002BA9.H (11.025 KHz, 4-bit stereo)<br>00002B5C.H (22.05 KHz, 4-bit monaural)<br>000056B9.H (22.05 KHz, 4-bit stereo)<br>0000566D.H (44.10 KHz, 4-bit monaural)<br>0000ACDB.H (44.10 KHz, 4-bit stereo)<br>Definition: nSamplesPerSec*nBlockAlign/wSamplesPerBlock  |
| nBlockAlign                  | The values of each mode are as follows.<br>0100.H (8.0 KHz, 4-bit monaural)<br>0200.H (8.0 KHz, 4-bit stereo)<br>0100.H (11.025 KHz, 4-bit monaural)<br>0200.H (11.025 KHz, 4-bit stereo)<br>0200.H (22.05 KHz, 4-bit monaural)<br>0400.H (22.05 KHz, 4-bit stereo)<br>0400.H (44.10 KHz, 4-bit monaural)<br>0800.H (44.10 KHz, 4-bit stereo)<br>Although the definition is (N+1) * 4 * nChannels, the use of<br>256 * nChannels * max (1, nSamplesPerSec / 11.025KHz)<br>is recommended. |
| wBitsPerSample               | 0004.H (4 bits)   |
| cbSize                       | 0002.H  |



**Table 32 IMA-ADPCM Format fmt-ck and fact-ck Information (2)**

| IMA-ADPCM (DVI-ADPCM) Format |   |
|------------------------------|---|
| extByte[cbSize]              | <p>The values of each mode are as follows.</p> <p>01F9.H (8.0 KHz, 4-bit monaural)<br/>                     01F9.H (8.0 KHz, 4-bit stereo)<br/>                     01F9.H (11.025 KHz, 4-bit monaural)<br/>                     01F9.H (11.025 KHz, 4 bit stereo)<br/>                     03F9.H (22.05 KHz, 4-bit monaural)<br/>                     03F9.H (22.05 KHz, 4-bit stereo)<br/>                     07F9.H (44.10 KHz, 4-bit monaural)<br/>                     07F9.H (44.10 KHz, 4-bit stereo)</p> <p>If the definition is, wSamplesPerBlock (an unsigned 16-bit integer indicating the samples per channel-unit block), and<br/> <math>X = (nBlockAlign - (4 * nChannels)) * 8</math><br/> <math>Y = wBitsPerSample * nChannels</math><br/>                     then,<br/> <math>wSamplesPerBlock = (X/Y) + 1</math></p> |
| dwSampleLength               | <p>It is recommended that the actual number of samples that can be played back be recorded.<br/>                     The definition is as follows.<br/>                     If <math>X = ckSize\_of\_data-ck / nBlockAlign</math><br/>                     then,<br/> <math>dwSampleLength = (X + 1) * wSamplesPerBlock</math></p>  |

The IMA-ADPCM audio data contained in data-ck is packed as shown in **Figure 49**, **Figure 50** and **Figure 51** when it is recorded.

A feature of this format is the existence of a header at the start of each block. The header records the initial sample value for that block and a step (quantization table) index. The audio data in each channel is independent, so the number of header words is the same as the number of channels.

A header word consists of 4 Bytes, and is defined as in Equation 5. The existence of a header means IMA-ADPCM audio data can be played from any block. In other words, random access is possible on a per-block basis.

In **Figure 49** to **Figure 51**, the left-hand byte stores the lower address and the right-hand byte holds the upper address.

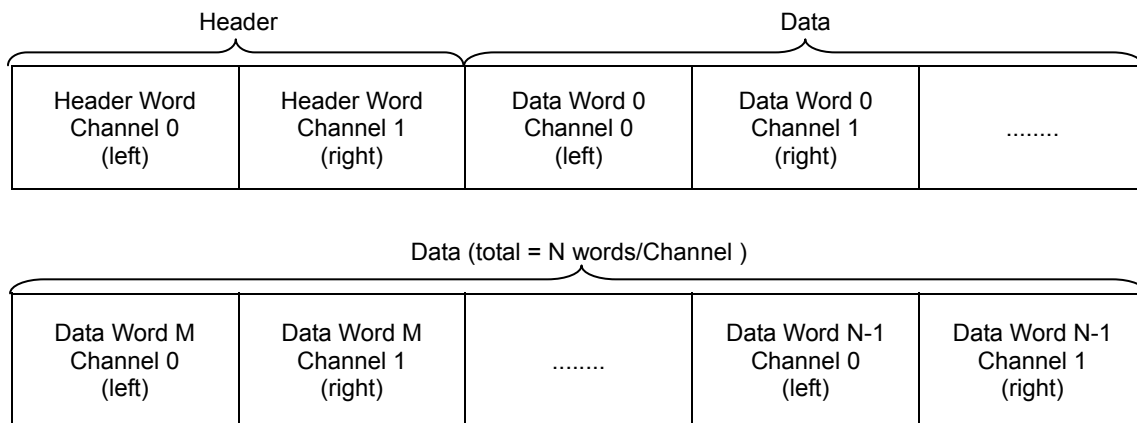
```
typedef struct {
    signed int    iSamp0; // Initial sample value of the block
    unsigned char bStepTableIndex; // Step table index
    unsigned char bReserved; // reserved byte
} IMA_ADPCMBLOCKHEADER; // -- [Equation 5]
```

In **Figure 49** to **Figure 51**, N, M, and P have the following significance.

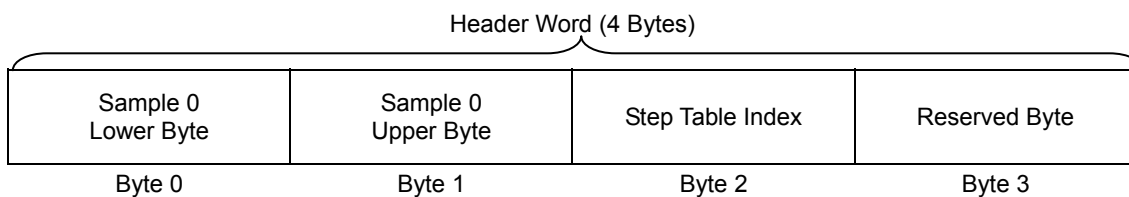
$$N = (\text{nBlockAlign}/(4*\text{nChannels})) - 1 \quad \text{---[Equation 6]}$$

$$M = 0, 1, 2, 3, \dots, N-1 \quad \text{---[Equation 7]}$$

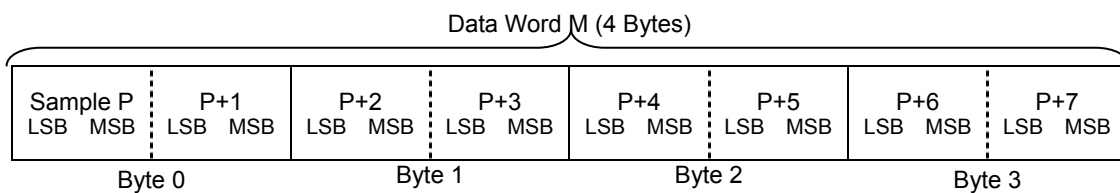
$$P = (M * 8) + 1 \quad \text{---[Equation 8]}$$



**Figure 49 Packing of IMA-ADPCM Audio Data**



**Figure 50 Header Word of IMA-ADPCM Audio Data**



**Figure 51 Data Word M of IMA-ADPCM Audio Data**

## 5.6 Chunks Used

The chunks used in Exif audio files are described here.

### 5.6.1 WAVE Form Audio File Basic Chunks

The basic chunks of a WAVE Form Audio File, as is evident from the basic structure of the WAVE file shown in **Figure 40**, are the four below.

- RIFF chunk
- fmt chunk
- fact chunk
- data chunk

[Additional Explanation]

The fmt chunk, fact chunk and data chunk are sub-chunks of the RIFF chunk. A WAVE file consists of one RIFF chunk, with specific information recorded in the sub-chunks.

Only when the form type is PCM (Pulse Code Modulation) format, the fact chunk is unnecessary. With non-PCM formats such as  $\mu$ -Law and IMA-ADPCM, it is mandatory, which is why fact-ck is included in the basic chunks here.

It is possible to add other optional sub-chunks as well.

At the head of the chunk data (ckData) of the RIFF chunk there is a form type called "WAVE".

### 5.6.2 LIST Chunk and INFO List

A WAVE form and other RIFF forms store a variety of information in sub-chunks of the RIFF chunk. These sub-chunks in many cases are specific to each form type; but there are also general-purpose chunks for storing additional information regardless of the data specified for a given form type.

One of these general-purpose chunks is the LIST chunk. Here the use of the LIST chunk is explained.

#### (1) LIST Chunk

The LIST chunk is a general-purpose chunk that may be used with the files of many different form types. The LIST chunk is a pre-registered general-purpose chunk, so its ckID (chunk ID) should be written in upper-case letters.

Included in the LIST chunk is a sub-chunk list (series of sub-chunks) and sequence designation. The LIST chunk ckData (chunk data) consists of a four-character code at the beginning called a listType (list type), followed by the sub-chunk list.

This structure resembles that of the RIFF chunk, but the LIST chunk is always farther down the hierarchy than the RIFF chunk.

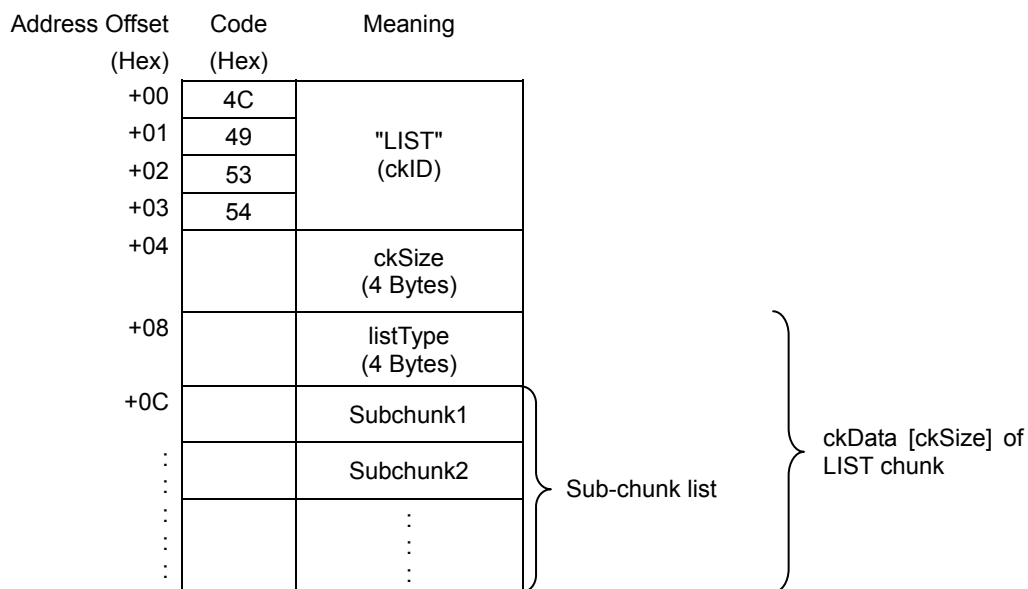
The list type is used to identify the list contents. For this reason there are list types that are used only with certain form types. If a list type is encountered that cannot be Interoperability, that LIST chunk may be ignored.

The list type shall be registered. A general-purpose list type that is registered and should be used with

various form types is written in all upper-case letters.

A list type that can be used only with a specific form type is written in lower-case letters.

The LIST chunk structure is illustrated in **Figure 52**.



**Figure 52 LIST Chunk Structure**

**(2) INFO List**

An "INFO list" is a LIST chunk having the registered, general-purpose listType "INFO".

The need for information such as title, copyright and comments is similar in each of the form types.

The INFO list is used for storing these kinds of information.

The information itself in an INFO list is stored in the sub-chunk lists. These sub-chunks use only pre-registered, general-purpose chunks, described later below.

The INFO list information is supplementary and has no influence on the Interoperability of the main data, such as WAVE form audio data. It may therefore be skipped without problem. If an unknown chunk is included on the INFO list, as when a new chunk has been defined, it shall be to be ignored.

The INFO list chunks currently defined are given in **Table 33**. These pre-registered chunks are stored as ASCII text strings terminated by NULL (the final byte is '00.H').

**Table 33 INFO List Chunks**

| Chunk ID | Description   |
|----------|---|
| IARL     | Archival Location. Indicates where the subject of the file is archived.   |
| IART     | Artist. Lists the artist of the original subject of the file.   |
| ICMS     | Commissioned. Lists the name of the person or organization that commissioned the subject of the file.                                 |
| ICMT     | Comments. Provides general comments about the file or the subject of the file.  |
| ICOP     | Copyright. Records the copyright information for the file.  |
| ICRD     | Creation date. Indicates the date the subject of the file was created.  |
| ICRP     | Cropped. Indicates whether an image has been cropped  |
| IDIM     | Dimensions. Specifies the size of the original subject of the file.   |
| IDPI     | Dots Per Inch. Stores the dots per inch (DPI) setting of the digitizer used to produce the file.                                      |
| IENG     | Engineer. Stores the name of the engineer who worked on the file.   |
| IGNR     | Genre. Describes the genre of the original work.  |
| IKEY     | Keywords. Provides a list of keywords that refer to the file or subject of the file.  |
| ILGT     | Lightness. Describes the changes in lightness settings on the digitizer required to produce the file.                                 |
| IMED     | Medium. Describes the original subject of the file, such as, "computer image," "drawing," "lithograph," and so forth.                 |
| INAM     | Name. Stores the title of the subject of the file.  |
| IPLT     | Palette Setting. Specifies the number of colors requested when digitizing an image.   |
| IPRD     | Product. Specifies the name of the title the file was originally intended for, such as "Encyclopedia of Pacific Northwest Geography." |
| ISBJ     | Subject. Describes the file contents, such as "Aerial view of Seattle."   |
| ISFT     | Software. Identifies the name of the software package used to create the file.  |
| ISHP     | Sharpness. Identifies the changes in sharpness for the digitizer required to produce the file.  |
| ISRC     | Source. Identifies the name of the person or organization who supplied the original subject of the file.                              |
| ISRF     | Source Form. Identifies the original form of the material that was digitized, such as "slide," "paper," "map," and so forth.          |
| ITCH     | Technician. Identifies the technician who digitized the subject file.   |

A typical INFO list is shown in **Figure 53**.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning                | Code<br>(Hex) | Meaning   |
|-------------------------|---------------|------------------------|---------------|---|
| +00                     | 4C            | "LIST"<br>(ckID)       | 49            | "INAM"<br>(ckID)                                      |
| +01                     | 49            |                        | 4E            |   |
| +02                     | 53            |                        | 41            |   |
| +03                     | 54            |                        | 4D            |   |
| +04                     | 40            | 00000040.H<br>(ckSize) | 0A            | 0000000A.H<br>(ckSize)                                |
| +05                     | 00            |                        | 00            |   |
| +06                     | 00            |                        | 00            |   |
| +07                     | 00            | "INFO"<br>(listType)   |               | "Two Trees"Z<br>(ckData)                              |
| +08                     | 49            |                        |               |   |
| +09                     | 4E            |                        |               |   |
| +0A                     | 46            | INAM-ck<br>(18 Bytes)  |               | "ICMT"<br>(ckID)                                      |
| +0B                     | 4F            |                        | 49            |   |
| +0C                     |               | ICMT-ck<br>(42 Bytes)  | 4E            | "ICMT"<br>(ckID)                                      |
| +0D                     |               |                        | 41            |   |
| +0E                     |               |                        | 4D            |   |
| +0F                     |               | ICMT-ck<br>(42 Bytes)  | 21            | 00000021.H<br>(ckSize)                                |
| +10                     |               |                        | 00            |   |
| +11                     |               |                        | 00            |   |
| +12                     |               | ICMT-ck<br>(42 Bytes)  | 00            | "A picture for<br>the opening<br>screen"Z<br>(ckData) |
| +13                     |               |                        |               |   |
| +14                     |               |                        |               |   |
| +15                     |               | ICMT-ck<br>(42 Bytes)  |               | "A picture for<br>the opening<br>screen"Z<br>(ckData) |
| +16                     |               |                        |               |   |
| +17                     |               |                        |               |   |

**Figure 53 Typical INFO List**

The following points need to be observed in using the INFO list. They are explained in reference to **Figure 53**.

The 'Z' at the end of the text string information in the INAM and ICMT chunks means NULL termination. The actual code appended is '00.H'.

The chunk data (ckData) in each chunk shall be an even number of bytes. If the data itself is an odd number of bytes, it shall be padded by one additional byte.

In the example in **Figure 53**, the ICMT chunk has 33 Bytes of information including the NULL termination, so a padding byte '00.H' shall be appended. No padding is necessary with the INAM chunk information, since the size including NULL termination is 10 Bytes.

The value of the chunk size (ckSize) of the ICMT chunk does not include the padding byte. However, the chunk size of the LIST chunk that is its parent chunk shall include the padding bytes in the sub-chunks. If this rule is not observed, it will not be possible to determine the start address of a chunk following after this LIST chunk.

**(3) INFO List used by Exif audio files**

The INFO list used with Exif audio files is as follows.

The chunks that may be included on the INFO list are those given in **Table 33**; but of these, only the following are used with Exif audio files.

[Chunks Used with Exif]

**INAM**

Records the title of the Exif audio file. The title is written in an ASCII string and terminated with NULL.

Recording this information is optional.

Ex.) "Exif Audio File Example"Z

**IGNR**

Records the genre of the Exif audio file subject. The genre name is written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "narration"Z

**ICRD**

Records the date the Exif audio file was created. It is written as a fixed-length ASCII string, in the format year-month-day. That is, the year, month, and day are separated by a hyphen. The year is four digits, while month and day are two digits each. If the number of the month or the day is less than 10, the first digit is 0. The order shall be year-month-day. Since this information is written as an ASCII string, it shall be terminated with NULL. This chunk is fixed-length (the chunk data is 11 Bytes, and a padding byte is added to make it an even byte number). Recording this information is optional.

Ex.) "1997-04-08"Z (Note: =April 8, 1997)

**ICMT**

Records a general comment on the Exif audio file or its subject. Comments are written in ASCII text terminated with NULL. If there are two or more comments, each statement ends with a period. A carriage return or line feed character shall not be used. Recording this information is optional.

Ex.) "Recorded by Digital Still Camera"Z

**IART**

Records the name of the Exif audio file creator. The name is written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "Taro Yamada"Z

**ICOP**

Records copyright information for the Exif audio file. The copyright is written in ASCII text and terminated with NULL. In case of multiple copyright information, each is separated by a semicolon followed by one blank space (20.H). Recording this information is optional.

Ex.) "Copyright Exif Corporation 1997."Z

[Notes and Additional Information]

A camera shall not record chunks other than those listed above.

If a camera encounters an unknown chunk when reading the INFO list, it shall skip that chunk. It is

possible that the INFO list will be expanded in the future, and this provision ensures that compatibility will be maintained.

Information shall be recorded in accord with the general INFO list stipulations.

All the information on the INFO list is optional, and does not have to be recorded.

The INFO list used for Exif audio files consists of pre-registered, general-purpose chunks only, which means this information can be read by commercial "RIFF Form Reader" software (such as the utility software provided with Windows(tm)).

### 5.6.3 Chunks for Attribute Information Specific to Exif Audio Files

Recording of attribute information specific to Exif audio files is done as follows.

Exif-specific attributes are those not defined for ordinary WAVE Form Audio Files but only for Exif audio files. This is auxiliary information with no influence on Interoperability of the audio data itself. For this reason an Exif audio file can still be compatible with a standard WAVE Form Audio File.

