ALOS-2/PALSAR-2
Level 1.1/1.5/2.1/3.1 GeoTIFF Product
Format Description

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Japan Aerospace Exploration Agency

PALSAR-2
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ALOS-2 Product Format Description

GeoTIFF Level 1.1/1.5/3.1 Revision History (1/1)

Rev.	Date	Revision Contents	Remark
NC	2012/12/28	First Edition	
A	2014/5/16	P5 Added the description about storing data as BigTIFF.	
		P6 Table 3-1 Revised the tag type of “ImageWidth” and “ImageLength”. Before: LONG After: SHORT or LONG	
		P7 Table 3-1 Revised the remark of “Orientation”. Before: 3 = row: Bottom to Top, column: Left to Right 4 = row: Bottom to Top, column: Right to Left After: 3 = row: Bottom to Top, column: Right to Left 4 = row: Bottom to Top, column: Left to Right	
		P16 Added the description that the offset value “B” is set to 0 in the case of L1.1 data.	
		P17-24 Added Section 4. “Summary information.”	

ALOS-2 Product Format Description
(GeoTIFF Level 1.1/1.5/3.1)
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1. Overview

This document describes the format specifications for ALOS-2 GeoTIFF Level 1.1/1.5/3.1 products which are generated with ALOS-2 Data Processing System.

2. Product Specifications

2.1. Outline of GeoTIFF Standard

GeoTIFF is a metadata standard, which allows geometric information to be embedded within Aldus-Adobe's raster Tagged Image File Format (TIFF) file.

2.2.Composition of Product

ALOS-2 GeoTIFF product is generated from ALOS-2 Level 1.1/1.5/3.1 processed data, except Level 1.1 data of ScanSAR mode. GeoTIFF product contains some pairs of GeoTIFF files and LUT (Look-Up Table) files according to the number of polarizations. The LUT is required in order to convert each pixel value (integer) into a Sigma-Naught value (Real). Figure 2-1 shows a block diagram of GeoTIFF product. Table 2-1 shows the number of GeoTIFF/LUT files in each observation mode.

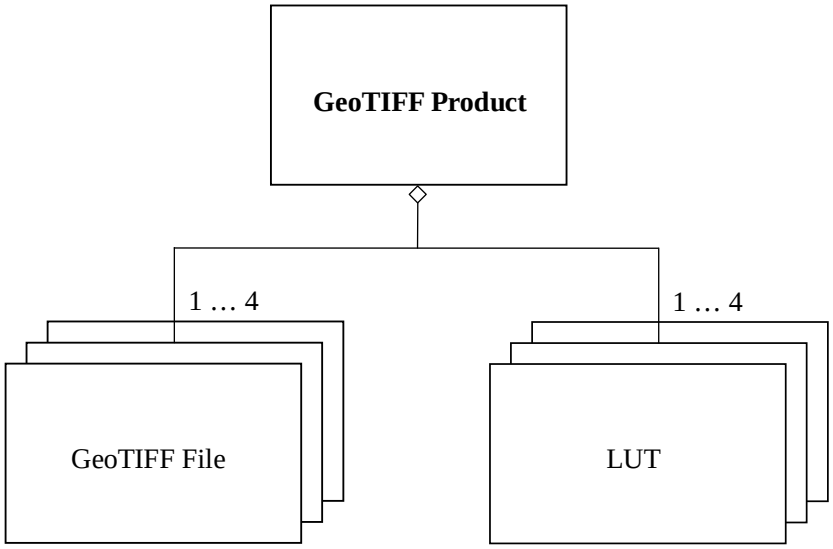

Figure 2-1 Block Diagram of GeoTIFF Product

Table 2-1 Relationship between number of GeoTIFF/LUT Files and Observation Mode

Observation mode (Number of Polarizations)	Single	Dual	Full (Quad)
GeoTIFF	1	2	4
LUT	1	2	4

2.3. Filename

The filename definitions of GeoTIFF product and LUT are shown in Table 2-2.

Table 2-2 Filename Definition of ALOS-2 GeoTIFF Product

File Type	Definition of Filename	Contents
GeoTIFF	IMG-XX- Scene ID -Product ID.tif	The file of GeoTIFF form. An integer value is indicated to each pixel. Geographic information and map projection are written in the header.
LUT	LUT-XX- Scene ID -Product ID.txt	The text file which summarizes the conversion factor for changing each pixel value (integer) of a GeoTIFF file into a Sigma Naught value (real).

