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OGC GeoTIFF Standard

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Abstract

This profile specifies the requirements and encoding rules for using the Tagged Image File Format (TIFF) for the exchange of georeferenced imagery. It formalizes the existing community standard for the Geographic Tagged Image File Format (GeoTIFF) file format.

Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, <tags separated by commas>

Preface

<Insert Preface Text here. Give OGC specific commentary: describe the technical content, reason for document, history of the document and precursors, and plans for future work. >

The GeoTIFF format was initially developed during the early 1990’s (N. Ritter & Ruth, 1997) in order to leverage a mature platform independent file format (TIFF) by adding metadata required for describing and using geographic image data. TIFF met the requirements for an underlying format, as it was lossless and extensible. In September 1994, SPOT Image Corp proposed a GeoTIFF structure that was limited to Universal Transverse Mercator (N. Ritter & Ruth, 1997). The proposed GeoTIFF specification has augmented and formalized by Niles and Ruth as Revision 1.0, specification version 1.8.2 in November 1995 (N. Ritter & Ruth, 1995). This specification is currently the official GeoTIFF specification (GeoTIFF, n.d).

The GeoTIFF format is used throughout the geospatial and earth science communities to share geographic image data. That usage inevitably leads to identification of new requirements and needs for profiles, extensions, and improvements to the original GeoTIFF Specification. The OGC is well established as a forum for standardization in the GeoTIFF producer and user communities and, as such, it provides an inclusive standardization process for those communities. This document is the first step in the process of integration of the GeoTIFF into that standardization process. Once GeoTIFF is ensconced in the OGC, the standard can be evolved using a formal process.

Suggested additions, changes, and comments on this standard are welcome and

encouraged. Such suggestions may be submitted by email message or by submitting an

official OGC Change Request using the online CR application:

https://portal.opengeospatial.org/public\_ogc/change\_request.php

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

*Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.*

Submitting organizations

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

The HDF Group

Submitters

All questions regarding this submission should be directed to the editor or the submitters:

|  |  |
| --- | --- |
| Name | Affiliation |
| Ted Habermann | The HDF Group |
|  |  |
|  |  |

# Scope

This OGC**®** Standard defines a set of TIFF tags provided to describe all "Cartographic" information associated with TIFF imagery that originates from satellite imaging systems, scanned aerial photography, scanned maps, digital elevation models, or as a result of geographic analyses. Its aim is to allow means for tying a raster image to a known model space or map projection, and for describing those projections. This OGC**®** Standard defines the Geographic Tagged Image File Format (GeoTIFF) file format and the requirements to which every GeoTIFF file must adhere. It focuses on updating the current GeoTIFF community specification and aligning it with current OGC standardization practice.

The tags documented in this spec are to be considered completely orthogonal to the raster-data descriptions of the TIFF spec, and impose no restrictions on how the standard TIFF tags are to be interpreted, which color spaces or compression types are to be used, etc.

# Conformance

This standard defines XXXX.

Requirements for N standardization target types are considered:

* AAAA
* BBBB

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site[[1]](#footnote-1).

In order to conform to this OGC™interface standard, a software implementation shall choose to implement:

1. Any one of the conformance levels specified in Annex B (normative).
2. Any one of the Distributed Computing Platform profiles specified in Annexes TBD through TBD (normative).

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

# References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

There are no normative references.

# Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

For the purposes of this document, the following additional terms and definitions apply.

1. absolute accuracy

Closeness of coordinate value to the true or accepted valuein a specified reference system (in this profile, the reference system is the World Geodetic System 1984 (WGS84))

1. ASCII

[American Standard Code for Information Interchange] The predominant character set encoding of present-day computers.

1. band

A well-defined range of wavelengths, frequencies or energies of optical, electric or acoustic radiation. At the pixel level, a band is represented as one of the vector values of the pixel. At image level, band i of an image is the rectangular array of ith sample values from the pixel vectors.

1. cell

A rectangular area in Raster space, in which a single pixel value is filled.

1. code

representation of a label according to a specified scheme

1. coordinate

One of a sequence of numbers designating the position of a point in N-dimensional space

1. coordinate reference system

Coordinate system that is related to an object (of the real world) by a datum.

1. coordinate system

A set of mathematical rules for specifying how coordinates are to be assigned to points

1. coverage

Feature that acts as a function to return values from its range for any direct position within its spatial, temporal, or spatiotemporal domain. Examples include a digital image, raster map, and digital elevation matrix.

1. coverage geometry

Configuration of the domain of a coverage described in terms of coordinates.

1. data compression

Reducing the amount of storage space required to store a given amount of data, or reducing the length of message required to transfer a given amount of reduction in the number of bits used to represent source image data [ISO 10918-1] (JPEG Part 1) information. (data / image) compression

1. dataset

Identifiable collection of data.

1. datum

A parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system

1. device space

A coordinate space referencing scanner, printers and display devices.

1. direct position

Position described by a single set of coordinates within a coordinate reference system.

1. domain

Well-defined set. Note, Domains are used to define the domain set and range set of operators and functions.

1. double

8-byte IEEE double precision floating point.

1. ellipsoid

A surface formed by the rotation of an ellipse about a main axis

1. EPSG

European Petroleum Survey Group.

1. evaluation

Determination of the values of a coverage at a direct position within the domain of the coverage.