The attributes specific to Exif audio files are recorded as follows.

#### (1) LIST chunk is used.

The compatibility noted above is realized by using a pre-registered, general-purpose LIST chunk to record the attribute information specific to Exif audio files. Since it may be used with all the LIST chunk form types, this chunk may be put in the WAVE Form Audio File. The individual information is recorded in sub-chunks of the LIST chunk.

#### (2) A dedicated list type "exif" is defined.

The information in the LIST chunk is explicitly labeled as information specific to Exif audio files by defining a dedicated list type. The following is used as this list type.

- Dedicated Exif list type: "exif" (all lower-case letters)

The attributes specific to Exif audio files cannot be used in the WAVE Form Audio File format, so it is all written in lower-case letters.

Hereafter, the notation "exif list" is used to mean the LIST chunk whose list type is exif.

#### (3) A dedicated chunk is defined for each of the attributes.

Since there are no corresponding existing chunks, a dedicated chunk is defined to record the attribute information specific to Exif audio files. The information items and their chunks are described below.

[Information items and chunks]

##### **ever**

Records the version information (number) of this standard.

As with Exif image files, it is recorded in 4 Bytes. The address bytes are recorded as A1, A2, B1, 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. A1, A2, B1 and B2 are ASCII numerals giving the version number, but NULL termination is unnecessary. This chunk is mandatory.

On the conventions for version number updating, see **section 5.2**.

Ex.) "0200" (Note: =Version 2.00)

##### **erel**



Records information pointing to an Exif image file related to the Exif audio file recorded in this chunk. Recording this information makes it possible for a camera or application software to map an image to sound during playback.

The relational information consists of the name of the corresponding Exif image file, given as an 8-character file name plus 3-character extension in ASCII format. The path is not written. Stipulations on images are given in **section 4.6.5**. File naming rules are covered in **section 5.7.1**.

The mapping of Exif image files and audio files is done in any of the three ways shown in **Table 34**. If multiple files are mapped to one file as in [2] or [3] of **Table 34**, the above format is used to record just one destination file name. If there are multiple destination files, the first recorded file is given.

In the case of [2] in **Table 34**, for the Exif audio file "SND00001.WAV" only "DSC00001.JPG" is given as the related image file. When there are three Exif image files "DSC00001.JPG," "DSC00002.JPG" and "DSC00003.JPG," the related Exif audio file name for each of them, "SND00001.WAV," 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. If there is a related Exif image file, this chunk is mandatory.

Ex.) "DSC00001.JPG"Z

**Table 34 Mapping between Image and Audio Files**

|     | Relationship | Exif Image File                              | Exif Audio File                              |
|-----|--------------|--|--|
| [1] | 1 to 1       | DSC00001.JPG                                 | SND00001.WAV                                 |
| [2] | Many to 1    | DSC00001.JPG<br>DSC00002.JPG<br>DSC00003.JPG | SND00001.WAV                                 |
| [3] | 1 to many    | DSC00001.JPG                                 | SND00001.WAV<br>SND00002.WAV<br>SND00003.WAV |

**etim**

Records the time of Exif audio file creation. This is defined as the time the recording of audio data was started. Time is expressed as a variable-length ASCII string. In order to conform as closely as possible to the Exif image file, time is recorded in the format "hour:minute:second.subsecond," with a colon in between each time unit and a period before the subsecond position.

Hour, minute and second are written as two digits each, with the first digit a zero if the value is one digit. Subseconds may be expressed to any desired decimal place. If there is no subsecond information, the string ends with a period only.

The order of time units is hour, minute, second, subsecond. The information is written as an ASCII string, so it shall be terminated with NULL. Recording this information is optional.

Ex.) "10:05:10.130"Z

**ecor**

Records the name of the manufacturer of the equipment on which the Exif audio file was created. The manufacturer name shall be written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "Digital Still Camera Corporation"Z

**emdl**

Records the model name of the equipment on which the Exif audio file was created. The model name shall be written in an ASCII string and terminated with NULL. Recording this information is optional.

Ex.) "DSCamera1000"Z

**emnt**

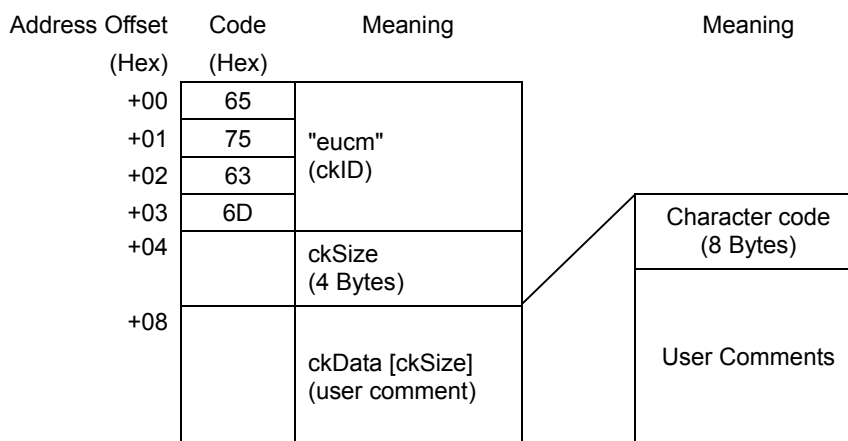
As with Exif image files, this chunk is used by the Exif/DCF writer manufacturer to record design information, version history and other maker-specific information. The contents and format of the information are up to each manufacturer. Other manufacturers see this information only as a byte array of the size determined by the chunk size ( ckSize).

Recording this information is optional.

**eucm**

Records user comment information that cannot be recorded on, or is not suitable for, the INFO list. Basically this is text information. Character code information is included so languages that do not use ASCII may be used here. Recording this chunk is optional.

Recording of user comments is discussed below. The structure of the user comment chunk is shown in **Figure 54**.



**Figure 54 Structure of User Comment Chunk**

As seen in **Figure 54**, the chunk data area storing the user comment starts with an 8-byte character code area, where the character code is given. The rest of the chunk data area is the user comment area, used for writing comments. The currently defined character codes are shown in **Table 35**. A registration system is used for character codes to avoid duplication. When a character code is

registered, a standard document is indicated in the reference column to indicate the character format specification. If a character code is used for which there is no clear specification like Shift-JIS in Japan, Undefined is designated.

The character code is written from the start of the character code area, and the unused portion is padded with NULL ('00.H'). In order to match the format of the actual comments in the user comment part to that of the Exif image file UserComment tag, NULL termination is not used even if the comment is written in ASCII text. In accord with the chunk specification, however, a padding byte ('00.H') shall be used if the chunk data is not an even number of bytes.

**Table 35 Character Codes and Character Code Designation**

| Character Code | Code Designation (8 Bytes)                     | Reference        |
|----------------|--|------------------|
| 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 X0208-1990   |
| 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        |

[Notes and Additional Information]

The above chunks incorporated in exif list are used with a specific form type ('WAVE') and are therefore written in all lower-case letters.

Only the ever chunk is mandatory; the others are optional. If an Exif image file related to an audio file exists, the erel chunk is also mandatory.

When the exif list is read by a camera, information that cannot be recognized may be encountered, such as the emnt chunk or an Undefined string in the eucm chunk. In that case the chunk shall be skipped.

An Exif/DCF reader and writer shall conform to the stipulations for an ordinary LIST chunk.

A general-purpose RIFF Form Reader will ignore the exif list. A dedicated Exif/DCF reader is required for reading the exif list.

**Figure 55** shows the exif list structure and a coding example. The ever chunk is mandatory and has a fixed length (chunk data is 4 Bytes). The erel chunk data is 13 Bytes (odd), so a padding byte is added. The erel chunk is also fixed length.

| Address Offset<br>(Hex) | Code<br>(Hex) | Meaning                | Code<br>(Hex) | Meaning                         |
|-------------------------|---------------|------------------------|---------------|---------------------------------|
| +00                     | 4C            | "LIST"<br>(ckID)       | 65            | "ever"<br>(ckID)                |
| +01                     | 49            |                        | 76            |                                 |
| +02                     | 53            |                        | 65            |                                 |
| +03                     | 54            |                        | 72            |                                 |
| +04                     | 26            | 00000026.H<br>(ckSize) | 04            | 0000000A.H<br>(ckSize)          |
| +05                     | 00            |                        | 00            |                                 |
| +06                     | 00            |                        | 00            |                                 |
| +07                     | 00            |                        | 00            |                                 |
| +08                     | 65            | "exif"<br>(listType)   |               | "0200"<br>(ckData)              |
| +09                     | 78            |                        |               |                                 |
| +0A                     | 69            |                        |               |                                 |
| +0B                     | 66            |                        |               |                                 |
| +0C                     |               | ever-ck<br>(12 Bytes)  |               |                                 |
| +1E                     |               | erel-ck<br>(22 Bytes)  |               |                                 |
|                         |               |                        | 65            | "erel"<br>(ckID)                |
|                         |               |                        | 72            |                                 |
|                         |               |                        | 65            |                                 |
|                         |               |                        | 6C            | 000000D.H<br>(ckSize)           |
|                         |               |                        | 0D            |                                 |
|                         |               |                        | 00            |                                 |
|                         |               |                        | 00            |                                 |
|                         |               |                        | 00            | "DSC00001.JPG"<br>Z<br>(ckData) |
|                         |               |                        |               |                                 |
|                         |               |                        |               |                                 |

Figure 55 exif List Structure and Typical Coding

## 5.7 Data Description

### 5.7.1 File Naming Stipulation

The file name and characters used for file names are not specified, other than to stipulate the use of ASCII alphanumerics. (File names in Japanese or other character sets are not to be used.) File names shall be 8 characters or fewer, not including the extension. (Long file names are not to be used.) The file extension is ".WAV" (to match the WAVE Form Audio File extension) regardless of the audio data format type.

### 5.7.2 Typical Exif Audio File

Typical Exif Audio File **Figure 56** shows the configuration of a typical Exif audio file.

The shaded parts of **Figure 56** are the mandatory elements of an Exif audio file. The hatching (fact-ck only) means that this chunk is not required if the audio data is PCM (Pulse Code Modulation) format, but is mandatory for all non-PCM formats (μ-Law, IMA-ADPCM), etc. The non-shaded elements are optional.

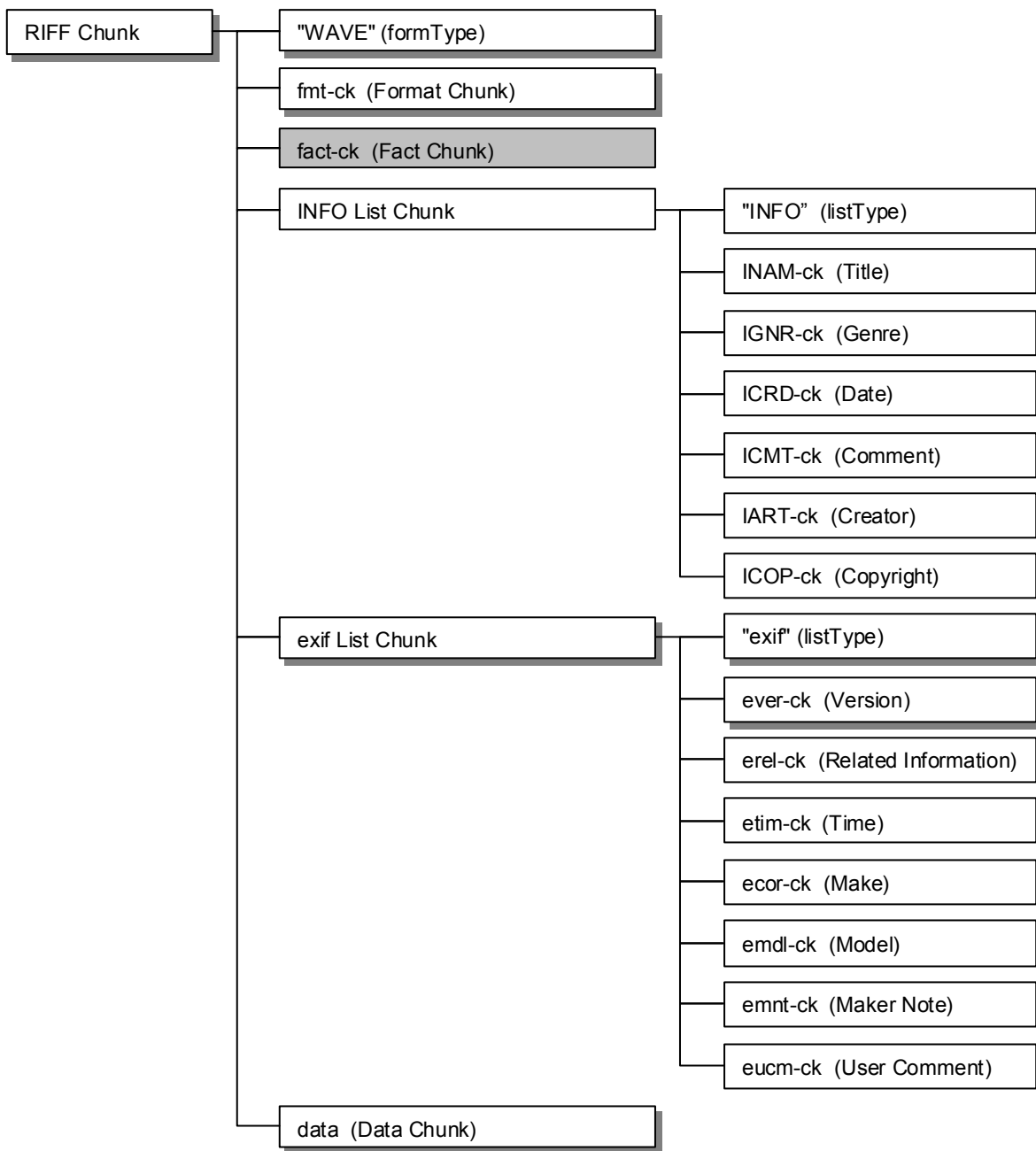
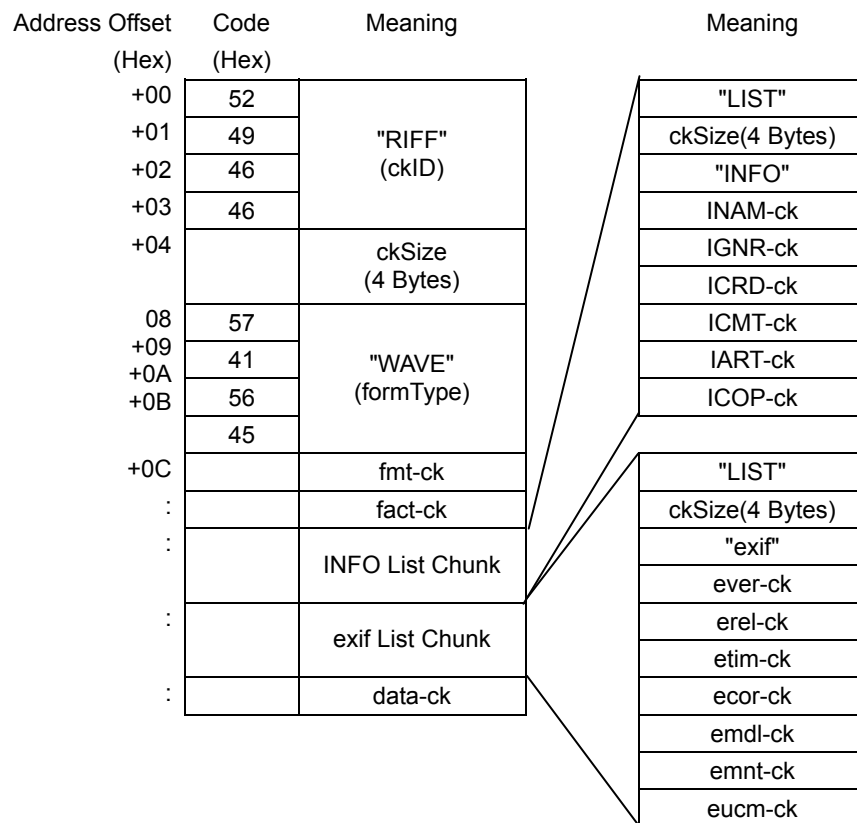


Figure 56 Exif Audio File Configuration

The means of recording the data of each element is given in the section for that element.

**Figure 57** shows the most common Exif audio file data structure. Exif audio file data is recorded in accord with the structure shown in **Figure 57**. Each sub-chunk is recorded in accord with its stipulations. Optional chunks may be omitted.



**Figure 57 Data Structure of a Typical Exif Audio File**

## 6. 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://www.jeita.or.jp/>



## 7. References

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

|         |   |
|---------|---|
| ExifR98 | ExifR98 Version 1.0<br><b>JEIDA-49-1</b> June, 1998<br><a href="http://www.jeita.or.jp/">http://www.jeita.or.jp/</a>  |
| DCF     | Design rule for Camera File system:<br><b>CIPA DC-009</b><br><a href="http://www.cipa.jp/index.html">http://www.cipa.jp/index.html</a><br><b>CP-3461</b><br><a href="http://www.jeita.or.jp/">http://www.jeita.or.jp/</a>   |
|         | 7-bit and 8-bit double byte coded KANJI sets for information interchange<br><b>JIS X 0208</b><br><a href="http://www.jisa.or.jp/">http://www.jisa.or.jp/</a>  |
|         | Classification of fluorescent lamps by chromaticity and colour rendering property<br><b>JIS Z 9112</b><br><a href="http://www.jisa.or.jp/">http://www.jisa.or.jp/</a>   |
|         | Standard Practice for Electronic Interchange of Color and Appearance Data<br><b>ASTM E1708 - 95</b><br><a href="http://www.astm.org/">http://www.astm.org/</a>  |
|         | Photography -- Cameras using 35 mm film and roll film -- Picture sizes<br><b>ISO 1754</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>  |
|         | Photography -- Illuminants for sensitometry -- Specifications for daylight, incandescent tungsten and printer<br><b>ISO 7589</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>   |
|         | Information technology -- Universal Multiple-Octet Coded Character Set (UCS)<br>Part1: Architecture and Basic Multilingual Plane<br><b>ISO/IEC 10646-1</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>   |
| JPEG    | Information technology -- Digital compression and coding of continuous-tone still images: Requirements and guidelines<br><b>ISO/IEC 10918-1</b><br><a href="http://www.iso.org/">http://www.iso.org/</a><br><b>Recommendation T.81</b><br><a href="http://www.itu.int/">http://www.itu.int/</a> |
|         | Photography — Digital still cameras — Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index<br><b>ISO 12232</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>  |



|             |  |
|-------------|--|
|             | Photography -- Electronic still-picture cameras -- Resolution measurements<br><b>ISO 12233</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>  |
|             | Photography -- Electronic still-picture cameras -- Methods for measuring opto-electronic conversion functions (OECFs)<br><b>ISO 14524</b><br><a href="http://www.iso.org/">http://www.iso.org/</a>   |
| sRGB        | Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management - Default RGB colour space – sRGB<br><b>IEC 61966-2-1 ed1.0</b><br><a href="http://www.iec.ch/">http://www.iec.ch/</a>  |
| sRGB        | Amd.1 Ed.1 to Multimedia systems and equipment<br>Colour measurement and management<br>Part 2-1: Colour Management Default RGB colour space sRGB (2003)<br><b>IEC 61966-2-1-am1 ed1.0</b><br><a href="http://www.iec.ch/">http://www.iec.ch/</a>   |
| PCM         | Pulse code modulation(PCM) of voice frequencies<br><b>Recommendation G.711</b><br><a href="http://www.itu.int/">http://www.itu.int/</a>  |
|             | International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) - Information technology - 7-bit coded character set for information interchange<br><b>Recommendation T.50 (09/1992)</b><br><a href="http://www.itu.int/">http://www.itu.int/</a>  |
| TIFF        | <b>TIFF Revision 6.0 Final</b> , June 3, 1992<br><a href="http://www.adobe.com/">http://www.adobe.com/</a>   |
| Flashpix    | <b>Flashpix Format Specification Version 1.0</b> , September 11, 1996<br>Eastman Kodak Company   |
| RIFF        | <b>New Multimedia Data Types and Data Techniques</b> , 1996<br>Microsoft Corporation<br><a href="http://www.microsoft.com/">http://www.microsoft.com/</a>  |
| ADPCM       | <b>Recommended Practices for Enhancing Digital Audio Compatibility in Multimedia Systems Revision 3.00</b> , October 21, 1992<br>The Interactive Multimedia Association(IMA)   |
| Unicode     | <b>Unicode Standard</b> , 1991<br><a href="http://www.unicode.org/">http://www.unicode.org/</a><br>The Unicode Consortium  |
| IMA-ADPCM   | <b>IMA Digital Audio Doc-Pac</b> , 1992<br>The Interactive Multimedia Association(IMA)   |
| Directives2 | ISO/IEC Directives, Part 2 “Rules for the structure and drafting of International Standards”<br><a href="http://www.iso.org/">http://www.iso.org/</a><br><a href="http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3146825/4229629/4230450/4230456/ISO%20IEC%20Directives%20Part%20Rules%20for%20the%20structure%20and%20drafting%20of%20International%20Standards%202004%205th%20edition%20pdf%20format%20.pdf?nodeid=4230517&amp;vernum=0">http://isotc.iso.org/livelink/livelink/fetch/2000/2122/3146825/4229629/4230450/4230456/ISO IEC Directives Part 2 Rules for the structure and drafting of International Standards 2004 5th edition pdf format .pdf?nodeid=4230517&amp;vernum=0</a> |