Scene ID = AAAAABBBBBCCCC-YYMMDD

AAAAA : Satellite ID = 'ALOS2'

BBBBB : Orbit accumulation number of a scene center

CCCC : Scene frame number of a scene center

\- : Separator (hyphen)

YYMMDD : Observation date of a scene center

(YY: lower 2 figures of a year, MM: month, DD: day)

Product ID = DDDEFFFGHI

DDD : Observation Mode

(SBS : Spotlight mode

UBS : Ultra-fine mode Single polarization

UBD : Ultra-fine mode Dual polarization

HBS : High-sensitive mode Single polarization

HBD : High-sensitive mode Dual polarization

HBQ : High-sensitive mode Full (Quad.) polarimetry

FBS : Fine mode Single polarization

FBD : Fine mode Dual polarization

FBQ : Fine mode Full (Quad.) polarimetry

WBS : ScanSAR nominal [14MHz] mode Single polarization

WBD: ScanSAR nominal [14MHz] mode Dual polarization

WWS: ScanSAR nominal [28MHz] mode Single polarization

WWD: ScanSAR nominal [28MHz] mode Dual polarization

VBS : ScanSAR wide mode Single polarization

VBD : ScanSAR wide mode Dual polarization)

E : Observation Direction (L: Left looking, R: Right looking)

FFF : Processing Level

(1.1: Level 1.1, 1.5: Level 1.5, 3.1: Level 3.1)

G : Processing Option

(G: Geo-Coded, R: Geo-Reference, _: Not specified (underscore))

H : Map Projection

(U: UTM, P: PS, M: MER, L: LCC, _: Not specified)

I : Orbit Direction

(A: Ascending, D: Descending)

Polarization (Transmission and Receiving) = XX

HH : Horizontally polarized wave transmission / Horizontally polarized wave receiving

HV :Horizontally polarized wave transmission / Vertically polarized wave receiving

VH :Vertically polarized wave transmission / Horizontally polarized wave receiving

VV : Vertically polarized wave transmission / Vertically polarized wave receiving

3. Format

3.1. GeoTIFF File

GeoTIFF is a metadata standard which allows geometric information to be embedded within a TIFF image file. In ALOS-2 GeoTIFF products, GeoTIFF files are generated in TIFF-Strip format, and some GeoTIFF-tags (identifiers) are different in each processing level. All TIFF files and GeoTIFF-tags are based on TIFF Revision 6.0 and GeoTIFF Revision 1.0 standard, and image data is recorded in little endian.

Since TIFF format supports 4 GB image size in maximum, the image which exceeds 4 GB is stored in BigTIFF format. A

3.1.1. Common TIFF Tag

Some TIFF-tags common to all processing levels are shown in Table 3-1.

Table 3-1 Common TIFF-tags in All Processing Levels (1/2)

Tag name	Tag type	Description	Remark
ImageWidth	SHORT or LONG	Number of pixels in one line.	
ImageLength	SHORT or LONG	Number of lines.	
BitsPerSample	SHORT	Number of bits in one sample L1.1 = 16, 16 (fixed value) L1.5 = 16 (fixed value) L3.1 = 16 (fixed value)	L1.1: 16bit, 16bit (real part, imaginary part) L1.5: 16bit (absolute value) L3.1: 16bit (absolute value)
Compression	SHORT	Compression type = 1 (fixed value)	1 = No compression 2 = ITU-T modified Huffman RLE 3 = ITU-T Group 3 fax encoding 4 = ITU-T Group 4 fax encoding 5 = LZW (fixed-length) compression 6 = JPEG compression (old style) 7 = JPEG compression (new style) 8 = ZIP compression 32773 = Packbits compression
PhotometricInterpretation	SHORT	Color space type of bitmap image data = 1 (fixed value)	0 = WhiteIsZero (Pixel value: White=0, Black =(2^BitsPerSample-1)) 1 = BlackIsZero (Pixel value: Black=0, White=(2^BitsPerSample-1)) 2 = RGB direct color (min=0 as black, max=(2^BitsPerSample-1) as white) 3 = Palette color (min=0, max=(2^BitsPerSample-1)) 4 = Transparency Mask (definition of masked region)
ImageDescription	ASCII	Polarization of Tx and Rx = 'HH', 'HV', 'VH', 'VV'	In order of Tx and Rx

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Table 3-1 Common TIFF-tags in All Processing Levels (2/2)