1. flattening

A ratio of the difference between the semi-major (a) and semi-minor axis (b) of an ellipsoid to the semi-major axis; f = (a - b)/a

1. geocoding

A translation of one form of location into another

1. geographic coordinate system

A Geographic CS consists of a well-defined ellipsoidal datum, a Prime Meridian, and an angular unit, allowing the assignment of a Latitude-Longitude (and optionally, geodetic height) vector to a location on earth.

1. geokey

In GeoTIFF, a GeoKey is equivalent in function to a TIFF tag, but uses a different storage mechanism.

1. georectified grid

Rectified Grid: grid for which there is an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system

1. georeferencing

geopositioning an object using a Correspondence Model derived from a set of points for which both ground and image coordinates are known

1. geotiff

A standard for storing georeference and geocoding information in a TIFF 6.0 compliant raster file.

1. grid

A network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way

1. grid

gridded data Network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in a algorithmic way.

1. IEEE

Institute of Electrical and Electronics Engineers, Inc.

1. IFD

In TIFF format, an Image File Directory, containing all the TIFF tags for one image in the file (there may be more than one).

1. imagery

Representation of phenomena as images produced electronically and/or optical techniques.

1. meridian

An intersection of an ellipsoid by a plane containing the shortest axis of the ellipsoid

1. metadata

Data about data.

1. model space

A flat geometrical space used to model a portion of the earth.

1. mosaic

For purposes of this profile, a mosaic image is an image composed of two or more separately collected (sensed) images. Additional XML metadata may be used to identify the cut-lines (boundaries and parameters for the images used to compose the mosaic.

1. null value

Value having no value or existence.

1. orthorectified grid

Georectified grid created using ground control points and elevation data where constant scale is maintained throughout the grid.

1. parallel

Lines of constant latitude, parallel to the equator.

1. pixel

The smallest element of a digital image to which attributes are assigned

1. pixel

Smallest element of a digital image to which attributes are assigned.

NOTE 1 This term originated as a contraction of “picture element”.

NOTE 2 Related to the concept of a grid cell The intensity of each pixel is variable; in color systems, each pixel has typically three or four dimensions of variability such as red, green and blue, or cyan, magenta, yellow and black.

1. POSC

Petrotechnical Open Software Corporation.

1. prime meridian

A meridian from which the longitudes of other meridians are quantified

1. projected coordinate system

A coordinate reference system derived from a two-dimensional geodetic coordinate reference system by applying a map projection

1. projection

projected coordinate reference system: coordinate reference system derived from a two-dimensional geodetic coordinate reference system by applying a map projection

1. qualification layer

A qualification layer is a coverage consisting of graphics information associated to geospatial data together with associated metadata (these metadata mostly identify the meaning of colour codes used in graphics).

1. range

Set of feature attribute values associated by a function with the elements of the domain of a coverage.

1. raster space

Raster: usually rectangular pattern of parallel scanning lines forming or corresponding to the display on a cathode ray tube

1. rational

In TIFF format, a RATIONAL value is a fractional value represented by the ratio of two unsigned 4-byte integers.

1. rectified grid

Grid for which there is an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system.

1. referenceable grid

Grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to an external coordinate reference system

1. relative accuracy / relative positional accuracy

Evaluation of the random errors in determining the position of one point or feature with respect to another / closeness of coordinate difference value to the true or accepted value in a specified reference system

1. SDTS

The USGS Spatial Data Transmission Standard.

1. tag

In TIFF format, a tag is packet of numerical or ASCII values, which have a numerical "Tag" ID indicating their information content.

1. tessellation / tiling

Partitioning of a space into a set of conterminous subspaces having the same dimension as the space being partitioned

1. TIFF

Acronym for Tagged Image File Format; a platform-independent, extensive specification for storing raster data and ancillary information in a single file.

1. transparency mask

A Transparency Mask defines visible pixels of another image in the same TIFF file (that may be organised as an irregularly shaped region of visible pixels). The 1-bits define the visible pixels; the 0-bits define transparent pixels. (fdefinition based on TIFF specification)

1. USGS

US Geological Survey

# Conventions

None

# Clauses not Containing Normative Material

Paragraph

## Clauses not containing normative material sub-clause 1

Paragraph

### Clauses not containing normative material sub-clause 2

# Clause containing normative material

## Requirements Class GeoAsciiParamsTag

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag.count  *The GeoAsciiParamsTag MAY hold any number of key parameters with type = ASCII. (May not be necessary, the same as keyentry.count)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag.ID  *The GeoAsciiParamsTag SHALL have ID = 34737* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag.NULLRead  *Pipe characters (“|”) in the GeoAsciiParamsTag SHALL be converted NULL characters before returning strings to the client* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag.NULLWrite  *NULL characters used to terminate strings in the GeoAsciiParamsTag SHALL be converted to a “|” (pipe) prior to being written into the GeoAsciiParamsTag* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoAsciiParamsTag.type  *The GeoAsciiParamsTag SHALL have type = ASCII* |

## Requirements Class GeodeticDatumGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.ArchaicDatum  *GeodeticDatumGeoKey values in the range 6900-6999 SHALL be Archaic Datum* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.EPSGDatum  *GeodeticDatumGeoKey values in the range 6200-6999 SHALL be EPSG Datum Based on EPSG Datum* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.EPSGEllipsoid  *GeodeticDatumGeoKey values in the range 6000-6199 SHALL be EPSG Datum Based on Ellipsoid only* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.obsolete  *GeodeticDatumGeoKey values in the range 1-1000 SHALL be obsolete EPSG/POSC Datum Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.private  *GeodeticDatumGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.reserved  *GeodeticDatumGeoKey values in the range 1001-5999 and 7000-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeodeticDatumGeoKey.WGSDatum  *GeodeticDatumGeoKey values in the range 6322-6327 SHALL be WGS Datum* |