# Annex A Image File Description Examples

## A.1 Uncompressed RGB File

**Table 36 Uncompressed RGB File Description Sample Contents**

|  |                                 |
|--|---------------------------------|
| Primary Image                            |                                 |
| Pixels                                   | 640 (W) x 480 (H)               |
| Image Title                              | Exif_TIFF_RGB                   |
| Image Input Equipment Manufacturer       | DSCCompany                      |
| Image Input Equipment Model Name         | Example                         |
| Orientation                              | Normal                          |
| Strips                                   | 96                              |
| Lines per Strip                          | 5                               |
| Bytes per Strip                          | 9600                            |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |
| Image Data Arrangement                   | Chunky                          |
| File Change Date and Time                | 1997:09:01 12:00:00.000         |
| Copyright                                | Copyright, ABCDE,1997           |
| Exif-specific Information                |                                 |
| Version                                  | Ver. 2.0                        |
| Date and Time of Original Image Creation | 1997:09:01 12:00:00.000         |
| Date and Time of File Creation           | 1997:09:01 12:00:00.000         |
| Thumbnail                                |                                 |
| Pixels                                   | 80 (W) x 60 (H)                 |
| Orientation                              | Normal                          |
| Strips                                   | 1                               |
| Lines per Strip                          | 60                              |
| Bytes per Strip                          | 14400                           |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |

Table 37 Uncompressed RGB File Description Sample

| Header                             | Offset (Hex)                          | Name                       | Data (Hex or "ASCII")                |              |             |                              |
|------------------------------------|---------------------------------------|----------------------------|--------------------------------------|--------------|-------------|------------------------------|
|                                    |                                       | 0000                       | Byte Order                           | 4D4D ("MM" ) |             |                              |
|                                    | 0002                                  | 42                         | 002A                                 |              |             |                              |
|                                    | 0004                                  | 0th IFD Offset             | 00000008                             |              |             |                              |
| 0th IFD                            | Offset (Hex)                          | Name                       | Interoperability Number (Hex)        |              |             |                              |
|                                    | 0008                                  | Number of Interoperability | 0014                                 |              |             |                              |
| 0th IFD                            | Offset (Hex)                          | Name                       | Tag ID (Hex)                         | Type (Hex)   | Count (Hex) | ValueOffset (Hex or "ASCII") |
|                                    | 000A                                  | ImageWidth                 | 0100                                 | 0004         | 00000001    | 00000280                     |
|                                    | 0016                                  | ImageLength                | 0101                                 | 0004         | 00000001    | 000001E0                     |
|                                    | 0022                                  | BitsPerSample              | 0102                                 | 0003         | 00000003    | 000000FE                     |
|                                    | 002E                                  | Compression                | 0103                                 | 0003         | 00000001    | 00010000                     |
|                                    | 003A                                  | PhotometricInterpretation  | 0106                                 | 0003         | 00000001    | 00020000                     |
|                                    | 0046                                  | ImageDescription           | 010E                                 | 0002         | 0000000E    | 00000104                     |
|                                    | 0052                                  | Make                       | 010F                                 | 0002         | 00000009    | 00000112                     |
|                                    | 005E                                  | Model                      | 0110                                 | 0002         | 00000008    | 0000011C                     |
|                                    | 006A                                  | StripOffsets               | 0111                                 | 0004         | 00000060    | 00000124                     |
|                                    | 0076                                  | Orientation                | 0112                                 | 0003         | 00000001    | 00010000                     |
|                                    | 0082                                  | SamplesPerPixel            | 0                                    | 0003         | 00000001    | 00030000                     |
|                                    | 008E                                  | RowsPerStrip               | 0116                                 | 0004         | 00000001    | 00000005                     |
|                                    | 009A                                  | StripByteCounts            | 0117                                 | 0004         | 00000060    | 000002A4                     |
|                                    | 00A6                                  | XResolution                | 011A                                 | 0005         | 00000001    | 00000424                     |
|                                    | 00B2                                  | YResolution                | 011B                                 | 0005         | 00000001    | 0000042C                     |
|                                    | 00BE                                  | PlanarConfiguration        | 011C                                 | 0003         | 00000001    | 00010000                     |
|                                    | 00CA                                  | ResolutionUnit             | 0128                                 | 0003         | 00000001    | 00020000                     |
|                                    | 00D6                                  | DateTime                   | 0132                                 | 0002         | 00000014    | 00000434                     |
|                                    | 00E2                                  | Copyright                  | 8298                                 | 0002         | 00000015    | 00000484                     |
|                                    | 00EE                                  | Exif IFD Pointer           | 8769                                 | 0004         | 00000001    | 0000045E                     |
| 0th IFD                            | Offset (Hex)                          | Name                       | Offset (Hex)                         |              |             |                              |
|                                    | 00FA                                  | Next IFD Offset            | 000004EC                             |              |             |                              |
| Value longer than 4Byte of 0th IFD | Offset (Hex)                          | Name                       | Data (Hex or "ASCII")                |              |             |                              |
|                                    | 00FE                                  | BitPerSample Value         | 000800080008                         |              |             |                              |
|                                    | 0104                                  | ImageDescription Value     | "Exif_TIFF_RGB"00                    |              |             |                              |
|                                    | 0112                                  | Make Value                 | "DSCCompany"00                       |              |             |                              |
|                                    | 011C                                  | Model Value                | "Example"00                          |              |             |                              |
|                                    | 0124                                  | StripOffsets Value         | offset0,offset1,offset2.....offset95 |              |             |                              |
|                                    | 02A4                                  | StripByteCounts Value      | count0, count1, count2....count95    |              |             |                              |
|                                    | 0424                                  | XResolution Value          | 0000004800000001                     |              |             |                              |
|                                    | 042C                                  | YResolution Value          | 0000004800000001                     |              |             |                              |
|                                    | 0434                                  | DateTime Value             | "1997:09:01 12:00:00"00              |              |             |                              |
| 0448                               | Copyright Value (Last Byte is Padded) | "Copyright,ABCDE,1997"0000 |                                      |              |             |                              |
| Exif IFD                           | Offset (Hex)                          | Name                       | Interoperability Number (Hex)        |              |             |                              |
|                                    | 045E                                  | Exif IFD Number            | 0008                                 |              |             |                              |
| Exif IFD                           | Offset (Hex)                          | Name                       | Tag ID (Hex)                         | Type (Hex)   | Count (Hex) | ValueOffset (Hex or "ASCII") |
|                                    | 0460                                  | ExifVersion                | 9000                                 | 0007         | 00000004    | "0200"                       |
|                                    | 046C                                  | DateTimeOriginal           | 9003                                 | 0002         | 00000014    | 000004C4                     |
|                                    | 0478                                  | DateTimeDigitized          | 9004                                 | 0002         | 00000014    | 000004D8                     |
|                                    | 0484                                  | SubSecTime                 | 9290                                 | 0002         | 00000004    | "00"00                       |
|                                    | 0490                                  | SubSecTimeOriginal         | 9291                                 | 0002         | 00000004    | "00"00                       |
|                                    | 049C                                  | SubSecTimeDigitized        | 9292                                 | 0002         | 00000004    | "00"00                       |

|  |                     |                            |                                      |                   |                    |                          |
|--|---------------------|----------------------------|--------------------------------------|-------------------|--------------------|--------------------------|
|  | 04A8                | FlashpixVersion            | A000                                 | 0007              | 00000004           | "0100"                   |
|  | 04B4                | Colorspace                 | A001                                 | 0003              | 00000001           | 0001                     |
|  | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Offset (Hex)</b>                  |                   |                    |                          |
|  | 04C0                | Next IFD Offset            | 00000000                             |                   |                    |                          |
| <b>Value longer than 4Byte of Exif IFD</b> | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Data (Hex or "ASCII")</b>         |                   |                    |                          |
|  | 04C4                | SubSecTimeOriginal Value   | "1997:09:01 12:00:00"00              |                   |                    |                          |
|  | 04D8                | SubSecTimeDigitized Value  | "1997:09:01 12:00:00"00              |                   |                    |                          |
| <b>1st IFD</b>                             | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Interoperability Number (Hex)</b> |                   |                    |                          |
|  | 04EC                | Number Of Interoperability | 000D                                 |                   |                    |                          |
|  | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Tag ID (Hex)</b>                  | <b>Type (Hex)</b> | <b>Count (Hex)</b> | <b>ValueOffset (Hex)</b> |
|  | 04EE                | ImageWidth                 | 0100                                 | 0004              | 00000001           | 00000050                 |
|  | 04FA                | ImageLength                | 0101                                 | 0004              | 00000001           | 0000003C                 |
|  | 0506                | BitsPerSample              | 0102                                 | 0003              | 00000003           | 0000058E                 |
|  | 0512                | Compression                | 0103                                 | 0003              | 00000001           | 00010000                 |
|  | 051E                | PhotometricInterpretation  | 0106                                 | 0003              | 00000001           | 00020000                 |
|  | 052A                | StripOffsets               | 0111                                 | 0004              | 00000001           | 000005A4                 |
|  | 0536                | SamplesPerPixel            | 011                                  | 0003              | 00000001           | 00030000                 |
|  | 0542                | RowsPerStrip               | 0116                                 | 0004              | 00000001           | 0000003C                 |
|  | 054E                | StripByteCounts            | 0117                                 | 0004              | 00000001           | 00003840                 |
|  | 055A                | XResolution                | 011A                                 | 0005              | 00000001           | 00000594                 |
|  | 0566                | YResolution                | 011B                                 | 0005              | 00000001           | 0000059C                 |
|  | 0572                | PlanarConfiguration        | 011C                                 | 0003              | 00000001           | 00010000                 |
| 057E                                       | ResolutionUnit      | 0128                       | 0003                                 | 00000001          | 00020000           |                          |
|  | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Offset (Hex)</b>                  |                   |                    |                          |
|  | 058A                | Next IFD Offset            | 00000000                             |                   |                    |                          |
| <b>Value longer than 4Byte of 1st IFD</b>  | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Data (Hex or "ASCII")</b>         |                   |                    |                          |
|  | 058E                | BitPerSample Value         | 000800080008                         |                   |                    |                          |
|  | 0594                | XResolution Value          | 0000004800000001                     |                   |                    |                          |
|  | 059C                | YResolution Value          | 0000004800000001                     |                   |                    |                          |
|  | 05A4                | Thumbnail Image Data Strip | :                                    |                   |                    |                          |
| <b>Primary Image</b>                       | <b>Offset (Hex)</b> | <b>Name</b>                | <b>Data (Hex or "ASCII")</b>         |                   |                    |                          |
|  | 3DE4                | Primary Image Data Strip0  | :                                    |                   |                    |                          |
|  | 6364                | Primary Image Data Strip1  | :                                    |                   |                    |                          |
|  | :                   | :                          | :                                    |                   |                    |                          |
|  | 0E2864              | Primary Image Data Strip95 | :                                    |                   |                    |                          |

## A.2 Uncompressed YCbCr File

**Table 38 Uncompressed YCbCr File Description Sample Contents**

|  |   |
|--|---|
| Primary Image                            |   |
| Pixels                                   | 640 (W) x 480 (H)   |
| Image Title                              | Exif_TIFF_YCC   |
| Image Input Equipment Manufacturer       | DSCCompany  |
| Image Input Equipment Model Name         | Example   |
| Orientation                              | Normal  |
| Strips                                   | 69  |
| Lines per Strip                          | 7   |
| Bytes per Strip                          | 8960  |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length)   |
| Image Data Arrangement                   | Chunky  |
| File Change Date and Time                | 1997:09:01 12:00:00   |
| Pixel Composition                        | Subsampling = 4:2:2<br>Chrominance Subsampling point matches<br>luminance point   |
| Copyright                                | Copyright, ABCDE,1997   |
| Exif-specific Information                |   |
| Version                                  | Ver. 2.0  |
| Date and Time of Original Image Creation | 1997:09:01 12:00:00   |
| Date and Time of File Creation           | 1997:09:01 12:00:00   |
| Shutter Speed                            | 59/10 (equivalent to 1/60 sec.)   |
| Aperture                                 | 50/10 (equivalent to F:5.6)   |
| Brightness                               | 80/10   |
| Exposure Bias                            | 0/0   |
| Maximum Lens Aperture                    | 200/10  |
| Subject Distance                         | 20/10   |
| Metering Mode                            | MultiSpot   |
| Light Source                             | Daylight  |
| Flash ON/OFF                             | ON  |
| GPS Information                          |   |
| Version                                  | Ver. 2.0  |
| Measurement Position                     | North Latitude 35 deg. 48 min. 8 sec., East<br>Longitude 139 deg. 34 min. 55 sec. |
| Altitude                                 | 30.48 meters above sea level  |
| GPS Time                                 | 0:00:00   |
| GPS Receiver Movement                    | Moving at 1km/h at 0 deg. true direction  |
| Image Direction                          | 0 deg. true direction   |
| Geodetic Data Used for Measurement       | TOKYO   |
| Thumbnail                                |   |
| Pixels                                   | 80 (W) x 60 (H)   |
| Orientation                              | Normal  |
| Strips                                   | 1   |
| Lines per Strip                          | 60  |
| Bytes per Strip                          | 9600  |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length)   |

Table 39 Uncompressed YCbCr File Description Sample

| Header                             | Offset (Hex)                          | Name                       | Data (Hex or "ASCII")                  |             |             |                              |
|------------------------------------|---------------------------------------|----------------------------|--|-------------|-------------|------------------------------|
|                                    |                                       | 0000                       | Byte Order                             | 4D4D ("II") |             |                              |
|                                    | 0002                                  | 42                         | 2A00                                   |             |             |                              |
|                                    | 0004                                  | 0th IFD Offset             | 08000000                               |             |             |                              |
| 0th IFD                            | Offset (Hex)                          | Name                       | Interoperability Number (Hex)          |             |             |                              |
|                                    | 0008                                  | Number of Interoperability | 1700                                   |             |             |                              |
|                                    | Offset (Hex)                          | Name                       | Tag ID (Hex)                           | Type (Hex)  | Count (Hex) | ValueOffset (Hex or "ASCII") |
|                                    | 000A                                  | ImageWidth                 | 0001                                   | 0400        | 01000000    | 80020000                     |
|                                    | 0016                                  | ImageLength                | 0101                                   | 0400        | 01000000    | E0010000                     |
|                                    | 0022                                  | BitsPerSample              | 0201                                   | 0300        | 03000000    | 22010000                     |
|                                    | 002E                                  | Compression                | 0301                                   | 0300        | 01000000    | 01000000                     |
|                                    | 003A                                  | PhotometricInterpretation  | 0601                                   | 0300        | 01000000    | 06000000                     |
|                                    | 0046                                  | ImageDescription           | 0E01                                   | 0200        | 0E000000    | 28010000                     |
|                                    | 0052                                  | Make                       | 0F01                                   | 0200        | 09000000    | 36010000                     |
|                                    | 005E                                  | Model                      | 1001                                   | 0200        | 08000000    | 40010000                     |
|                                    | 006A                                  | StripOffsets               | 1101                                   | 0400        | 45000000    | 48010000                     |
|                                    | 0076                                  | Orientation                | 1201                                   | 0300        | 01000000    | 01000000                     |
|                                    | 0082                                  | SamplesPerPixel            | 1501                                   | 0300        | 01000000    | 03000000                     |
|                                    | 008E                                  | RowsPerStrip               | 1601                                   | 0400        | 01000000    | 07000000                     |
|                                    | 009A                                  | StripByteCounts            | 1701                                   | 0400        | 45000000    | 5C020000                     |
|                                    | 00A6                                  | XResolution                | 1A01                                   | 0500        | 01000000    | 70030000                     |
|                                    | 00B2                                  | YResolution                | 1B01                                   | 0500        | 01000000    | 78030000                     |
|                                    | 00BE                                  | PlanarConfiguration        | 1C01                                   | 0300        | 01000000    | 01000000                     |
|                                    | 00CA                                  | ResolutionUnit             | 2801                                   | 0300        | 01000000    | 02000000                     |
|                                    | 00D6                                  | DateTime                   | 3201                                   | 0200        | 14000000    | 80030000                     |
| 00E2                               | YCbCrSubSampling                      | 1202                       | 0300                                   | 02000000    | 02000100    |                              |
| 00EE                               | YCbCrPositioning                      | 1302                       | 0300                                   | 01000000    | 02000000    |                              |
| 00FA                               | Copyright                             | 9882                       | 0200                                   | 15000000    | 94030000    |                              |
| 0106                               | Exif IFD Pointer                      | 6987                       | 0400                                   | 01000000    | AA030000    |                              |
| 0112                               | GPS IFD Offset                        | 2588                       | 0400                                   | 01000000    | 10050000    |                              |
|                                    | Offset (Hex)                          | Name                       | Offset (Hex)                           |             |             |                              |
|                                    | 011E                                  | Next IFD Offset            | 7E060000                               |             |             |                              |
| Value longer than 4Byte of 0th IFD | Offset (Hex)                          | Name                       | Data (Hex or "ASCII")                  |             |             |                              |
|                                    | 0122                                  | BitPerSample Value         | 080008000800                           |             |             |                              |
|                                    | 0128                                  | ImageDescription Value     | "Exif_TIFF_YCC"00                      |             |             |                              |
|                                    | 0136                                  | Make Value                 | "DSCCompany"00                         |             |             |                              |
|                                    | 0140                                  | Model Value                | "Example"00                            |             |             |                              |
|                                    | 0148                                  | StripOffsets Value         | (offset0,offset1,offset2.....offset95) |             |             |                              |
|                                    | 025C                                  | StripByteCounts Value      | (count0, count1, count2....count95)    |             |             |                              |
|                                    | 0370                                  | XResolution Value          | 4800000001000000                       |             |             |                              |
|                                    | 037C                                  | YResolution Value          | 4800000001000000                       |             |             |                              |
|                                    | 0380                                  | DateTime Value             | "1997:09:01 12:00:00"00                |             |             |                              |
| 0394                               | Copyright Value (Last Byte is Padded) | "Copyright,ABCDE,1997"0000 |  |             |             |                              |
| Exif IFD                           | Offset (Hex)                          | Name                       | Interoperability Number (Hex)          |             |             |                              |
|                                    | 03AA                                  | Exif IFD Number            | 1400                                   |             |             |                              |
|                                    | Offset (Hex)                          | Name                       | Tag ID (Hex)                           | Type (Hex)  | Count (Hex) | ValueOffset (Hex or "ASCII") |
|                                    | 03AC                                  | ExposureTime               | 9A82                                   | 0500        | 01000000    | A0040000                     |
| 03B8                               | FNumber                               | 9D82                       | 0500                                   | 01000000    | A8040000    |                              |