Tag name	Tag type	Description	Remark
Orientation	SHORT	Orientation of image = 1 (fixed value)	1 = row: Top to Bottom, column: Left to Right 2 = row: Top to Bottom, column: Right to Left 3 = row: Bottom to Top, column: Right to Left 4 = row: Bottom to Top, column: Left to Right 5 = row: Left to Right, column: Top to Bottom 6 = row: Right to Left, column: Top to Bottom 7 = row: Right to Left, column: Bottom to Top 8 = row: Left to Right, column: Bottom to Top
SamplesPerPixel	SHORT	Number of samples in one pixel L1.1 = 2 (fixed value) L1.5 = 1 (fixed value) L3.1 = 1 (fixed value)	L1.1: 2 (real part, imaginary part) L1.5: 1 (absolute value) L3.1: 1 (absolute value)
PlanarConfiguration	SHORT	Storing order of the data = 1(fixed value)	1 = Chunky format: The component values for each pixel are stored contiguously 2 = Planar format: The components are stored in separate components. L1.1: IQIQIQ… L1.5: MMM… L3.1: MMM…
SampleFormat	Array of SHORT	Type of data L1.1 = 2, 2(fixed value) L1.5 = 1(fixed value) L3.1 = 1(fixed value)	1 = unsigned integer 2 = signed integer 3 = float 4 = undefined 5 = complex integer 6 = complex float The number of elements of the array is equal to the value of “SamplePerPixel” tag

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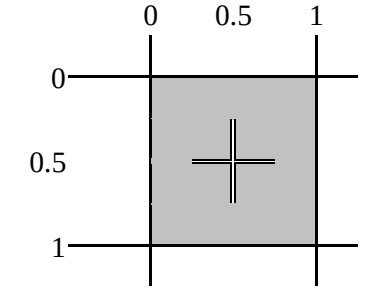
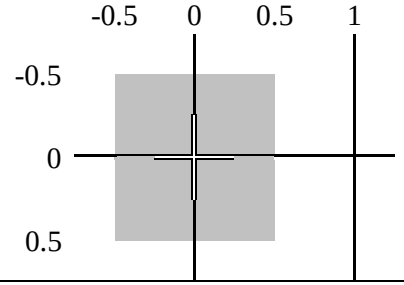
3.1.2. GeoTIFF tag of Level 1.1 Product

GeoTIFF tags of ALOS-2 Level 1.1 processed GeoTIFF product are shown in Table 3-2.

Table 3-2 GeoTIFF-tags of Level 1.1 Product (1/2)

Tag name	Tag type	Description	Remark
GeogLinearUnitsGeoKey	SHORT	Geographical unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogAngularUnitsGeoKey	SHORT	Geographical unit (angle) = 9102 (fixed value)	9102 = Angular_Degree[deg]
ModelTiepointTag	DOUBLE	The coordinate value on the map corresponding to the point of the four corners of TIFF image In *N* [pixels] × *M* [line] image: (Pixel No., Line No., 0.0, Longitude, Latitude, 0.0) = (0.5, 0.5, 0.0, Lon1, Lat1, 0.0, 0.5, *M*-0.5, 0.0, Lon2, Lat2, 0.0, *N*-0.5, 0.5, 0.0, Lon3, Lat3, 0.0, *N*-0.5, *M*-0.5 , 0.0, Lon4, Lat4, 0.0)	
GTModelTypeGeoKey	SHORT	Coordinate system type = 2 (fixed value)	1 = ModelTypeProjected (Projection Coordinate System) 2 = ModelTypeGeographic (Geographic Latitude-Longitude System) 3 = ModelTypeGeocentric (Geocentric (X,Y,Z) Coordinate System)

Table 3-2 GeoTIFF-tags of Level 1.1 Product (2/2)

Tag name	Tag type	Description	Remark
GTRasterTypeGeoKey	SHORT	Alignment of pixel value = 1 (fixed value)	1 = PixelIsArea The first pixel applies the domain surrounded by (0, 0), (0, 1), (1, 0), and (1, 1). The center of pixel is located in (0.5, 0.5).  2 = PixelIsPoint The first pixel applies the domain surrounded by (-0.5,-0.5), (0.5,-0.5), (-0.5, 0.5), (0.5,0.5). The center of pixel is located in (0,0). 

3.1.3. GeoTIFF tag of level 1.5 and level 3.1 Product

GeoTIFF tags of ALOS-2 Level 1.5/3.1 processed GeoTIFF products are shown in Table 3-3.