## Requirements Class GeoDoubleParamsTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeoDoubleParamsTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoDoubleParamsTag.count  *The GeoDoubleParamsTag MAY hold any number of key parameters with type = double. (May not be necessary, the same as keyentry.count)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoDoubleParamsTag.ID  *The GeoDoubleParamsTag SHALL have ID = 34736* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoDoubleParamsTag.type  *The GeoDoubleParamsTag SHALL have type = DOUBLE (IEEE Double Precision)* |

## Requirements Class GeogAngularUnitsGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitsGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitsGeoKey.ID  *The GeogAngularUnitsGeoKey SHALL have ID = 2054* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitsGeoKey.type  *The GeogAngularUnitsGeoKey SHALL have type = SHORT* |

## Requirements Class GeogAngularUnitSizeGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitSizeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitSizeGeoKey.ID  *The GeogAngularUnitSizeGeoKey SHALL have ID = 2055* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitSizeGeoKey.type  *The GeogAngularUnitSizeGeoKey SHALL have type = DOUBLE* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAngularUnitSizeGeoKey.units  *The units of the GeogAngularUnitSizeGeoKey SHALL be radians* |

## Requirements Class GeogAzimuthUnitsGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogAzimuthUnitsGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAzimuthUnitsGeoKey.ID  *The GeogAzimuthUnitsGeoKey SHALL have ID = 2060* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogAzimuthUnitsGeoKey.type  *The GeogAzimuthUnitsGeoKey SHALL have type = SHORT* |

## Requirements Class GeogCitationGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogCitationGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogCitationGeoKey.ID  *The GeogCitationGeoKey SHALL have ID = 2049* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogCitationGeoKey.type  *The GeogCitationGeoKey SHALL have type = ASCII* |

## Requirements Class GeogEllipsoidGeoKey

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.EPSGEllipsoid  *GeogEllipsoidGeoKey values in the range 7000-7999 SHALL be EPSG Ellipsoid Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.ID  *The GeogEllipsoidGeoKey SHALL have ID = 2056* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.obsolete  *GeogEllipsoidGeoKey values in the range 1-1000 SHALL be obsolete EPSG/POSC Datum Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.private  *GeogEllipsoidGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.reserved  *GeogEllipsoidGeoKey values in the range 1001-6999 and 8000-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogEllipsoidGeoKey.type  *The GeogEllipsoidGeoKey SHALL have type = SHORT* |

## Requirements Class GeogGeodeticDatumGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogGeodeticDatumGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogGeodeticDatumGeoKey.ID  *The GeogCitationGeoKey SHALL have ID = 2050* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogGeodeticDatumGeoKey.type  *The GeogCitationGeoKey SHALL have type = SHORT* |

## Requirements Class GeogInvFlatteningGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogInvFlatteningGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogInvFlatteningGeoKey.ID  *The GeogInvFlatteningGeoKey SHALL have ID = 2059* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogInvFlatteningGeoKey.type  *The GeogInvFlatteningGeoKey SHALL have type = DOUBLE* |

## Requirements Class GeogLinearUnitsGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.angular  *GeogLinearUnitsGeoKey values in the range 9100-9199 SHALL be EPSG angular units* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.ID  *The GeogLinearUnitsGeoKey SHALL have ID = 2052* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.linear  *GeogLinearUnitsGeoKey values in the range 9000-9099 SHALL be EPSG linear units* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.obsolete  *GeogLinearUnitsGeoKey values in the range 1-2000 SHALL be obsolete GeoTIFF Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.private  *GeogLinearUnitsGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.reserved  *GeogLinearUnitsGeoKey values in the range 2001-8999 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitsGeoKey.type  *The GeogLinearUnitsGeoKey SHALL have type = DOUBLE* |

## Requirements Class GeogLinearUnitSizeGeoKey

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| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitSizeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitSizeGeoKey.ID  *The GeogLinearUnitSizeGeoKey SHALL have ID = 2053* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitSizeGeoKey.type  *The GeogLinearUnitSizeGeoKey SHALL have type = DOUBLE* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogLinearUnitSizeGeoKey.units  *The units of the GeogLinearUnitSizeGeoKey SHALL be meters* |

## Requirements Class GeogPrimeMeridianGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.EPSGEllipsoid  *GeogPrimeMeridianGeoKey values in the range 8000-8999 SHALL be EPSG Prime Meridian Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.ID  *The GeogPrimeMeridianGeoKey SHALL have ID = 2051* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.obsolete  *GeogPrimeMeridianGeoKey values in the range 1-100 SHALL be obsolete EPSG/POSC Datum Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.private  *GeogPrimeMeridianGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.reserved  *GeogPrimeMeridianGeoKey values in the range 101-7999 and 9000-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianGeoKey.type  *The GeogPrimeMeridianGeoKey SHALL have type = SHORT* |

## Requirements Class GeogPrimeMeridianLongGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianLongGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianLongGeoKey.ID  *The GeogPrimeMeridianLongGeoKey SHALL have ID = 2061* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianLongGeoKey.type  *The GeogPrimeMeridianLongGeoKey SHALL have type = DOUBLE* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogPrimeMeridianLongGeoKey.units  *The GeogPrimeMeridianLongGeoKey SHALL have units = GeogAngularUnits* |