|  |                     |                         |                                      |                   |                    |                                     |
|--|---------------------|-------------------------|--------------------------------------|-------------------|--------------------|-------------------------------------|
|  | 03C4                | ExifVersion             | 0090                                 | 0700              | 04000000           | "0200"                              |
|  | 03D0                | DateTimeOriginal        | 0390                                 | 0200              | 14000000           | B0040000                            |
|  | 03DC                | DateTimeDigitized       | 0490                                 | 0200              | 14000000           | C4040000                            |
|  | 03E8                | ShutterSpeedValue       | 0192                                 | 0A00              | 01000000           | D8040000                            |
|  | 03F4                | ApertureValue           | 0292                                 | 0500              | 01000000           | E0040000                            |
|  | 0400                | BrightnessValue         | 0392                                 | 0A00              | 01000000           | E8040000                            |
|  | 040C                | ExposureBiasValue       | 0492                                 | 0A00              | 01000000           | F0040000                            |
|  | 0418                | MaxApertureRatioValue   | 0592                                 | 0500              | 01000000           | F8040000                            |
|  | 0424                | SubjectDistance         | 0692                                 | 0500              | 01000000           | 00050000                            |
|  | 0430                | MeteringMode            | 0792                                 | 0300              | 01000000           | 01000000                            |
|  | 043C                | LightSource             | 0892                                 | 0300              | 01000000           | 01000000                            |
|  | 0448                | Flash                   | 0992                                 | 0300              | 01000000           | 01000000                            |
|  | 0454                | FocalLength             | 0A92                                 | 0500              | 01000000           | 08050000                            |
|  | 0460                | SubSecTime              | 9092                                 | 0200              | 04000000           | "000"00                             |
|  | 046C                | SubSecTimeOriginal      | 9192                                 | 0200              | 04000000           | "000"00                             |
|  | 0478                | SubSecTimeDigitized     | 9292                                 | 0200              | 04000000           | "000"00                             |
|  | 0484                | FlashpixVersion         | A000                                 | 0700              | 04000000           | "0100"                              |
|  | 0490                | ColorSpace              | A001                                 | 0300              | 01000000           | 01000000                            |
|  | <b>Offset (Hex)</b> | <b>Name</b>             | <b>Offset (Hex)</b>                  |                   |                    |                                     |
|  | 049C                | Next IFD Offset         | 00000000                             |                   |                    |                                     |
| <b>Value longer than 4 Bytes of Exif IFD</b> | <b>Offset (Hex)</b> | <b>Name</b>             | <b>Data (Hex or "ASCII")</b>         |                   |                    |                                     |
|  | 04A0                | ExposureTime Value      | 010000003C000000                     |                   |                    |                                     |
|  | 04A8                | FNumber Value           | 0400000001000000                     |                   |                    |                                     |
|  | 04B0                | DateTimeOriginal Value  | "1997:09:01 12:00:00"00              |                   |                    |                                     |
|  | 04C4                | DateTimeDigitized Value | "1997:09:01 12:00:00"00              |                   |                    |                                     |
|  | 04D8                | ShutterSpeed Value      | 0600000001000000                     |                   |                    |                                     |
|  | 04E0                | ApertureValue Value     | 0400000001000000                     |                   |                    |                                     |
|  | 04E8                | BrightnessValue Value   | 0000000001000000                     |                   |                    |                                     |
|  | 04F0                | ExposureBiasValue Value | 0000000001000000                     |                   |                    |                                     |
|  | 04F8                | MaxApertureRatio Value  | 0100000001000000                     |                   |                    |                                     |
|  | 0500                | SubjectDistance Value   | 0F0000000A000000                     |                   |                    |                                     |
| 0508   | FocalLength Value   | 3200000001000000        |                                      |                   |                    |                                     |
| <b>GPS IFD</b>                               | <b>Offset (Hex)</b> | <b>Name</b>             | <b>Interoperability Number (Hex)</b> |                   |                    |                                     |
|  | 0510                | GPS IFD Number          | 0013                                 |                   |                    |                                     |
|  | <b>Offset (Hex)</b> | <b>Name</b>             | <b>Tag ID (Hex)</b>                  | <b>Type (Hex)</b> | <b>Count (Hex)</b> | <b>ValueOffset (Hex or "ASCII")</b> |
|  | 0512                | GPSVersionID            | 0000                                 | 0100              | 04000000           | 02000000                            |
|  | 051E                | GPSLatitudeRef          | 0100                                 | 0200              | 02000000           | "N"000000                           |
|  | 052A                | GPSLatitude             | 0200                                 | 0500              | 03000000           | FA050000                            |
|  | 0536                | GPSLongitudeRef         | 0300                                 | 0200              | 02000000           | "E"000000                           |
|  | 0542                | GPSLongitude            | 0400                                 | 0500              | 03000000           | 12060000                            |
|  | 054E                | GPSAltitudeRef          | 0500                                 | 0100              | 01000000           | 00000000                            |
|  | 055A                | GPSAltitude             | 0600                                 | 0500              | 01000000           | 2A060000                            |
|  | 0566                | GPSTimeStamp            | 0700                                 | 0500              | 03000000           | 32060000                            |
|  | 0572                | GPSSatellites           | 0800                                 | 0200              | 0D000000           | 4A060000                            |
|  | 057E                | GPSStatus               | 0900                                 | 0200              | 02000000           | "A"000000                           |
|  | 058A                | GPSMeasureMode          | 0A00                                 | 0200              | 02000000           | "2"000000                           |
|  | 0596                | GPSDOP                  | 0B00                                 | 0500              | 01000000           | 58060000                            |
|  | 05A2                | GPSSpeedRef             | 0C00                                 | 0200              | 02000000           | "K"000000                           |
|  | 05AE                | GPSSpeed                | 0D00                                 | 0500              | 01000000           | 60060000                            |
|  | 05BA                | GPSTrackRef             | 0E00                                 | 0200              | 02000000           | "T"000000                           |
|  | 05C6                | GPSTrack                | 0F00                                 | 0500              | 01000000           | 68060000                            |
|  | 05D2                | GPSImgDirectionRef      | 1000                                 | 0200              | 02000000           | "T"000000                           |
|  | 05DE                | GPSImgDirection         | 1100                                 | 0500              | 01000000           | 70060000                            |
|  | 05EA                | GPSMapDatum             | 1200                                 | 0200              | 06000000           | 78060000                            |

|   |                     |   |  |                   |                    |                                     |
|---|---------------------|---|--|-------------------|--------------------|-------------------------------------|
|   | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Offset (Hex)</b>                                  |                   |                    |                                     |
|   | 05F6                | Next IFD Offset                           | 00000000   |                   |                    |                                     |
| <b>Value longer than 4 Bytes of GPS IFD</b> | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Data (Hex or "ASCII")</b>                         |                   |                    |                                     |
|   | 05FA                | GPSLatitude Value                         | 230000000100000030000000010000000800000001000000     |                   |                    |                                     |
|   | 0612                | GPSLongitude Value                        | 8B00000000100000022000000001000000037000000001000000 |                   |                    |                                     |
|   | 062A                | GPSAltitude Value                         | E80B000064000000                                     |                   |                    |                                     |
|   | 0632                | GPSTimeStamp Value                        | 000000000100000000000000010000000000000001000000     |                   |                    |                                     |
|   | 064A                | GPSSatellites Value (Last Byte is padded) | "2,7,14,15,16"0000                                   |                   |                    |                                     |
|   | 0658                | GPSDOP Value                              | 0100000001000000                                     |                   |                    |                                     |
|   | 0660                | GPSSpeed Value                            | 0000000001000000                                     |                   |                    |                                     |
|   | 0668                | GPSTrack Value                            | 0000000001000000                                     |                   |                    |                                     |
|   | 0670                | GPSTimeStamp Value                        | 0000000001000000                                     |                   |                    |                                     |
| 0678  | GPSMapDatum Value   | "TOKYO"00                                 |  |                   |                    |                                     |
| <b>1st IFD</b>                              | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Interoperability Number (Hex)</b>                 |                   |                    |                                     |
|   | 067E                | Number Of Interoperability                | 0F00   |                   |                    |                                     |
|   | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Tag ID (Hex)</b>                                  | <b>Type (Hex)</b> | <b>Count (Hex)</b> | <b>ValueOffset (Hex or "ASCII")</b> |
|   | 0680                | ImageWidth                                | 0001   | 0400              | 01000000           | 50000000                            |
|   | 068C                | ImageLength                               | 0101   | 0400              | 01000000           | 3C000000                            |
|   | 0698                | BitsPerSample                             | 0201   | 0300              | 03000000           | 38070000                            |
|   | 06A4                | Compression                               | 0301   | 0300              | 01000000           | 01000000                            |
|   | 06B0                | PhotometricInterpretation                 | 0601   | 0300              | 01000000           | 06000000                            |
|   | 06BC                | StripOffsets                              | 1101   | 0400              | 01000000           | 4E070000                            |
|   | 06C8                | SamplesPerPixel                           | 1501   | 0300              | 01000000           | 03000000                            |
|   | 06D4                | RowsPerStrip                              | 1601   | 0400              | 01000000           | 3C000000                            |
|   | 06E0                | StripByteCounts                           | 1701   | 0400              | 01000000           | 80250000                            |
|   | 06EC                | XResolution                               | 1A01   | 0500              | 01000000           | 3E070000                            |
|   | 06F8                | YResolution                               | 1B01   | 0500              | 01000000           | 46070000                            |
|   | 0704                | PlanarConfiguration                       | 1C01   | 0300              | 01000000           | 01000000                            |
|   | 0710                | ResolutionUnit                            | 2801   | 0300              | 01000000           | 02000000                            |
|   | 071C                | YCbCrSubSampling                          | 1202   | 0300              | 02000000           | 02000100                            |
| 0728  | YCbCrPositioning    | 1302                                      | 0300   | 01000000          | 02000000           |                                     |
|   | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Offset (Hex)</b>                                  |                   |                    |                                     |
|   | 0734                | Next IFD Offset                           | 00000000   |                   |                    |                                     |
| <b>Value longer than 4Byte of 1st IFD</b>   | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Data (Hex or "ASCII")</b>                         |                   |                    |                                     |
|   | 0738                | BitPerSample Value                        | 080008000800   |                   |                    |                                     |
|   | 073E                | XResolution Value                         | 4800000001000000                                     |                   |                    |                                     |
|   | 0746                | YResolution Value                         | 4800000001000000                                     |                   |                    |                                     |
|   | 074E                | (Thumbnail Image Data Strip)              |  |                   |                    |                                     |
| <b>Primary Image Data</b>                   | <b>Offset (Hex)</b> | <b>Name</b>                               | <b>Data (Hex or "ASCII")</b>                         |                   |                    |                                     |
|   | 2CCE                | Image Data Strip0                         | :  |                   |                    |                                     |
|   | 4FCE                | Image Data Strip1                         | :  |                   |                    |                                     |
|   | :                   | :   | :  |                   |                    |                                     |
|   | :                   | :   | :  |                   |                    |                                     |
|   | 0978CE              | Image Data Strip68                        | :  |                   |                    |                                     |



### A.3 JPEG Compressed (4:2:2) File

**Table 40 JPEG Compressed (4:2:2) File Description Sample Contents**

|  |                                 |
|--|---------------------------------|
| Primary Image                            |                                 |
| Recording Format                         | JPEG                            |
| Subsampling                              | YCC 4:2:2                       |
| Restart Markers                          | Inserted                        |
| Quantization Tables                      | 3                               |
| Pixels                                   | 640 (W) x 480 (H)               |
| Image Title                              | Exif_JPEG_422                   |
| Image Input Equipment Manufacturer       | DS Company                      |
| Image Input Equipment Model Name         | Example                         |
| Orientation                              | Normal                          |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |
| File Change Date and Time                | 1997:09:01 12:00:00             |
| Copyright                                | Copyright, ABCDE, 1997          |
| Exif-specific Information                |                                 |
| Version                                  | Ver. 2.0                        |
| Date and Time of Original Image Creation | 1997:09:01 12:00:00             |
| Date and Time of File Creation           | 1997:09:01 12:00:00             |
| Components                               | Y,Cb,Cr                         |
| Image Compression Mode                   | 2bit/pel                        |
| Shutter Speed                            | 59/10 (equivalent to 1/60 sec.) |
| Aperture                                 | 50/10 (equivalent to F:5.6)     |
| Brightness                               | 80/10                           |
| Exposure Bias                            | 0/0                             |
| Maximum Lens Aperture                    | 200/10                          |
| Subject Distance                         | 20/10                           |
| Metering Mode                            | MultiSpot                       |
| Light Source                             | Daylight                        |
| Flash ON/OFF                             | ON                              |
| Thumbnails                               |                                 |
| Recording Format                         | JPEG                            |
| Subsampling                              | YCC 4:2:2                       |
| Pixels                                   | 80 (W) x 60 (H)                 |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |

Table 41 JPEG Compressed (4:2:2) File JPEG Stream Description Sample

| Offset (Hex) | Maker Segment  | Name           | Code (Hex)    | Comment                   |
|--------------|----------------|----------------|---------------|---------------------------|
| 0000         | SOI            | SOI Marker     | FFD8          | Start of Image            |
| 0002         | APP1           | APP1 Marker    | FFE1          | See Next Table            |
| 0004         |                | APP1 Length    | 291C          |                           |
| 0006         |                | Identifier     | "Exif"00      |                           |
| 000B         |                | Pad            | 00            |                           |
| 000C         |                | APP1 Body      |               |                           |
| 0E39         | DQT            | DQT Marker     | FFDB          | Define Quantization Table |
| 0E3B         |                | DQT Length     | 00C5          | 64 Bytes of Data          |
| 0E3D         |                | Pq, Tq         | 00            |                           |
| 0E3E         |                | table elements | 100B0C0E..... |                           |
| 0E7E         |                | Pq,Tq          | 01            | 64 Bytes of Data          |
| 0E7F         |                | table elements | 0F101016....  |                           |
| 0EBF         |                | Pq,Tq          | 02            | 64 Bytes of Data          |
| 0EC0         | table elements | 0F101016....   |               |                           |
| 0F00         | DHT            | DHT Marker     | FFC4          | Table 0 for DC            |
| 0F02         |                | DHT Length     | 01A2          |                           |
| 0F04         |                | Th             | 00            |                           |
| 0F05         |                | Li             | 00010501....  |                           |
| 0F15         |                | Vij            | 00010203....  | Table 0 for AC            |
| 0F21         |                | Th             | 10            |                           |
| 0F22         |                | Li             | 00020103....  |                           |
| 0F32         |                | Vij            | 01020300....  |                           |
| 0FD4         |                | Th             | 01            | Table 1 for DC            |
| 0FD5         |                | Li             | 00030101....  |                           |
| 0FE5         |                | Vij            | 00010203....  | Table 1 for AC            |
| 0FF1         |                | Th             | 11            |                           |
| 0FF2         |                | Li             | 00020102....  |                           |
| 1002         |                | Vij            | 00010203....  |                           |
| 10A4         | DRI            | DRI Marker     | FFDD          |                           |
| 10A6         |                | DRI Length     | 0004          |                           |
| 10A8         |                | Ri             | 0004          |                           |
| 10AA         | SOF0           | SOF0 Marker    | FFC0          |                           |
| 10AC         |                | SOF0 Length    | 0011          |                           |
| 10AE         |                | P              | 08            |                           |
| 10AF         |                | Y              | 01E0          |                           |
| 10B1         |                | X              | 0280          |                           |
| 10B3         |                | Nf             | 03            |                           |
| 10B4         |                | C1             | 01            |                           |
| 10B5         |                | H1,V1          | 21            |                           |

|       |            |            |          |                 |
|-------|------------|------------|----------|-----------------|
| 10B6  |            | Tq1        | 00       |                 |
| 10B7  |            | C2         | 02       |                 |
| 10B8  |            | H2,V2      | 11       |                 |
| 10B9  |            | Tq2        | 01       |                 |
| 10BA  |            | C3         | 03       |                 |
| 10BB  |            | H3,V3      | 11       |                 |
| 10BC  |            | Tq3        | 02       |                 |
| 10BD  | SOS        | SOS Marker | FFDA     |                 |
| 10BF  |            | SOS Length | 000C     |                 |
| 10C1  |            | Ns         | 03       |                 |
| 10C2  |            | Cs1        | 01       |                 |
| 10C3  |            | Td1,Ta1    | 00       |                 |
| 10C4  |            | Cs2        | 02       |                 |
| 10C5  |            | Td2,Ta2    | 11       |                 |
| 10C6  |            | Cs3        | 03       |                 |
| 10C7  |            | Td3,Ta3    | 11       |                 |
| 10C8  |            | Ss         | 00       |                 |
| 10C9  |            | Se         | 3F       |                 |
| 10CA  | Ah,AI      | 00         |          |                 |
| 10CB  | Image Data |            | F36A.... | Compressed Data |
| 111C4 | EOI        |            | FFD9     |                 |