Table 3-3 GeoTIFF-tags of Level 1.5 and Level 3.1 Product (1/4)

Tag name	Tag type	Description	Remark
GTCitationGeoKey	ASCII	Processing option Geo-coded = 'Geo-coded' Geo-reference = 'Geo-reference'	
GeogLinearUnitsGeoKey	SHORT	Coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogAngularUnitsGeoKey	SHORT	Coordinates unit (angle) = 9102 (fixed value)	9102 = Angular_Degree[deg]
ProjLinearUnitsGeoKey	SHORT	Projection coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogPrimeMeridianGeoKey	SHORT	The position of the standard meridian line = 8901 (fixed value)	8901 = PM_Greenwich (Greenwich meridian)
ModelPixelScaleTag	DOUBLE	The size of a pixel = (pixel width, line width, 0.0)	Units of width are as same as “GeogLinearUnitsGeoKey” and “ProjLinearUnitsGeoKey”. [m]
ModelTiepointTag	DOUBLE	Correspondence of pixel-line coordinates and map coordinates. (Pixel no., Line no, 0.0, Map-addr. X, Map-addr. Y, 0.0) =(0.5, 0.5, 0.0, Map-addr. X, Map-addr. Y, 0.0)	
ModelTransformationTag	DOUBLE	The conversion matrix from a pixel and line coordinates to map coordinates = (a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p) In a two-dimensional coordinate plane, $\begin{vmatrix} \text{Map address X} \\ \text{Map address Y} \\ 0 \\ 1 \end{vmatrix} = \begin{vmatrix} a & b & 0 & d \\ e & f & 0 & h \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} \text{Pixel no.} \\ \text{Line no.} \\ 0 \\ 1 \end{vmatrix}$ = (a, b, 0, d, e, f, 0, g, 0, 0, 0, 0, 0, 0, 0, 1)	When (pixel no., line no.) = (P, L); Map address X = a * P + b * L + d Map address Y = e * P + f * L + h

Table 3-3 GeoTIFF-tags of Level 1.5 and Level 3.1 Product (2/4)

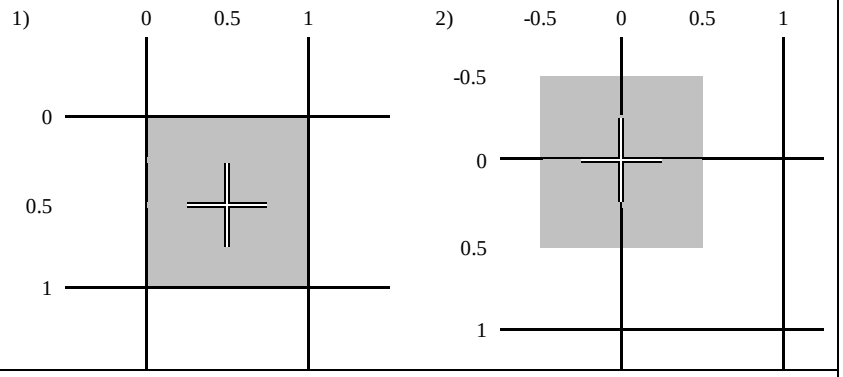
Tag name	Tag type	Description	Remark
GTModelTypeGeoKey	SHORT	Coordinate system type = 1 (fixed value)	1 = ModelTypeProjected (Projection Coordinate System) 2 = ModelTypeGeographic (Geographic Latitude-Longitude System) 3 = ModelTypeGeocentric (Geocentric (X,Y,Z) Coordinate System)
GTRasterTypeGeoKey	SHORT	Alignment of pixel value = 1 (fixed value)	1 = PixelIsArea The first pixel applies the domain surrounded by (0, 0), (0, 1), (1, 0), and (1, 1). The center of pixel is located in (0.5, 0.5). 2 = PixelIsPoint The first pixel applies the domain surrounded by (-0.5,-0.5), (0.5,-0.5), (-0.5, 0.5), (0.5, 0.5). The center of pixel is located in (0, 0). 
GeogGeodeticDatumGeoKey	SHORT	Geographic coordinate system = 6655(fixed value)	6655 = The International Terrestrial Reference Frame 1997(ITRF97)
GeogEllipsoidGeoKey	SHORT	Ellipsoid code = 7019 (fixed value)	7019 = Ellipse_GRS_1980(GRS80)
ProjectedCSTypeGeoKey	SHORT	Map projection code User defined = 32767 (fixed value)	In all the projection system, the value “User defined” is set