## Requirements Class GeographicTypeGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.DGIWGReference  *WGS84 + may include Reference document citation (EPSG, DGIWG Registry or [DMA TR 8350.2])* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.DGIWGValues  *SHALL be 4326 (GCS\_WGS84) or 4030 (GCSE\_WGS84, not recommended by GeoTIFF)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.EPSGDatum  *GeographicTypeGeoKey values in the range 4200-4999 SHALL be EPSG GCS Based on EPSG Datum* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.EPSGEllipsoid  *GeographicTypeGeoKey values in the range 4000-4199 SHALL be EPSG GCS Based on Ellipsoid only* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.ID  *The GeographicTypeGeoKey SHALL have ID = 2048* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.obsolete  *GeographicTypeGeoKey values in the range 1-1000 SHALL be obsolete EPSG/POSC Geographic Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.private  *GeographicTypeGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.reserved  *GeographicTypeGeoKey values in the range 1001-3999 and 5000-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeographicTypeGeoKey.type  *The GeographicTypeGeoKey SHALL have type = SHORT* |

## Requirements Class GeogSemiMajorAxisGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMajorAxisGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMajorAxisGeoKey.ID  *The GeogSemiMajorAxisGeoKey SHALL have ID = 2057* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMajorAxisGeoKey.type  *The GeogSemiMajorAxisGeoKey SHALL have type = DOUBLE* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMajorAxisGeoKey.units  *The units of the GeogSemiMajorAxisGeoKey SHALL be Geocentric CS linear Units* |

## Requirements Class GeogSemiMinorAxisGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMinorAxisGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMinorAxisGeoKey.ID  *The GeogSemiMinorAxisGeoKey SHALL have ID = 2058* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMinorAxisGeoKey.type  *The GeogSemiMinorAxisGeoKey SHALL have type = DOUBLE* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeogSemiMinorAxisGeoKey.units  *The units of the GeogSemiMinorAxisGeoKey HALL be Geocentric CS linear Units* |

## Requirements Class GeoKeyCode

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyCode | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyCode.undefined  *GeoKeys with a value of zero SHALL indicate intentionally omitted parameters* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyCode.userDefined  *GeoKeys with a value of 32767 SHALL indicate user-defined parameters* |

## Requirements Class GeoKeyDirectoryTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.count  *The GeoKeyDirectoryTag SHALL include at least 4 keys (short integers) as header information* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.ID  *The GeoKeyDirectoryTag SHALL have ID = 34735* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.keyDirectoryVersion  *The first unsigned short integer in the GeoKeyDirectoryTag SHALL hold the KeyDirectoryVersion.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.keyEntrySetCount  *The GeoKeyDirectoryTag SHALL hold NumberOfKeys KeyEntry Sets in addition to the header information* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.keyRevision  *The second unsigned short integer in the GeoKeyDirectoryTag SHALL hold the KeyRevision.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.minorRevision  *The third unsigned short integer in the GeoKeyDirectoryTag SHALL hold the MinorRevision.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.numberOfKeys  *The fourth unsigned short integer in the GeoKeyDirectoryTag SHALL hold the NumberOfKeys defined in the rest of the GeoKeyDirectoryTag.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyDirectoryTag.type  *The GeoKeyDirectoryTag SHALL have type = SHORT (2-byte unsigned integer)* |

## Requirements Class GeoKeyRange

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.configuration  *GeoKey ID's in the range 1024-2047 SHALL be GeoTIFF Configuration Keys* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.geographic  *GeoKey ID's in the range 2048-3071 SHALL be Geographic/Geocentric Coordinate System Parameter Keys* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.projected  *GeoKey ID's in the range 3072-4095 SHALL be Projected Coordinate System Parameter Keys* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.reserved  *GeoKey ID's in the range 0-1023 and 5120-32767 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.reserved  *GeoKey ID's in the range 4096-5119 SHALL be Vertical Coordinate System Parameter Keys* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GeoKeyRange.reserved  *GeoKey ID's in the range 32768-65535 SHALL be for private use* |

## Requirements Class GTCitationGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GTCitationGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTCitationGeoKey.ID  *The GTCitationGeoKey SHALL have ID = 1026* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTCitationGeoKey.type  *The GTCitationGeoKey SHALL have type = ASCII* |

## Requirements Class GTModelTypeGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.geocentric  *A value of 3 for the GTModelTypeGeoKey SHALL indicate a geocentric(X,Y,Z) coordinate system* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.geographic  *A value of 2 for the GTModelTypeGeoKey SHALL indicate a geographic latitude-longitude coordinate system* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.ID  *The GTModelTypeGeoKey SHALL have ID = 1024* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.private  *GTModelTypeGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.projected  *A value of 1 for the GTModelTypeGeoKey SHALL indicate a projected coordinate system* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.reserved  *GTModelTypeGeoKey values in the range 1-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTModelTypeGeoKey.type  *The GTModelTypeGeoKey SHALL have type = SHORT* |

## Requirements Class GTRasterTypeGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.ID  *The GTModelTypeGeoKey SHALL have ID = 1025* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.private  *GTRasterTypeGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.rasterPixelIsArea  *A value of 1 for the GTRasterTypeGeoKey SHALL indicate that this raster pixel is an area (for DGIWG profile, this is used by imagery products).* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.rasterPixelIsPoint  *A value of 2 for the GTRasterTypeGeoKey SHALL indicate that this raster pixel is a point (for DGIWG profile, this is used for discrete coverage data including elevation data ).* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.reserved  *GTRasterTypeGeoKey values in the range 1-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/GTRasterTypeGeoKey.type  *The GTModelTypeGeoKey SHALL have type = SHORT* |