Table 42 JPEG Compressed (4:2:2) File APP1 Description Sample

| Header                             | Offset (Hex) | Name                                  | Data (Hex or "ASCII")         |                         |             |                              |          |
|------------------------------------|--------------|---------------------------------------|-------------------------------|-------------------------|-------------|------------------------------|----------|
|                                    |              | 0000                                  | Byte Order                    | 4D4D ("II")             |             |                              |          |
|                                    | 0002         | 42                                    | 2A00                          |                         |             |                              |          |
|                                    | 0004         | 0th IFD Offset                        | 08000000                      |                         |             |                              |          |
| 0th IFD                            | Offset (Hex) | Name                                  | Interoperability Number (Hex) |                         |             |                              |          |
|                                    |              | 0008                                  | Number of Interoperability    | 0B00                    |             |                              |          |
|                                    | Offset (Hex) | Name                                  | Tag ID (Hex)                  | Type (Hex)              | Count (Hex) | ValueOffset (Hex or "ASCII") |          |
|                                    |              | 000A                                  | ImageDescription              | 0E01                    | 0200        | 0E000000                     | 92000000 |
|                                    |              | 0016                                  | Make                          | 0F01                    | 0200        | 09000000                     | A0000000 |
|                                    |              | 0022                                  | Model                         | 1001                    | 0200        | 08000000                     | AA000000 |
|                                    |              | 002E                                  | Orientation                   | 1201                    | 0300        | 01000000                     | 01000000 |
|                                    |              | 003A                                  | XResolution                   | 1A01                    | 0500        | 01000000                     | B2000000 |
|                                    |              | 0046                                  | YResolution                   | 1B01                    | 0500        | 01000000                     | BA000000 |
|                                    |              | 0052                                  | ResolutionUnit                | 2801                    | 0300        | 01000000                     | 02000000 |
|                                    |              | 005E                                  | DateTime                      | 3201                    | 0200        | 14000000                     | C2000000 |
|                                    |              | 006A                                  | YCbCrPositioning              | 1302                    | 0300        | 01000000                     | 02000000 |
|                                    |              | 0076                                  | CopyRight                     | 9882                    | 0200        | 15000000                     | D6000000 |
|                                    | 0082         | Exif IFD Pointer                      | 6987                          | 0400                    | 01000000    | EC000000                     |          |
|                                    | Offset (Hex) | Name                                  | Offset (Hex)                  |                         |             |                              |          |
|                                    | 008E         | Next IFD Offset                       | C402                          |                         |             |                              |          |
| Value longer than 4Byte of 0th IFD | Offset (Hex) | Name                                  | Data (Hex or "ASCII")         |                         |             |                              |          |
|                                    |              | 0092                                  | ImageDescription Value        | "Exif_JPEG_422"00       |             |                              |          |
|                                    |              | 00A0                                  | Make Value                    | "DSCCompany"00          |             |                              |          |
|                                    |              | 00AA                                  | Model Value                   | "Example"00             |             |                              |          |
|                                    |              | 00B2                                  | XResolution Value             | 4800000001000000        |             |                              |          |
|                                    |              | 00BA                                  | YResolution Value             | 4800000001000000        |             |                              |          |
|                                    |              | 00C2                                  | DateTime Value                | "1997:09:01 12:00:00"00 |             |                              |          |
|                                    | 00D6         | Copyright Value (Last Byte is Padded) | "Copyright,ABCDE,1997"0000    |                         |             |                              |          |
| Exif IFD                           | Offset (Hex) | Name                                  | Interoperability Number (Hex) |                         |             |                              |          |
|                                    |              | 00EC                                  | Exif IFD Number               | 1900                    |             |                              |          |
|                                    | Offset (Hex) | Name                                  | Tag ID (Hex)                  | Type (Hex)              | Count (Hex) | ValueOffset (Hex or "ASCII") |          |
|                                    |              | 00EE                                  | ExposureTime                  | 9A82                    | 0500        | 01000000                     | 1E020000 |
|                                    |              | 00FA                                  | FNumber                       | 9D82                    | 0500        | 01000000                     | 26020000 |
|                                    |              | 0106                                  | ExifVersion                   | 0090                    | 0700        | 04000000                     | "0200"   |
|                                    |              | 0112                                  | DateTimeOriginal              | 0390                    | 0200        | 14000000                     | 2E020000 |
|                                    |              | 011E                                  | DateTimeDigitized             | 0490                    | 0200        | 14000000                     | 42020000 |
|                                    |              | 012A                                  | ComponentsConfiguration       | 0191                    | 0700        | 04000000                     | 01020000 |
|                                    |              | 0136                                  | CompressedBitsPerPixel        | 0292                    | 0500        | 01000000                     | 56020000 |
|                                    |              | 0142                                  | ShutterSpeedValue             | 0192                    | 0A00        | 01000000                     | 5E020000 |
|                                    |              | 014E                                  | ApertureValue                 | 0292                    | 0500        | 01000000                     | 66020000 |
|                                    |              | 015A                                  | BrightnessValue               | 0392                    | 0A00        | 01000000                     | 6E020000 |
|                                    |              | 0166                                  | ExposureBiasValue             | 0492                    | 0A00        | 01000000                     | 76020000 |
|                                    |              | 0172                                  | MaxApertureRatioValue         | 0592                    | 0500        | 01000000                     | 7E020000 |
|                                    |              | 017E                                  | SubjectDistance               | 0692                    | 0500        | 01000000                     | 86020000 |
|                                    |              | 018A                                  | MeteringMode                  | 0792                    | 0300        | 01000000                     | 01000000 |
|                                    |              | 0196                                  | LightSource                   | 0892                    | 0300        | 01000000                     | 01000000 |
|                                    |              | 01A2                                  | Flash                         | 0992                    | 0300        | 01000000                     | 00000000 |
|                                    |              | 01AE                                  | FocalLength                   | 0A92                    | 0500        | 01000000                     | 8E020000 |
|                                    |              | 01BA                                  | UserComments                  | 8692                    | 0700        | 2E000000                     | 96020000 |

|  |                              |                              |                                      |                   |                    |                                     |
|--|------------------------------|------------------------------|--------------------------------------|-------------------|--------------------|-------------------------------------|
|  | 01C6                         | SubSecTime                   | 9092                                 | 0200              | 04000000           | "000"00                             |
|  | 01D2                         | SubSecTimeOriginal           | 9192                                 | 0200              | 04000000           | "000"00                             |
|  | 01DE                         | SubSecTimeDigitized          | 9292                                 | 0200              | 04000000           | "000"00                             |
|  | 01EA                         | FlashpixVersion              | A000                                 | 0700              | 04000000           | "0100"                              |
|  | 01F6                         | Colorspace                   | A001                                 | 0300              | 01000000           | 01000000                            |
|  | 0202                         | Pixel X Dimension            | A002                                 | 0400              | 01000000           | 80020000                            |
|  | 020E                         | Pixel Y Dimension            | A003                                 | 0400              | 01000000           | E0010000                            |
|  | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Offset (Hex)</b>                  |                   |                    |                                     |
|  | 021A                         | Next IFD Offset              | 00000000                             |                   |                    |                                     |
| <b>Value longer than 4 Bytes of Exif IFD</b> | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Data (Hex or "ASCII")</b>         |                   |                    |                                     |
|  | 021E                         | ExposureTime Value           | 010000003C000000                     |                   |                    |                                     |
|  | 0226                         | FNumber Value                | 0400000001000000                     |                   |                    |                                     |
|  | 022E                         | DateTimeOriginal Value       | "1997:09:01 12:00:00"00              |                   |                    |                                     |
|  | 0242                         | DateTimeDigitized Value      | "1997:09:01 12:00:00"00              |                   |                    |                                     |
|  | 0256                         | CompressedBitsPerPixel Value | 0200000001000000                     |                   |                    |                                     |
|  | 025E                         | ShutterSpeedValue Value      | 0600000001000000                     |                   |                    |                                     |
|  | 0266                         | ApertureValue Value          | 0400000001000000                     |                   |                    |                                     |
|  | 026E                         | BrightnessValue Value        | 0000000001000000                     |                   |                    |                                     |
|  | 0276                         | ExposureBiasValue Value      | 0000000001000000                     |                   |                    |                                     |
|  | 027E                         | MaxApertureRatioValue Value  | 0100000001000000                     |                   |                    |                                     |
|  | 0286                         | SubjectDistance Value        | 0F0000000A000000                     |                   |                    |                                     |
| 028E   | FocalLength Value            | 3200000001000000             |                                      |                   |                    |                                     |
| 0296   | UserComment Value (46 Bytes) | 4A49530000000000....         |                                      |                   |                    |                                     |
| <b>1st IFD</b>                               | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Interoperability Number (Hex)</b> |                   |                    |                                     |
|  | 02C4                         | Number Of Interoperability   | 0700                                 |                   |                    |                                     |
|  | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Tag ID (Hex)</b>                  | <b>Type (Hex)</b> | <b>Count (Hex)</b> | <b>ValueOffset (Hex or "ASCII")</b> |
|  | 02C6                         | Compression                  | 0301                                 | 0300              | 01000000           | 01000000                            |
|  | 02D2                         | XResolution                  | 1A01                                 | 0500              | 01000000           | 1E030000                            |
|  | 02DE                         | YResolution                  | 1B01                                 | 0500              | 01000000           | 26030000                            |
|  | 02EA                         | ResolutionUnit               | 2801                                 | 0300              | 01000000           | 02000000                            |
|  | 02F6                         | JPEGInterchangeFormat        | 0102                                 | 0400              | 01000000           | 2D0E0000                            |
|  | 0302                         | JPEGInterchangeFormatLength  | 0202                                 | 0400              | 01000000           | FF0A0000                            |
|  | 030E                         | YCbCrPositioning             | 1302                                 | 0300              | 01000000           | 02000000                            |
|  | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Offset (Hex)</b>                  |                   |                    |                                     |
|  | 031A                         | Next IFD Offset              | 00000000                             |                   |                    |                                     |
| <b>Value longer than 4Byte of 1st IFD</b>    | <b>Offset (Hex)</b>          | <b>Data (Hex or "ASCII")</b> | <b>Name</b>                          |                   |                    |                                     |
|  | 031E                         | 4800000001000000             | XResolution Value                    |                   |                    |                                     |
|  | 0326                         | 4800000001000000             | YResolution Value                    |                   |                    |                                     |
| <b>Thumbnail Image Data</b>                  | <b>Offset (Hex)</b>          | <b>Name</b>                  | <b>Data</b>                          |                   |                    |                                     |
|  | 032E                         | Thumbnail Data               | (JPEG Stream)                        |                   |                    |                                     |

## A.4 JPEG Compressed (4:2:0) File

**Table 43 JPEG Compressed (4:2:0) File Description Sample Contents**

|  |                                 |
|--|---------------------------------|
| Primary Image                            |                                 |
| Recording Format                         | JPEG                            |
| Subsampling                              | YCC 4:2:0                       |
| Restart Markers                          | Inserted                        |
| Quantization Tables                      | 2                               |
| Pixels                                   | 620 (W) x 475 (H)               |
| Image Title                              | 620x475                         |
| SOF Recorded Pixels                      | 640x475                         |
| DCT Data                                 | 640x480                         |
| Image Title                              | Exif_JPEG_420                   |
| Image Input Equipment Manufacturer       | DSCcompany                      |
| Image Input Equipment Model Name         | Example                         |
| Orientation                              | Normal                          |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |
| File Change Date and Time                | 1997:09:01 12:00:00             |
| Copyright                                | Copyright, ABCDE, 1997          |
| Exif-specific Information                |                                 |
| Version                                  | Ver. 2.0                        |
| Date and Time of Original Image Creation | 1997:09:01 12:00:00             |
| Date and Time of File Creation           | 1997:09:01 12:00:00             |
| Components                               | Y,Cb,Cr                         |
| Image Compression Mode                   | 2bit/pel                        |
| Shutter Speed                            | 59/10 (equivalent to 1/60 sec.) |
| Aperture                                 | 50/10 (equivalent to F:5.6)     |
| Brightness                               | 80/10                           |
| Exposure Bias                            | 0/0                             |
| Maximum Lens Aperture                    | 200/10                          |
| Subject Distance                         | 20/10                           |
| Metering Mode                            | MultiSpot                       |
| Light Source                             | Daylight                        |
| Flash ON/OFF                             | ON                              |
| Thumbnails                               |                                 |
| Recording Format                         | TIFF                            |
| Subsampling                              | YCC 4:2:0                       |
| Pixels                                   | 80x60                           |
| Image Resolution                         | 72 dpi (Width), 72 dpi (Length) |

**Table 44 JPEG Compressed (4:2:0) File JPEG Stream Description Sample**

| Offset (Hex) | Maker Segment | Name           | Code (Hex)   | Comment                   |
|--------------|---------------|----------------|--------------|---------------------------|
| 0000         | SOI           | SOI Marker     | FFD8         | Start of Image            |
| 0002         | APP1          | APP1 Marker    | FFE1         | See Next Table            |
| 0004         |               | APP1 Length    | 1FBC         |                           |
| 0006         |               | Identifier     | "Exif"00     |                           |
| 000B         |               | Pad            | 00           |                           |
| 000C         |               | APP1 Body      |              |                           |
| 1FC0         | DQT           | DQT Marker     | FFDB         | Define Quantization Table |
| 1FC2         |               | DQT Length     | 0084         |                           |
| 1FC4         |               | Pq, Tq         | 00           | 64 Bytes of Data          |
| 1FC5         |               | table elements | 08060607.... |                           |
| 2005         |               | Pq,Tq          | 01           |                           |
| 2006         |               | table elements | 0909090C.... |                           |
| 2046         | DHT           | DHT Marker     | FFC4         | Table 0 for DC            |
| 2048         |               | DHT Length     | 01A2         |                           |
| 204A         |               | Th             | 00           |                           |
| 204B         |               | Li             | 00010501.... |                           |
| 205B         |               | Vij            | 00010203.... | Table 0 for AC            |
| 2067         |               | Th             | 10           |                           |
| 2068         |               | Li             | 00020103.... |                           |
| 2078         |               | Vij            | 01020300.... |                           |
| 211A         |               | Th             | 01           | Table 1 for DC            |
| 211B         |               | Li             | 00030101.... |                           |
| 212B         |               | Vij            | 00010203.... | Table 1 for AC            |
| 2137         |               | Th             | 11           |                           |
| 2138         |               | Li             | 00020102.... |                           |
| 2148         |               | Vij            | 00010203.... |                           |
| 21EA         | DRI           | DR Marker      | FFDD         |                           |
| 21EC         |               | DRI Length     | 0004         |                           |
| 21EE         |               | Ri             | 0004         |                           |
| 21F0         | SOF0          | SOF0 Marker    | FFC0         |                           |
| 21F2         |               | SOF0 Length    | 0011         |                           |
| 21F4         |               | P              | 08           |                           |
| 21F5         |               | Y              | 01DB         |                           |
| 21F7         |               | X              | 0280         |                           |
| 21F9         |               | Nf             | 03           |                           |
| 21FA         |               | C1             | 01           |                           |
| 21FB         |               | H1,V1          | 22           |                           |
| 21FC         |               | Tq1            | 00           |                           |
| 21FD         |               | C2             | 02           |                           |

|           |            |            |          |                 |
|-----------|------------|------------|----------|-----------------|
| 21FE      |            | H2,V2      | 11       |                 |
| 21FF      |            | Tq2        | 01       |                 |
| 2200      |            | C3         | 03       |                 |
| 2201      |            | H3,V3      | 11       |                 |
| 2202      |            | Tq3        | 01       |                 |
| 2203      | SOS        | SOS Marker | FFDA     |                 |
| 2205      |            | SOS Length | 000C     |                 |
| 2207      |            | Ns         | 03       |                 |
| 2208      |            | Cs1        | 01       |                 |
| 2209      |            | Td1,Ta1    | 00       |                 |
| 220A      |            | Cs2        | 02       |                 |
| 220B      |            | Td2,Ta2    | 11       |                 |
| 220C      |            | Cs3        | 03       |                 |
| 220D      |            | Td3,Ta3    | 11       |                 |
| 220E      |            | Ss         | 00       |                 |
| 220F      |            | Se         | 3F       |                 |
| 2210      | Ah,Al      | 00         |          |                 |
| 2211      | Image Data |            | F9FE.... | Compressed Data |
| 13BA<br>4 | EOI        |            | FFD9     |                 |



Table 45 JPEG Compressed (4:2:0) File APP1 Description Sample

| Header   | Offset<br>(Hex)                       | Name                       | Data<br>(Hex or "ASCII")         |               |                |                                 |
|--|---------------------------------------|----------------------------|----------------------------------|---------------|----------------|---------------------------------|
|  |                                       | 0000                       | Byte Order                       | 4D4D ("II")   |                |                                 |
|  | 0002                                  | 42                         | 2A00                             |               |                |                                 |
|  | 0004                                  | 0th IFD Offset             | 08000000                         |               |                |                                 |
| 0th IFD  | Offset<br>(Hex)                       | Name                       | Interoperability Number<br>(Hex) |               |                |                                 |
|  | 0008                                  | Number of Interoperability | 0B00                             |               |                |                                 |
|  | Offset<br>(Hex)                       | Name                       | Tag ID<br>(Hex)                  | Type<br>(Hex) | Count<br>(Hex) | ValueOffset<br>(Hex or "ASCII") |
|  | 000A                                  | ImageDescription           | 0E01                             | 0200          | 0E000000       | 92000000                        |
|  | 0016                                  | Make                       | 0F01                             | 0200          | 09000000       | A0000000                        |
|  | 0022                                  | Model                      | 1001                             | 0200          | 08000000       | AA000000                        |
|  | 002E                                  | Orientation                | 1201                             | 0300          | 01000000       | 01000000                        |
|  | 003A                                  | XResolution                | 1A01                             | 0500          | 01000000       | B2000000                        |
|  | 0046                                  | YResolution                | 1B01                             | 0500          | 01000000       | BA000000                        |
|  | 0052                                  | ResolutionUnit             | 2801                             | 0300          | 01000000       | 02000000                        |
|  | 005E                                  | DateTime                   | 3201                             | 0200          | 14000000       | C2000000                        |
|  | 006A                                  | YCbCrPositioning           | 1302                             | 0300          | 01000000       | 02000000                        |
|  | 0076                                  | Copyright                  | 9882                             | 0200          | 15000000       | D6000000                        |
| 0082   | Exif IFD Pointer                      | 6987                       | 0400                             | 01000000      | EC000000       |                                 |
| Offset<br>(Hex)                                | Name                                  | Offset<br>(Hex)            |                                  |               |                |                                 |
| 008E   | Next IFD Offset                       | C402                       |                                  |               |                |                                 |
| Value<br>longer<br>than<br>4Byte of<br>0th IFD | Offset<br>(Hex)                       | Name                       | Data<br>(Hex or "ASCII")         |               |                |                                 |
|  | 0092                                  | ImageDescription Value     | "Exif_JPEG_420"00                |               |                |                                 |
|  | 00A0                                  | Make Value                 | "DSCompany"00                    |               |                |                                 |
|  | 00AA                                  | Model Value                | "Example"00                      |               |                |                                 |
|  | 00B2                                  | XResolution Value          | 4800000001000000                 |               |                |                                 |
|  | 00BA                                  | YResolution Value          | 4800000001000000                 |               |                |                                 |
|  | 00C2                                  | DateTime Value             | "1997:09:01 12:00:00"00          |               |                |                                 |
| 00D6   | Copyright Value (Last Byte is Padded) | "Copyright,ABCDE,1997"0000 |                                  |               |                |                                 |
| Exif IFD                                       | Offset<br>(Hex)                       | Name                       | Interoperability Number<br>(Hex) |               |                |                                 |
|  | 00EC                                  | Exif IFD Number            | 1900                             |               |                |                                 |

