Explication of Exchangeable image file format for digital still cameras:

Exif Version 2.2

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

1. Purpose of the Revised Edition

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

2. History of Revisions

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

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

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

c) Exif Standard Version 2.1   Addition of interoperability tag.

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

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

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

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

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

3. Main Issues Arising in the Deliberations

3.1 Summary of the Discussions

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

3.2 Tag Information

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

4. Main Revisions

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

4.1 Newly added tag information

a) SubjectArea

b) CustomRendered

c) ExposureMode

d) WhiteBalance

e) DigitalZoomRatio

f)   FocalLengthIn35mmfilm

g)   SceneCaptureType

h)   GainControl

i)   Contrast

j)   Saturation

k)   Sharpness

l)   DeviceSettingDescription

m) SubjectDistanceRange

n)   ImageUniqueID

o)   GPSProcessingMethod

p)   GPSAreaInformation

q)   GPSDateStamp

r)   GPSDifferential

4.2 Changed tag information

a)   LightSource

b)   Flash

5. Industrial Properties Rights

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

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

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

6.   The DCF Standard

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

a)   "Background to this standard recommendation"

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

b)   1.3. Glossary, Exif Standard

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

c)   3.3.1. Purpose

Change to read "Exif Version 2.1 or Exif Version 2.2."

d)   Annex C, Fig. C-1

Change to read "Exif Version2.1 conformant or Exif Version 2.2 conformant."

7.   Guidelines for Implementing Exif 2.2 Tag Information

7.1   General

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

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

7.2   Definitions

Key terms used in this document are defined as follows.

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

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

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

7.3 Tag Use in Readers

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

a) ExposureMode

b) WhiteBalance

c) Flash

d) SceneCaptureType

e) ExposureTime

f) CustomRendered

7.3.1 ExposureTime

Tag Information

Exposure time, given in seconds (sec).

[Reader]

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

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

7.3.2 BrightnessValue

Tag Information

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

[Writer]

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

[Reader]

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

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

7.3.3 LightSource

Tag Information

Indicates the kind of light source.

[Writer]

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

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

[Reader]

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

7.3.4 Flash

Tag Information

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

[Writer]

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

[Reader]

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

7.3.5 SubjectArea

Tag Information

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

[Writer]

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

[Reader]

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

7.3.6 CustomRendered

Tag Information

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

[Writer]

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

[Reader]

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

7.3.7 ExposureMode

Tag Information

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

[Writer]

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

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

[Reader]

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

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

7.3.8 WhiteBalance

Tag Information

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

[Writer]

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

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

[Reader]

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

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

7.3.9 DigitalZoomRatio

Tag Information

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

[Reader]

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

7.3.10 FocalLengthIn35mmFilm

Tag Information

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

[Writer]

μ Digital zoom ratio is not taken into account.

[Reader]

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

7.3.11 SceneCaptureType

Tag Information

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

[Writer]

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

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

[Reader]

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

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

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

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

Explication Table 1 Examples of Processing for Different Scene Types

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

7.3.12 GainControl
Tag Information
This tag indicates the degree of overall image gain adjustment.

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

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

[Reader]
μ The reader can estimate the degree of noise occurrence in accord with the recorded value.

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

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

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

μ The defaults may differ for each writer.

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

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

Explication Table 2 Examples of Processing to be Avoided by Readers

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

7.3.14 SubjectDistanceRange

Tag Information

Indicates the distance range to the subject.

[Writer]

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

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

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

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

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

[Reader]

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

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

7.4 Application Software Guidelines

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

7.4.1 Tag handling by application software

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

7.4.2 Tag handling examples

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

a) Rotation

b) Trimming

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

d) Red-eye reduction (partial image retouching)

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

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

7.4.3 0th IFD
The following tags should be copied unchanged.

- ImageDescription; ID= 270

- Make; ID= 271

- Model; ID= 272

- Xresolution; ID= 282

- Yresolution; ID= 283

- ResolutionUnit; ID= 296

- TransferFunction; ID= 301

- Artist; ID= 315

- WhitePoint; ID= 318

- PrimaryChromaticities; ID= 319

- YcbCrCoefficients; ID= 529

- ReferenceBlackWhite; ID= 532

- Copyright; ID= 33432

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

Explication Table 3   0th IFD tag handling examples

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

7.4.4 Exif IFD , Primary Image

The following tags should be copied unchanged.

- ExposureTime; ID= 33434

- Fnumber; ID= 33437

- ExposureProgram; ID= 34850

- SpectralSensitivity; ID= 34852

- ISOSpeedRatings; ID= 34855

- OECF; ID= 34856

- ExifVersion; ID= 36864

- DateTimeOrginal; ID= 36867

- DateTimeDigitized; ID= 36868

- ComponentsConfiguration; ID= 37121

- ShutterSpeedValue; ID= 37377

- ApertureValue; ID= 37378

- BrightnessValue; ID= 37379

- ExposureBiasValue; ID= 37380

- MaxApertureValue; ID= 37381

- SubjectDistance; ID= 37382

- MeteringMode; ID= 37383

- LightSource; ID= 37384

- Flash; ID= 37385

- FocalLength; ID= 37386

- MakerNotes; ID= 37500

- SubSecTimeOriginal; ID= 37521

- SubSecTimeDigitized; ID= 37522

- FlashPixVersion; ID= 40960

- ColorSpace; ID= 40961

- RelatedSoundFile; ID= 40964

- FlashEnergy; ID= 41483

- SpatialFrequencyResponse ; ID= 41484

- FocalPlaneX-Resolution; ID= 41486

- FocalPlaneY-Resolution; ID= 41487

- FocalPlane-ResolutionUnit; ID= 41488

- ExposureIndex; ID= 41493

- SensingMethod; ID= 41495

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 - FileSource; ID= 41728

 - SceneType; ID= 41729

 - CFApattern; ID= 41730

 - ExposureMode; ID= 41986

 - WhiteBalance; ID= 41987

 - DigitalZoomRatio; ID= 41988

 - FocalLengthIn35mmFilm; ID= 441989

 - SceneCaptureType; ID= 41990

 - GainControl; ID= 41991

 - Contrast; ID= 41992

 - Saturation; ID= 41993

 - Sharpness; ID= 41994

 - DeviceSettingDescription; ID= 41995

 - SubjectDistanceRange; ID= 41996

 - ImageUniqueID; ID= 42016

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

Explication Table 4　Exif IFD tag handling examples

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

7.4.5　InterOperability IFD
Tags in the InterOperability IFD should be copied unchanged.

7.4.6　GPS Info IFD
Tags in the GPS Info IFD should be copied unchanged.

7.4.7　1st IFD
The following tags should be copied unchanged.

JEITA CP-3451 Explication
 - Compression; ID= 259

 - ImageDescription; ID= 270

 - Make; ID= 271

 - Model; ID= 272

 - TransferFunction; ID= 301

 - Artist; ID= 306

 - WhitePoint; ID= 318

 - PrimaryChromaticities; ID= 319

 - YCbCrCoefficients; ID= 529

 - ReferenceBlackWhite; ID= 532

 - Copyright; ID= 33432

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

Explication Table 5 1st IFD tag handling examples

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

8. Logo Mark Guidelines

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

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

Exif Print