## Requirements Class IntergraphMatrixTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/IntergraphMatrixTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/IntergraphMatrixTag.count  *The IntergraphMatrixTag SHALL hold sixteen or seventeen values* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/IntergraphMatrixTag.deprecated  *The IntergraphMatrixTag SHALL not be used* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/IntergraphMatrixTag.ID  *The IntergraphMatrixTag SHALL have ID = 33920* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/IntergraphMatrixTag.type  *The IntergraphMatrixTag SHALL have type = DOUBLE* |

## Requirements Class KeyEntrySet

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.count  *The third unsigned short integer in each Key Entry Set SHALL hold the number of values in the key (the Count). If TIFFTagLocation=0, Count=1 is implied.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.keyID  *The first unsigned short integer in each Key Entry Set SHALL hold the KeyID.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.shortKeyValues  *Following the KeyEntry definitions, the GeoKeyDirectoryTag MAY hold values for keys that are short integers. (NOT CLEAR, maybe the following: If TIFFTagLocation=0, then Value\_Offset contains the actual (SHORT) value of the Key, and Count=1 is implied. shortKeyValues specifies that value. )* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.size  *Each Key Entry Set SHALL hold four unsigned short integers* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.TIFFTagLocation  *The second unsigned short integer in each Key Entry Set SHALL hold the TIFFTagLocation. If TIFFTagLocation is 0, then the value is SHORT, and is contained in the "Value\_Offset" entry. Otherwise, the type of the value is implied by the TIFF-Type of the tag containing the value.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/KeyEntrySet.valueOffset  *The fourth unsigned short integer in each Key Entry Set SHALL hold the Value\_Offset. Value\_Offset indicates the index-offset \*into\* the TagArray indicated by TIFFTagLocation, if it is nonzero. If TIFFTagLocation is 0, then Value\_Offset contains the actual (SHORT) value of the Key, and Count=1 is implied. Note that the offset is not a byte-offset, but rather an index based on the natural data type of the specified tag array.* |

## Requirements Class MetadataTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/MetadataTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/MetadataTag.cardinality  *The private TIFF tag for holding XML metadata MAY be used more than once in a single GeoTIFF file.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/MetadataTag.ID  *The private TIFF tag for holding XML metadata SHALL have ID=50909* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/MetadataTag.Name  *The private TIFF tag for holding XML metadata SHALL be named GEO\_METADATA* |

## Requirements Class ModelPixelScaleTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.count  *The ModelPixelScaleTag SHALL hold three values (ScaleX, ScaleY, ScaleZ)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.count  *The ModelPixelScaleTag SHALL hold three values (ScaleX, ScaleY, ScaleZ)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.ID  *The ModelPixelScaleTag SHALL have ID = 33550* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.independent  *The ModelPixelScaleTag SHALL be independent of the Xposition, Yposition, and Orientation TIFF tags* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.reversal  *Negative values of the ModelPixelScaleTag components SHALL indicate simple reversals of orientation between raster and model space (e.g. horizontal or vertical flips)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelPixelScaleTag.type  *The ModelPixelScaleTag SHALL have type = DOUBLE* |

## Requirements Class ModelTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/ModelTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTag.count  *If the ModelTiePointTag and ModelPixelScaleTags are defined the ModelTransformationTag SHALL not be used* |

## Requirements Class ModelTiePointTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.count  *The ModelTiePointTag MAY hold any number of tiepoints* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.count  *The ModelTiePointTag SHALL only hold one tiepoint that corresponds to the upper left corner of the image.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.ID  *The ModelTiePointTag SHALL have ID = 33922* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.independent  *The ModelTiePointTag SHALL be independent of the Xposition, Yposition, and Orientation TIFF tags* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.size  *The ModelTiePointTag SHALL include six values for each tiepoint* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTiePointTag.type  *The ModelTiePointTag SHALL have type = DOUBLE* |

## Requirements Class ModelTransformationTag

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/ModelTransformationTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTransformationTag.count  *The ModelTransformationTag SHALL hold sixteen values* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTransformationTag.ID  *The ModelTransformationTag SHALL have ID = 34264* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTransformationTag.notAllowed  *The ModelTransformationTag SHALL not be used.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ModelTransformationTag.type  *The ModelTransformationTag SHALL have type = DOUBLE* |

## Requirements Class PCSCitationGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/PCSCitationGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/PCSCitationGeoKey.ID  *The PCSCitationGeoKey SHALL have ID = 3073* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/PCSCitationGeoKey.type  *The PCSCitationGeoKey SHALL have type = ASCII* |

## Requirements Class ProjectedCSTypeGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.EPSGProjection  *ProjectedCSTypeGeoKey values in the range 20000-32760 SHALL be EPSG Projection System Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.ID  *The ProjectedCSTypeGeoKey SHALL have ID = 3072* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.KeyValues  *326zz ““ UTM Northern Hemisphere, 327zz ““ UTM Southern Hemisphere (Where zz is the UTM zone number), Other PCS allowed by this standard (in conformance with DGIWG Geodetic Codes and Parameters Registry) 12 Present only for cartographic data. In this case, GTModelTypeGeoKey = 1 and GeographicTypeGeoKey is absent* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.obsolete  *ProjectedCSTypeGeoKey values in the range 1-1000 SHALL be obsolete EPSG/POSC Datum Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.private  *ProjectedCSTypeGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/ProjectedCSTypeGeoKey.type  *The ProjectedCSTypeGeoKey SHALL have type = SHORT* |