|  | Offset<br>(Hex)         | Name                         | Tag ID<br>(Hex)                  | Type<br>(Hex) | Count<br>(Hex) | ValueOffset<br>(Hex or "ASCII") |
|--|-------------------------|------------------------------|----------------------------------|---------------|----------------|---------------------------------|
|  | 00EE                    | ExposureTime                 | 9A82                             | 0500          | 01000000       | 1E020000                        |
|  | 00FA                    | FNumber                      | 9D82                             | 0500          | 01000000       | 26020000                        |
|  | 0106                    | ExifVersion                  | 0090                             | 0700          | 04000000       | "0200"                          |
|  | 0112                    | DateTimeOriginal             | 0390                             | 0200          | 14000000       | 2E020000                        |
|  | 011E                    | DateTimeDigitized            | 0490                             | 0200          | 14000000       | 42020000                        |
|  | 012A                    | ComponentsConfiguration      | 0191                             | 0700          | 04000000       | 01020300                        |
|  | 0136                    | CompressedBitsPerPixel       | 0292                             | 0500          | 01000000       | 56020000                        |
|  | 0142                    | ShutterSpeedValue            | 0192                             | 0A00          | 01000000       | 5E020000                        |
|  | 014E                    | ApertureValue                | 0292                             | 0500          | 01000000       | 66020000                        |
|  | 015A                    | BrightnessValue              | 0392                             | 0A00          | 01000000       | 6E020000                        |
|  | 0166                    | ExposureBiasValue            | 0492                             | 0A00          | 01000000       | 76020000                        |
|  | 0172                    | MaxApertureRatioValue        | 0592                             | 0500          | 01000000       | 7E020000                        |
|  | 017E                    | SubjectDistance              | 0692                             | 0500          | 01000000       | 86020000                        |
|  | 018A                    | MeteringMode                 | 0792                             | 0300          | 01000000       | 01000000                        |
|  | 0196                    | LightSource                  | 0892                             | 0300          | 01000000       | 01000000                        |
|  | 01A2                    | Flash                        | 0992                             | 0300          | 01000000       | 00000000                        |
|  | 01AE                    | FocalLength                  | 0A92                             | 0500          | 01000000       | 8E020000                        |
|  | 01BA                    | UserComments                 | 8692                             | 0700          | 2E000000       | 96020000                        |
|  | 01C6                    | SubSecTime                   | 9092                             | 0200          | 04000000       | 30303000                        |
|  | 01D2                    | SubSecTimeOriginal           | 9192                             | 0200          | 04000000       | "000"00                         |
|  | 01DE                    | SubSecTimeDigitized          | 9292                             | 0200          | 04000000       | "000"00                         |
|  | 01EA                    | FlashpixVersion              | A000                             | 0700          | 04000000       | "0100"                          |
|  | 01F6                    | ColorSpace                   | A001                             | 0300          | 01000000       | 01000000                        |
|  | 0202                    | Pixel X Dimension            | A002                             | 0400          | 01000000       | 6C020000                        |
|  | 020E                    | Pixel Y Dimension            | A003                             | 0400          | 01000000       | DB010000                        |
|  | <b>Offset<br/>(Hex)</b> | <b>Name</b>                  | <b>Offset<br/>(Hex)</b>          |               |                |                                 |
|  | 021A                    | Next IFD Offset              | 00000000                         |               |                |                                 |
| <b>Value longer than 4 Bytes of Exif IFD</b> | <b>Offset<br/>(Hex)</b> | <b>Name</b>                  | <b>Data<br/>(Hex or "ASCII")</b> |               |                |                                 |
|  | 021E                    | ExposureTime Value           | 010000003C000000                 |               |                |                                 |
|  | 0226                    | FNumber Value                | 0400000001000000                 |               |                |                                 |
|  | 022E                    | DateTimeOriginal Value       | "1997:09:01 12:00:00"00          |               |                |                                 |
|  | 0242                    | DateTimeDigitized Value      | "1997:09:01 12:00:00"00          |               |                |                                 |
|  | 0256                    | CompressedBitsPerPixel Value | 0200000001000000                 |               |                |                                 |
| 025E   | ShutterSpeedValue Value | 0600000001000000             |                                  |               |                |                                 |

|                                    |                     |                              |                                      |                   |                    |                                     |
|------------------------------------|---------------------|------------------------------|--------------------------------------|-------------------|--------------------|-------------------------------------|
|                                    | 0266                | ApertureValue Value          | 040000001000000                      |                   |                    |                                     |
|                                    | 026E                | BrightnessValue Value        | 000000001000000                      |                   |                    |                                     |
|                                    | 0276                | ExposureBiasValue Value      | 000000001000000                      |                   |                    |                                     |
|                                    | 027E                | MaxApertureRatioValue Value  | 010000001000000                      |                   |                    |                                     |
|                                    | 0286                | SubjectDistance Value        | 0F000000A000000                      |                   |                    |                                     |
|                                    | 028E                | FocalLength Value            | 320000001000000                      |                   |                    |                                     |
|                                    | 0296                | UserComment Value (46 Bytes) | 4A49530000000000....                 |                   |                    |                                     |
| 1st IFD                            | <b>Offset (Hex)</b> | <b>Name</b>                  | <b>Interoperability Number (Hex)</b> |                   |                    |                                     |
|                                    | 02C4                | Number Of Interoperability   | 0F00                                 |                   |                    |                                     |
|                                    | <b>Offset (Hex)</b> | <b>Name</b>                  | <b>Tag ID (Hex)</b>                  | <b>Type (Hex)</b> | <b>Count (Hex)</b> | <b>ValueOffset (Hex or "ASCII")</b> |
|                                    | 02C6                | ImageWidth                   | 0001                                 | 0400              | 01000000           | 50000000                            |
|                                    | 02D2                | ImageLength                  | 0101                                 | 0400              | 01000000           | 3C000000                            |
|                                    | 02DE                | BitsPerSample                | 0201                                 | 0300              | 03000000           | 7E030000                            |
|                                    | 02EA                | Compression                  | 0301                                 | 0300              | 01000000           | 01000000                            |
|                                    | 02F6                | PhotometricInterpretation    | 0601                                 | 0300              | 01000000           | 06000000                            |
|                                    | 0302                | StripOffsets                 | 1101                                 | 0400              | 01000000           | 94030000                            |
|                                    | 030E                | SamplesPerPixel              | 1501                                 | 0300              | 01000000           | 03000000                            |
|                                    | 031A                | RowsPerStrip                 | 1601                                 | 0400              | 01000000           | 3C000000                            |
|                                    | 0326                | StripByteCounts              | 1701                                 | 0400              | 01000000           | 201C0000                            |
|                                    | 0332                | XResolution                  | 1A01                                 | 0500              | 01000000           | 84030000                            |
|                                    | 033E                | YResolution                  | 1B01                                 | 0500              | 01000000           | 8C030000                            |
|                                    | 034A                | PlanarConfiguration          | 1C01                                 | 0300              | 01000000           | 01000000                            |
|                                    | 0356                | ResolutionUnit               | 2801                                 | 0300              | 01000000           | 02000000                            |
|                                    | 0362                | YCbCrSubSampling             | 1202                                 | 0300              | 02000000           | 02000200                            |
|                                    | 036E                | YCbCrPositioning             | 1302                                 | 0300              | 01000000           | 02000000                            |
|                                    | <b>Offset (Hex)</b> | <b>Name</b>                  | <b>Offset (Hex)</b>                  |                   |                    |                                     |
|                                    | 037A                | Next IFD Offset              | 00000000                             |                   |                    |                                     |
| Value longer than 4Byte of 1st IFD | <b>Offset (Hex)</b> | <b>Name</b>                  | <b>Data (Hex or "ASCII")</b>         |                   |                    |                                     |
|                                    | 037E                | BitsPerSample Value          | 080008000800                         |                   |                    |                                     |
|                                    | 0384                | XResolution Value            | 480000001000000                      |                   |                    |                                     |
|                                    | 038C                | YResolution Value            | 480000001000000                      |                   |                    |                                     |
| Thumbnail Image Data               | <b>Offset (Hex)</b> | <b>Name</b>                  | <b>Data (Hex or "ASCII")</b>         |                   |                    |                                     |
|                                    | 0394                | Thumbnail Image Data Strip   | :                                    |                   |                    |                                     |

## Annex B Audio File Description Examples

### B.1 PCM Audio Data

**Table 46 PCM Audio File Description Sample Contents**

|                                  |                                     |
|----------------------------------|-------------------------------------|
| Audio Data                       |                                     |
| Format Type                      | PCM Format                          |
| Channels                         | monaural                            |
| Sampling Frequency               | 22.05 KHz                           |
| Bits per Sample                  | 8 Bits/Sample                       |
| Total Samples                    | 27768 Samples                       |
| Attribute Information            |                                     |
| Audio Title                      | ExifPCMExampleZ                     |
| Audio Genre                      | None                                |
| Recording Date                   | 1997-07-13                          |
| Recording Engineer               | Taro Yamada                         |
| Copyright                        | Copyright Exif Corporation on 1997. |
| Exif-specific Information        |                                     |
| Exif Version                     | 0200 (Version 2.0)                  |
| Related Exif Image File          | DSC00001.JPGZ                       |
| Recording Start Time             | 10:15:30.130Z                       |
| Recording Equipment Manufacturer | DSC CorporationZ                    |
| Recording Equipment Model        | DSC1000Z                            |
| Manufacturer Note                | None                                |
| User Comment                     | None                                |

Table 47 PCM Audio File Description Example

|                  | Offset (Hex) | Name            | Comment                       | Data (Hex or "ASCII")                     |
|------------------|--------------|-----------------|-------------------------------|---|
| <b>RIFF-ck</b>   | 0000         | ckID            | RIFF                          | 52494646                                  |
|                  | 0004         | ckSize          |                               | 766D0000                                  |
|                  | 0008         | formType        | WAVE                          | 57415645                                  |
| <b>fmt-ck</b>    | 000C         | ckID            | fmt_                          | 666D7420                                  |
|                  | 0010         | ckSize          |                               | 10000000                                  |
|                  | 0014         | wFormatTag      | PCM Format                    | 0100                                      |
|                  | 0016         | nchannels       | monaural                      | 0100                                      |
|                  | 0018         | nSamplesPerSec  | 22.05 KHz                     | 22560000                                  |
|                  | 001C         | nAvgBytesPerSec | 22050 Bytes/sec               | 22560000                                  |
|                  | 0020         | nBlockAlign     | 1 Byte/block                  | 0100                                      |
|                  | 0022         | wBitsPerSample  | 8 bits/sample                 | 0800                                      |
| <b>INFO-LIST</b> | 0024         | ckID            | LIST                          | 4C495354                                  |
|                  | 0028         | ckSize          |                               | 6E000000                                  |
|                  | 002C         | listType        | "INFO"                        | 494E464F                                  |
| <b>INAM-ck</b>   | 0030         | ckID            | INAM                          | 494E414D                                  |
|                  | 0034         | ckSize          |                               | 0F000000                                  |
|                  | 0038         | ckData          | (audio title)                 | "ExifPCMExample"0000                      |
| <b>ICRD-ck</b>   | 0048         | ckID            | ICRD                          | 49435244                                  |
|                  | 004C         | ckSize          |                               | 0B000000                                  |
|                  | 0050         | ckData          | (July 13, 1997)               | "1997-07-13"0000                          |
| <b>IART-ck</b>   | 005C         | ckID            | IART                          | 49415254                                  |
|                  | 0060         | ckSize          |                               | 0C000000                                  |
|                  | 0064         | ckData          | (creator)                     | "Taro Yamada"00                           |
| <b>ICOP-ck</b>   | 0070         | ckID            | ICOP                          | 49434F50                                  |
|                  | 0074         | ckSize          |                               | 21000000                                  |
|                  | 0078         | ckData          | (copyright)                   | "Copyright Exif Corporation on 1997."0000 |
| <b>exif-LIST</b> | 009A         | ckID            | LIST                          | 4C495354                                  |
|                  | 009E         | ckSize          |                               | 64000000                                  |
|                  | 00A2         | listType        | exif                          | 65786966                                  |
| <b>ever-ck</b>   | 00A6         | ckID            | ever                          | 65766572                                  |
|                  | 00AA         | ckSize          |                               | 40000000                                  |
|                  | 00AE         | ckData          | Ver. 2.0                      | 200                                       |
| <b>erel-ck</b>   | 00B2         | ckID            | erel                          | 6572656C                                  |
|                  | 00B6         | ckSize          |                               | 0D000000                                  |
|                  | 00BA         | ckData          | (relation to Exif image file) | "DSC00001.JPG"0000                        |
| <b>etim-ck</b>   | 00C8         | ckID            | etim                          | 6574696D                                  |
|                  | 00CC         | ckSize          |                               | 0D000000                                  |
|                  | 00D0         | ckData          | (10:15:30.130)                | "10:15:30.130"0000                        |
| <b>ecor-ck</b>   | 00DE         | ckID            | ecor                          | 65636F72                                  |
|                  | 00E2         | ckSize          |                               | 10000000                                  |
|                  | 00E6         | ckData          | (equipment manufacturer)      | "DSC Corporation"00                       |
| <b>emdl-ck</b>   | 00F6         | ckID            | emdl                          | 656D646C                                  |
|                  | 00FA         | ckSize          |                               | 80000000                                  |
|                  | 00FE         | ckData          | (equipment model)             | "DSC1000"00                               |
| <b>data-ck</b>   | 0106         | ckID            | data                          | 64617461                                  |
|                  | 010A         | ckSize          |                               | 706C0000                                  |
|                  | 010E         | ckData          | PCM Audio Data                | 000000000000.....                         |

(Total samples = 27768)

## B.2 $\mu$ -Law Audio Data

**Table 48  $\mu$ -Law Audio File Description Sample Contents**

|                                  |  |
|----------------------------------|--|
| Audio Data                       |  |
| Format Type                      | $\mu$ -LAW PCM                           |
| Channels                         | monaural                                 |
| Sampling Frequency               | 8.000 KHz                                |
| Bits per Sample                  | 8 bits                                   |
| Total Samples                    | 111912                                   |
| Attribute Information            |  |
| Audio Title                      | $\mu$ -LAW PCM ExampleZ                  |
| Audio Genre                      | GreetingZ                                |
| Recording Date                   | 1997-07-17                               |
| Recording Engineer               | Interoperability Multimedia AssociationZ |
| Copyright                        | Copyright ABCZ                           |
| Exif-specific Information        |  |
| Exif Version                     | 0200 (Version 2.0)                       |
| Related Exif Image File          | DSC00001.JPGZ                            |
| Recording Start Time             | 10:20:30.130Z                            |
| Recording Equipment Manufacturer | ABCD CorporationZ                        |
| Recording Equipment Model        | Camera XYZZ                              |
| Manufacturer Note                | 0000000000000000                         |
| User Comment                     | User Comment (ASCII)                     |

Table 49 μ-Law Audio File Description Sample

|                  | Offset<br>(Hex) | Name            | Comment                  | Data<br>(Hex or "ASCII")                    |
|------------------|-----------------|-----------------|--------------------------|---|
| <b>RIFF-ck</b>   | 0000            | ckID            | RIFF                     | 52494646                                    |
|                  | 0004            | ckSize          |                          | AAB60100                                    |
|                  | 0008            | formType        | WAVE                     | 57415645                                    |
| <b>fmt-ck</b>    | 000C            | ckID            | fmt_                     | 666D7420                                    |
|                  | 0010            | ckSize          |                          | 12000000                                    |
|                  | 0014            | wFormatTag      | μ-Law Format             | 0700  |
|                  | 0016            | nchannels       | monaural                 | 0100  |
|                  | 0018            | nSamplesPerSec  | 8.00 KHz                 | 401F0000                                    |
|                  | 001C            | nAvgBytesPerSec | 8.00KBytes/sec           | 401F0000                                    |
|                  | 0020            | nBlockAlign     | 1Byte/block              | 0100  |
|                  | 0022            | wBitsPerSample  | 8 bits/sample            | 0800  |
| <b>fact-ck</b>   | 0024            | cbSize          | 0                        | 0000  |
|                  | 0026            | ckID            | fact                     | 66616374                                    |
|                  | 002A            | ckSize          |                          | 04000000                                    |
| <b>INFO-LIST</b> | 002E            | dwSampleLength  |                          | 28B50100                                    |
|                  | 0032            | ckID            | LIST                     | 4C495354                                    |
|                  | 0036            | ckSize          |                          | AC000000                                    |
| <b>INAM-ck</b>   | 003A            | listType        | INFO                     | 494E464F                                    |
|                  | 003E            | ckID            | INAM                     | 494E414D                                    |
|                  | 0042            | ckSize          |                          | 12000000                                    |
| <b>IGNR-ck</b>   | 0046            | ckData          | (audio title)            | "uLAW PCM Example"00                        |
|                  | 0058            | ckID            | IGNR                     | 49474E52                                    |
|                  | 005C            | ckSize          |                          | 09000000                                    |
| <b>ICRD-ck</b>   | 0060            | ckData          | (recording genre)        | "Greeting"Z                                 |
|                  | 006A            | ckID            | ICRD                     | 49435244                                    |
|                  | 006E            | ckSize          |                          | 0B000000                                    |
| <b>ICMT-ck</b>   | 0072            | ckData          | (July 17, 1997)          | "1997-07-17"00                              |
|                  | 007E            | ckID            | ICMT                     | 49434D54                                    |
|                  | 0082            | ckSize          |                          | 18000000                                    |
| <b>IART-ck</b>   | 0086            | ckData          | (This File μ-LAW Sample) | "This File uLAW Sample"000000               |
|                  | 009E            | ckID            | IART                     | 49415254                                    |
|                  | 00A2            | ckSize          |                          | 23000000                                    |
| <b>ICOP-ck</b>   | 00A6            | ckData          | (creator)                | "Interoperability Multimedia Association"00 |
|                  | 00CA            | ckID            | ICOP                     | 49434F50                                    |
|                  | 00CE            | ckSize          |                          | 10000000                                    |
| <b>exif-LIST</b> | 00D2            | ckData          | (creator)                | "ABCD Corporation"00                        |
|                  | 00E2            | ckID            | LIST                     | 4C495354                                    |
|                  | 00E6            | ckSize          |                          | 94000000                                    |
| <b>ever-ck</b>   | 00EA            | listType        | exif                     | 65786966                                    |
|                  | 00EE            | ckID            | ever                     | 4C495354                                    |
|                  | 00F2            | ckSize          |                          | 94000000                                    |
| <b>erel-ck</b>   | 00F6            | ckData          | Ver. 2.0                 | 65786966                                    |
|                  | 00FA            | ckID            | erel                     | 4C495354                                    |

|                 |      |        |                               |                                  |
|-----------------|------|--------|-------------------------------|----------------------------------|
|                 | 00FE | ckSize |                               | 94000000                         |
|                 | 0102 | ckData | (relation to Exif image file) | "DSC00001.JPG"00                 |
| <b>etim-ck</b>  | 0110 | ckID   | etim                          | 4C495354                         |
|                 | 0114 | ckSize |                               | 94000000                         |
|                 | 0118 | ckData | (10:20:30.130)                | "10:20:30.130"00                 |
| <b>ecor-ck</b>  | 0126 | ckID   | ecor                          | 4C495354                         |
|                 | 012A | ckSize |                               | 94000000                         |
|                 | 012E | ckSize | (equipment manufacturer)      | "ABCD Corporation"00             |
| <b>emdl-ck</b>  | 0140 | ckID   | emdl                          | 656D646C                         |
|                 | 0144 | ckSize |                               | 0A000000                         |
|                 | 0148 | ckData | (equipment model)             | "Camera XY"0000                  |
| <b>emnt-ck</b>  | 0152 | ckID   | emnt                          | 656D6E74                         |
|                 | 0156 | ckSize |                               | 08000000                         |
|                 | 015A | ckData | (manufacturer note)           | 0000000000000000                 |
| <b>euclm-ck</b> | 0162 | ckID   | euclm                         | 6575636D                         |
|                 | 0166 | ckSize |                               | 14000000                         |
|                 | 016A | ckData | (user comment)                | 41534349490000005573657220436F6D |
| <b>data-ck</b>  | 017E | ckID   | data                          | 64617461                         |
|                 | 0182 | ckSize |                               | 28B50100                         |
|                 | 0186 | ckData | μ-Law Audio Data              | F2FE00007FFF0000E3.....          |

(Total samples = 111912)