## Requirements Class TIFF

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/TIFF | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.bitsPerSample  *The BitsPerSample field in the TIFF Image File Directory defines the number of bits per component* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.byteOrder  *The first two bytes of the GeoTIFF file SHALL be equal to "I" (ASCII) (49 in hexadecimal) for TIFF files encoded using “˜Little-Endian”™ and SHALL be equal to "M" (ASCII) (4D in hexadecimal) for TIFF files encoded using “˜Big-Endian”™* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.DateTime  *The format for the field in ASCII type is “YYYY:MM:DD HH:MM:SS” with 24 hour time used for the hours and one space character between the date and time, and one terminating NUL character. The length of the string, including the terminating NUL, is 20 bytes. All dates and times shall be expressed in Coordinated Universal Time (UTC).* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.double  *GeoTIFF requires support for all documented TIFF 6.0 tag data-types, and in particular requires the IEEE double-precision floating point "DOUBLE" type tag.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.fileStructure  *A GeoTIFF file is a TIFF 6.0 file, and inherits the file structure as described in the corresponding portion of the TIFF spec.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.griddedValueDataTypes  *For gridded data (e.g. elevation data, matrices of lat/lon values, etc.), the range (data) values MAY be stored in additional representations to include 8-bit and 16-bit signed integer and 32-bit floating point.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.IFD  *There must be at least 1 IFD in a TIFF file and each IFD must have at least one entry.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.IFDCount  *The maximum nuber of IFDs in a GeoTIFF is two, with the second IFD only used to support a transparency mask.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.imageryValueDataTypes  *For imagery, the range (data) values SHALL be unsigned integer data, 8 or 16-bits-per-band.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.noPrivateInformation  *All GeoTIFF specific information is encoded in several additional reserved TIFF tags, and contains no private Image File Directories (IFD's), binary structures or other private information invisible to standard TIFF readers* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/TIFF.tagOrder  *GeoKey entries SHALL be written within the CoordSystemInfoTag in tag-ID sorted order.* |

## Requirements Class VerticalCitationGeoKey

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| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCitationGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCitationGeoKey.ID  *The VerticalCitationGeoKey SHALL have ID = 4097* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCitationGeoKey.KeyValues  *WGS84 Ellipsoid, EGM84, EGM96, EGM2008, MSL height, MSL depth , or the name of the Sounding datum identified in DGIWG Geodetic registry (S-1 to S-40), or description os user-defined vertical CRS* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCitationGeoKey.type  *The VerticalCitationGeoKey SHALL have type = ASCII* |

## Requirements Class VerticalCSTypeGeoKey

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.EPSGEllipsoid  *VerticalCSTypeGeoKey values in the range 5000-5099 SHALL be EPSG Ellipsoid Vertical CS Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.EPSGOrthometric  *VerticalCSTypeGeoKey values in the range 5100-5199 SHALL be EPSG Orthometric Vertical CS Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.ID  *The VerticalCSTypeGeoKey SHALL have ID = 4096* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.KeyValues  *4979 (WGS84 3D ellipsoid), 5773 (EGM96), 3855 (EGM08), 5798 (EGM84), 5714 (MSL height), 5715 (MSL depth), 32767 for other Sounding datums idenfied in DGIWG Geodetic registry, or user defined Vertical CRS* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.private  *VerticalCSTypeGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.reserved  *VerticalCSTypeGeoKey values in the range 1-4999 and 6000-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.reservedEPSG  *VerticalCSTypeGeoKey values in the range 5200-5999 SHALL be reserved EPSG* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalCSTypeGeoKey.type  *The VerticalCSTypeGeoKey SHALL have type = SHORT* |

## Requirements Class VerticalDatumGeoKey

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey.ID  *The VerticalDatumGeoKey SHALL have ID = 4098* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey.private  *VerticalDatumGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey.reserved  *VerticalDatumGeoKey values in the range 16384-32766 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey.type  *The VerticalDatumGeoKey SHALL have type = SHORT* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalDatumGeoKey.VertDatum  *VerticalDatumGeoKey values in the range 1-16383 SHALL be Vertical Datum Codes* |

## Requirements Class VerticalUnitsGeoKey

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.angular  *VerticalUnitsGeoKey values in the range 9100-9199 SHALL be EPSG angular units* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.ID  *The VerticalUnitsGeoKey SHALL have ID = 4099* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.KeyValues  *9001 (meaning Linear\_Meter)* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.linear  *VerticalUnitsGeoKey values in the range 9000-9099 SHALL be EPSG linear units* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.obsolete  *VerticalUnitsGeoKey values in the range 1-2000 SHALL be obsolete GeoTIFF Codes* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.private  *VerticalUnitsGeoKey values in the range 32768-65535 SHALL be private* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.reserved  *VerticalUnitsGeoKey values in the range 2001-8999 SHALL be reserved* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VerticalUnitsGeoKey.type  *The VerticalUnitsGeoKey SHALL have type = SHORT* |

## Requirements Class VoidAreasTag

|  |  |
| --- | --- |
| **Requirements Class** | |
| http://www.opengis.net/spec/GeoTIFF/0.0/VoidAreasTag | |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VoidAreasTag.ID  *The private TIFF tag for defining void areas SHALL have ID = 42113.* |
| Requirement | http://www.opengis.net/spec/GeoTIFF/0.0/VoidAreasTag.Name  *The private TIFF tag for defining void areas SHALL be named GDAL\_NODATA. (GDAL\_NODATA is not defined in the GeoTIFF standard, however, this is an private TIFF tag that may be used for the purpose of declaring these values.)* |

# Media Types for any data encoding(s)

A section describing the MIME-types to be used is mandatory for any standard involving data encodings. If no suitable MIME type exists in http://www.iana.org/assignments/media-types/index.html then this section may be used to define a new MIME type for registration with IANA.