### B.3 IMA-ADPCM Audio Data

**Table 50 IMA-ADPCM Audio File Description Sample Contents**

|                                  |                                   |
|----------------------------------|-----------------------------------|
| Audio Data                       |                                   |
| Format Type                      | IMA-ADPCM Format                  |
| Channels                         | stereo                            |
| Sampling Frequency               | 8.000 KHz                         |
| Bytes per Block                  | 8110 Bytes/sec                    |
| Bits per Sample                  | 4 bits/sample                     |
| Total Data Bytes                 | 35840 Bytes                       |
| Attribute Information            |                                   |
| Audio Title                      | IMA-ADPCM ExampleZ                |
| Audio Genre                      | None                              |
| Recording Date                   | 1997-08-11Z                       |
| Comment                          | None                              |
| Recording Engineer               | Hanako YamadaZ                    |
| Copyright                        | Copyright XYZ on 1997.Z           |
| Exif-specific Information        |                                   |
| Exif Version                     | 0200 (Version 2.0)                |
| Related Exif Image File          | DSC00001.JPGZ                     |
| Recording Start Time             | 15:14:13.135Z                     |
| Recording Equipment Manufacturer | DSC Interoperability CorporationZ |
| Recording Equipment Model        | DSC Camera-2Z                     |
| Manufacturer Note                | None                              |
| User Comment                     | None                              |

Table 51 IMA-ADPCM Audio File Description Example

|                  | Offset<br>(Hex) | Name            | Comment              | Data<br>(Hex or "ASCII")     |                       |
|------------------|-----------------|-----------------|----------------------|------------------------------|-----------------------|
| <b>RIFF-ck</b>   | 0000            | ckID            | RIFF                 | 52494646                     |                       |
|                  | 0004            | ckSize          |                      | 248D0000                     |                       |
|                  | 0008            | formType        | WAVE                 | 57415645                     |                       |
| <b>fmt-ck</b>    | 000C            | ckID            | "fmt_"               | 666D7420                     |                       |
|                  | 0010            | ckSize          | IMA-ADPCM Format     | 14000000                     |                       |
|                  | 0014            | wFormatTag      |                      | 1100                         |                       |
|                  | 0016            | nchannels       | stereo               | 0200                         |                       |
|                  | 0018            | nSamplesPerSec  | 8.0KHz               | 401F0000                     |                       |
|                  | 001C            | nAvgBytesPerSec | 8110 Bytes/sec       | AE1F0000                     |                       |
|                  | 0020            | nBlockAlign     | 512 Bytes/block      | 0002                         |                       |
|                  | 0022            | wBitsPerSample  | 4 bits/sample        | 0400                         |                       |
|                  | 0024            | cbSize          | Additional Bytes = 2 | 0200                         |                       |
| <b>fact-ck</b>   | 0028            | ckID            | fact                 | 66616374                     |                       |
|                  | 002C            | ckSize          |                      | 04000000                     |                       |
|                  | 0030            | dwSampleLength  | 35350 samples        | 168A0000                     |                       |
| <b>INFO-LIST</b> | 0034            | ckID            | LIST                 | 4C495354                     |                       |
|                  | 0038            | ckSize          |                      | 68000000                     |                       |
|                  | 003C            | listType        | INFO                 | 494E464F                     |                       |
|                  | <b>INAM-ck</b>  | 0040            | ckID                 | INAM                         | 494E414D              |
|                  |                 | 0044            | ckSize               |                              | 12000000              |
|                  |                 | 0048            | ckData               | (audio title)                | "IMA-ADPCM Example"00 |
|                  | <b>IGNR-ck</b>  | 0058            | ckID                 | IGNR                         | 49474E52              |
|                  |                 | 005C            | ckSize               |                              | 09000000              |
|                  |                 | 0060            | ckData               | (recording genre)            | "Greeting"Z           |
|                  | <b>ICRD-ck</b>  | 005A            | ckID                 | ICRD                         | 49435244              |
| 005E             |                 | ckSize          |                      | 0B000000                     |                       |
| 0062             |                 | ckData          | (August 11, 1997)    | "1997-08-11"0000             |                       |
| <b>IART-ck</b>   | 006E            | ckID            | IART                 | 49415254                     |                       |
|                  | 0072            | ckSize          |                      | 0E000000                     |                       |
|                  | 0076            | ckData          | (creator)            | "Hanako Yamada"00            |                       |
| <b>ICOP-ck</b>   | 0084            | ckID            | ICOP                 | 49434F50                     |                       |
|                  | 0088            | ckSize          |                      | 17000000                     |                       |
|                  | 008C            | ckData          | (copyright)          | "Copyright XYZ on 1997."0000 |                       |
| <b>exif-LIST</b> | 00E2            | ckID            | LIST                 | 4C495354                     |                       |
|                  | 00E6            | ckSize          |                      | 94000000                     |                       |
|                  | 00EA            | listType        | exif                 | 65786966                     |                       |
|                  | <b>ever-ck</b>  | 00A4            | ckID                 | LIST                         | 4C495354              |
| 00A8             |                 | ckSize          |                      | 78000000                     |                       |
| 00AC             |                 | listType        | exif                 | 65786966                     |                       |

|                |      |        |                               |                                      |
|----------------|------|--------|-------------------------------|--------------------------------------|
| <b>erel-ck</b> | 00BC | ckID   | erel                          | 6572656C                             |
|                | 00C0 | ckSize |                               | 0D000000                             |
|                | 00C4 | ckData | (relation to Exif image file) | "DSC00001.JPG"0000                   |
| <b>etim-ck</b> | 00D2 | ckID   | etim                          | 6574696D                             |
|                | 00D6 | ckSize |                               | 0D000000                             |
|                | 00DA | ckData | (15:14:13.135)                | "15:14:13.135"0000                   |
| <b>ecor-ck</b> | 00E8 | ckID   | ecor                          | 65636F72                             |
|                | 00EC | ckSize |                               | 1E000000                             |
|                | 00F0 | ckSize | (equipment manufacturer)      | "DSC Interoperability Corporation"00 |
| <b>emdl-ck</b> | 010E | ckID   | emdl                          | 656D646C                             |
|                | 0112 | ckSize |                               | 0D000000                             |
|                | 0116 | ckData | (equipment model)             | "DSC Camera-2"0000                   |
| <b>data-ck</b> | 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.

- a) ApertureValue (Av) = 2 log 2 ( F number)
- b) ShutterSpeedValue (Tv) = - log 2 (exposure time)
- c) BrightnessValue (Bv) = log2 ( B/NK )     Note that: B:cd/cm<sup>2</sup>, N,K: constant

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

- d) Film sensitivity (Sv) = log2 ( ASA / 3.125 )

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

- e)  $Ev = Av + Tv = Bv + Sv$

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

**Table 52 Typical APEX Values**

| ApertureValue<br>(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<br>(APEX) | ExposureTime<br>(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<br>(APEX) | foot lambert |
|---------------------------|--------------|
| -2                        | 1/4          |
| -1                        | 1/2          |
| 0                         | 1            |
| 1                         | 2            |
| 2                         | 4            |
| 3                         | 8            |
| 4                         | 15           |
| 5                         | 30           |

## Annex D      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 E Guidelines for Implementing Tag Information

### E.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). Exif/DCF writers should record these tags as indicated in these guidelines. Exif/DCF 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 Exif/DCF readers are given for the sake of example. Examples of tag handling by application software are also given, in section **E.3 Application Software Guidelines**. Tag IDs and values are given in the explanations. For details, refer to the Exif Standard.

### E.2 Tag Use in Exif/DCF Readers

Exif/DCF 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**

#### E.2.1 ExposureTime

Tag Information

Exposure time, given in seconds (sec).

[Exif/DCF reader]

- When exposure time is unusually long, the Exif/DCF 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.

#### E.2.2 BrightnessValue

Tag Information

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

[Exif/DCF writer]

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

[Exif/DCF reader]

- The Exif/DCF 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.

### E.2.3 LightSource

#### Tag Information

Indicates the kind of light source.

[Exif/DCF writer]

- The Exif/DCF writer should record the light source as estimated by the Exif/DCF writer based on white balance, etc., or as set by the user.
- This will sometimes differ from the actual light source used for shooting

[Exif/DCF reader]

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

### E.2.4 Flash

#### Tag Information

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

[Exif/DCF writer]

- The red-eye bit indicates whether the flash was fired for the purpose of red-eye reduction, including pre-flash.
- The red-eye bit can be set when a flash mode for the purpose of reducing red-eye reduction is set.

[Exif/DCF 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.

### E.2.5 SubjectArea

#### Tag Information

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

[Exif/DCF writer]

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

[Exif/DCF reader]

- An Exif/DCF reader can refer to this information as the area for image optimization processing.

### E.2.6 CustomRendered

#### Tag Information

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

[Exif/DCF writer]

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

- When this tag is set to 1 (custom process), vendors should leads users to understand its function.
- Usage cases
  - When the user changes exposure or white balance on pursose
  - When the user takes pictures using not standard set up but different mode on purpose
  - When the user takes pictures using sepia mode or monochrome mode
  - When the user chooses soft focus effect
  - When the Exif/DCF writer chooses various effects meeting each scene

[Exif/DCF reader]

- When a value of 1 (custom process) is set, the Exif/DCF 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.
- Even if a value of 1(custom process) is recorded, basic processing, which depends on each output device, is not needed to be decreased. (See **Table 53**)

**Table 53 Relation between Custom Rendered and Output device process**

| Tag record value | Basic process | Image data-adaptive process | Tag information-utilized process |
|------------------|---------------|-----------------------------|----------------------------------|
| Ordinary process | Do            | Do                          | Do                               |
| Custom process   | Do            | No or less                  | No or less                       |

Basic process: process which depends on the output device.

Image data-adaptive process:Image data correction process which depends on the image data. (brightness retouch, color retouch etc)

Image information-utilized process: Image data correction processing, which depends on the tag information.

### E.2.7 ExposureMode

Tag Information

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

[Exif/DCF writer]

- If shutter speed and aperture were set by the user, the Exif/DCF 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 Exif/DCF writer whether to record 0 (auto exposure) or 1 (manual exposure).

[Exif/DCF reader]

- When a value of 0 (auto exposure) is set, an Exif/DCF reader should perform automatic adjustment of exposure settings.
- When a value of 1 (manual exposure) or 2 (auto bracketing) is set, the Exif/DCF reader should either not perform automatic bias or should reduce the amount of bias.



## E.2.8 WhiteBalance

### Tag Information

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

[Exif/DCF 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.

[Exif/DCF reader]

- If 0 (auto white balance) is recorded, color balance should be adjusted automatically. The Exif/DCF 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.

## E.2.9 DigitalZoomRatio

### Tag Information

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

[Exif/DCF reader]

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

## E.2.10 FocalLengthIn35mmFilm

### Tag Information

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

[Exif/DCF writer]

- Digital zoom ratio is not taken into account.

[Exif/DCF reader]

- An Exif/DCF reader can use this value along with subject distance to estimate the magnification.

## E.2.11 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.

[Exif/DCF writer]

- The Exif/DCF writer records the shooting mode set by the user or the scene type determined by the Exif/DCF 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.
- In case of multiple objects in one scene, Exif/DCF writer chooses a value, which suites the main object.

- When the Exif/DCF writer changes the value of contrast, saturation, sharpness, gaincontrol etc, to realize some effects on the photograph, it is better to record the directions.

[Exif/DCF reader]

- The Exif/DCF reader can use this information to perform image processing suitable for the type of scene that was shot.
- The Exif/DCF 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 Exif/DCF reader which of these to use. These tags are recommended to be referred.
- Processing examples are given in the table below for each objective.

**Table 54 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<br>Noise reduction |

### E.2.12 GainControl

Tag Information

This tag indicates the degree of overall image gain adjustment.

[Exif/DCF writer]

- The Exif/DCF writer records the difference in gain in relation to the default (factory setting) sensitivity. The default sensitivity may differ for each Exif/DCF writer.
- If there is more than one default value, this tag is not used.

[Exif/DCF reader]

- The Exif/DCF 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.

### E.2.13 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.

[Exif/DCF writer]

- The Exif/DCF writer records the difference in contrast, saturation and sharpness in relation to the default (factory setting) values.
- The defaults may differ for each Exif/DCF writer.
- Regarding the effects matching SceneCaptureType, the Exif/DCF writer should record processing directions by using these tags.

[Exif/DCF reader]

- The Exif/DCF 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.
- Other tags (such as SceneCaptureType ) may be used as supplementary information.
- Processing examples are given in the table below for each objective.

**Table 55 Examples of Processing to be avoided by Exif/DCF Readers**

|            | Processing that goes against the intent of the recorded values | Double 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 |

### E.2.14 SubjectDistanceRange

Tag Information

Indicates the distance range to the subject.

[Exif/DCF writer]

- This is the distance to the part of the scene determined by the Exif/DCF 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.

[Exif/DCF 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.

## E.3 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.

### E.3.1 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.

### E.3.2 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 E.3.3** 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.

### E.3.3 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.

**Table 56 0th IFD tag handling examples**

| Tag                         | Rotation                        | Trimming                        | Retouch                         | Red-eye                         | Special                         |
|-----------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Orientation<br>ID=274       | Set to 1                        | Set to 1                        | Set to 1                        | Set to 1                        | Set to 1                        |
| YCbCrPositioning<br>ID= 531 | Update value                    | Update value                    | Update value                    | Update value                    | Update value                    |
| Software<br>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<br>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  |

### E.3.4 Exif IFD、Primary Image

The following tags should be copied unchanged.

- ExposureTime; ID= 33434
- Fnumber; ID= 33437
- ExposureProgram; ID= 34850
- SpectralSensitivity; ID= 34852
- PhotographicSensitivity; ID= 34855
- OECF; ID= 34856
- SensitivityType; ID= 34864
- StandardOutputSensitivity; ID= 34865
- RecommendedExposureIndex; ID= 34866
- ISO Speed; ID= 34867
- ISO SpeedLatitudeyyy; ID= 34868
- ISO SpeedLatitudezzz; ID= 34869
- ExifVersion; ID= 36864
- DateTimeOriginal; 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
- 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
- CameraOwnerName; ID= 42032
- BodySerialNumber; ID= 42033

- LensSpecification; ID= 42034
- LensMake; ID= 42035
- LensModel; ID= 42036
- LensSerialNumber; ID= 42037

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

**Table 57 Exif IFD tag handling examples**

| Tag                                |          | Rotation  | Trimming                         | Retouch  | Red-eye   | Special  |
|------------------------------------|----------|---|----------------------------------|--|---|--|
| CompressedBitsPerPixel<br>ID=37122 |          | Update value based on compression mode set when saved.          | Same as "Rotation"               | Same as "Rotation"   | Same as "Rotation"  | Same as "Rotation"   |
| PixelXDimension<br>ID=40962        |          | Update to width after rotation.                                 | Update to width after trimming.  | No change  | No change   | No change  |
| PixelYDimension<br>ID=40963        |          | Update to height after rotation.                                | Update to height after trimming. | No change  | No change   | No change  |
| SubsecTime<br>ID=37520             |          | If the Exif/DCF writer can record this tag, update when saving. | Same as "Rotation"               | Same as "Rotation"   | Same as "Rotation"  | Same as "Rotation"   |
| SubjectLocation<br>ID=41492        |          | Update to value after rotation                                  | Update to value after trimming   | No change  | No change   | No change  |
| SubjectArea<br>ID=37396            |          | Update to value after rotation                                  | Update to value after trimming   | No change  | No change   | No change  |
| CustomRendered<br>ID=41985         | value =0 | No change   | No change                        | Set to 1.  | Set to 1.<br>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. |



### E.3.5 InterOperability IFD

Tags in the InterOperability IFD should be copied unchanged.

### E.3.6 GPS Info IFD

Tags in the GPS Info IFD should be copied unchanged.

### E.3.7 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.

**Table 58 1st IFD tag handling examples**

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

## 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:

- a) All Exif tag information is mapped to the Flashpix Image Info Property Set,
- b) APP2 extended data can be converted to Flashpix extensions,
- c) JPEG images can be converted to the Flashpix tile structure without image quality loss, making use of restart markers.

Figure 58 illustrates the conversion process.

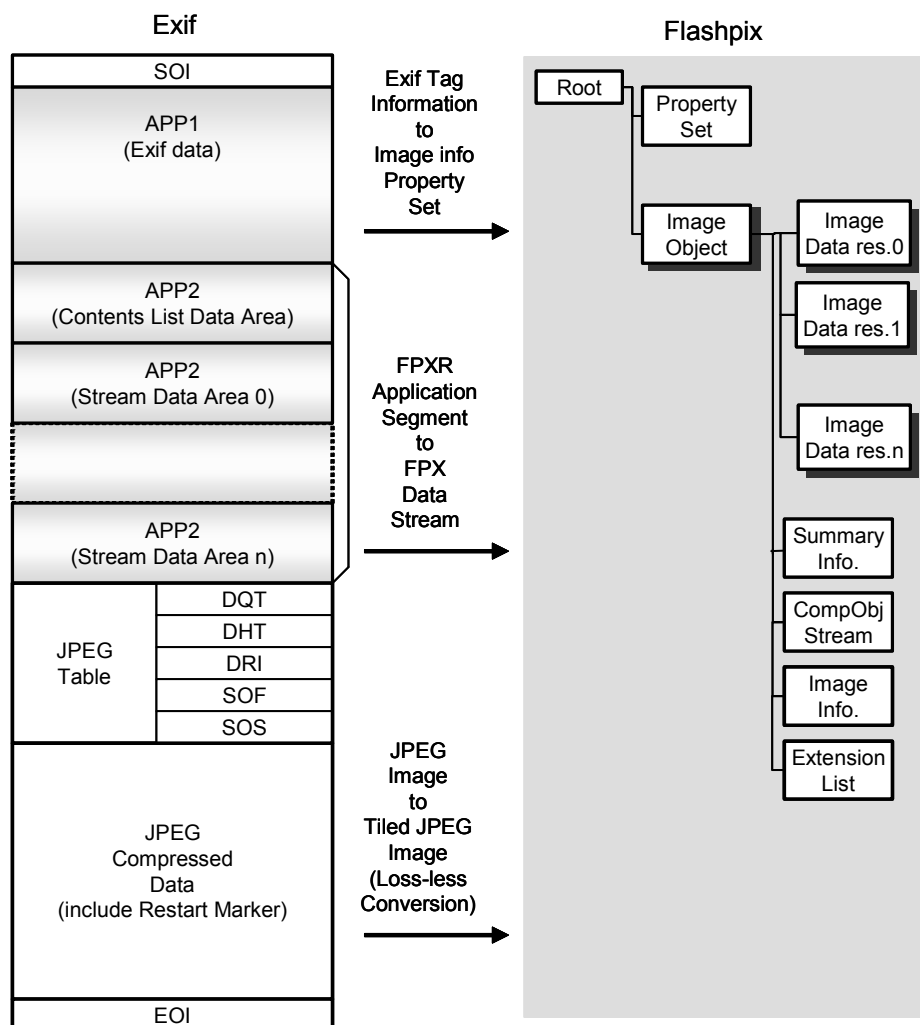


Figure 58 Conversion from Exif to Flashpix

## 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 59 shows how compressed data is rearranged using restart markers.

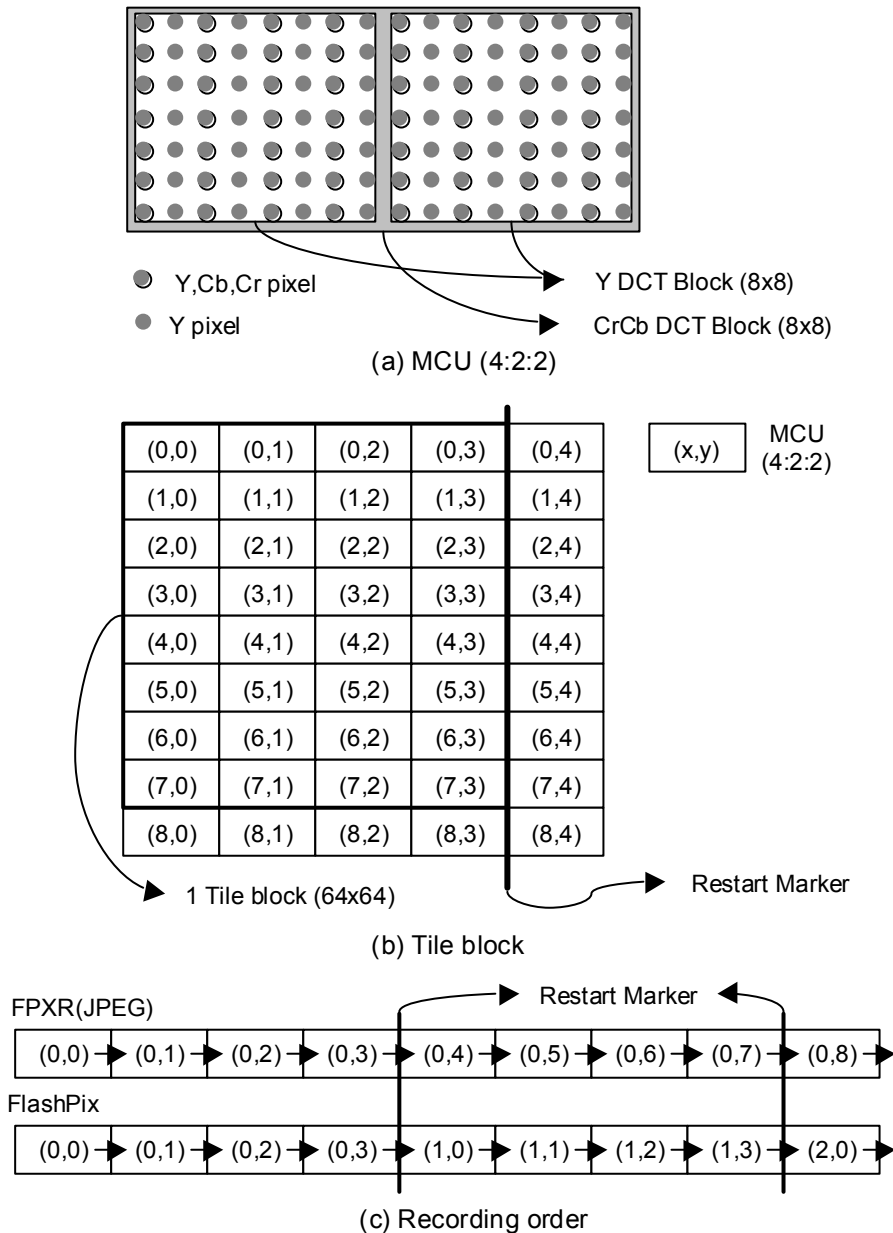


Figure 59 Conversion to Flashpix Using Restart Markers

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 pad the bottom edge of the image shall be necessary. .

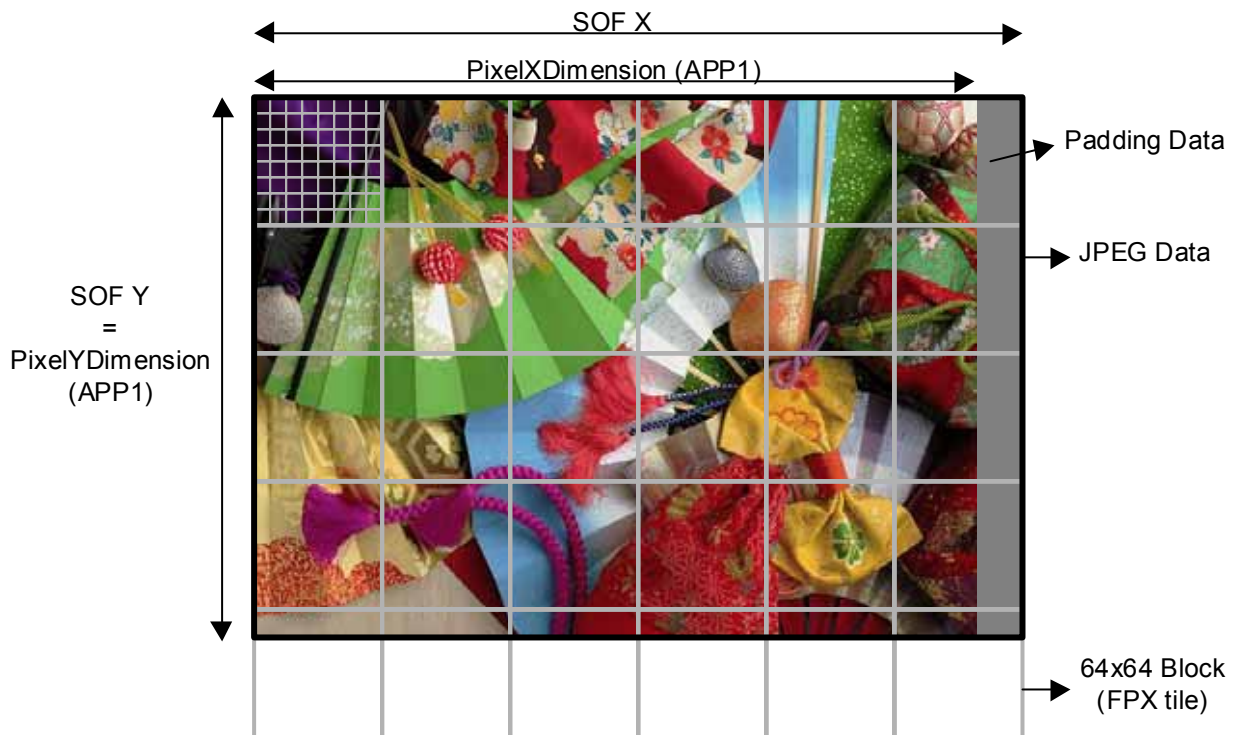


Figure 60 Image Size Restrictions

## 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 59 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 60 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            |
| PhotographicSensitivity  | 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      |
| DateTimeDigitized        | 36868    | 9004 | Image Info   | Per Picture Camera Setting      | Capture date                    |
| ComponentsConfiguration  | 37121    | 9101 | Summary Info | -                               | Create date/time                |
| CompressedBitsPerPixel   | 37122    | 9102 | Ignore       | Ignore                          | Ignore                          |
| ShutterSpeedValue        | 37377    | 9201 | Ignore       | Ignore                          | Ignore                          |
| ApertureValue            | 37378    | 9202 | Image Info   | Per Picture Camera Setting      | Exposure time                   |
| BrightnessValue          | 37379    | 9203 | Image Info   | Per Picture Camera Setting      | F-number                        |
| ExposureBiasValue        | 37380    | 9204 | Image Info   | Per Picture Camera Setting      | Brightness value                |
| MaxApertureValue         | 37381    | 9205 | Image Info   | Per Picture Camera Setting      | Exposure bias value             |
| SubjectDistance          | 37382    | 9206 | Image Info   | Per Picture Camera Setting      | Maximum aperture value          |
| MeteringMode             | 37383    | 9207 | Image Info   | Per Picture Camera Setting      | Subject distance                |
| LightSource              | 37384    | 9208 | Image Info   | Per Picture Camera Setting      | Metering mode                   |
| Flash                    | 37385    | 9209 | Image Info   | Per Picture Camera Setting      | Scene illuminant                |
| FocalLength              | 37386    | 920A | Image Info   | Per Picture Camera Setting      | Flash                           |
| MakerNote                | 37500    | 927C | Image Info   | Per Picture Camera Setting      | Flash return                    |
| UserComment              | 37510    | 9286 | Image Info   | Per Picture Camera Setting      | Focal length                    |
| SubSecTime               | 37520    | 9290 | -            | -                               | -                               |
| SubSecTimeOriginal       | 37521    | 9291 | Image Info   | Content description             | Content description notes       |
| SubSecTimeDigitized      | 37522    | 9292 | Image Info   | Ignore                          | Ignore                          |
| FlashpixVersion          | 40960    | A000 | Image Info   | Content Description             | Date of the original image      |
| ColorSpace               | 40961    | A001 | Image Info   | Per Picture Camera Setting      | Capture date                    |
| PixelXDimension          | 40962    | A002 | Image Info   | Per Picture Camera Setting      | Create date/time                |
| PixelYDimension          | 40963    | A003 | Image Info   | Per Picture Camera Setting      | Create date/time                |
| RelatedSoundFile         | 40964    | A004 | Image Info   | Per Picture Camera Setting      | -                               |
| FlashEnergy              | 41483    | A20B | Image Info   | Image Contents                  | Subimage color                  |
| SpatialFrequencyResponse | 41484    | A20C | Image Info   | Image Contents                  | Primary description             |
| FocalplaneXResolution    | 41486    | A20E | Image Info   | Image Contents                  | Primary description             |
| FocalplaneYResolution    | 41487    | A20F | Image Info   | Image Contents                  | Primary description             |
| FocalplaneResolutionUnit | 41488    | A210 | Image Info   | Image Contents                  | Primary description             |
| SubjectLocation          | 41492    | A214 | Image Info   | Image Info                      | Flash Energy                    |
| ExposureIndex            | 41493    | A215 | Image Info   | Image Info                      | Spatial frequency response      |
| SensingMethod            | 41495    | A217 | Image Info   | Image Info                      | Focal plane X resolution        |
| FileSource               | 41728    | A300 | Image Info   | Image Info                      | Digital Camera Characterization |
| SceneType                | 41729    | A301 | Image Info   | Image Info                      | Digital Camera Characterization |
| CFAPattern               | 41730    | A302 | Image Info   | Image Info                      | Digital Camera Characterization |

**Table 61 Conversion between Exif Tags and Flashpix Property Set (3) (GPS Info Tags)**

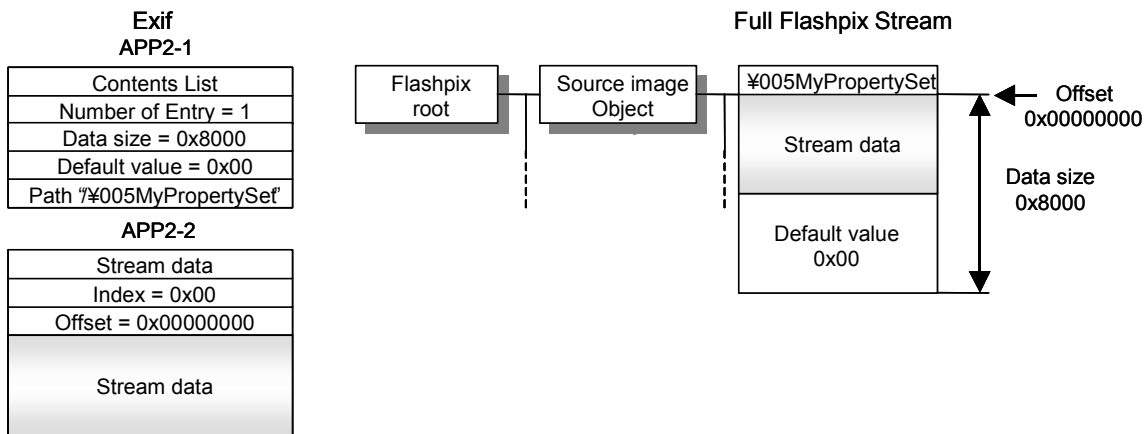
| Exif                |          |     | FPX                |       |                     |
|---------------------|----------|-----|--------------------|-------|---------------------|
| Field Name          | Tag Code |     | Property Set       | Group | Name                |
|                     | Dec      | 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 61** 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 61 Conversion to Flashpix Extensions (1)**

Next, **Figure 62** 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.



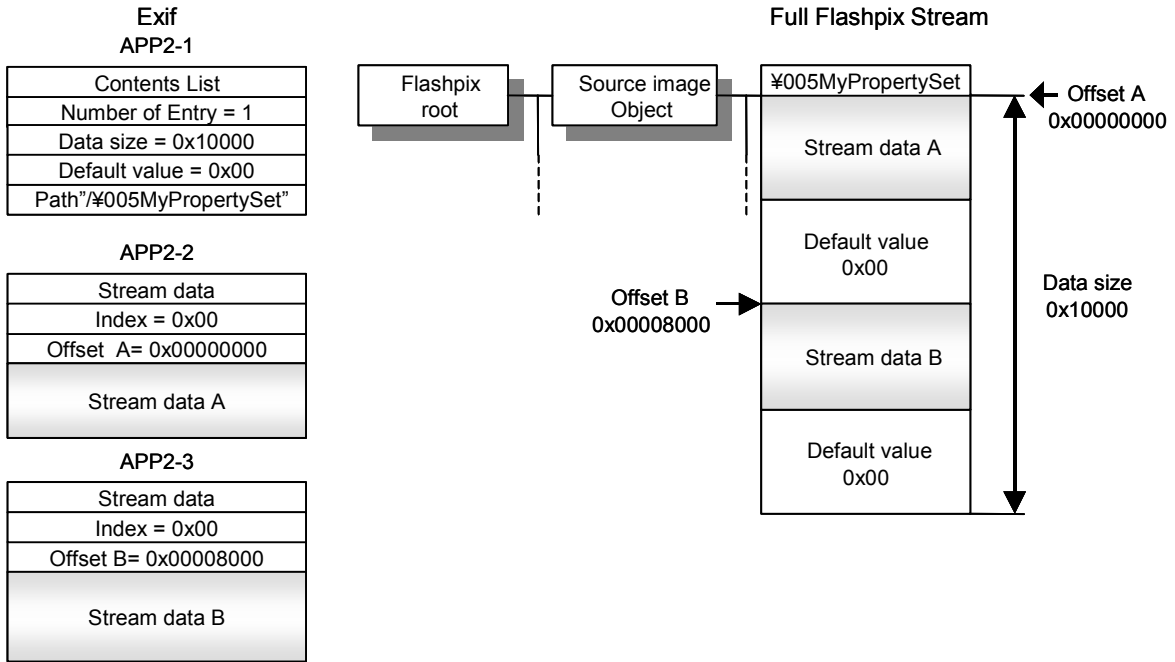


Figure 62 Conversion to Flashpix Extensions (2)

Finally, **Figure 63** 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.

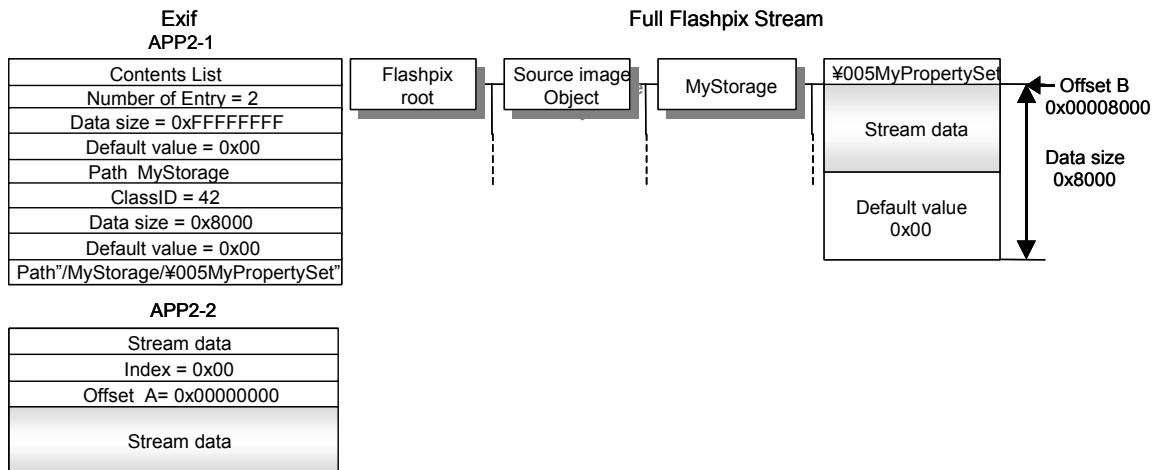


Figure 63 Conversion to Flashpix Extensions (3)

## Annex G Use of Sensitivity-Related Tags

“Sensitivity-related tags” refer generally to seven tags: PhotographicSensitivity, SensitivityType, StandardOutputSensitivity, RecommendedExposureIndex, ISO Speed, ISOSpeedLatitudeyyy, and ISOSpeedLatitudezzz.

The current specifications of sensitivity-related tags resulted from consideration of a couple of circumstances. First, the PhotographicSensitivity tag whose ID was 34855 was previously referred to as ISOSpeedRating, which, in reality, led to confused interpretations of sensitivity that resulted in many recordings that differed from ISO speed as defined under the ISO 12232 standard. Second, sensitivity parameters were added to ISO 12232 as a result of a 2006 revision.

The PhotographicSensitivity tag records the sensitivity of the camera or input device when the image of the relevant file was taken. And the parameter that can be recorded as sensitivity here is a value for one of the following, all of which are defined in ISO 12232: standard output sensitivity (SOS), recommended exposure index (REI), and ISO speed.

For the PhotographicSensitivity tag is an existing tag from Version 2.21 and earlier versions though its name and definition has changed, it is expected that its digit number will become insufficient to match the advancing sensitivity of cameras because its Type is SHORT. However, in the case that the sensitivity value to be noted is 65535 (the maximum value of SHORT) or higher, it records a value of 65535. Thus it is desirable for the file reader to read this value and then move on to read the values in related tags that correspond to the types that were designated by the SensitivityType tag. (Readers corresponding to Version 2.21 and earlier versions simply interpret this sensitivity value as having reached the upper limit.)

In other words, in the case that only one sensitivity parameter is used and digit number is sufficient, it is possible to record sensitivity by using only the existing PhotographicSensitivity tag (and the newly defined SensitivityTYPE tag). (Although using Count = 1 is first principle, this is only recommended and “Any” is continued as a specification based on consideration for interoperability.)

SensitivityTYPE tag indicates which one of the three kinds of parameters of ISO12232 is the PhotographicSensitivity. However, these three parameters sometimes can take the same numerical values depending on the camera’s gradation and exposure characteristics, Value = 4, 5, 6, or 7 may be used in such cases. At the same time, Value = 1, 2, or 3 should be used in case that the same numerical value is coincidentally occurred and only one kind of definition is contemplating camera design. Furthermore, in case of the camera compliant with CIPA standard DC-004 (sensitivity of digital cameras), it is necessary to use either SOS or REI in the sensitivity notation, and therefore one of value = 1, 2, 4, 5, 6, or 7 is used. And when type is unknown (for example, in case of handling a file recorded by a camera that applies to

Version 2.21 or earlier), then value = 0 should be used. (As a rule, the SensitivityType tag is also recorded when the PhotographicSensitivity tag is recorded; however, this is only recommended due to consideration for interoperability.)

On the tags of StandardOutputSensitivity, RecommendedExposureIndex and ISOSpeed, numerical values for the tags should be noted in accordance with their definitions respectively, however, when recording even just one of the three tags, it is necessary to record the PhotographicSensitivity tag and SensitivityType tag because it means that a sensitivity parameter is recorded in this case. (The three tags do not exist for Version 2.21 and earlier; therefore recording is possible if a device corresponds to one of the three tags.)

On ISOSpeedLatitudeyyy and ISOSpeedLatitudezzz tags, numerical values for the tags should be recorded in accordance with their definitions. However, using these tags on their own is prohibited because they are incidental parameters of ISO speed.

## Participating members

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

The members of the Working Group are listed below.

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