Annex A: Conformance Class Abstract Test Suite (Normative)

Conformance class: AAAA (repeat as necessary)

Annex B: Revision history

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date | Release | Author | Paragraph modified | Description |
| 2014-11-30 | 0.0 | Ted Habermann | Entire Document | Initial document |
|  |  |  |  |  |
|  |  |  |  |  |

Annex C: Bibliography

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Annex D: The GeoTIFF File Structure (Informative)

## Introduction

The current GeoTIFF specification (Ritter and Ruth, 1995) includes a detailed description of the structural approach used in GeoTIFF and the semantics and values of the tags. The tag specifications are included in Clause 6 of this standard. This Annex provides an overview of the structure of a GeoTIFF file and tags.

GeoTIFF fully complies with the TIFF 6.0 specifications, and its extensions do not in any way go against the TIFF recommendations, nor do they limit the scope of raster data supported by TIFF.

GeoTIFF uses a small set of reserved TIFF tags to store a broad range of georeferencing information, catering to geographic as well as projected coordinate systems needs. Projections include UTM, US State Plane and National Grids, as well as the underlying projection types such as Transverse Mercator, Lambert Conformal Conic, etc. No information is stored in private structures, IFD's or other mechanisms that would hide information from naive TIFF reading software.

GeoTIFF uses a "MetaTag" (GeoKey) approach to encode dozens of information elements into just 6 tags, taking advantage of TIFF platform-independent data format representation to avoid cross-platform interchange difficulties. These keys are designed in a manner parallel to standard TIFF tags, and closely follow the TIFF discipline in their structure and layout. New keys may be defined as needs arise, within the current framework, and without requiring the allocation of new tags from Aldus/Adobe.

GeoTIFF uses numerical codes to describe projection types, coordinate systems, datums, ellipsoids, etc. The projection, datums and ellipsoid codes are derived from the EPSG list compiled by the Petrotechnical Open Software Corporation (POSC), and mechanisms for adding further international projections, datums and ellipsoids has been established. The GeoTIFF information content is designed to be compatible with the data decomposition approach used by the National Spatial Data Infrastructure (NSDI) of the U.S. Federal Geographic Data Committee (FGDC).

While GeoTIFF provides a robust framework for specifying a broad class of existing Projected coordinate systems, it is also fully extensible, permitting internal, private or proprietary information storage. However, since this standard arose from the need to avoid multiple proprietary encoding systems, use of private implementations is to be discouraged.

## GeoTIFF File and "Key" Structure

This section describes the abstract file-format and "GeoKey" data storage mechanism used in GeoTIFF. Uses of this mechanism for implementing georeferencing and geocoding is detailed in section 2.6 and section 2.7.

A GeoTIFF file is a TIFF 6.0 file, and inherits the file structure as described in the corresponding portion of the TIFF spec. All GeoTIFF specific information is encoded in several additional reserved TIFF tags, and contains no private Image File Directories (IFD's), binary structures or other private information invisible to standard TIFF readers.

The number and type of parameters that would be required to describe most popular projection types would, if implemented as separate TIFF tags, likely require dozens or even hundred of tags, exhausting the limited resources of the TIFF tag-space. On the other hand, a private IFD, while providing thousands of free tags, is limited in that its tag-values are invisible to non-savvy TIFF readers (which don't know that the IFD\_OFFSET tag value points to a private IFD).

To avoid these problems, a GeoTIFF file stores projection parameters in a set of "Keys" which are virtually identical in function to a "Tag", but has one more level of abstraction above TIFF. Effectively, it is a sort of "Meta-Tag". A Key works with formatted tag-values of a TIFF file the way that a TIFF file deals with the raw bytes of a data file. Like a tag, a Key has an ID number ranging from 0 to 65535, but unlike TIFF tags, all key ID's are available for use in GeoTIFF parameter definitions.

The Keys in GeoTIFF (also call "GeoKeys") are all referenced from the GeoKeyDirectoryTag, which defined as follows:

GeoKeyDirectoryTag:

Tag = 34735 (87AF.H)

Type = SHORT (2-byte unsigned short)

N = variable, >= 4

Alias: ProjectionInfoTag, CoordSystemInfoTag

Owner: SPOT Image, Inc.

This tag may be used to store the GeoKey Directory, which defines and references the "GeoKeys", as described below.

The tag is an array of unsigned SHORT values, which are primarily grouped into blocks of 4. The first 4 values are special, and contain GeoKey directory header information. The header values consist of the following information, in order:

Header={KeyDirectoryVersion, KeyRevision, MinorRevision, NumberOfKeys} where

* *KeyDirectoryVersion* indicates the current version of Key implementation, and will only change if this Tag's Key structure is changed. (Similar to the TIFFVersion (42)). The current DirectoryVersion number is 1. This value will most likely never change, and may be used to ensure that this is a valid Key-implementation.
* *KeyRevision* indicates what revision of Key-Sets are used.
* *MinorRevision* indicates what set of Key-codes are used. The complete revision number is denoted <KeyRevision>.<MinorRevision>
* *NumberOfKeys* indicates how many Keys are defined by the rest of this Tag.

This header is immediately followed by a collection of <NumberOfKeys> KeyEntry sets, each of which is also 4-SHORTS long. Each KeyEntry is modeled on the "TIFFEntry" format of the TIFF directory header, and is of the form:

KeyEntry = { KeyID, TIFFTagLocation, Count, Value\_Offset } where

KeyID gives the key-ID value of the Key (identical in function to TIFF tag ID, but completely independent of TIFF tag-space),

TIFFTagLocation indicates which TIFF tag contains the value(s) of the Key: if TIFFTagLocation is 0, then the value is SHORT, and is contained in the "Value\_Offset" entry. Otherwise, the type (format) of the value is implied by the TIFF-Type of the tag containing the value.

Count indicates the number of values in this key.

Value\_Offset Value\_Offset indicates the index-offset \*into\* the TagArray indicated by TIFFTagLocation, if it is nonzero. If TIFFTagLocation=0, then Value\_Offset contains the actual (SHORT) value of the Key, and Count=1 is implied. Note that the offset is not a byte-offset, but rather an index based on the natural data type of the specified tag array.

Following the KeyEntry definitions, the KeyDirectory tag may also contain additional values. For example, if a Key requires multiple SHORT values, they shall be placed at the end of this tag, and the KeyEntry will set TIFFTagLocation=GeoKeyDirectoryTag, with the Value\_Offset pointing to the location of the value(s).

All key-values which are not of type SHORT are to be stored in one of the following two tags, based on their format:

GeoDoubleParamsTag:

Tag = 34736 (87BO.H)

Type = DOUBLE (IEEE Double precision)

N = variable

Owner: SPOT Image, Inc.

This tag is used to store all of the DOUBLE valued GeoKeys, referenced by the GeoKeyDirectoryTag. The meaning of any value of this double array is determined from the GeoKeyDirectoryTag reference pointing to it. FLOAT values should first be converted to DOUBLE and stored here.

GeoAsciiParamsTag:

Tag = 34737 (87B1.H)

Type = ASCII

Owner: SPOT Image, Inc.

N = variable

This tag is used to store all of the ASCII valued GeoKeys, referenced by the GeoKeyDirectoryTag. Since keys use offsets into tags, any special comments may be placed at the beginning of this tag. For the most part, the only keys that are ASCII valued are "Citation" keys, giving documentation and references for obscure projections, datums, etc.

Note on ASCII Keys:

Special handling is required for ASCII-valued keys. While it is true that TIFF 6.0 permits multiple NULL-delimited strings within a single ASCII tag, the secondary strings might not appear in the output of naive "tiffdump" programs. For this reason, the null delimiter of each ASCII Key value shall be converted to a "|" (pipe) character before being installed back into the ASCII holding tag, so that a dump of the tag will look like this.

AsciiTag="first\_value|second\_value|etc...last\_value|"

A baseline GeoTIFF-reader must check for and convert the final "|" pipe character of a key back into a NULL before returning it to the client software.

GeoKey Sort Order:

In the TIFF spec it is required that TIFF tags be written out to the file in tag-ID sorted order. This is done to avoid forcing software to perform N-squared sort operations when reading and writing tags.

To follow the TIFF philosophy, GeoTIFF-writers shall store the GeoKey entries in key-sorted order within the CoordSystemInfoTag.

Example:

GeoKeyDirectoryTag=( 1, 1, 2, 6,

1024, 0, 1, 2,

1026, 34737,12, 0,

2048, 0, 1, 32767,

2049, 34737,14, 12,

2050, 0, 1, 6,

2051, 34736, 1, 0 )

GeoDoubleParamsTag(34736)=(1.5)

GeoAsciiParamsTag(34737)=("Custom File|My Geographic|")

The first line indicates that this is a Version 1 GeoTIFF GeoKey directory, the keys are Rev. 1.2, and there are 6 Keys defined in this tag.

The next line indicates that the first Key (ID=1024 = GTModelTypeGeoKey) has the value 2 (Geographic), explicitly placed in the entry list (since TIFFTagLocation=0). The next line indicates that the Key 1026 (the GTCitationGeoKey) is listed in the GeoAsciiParamsTag (34737) array, starting at offset 0 (the first in array), and running for 12 bytes and so has the value "Custom File" (the "|" is converted to a null delimiter at the end). Going further down the list, the Key 2051 (GeogLinearUnitSizeGeoKey) is located in the GeoDoubleParamsTag (34736), at offset 0 and has the value 1.5; the value of key 2049 (GeogCitationGeoKey) is "My Geographic".

The TIFF layer handles all the problems of data structure, platform independence, format types, etc, by specifying byte-offsets, byte-order format and count, while the Key describes its key values at the TIFF level by specifying Tag number, array-index, and count. Since all TIFF information occurs in TIFF arrays of some sort, we have a robust method for storing anything in a Key that would occur in a Tag.

With this Key-value approach, there are 65536 Keys which have all the flexibility of TIFF tag, with the added advantage that a TIFF dump will provide all the information that exists in the GeoTIFF implementation.

This GeoKey mechanism will be used extensively in section 2.7, where the numerous parameters for defining Coordinate Systems and their underlying projections are defined.

1. [www.opengeospatial.org/cite](http://www.opengeospatial.org/cite) [↑](#footnote-ref-1)