Table 3-3 GeoTIFF-tags of Level 1.5 and Level 3.1 Product (3/4)

Tag name	Tag type	Description	Remark
ProjectionGeoKey	SHORT	Map projection code UTM projection Northern Hemisphere = 16000 + Zone no. Southern Hemisphere = 16100 + Zone no. PS / MER / LCC projection User defined = 32767 (fixed value)	In a case of other than UTM, the value “User defined” is set.
GeographicTypeGeoKey	SHORT	Map coordinate code = 4338 (fixed value)	4338 = ITRF97
GeogCitationGeoKey	ASCII	Specify a geographic coordinate system, an ellipsoid model, and a map projection system. = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=UTM' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=PS' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=MER' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=LCC'	
The following tag is specified only when “ProjectionGeoKey” is set as “user defined” (32767)			
ProjCoordTransGeoKey	SHORT	Map projection code PS projection = 15 (fixed value) MER projection = 7 (fixed value) LCC projection = 8 (fixed value)	PS projection 15 = CT_PolarStereographic MER projection 7 = CT_Mercator LCC projection 8 = CT_LambertConfConic_2SP
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjNatOriginLongGeoKey	DOUBLE	Longitude of the map-projection natural origin In UTM and PS projection: Center longitude of projection is specified In MER and LCC The longitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is [deg]. The map-projection natural origin of UTM and PS projection is specified in “ProjFalseEastingGeoKey”. The natural origin of northern hemisphere corresponds to negative value of map coordinate y, and that of southern hemisphere, positive value, in the case of PS projection.
ProjNatOriginLatGeoKey	DOUBLE	Latitude of the map-projection natural origin In UTM and PS projection: The center latitude of projection is specified In MER and LCC The latitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is [deg]. The map-projection natural origin of UTM and PS projection is specified in “ProjFalseNorthingGeoKey”.

Table 3-3 GeoTIFF-tags of Level 1.5 and Level 3.1 Product (4/4)

Tag name	Tag type	Description	Remark
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjFalseEastingGeoKey	DOUBLE	The easting value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. = 500000.0 (fixed value)	The unit specified in “ProjLinearUnitsGeoKey” is used [m]
ProjFalseNorthingGeoKey	DOUBLE	The northing value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. Northern Hemisphere = 0 (fixed value) Southern Hemisphere = 10000000.0 (fixed value)	The unit specified in “ProjLinearUnitsGeoKey” is used [m]
ProjStdParallel1GeoKey	DOUBLE	Latitude of primary standard parallel. It is specified only in the case of LCC projection	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]
ProjStdParallel2GeoKey	DOUBLE	Latitude of second standard parallel. It is specified only in the case of LCC projection	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]
ProjScaleAtNatOriginGeoKey	DOUBLE	Scale factor at natural origin It is specified only in the cases of UTM and PS projection. UTM = 0.9996 (fixed value) PS = 1.0 (fixed value)	non-dimension

3.2. Look Up Table

The LUT is the text file which records the conversion factor for converting from the integer value stored in each pixel of a GeoTIFF file into a real value (σ^0 : Sigma Naught). The conversion equations for the level 1.1 and for the levels 1.5/3.1 are shown below.

- Level 1.1

$$\sigma^0 = \frac{|C|^2}{A^2} \qquad 3\text{-}1$$

Here, $|C|^2 = I^2 + Q^2$. C is pixel value as complex-integer. I is real part of C, and Q is imaginary part of C. To change integral values into real values, use following expression:

$$I_{real} = \frac{I}{A}, \quad Q_{real} = \frac{Q}{A} \qquad 3\text{-}2$$

- Level 1.5 and Level 3.1

$$\sigma^0 = \frac{\left(M^2 + B\right)}{A} \qquad 3\text{-}3$$

Here, M is pixel value as unsigned integer. A is the coefficient which only depends on the range direction. B is an offset value and is common to all the pixels. In the case of level 1.1 products, B is set to 0.

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An example of LUT file is shown in Table 3-4. Here, N is the number of pixels in one line.

Table 3-4 Example of LUT Format

Line 1	offset value B
Line 2	scaling factor A[0]
Line 3	scaling factor A [1]
. . .	. . .
Line (N+1)	scaling factor A [N-1]

However, all A is the same value in the geocoded product of the levels 1.5/3.1.

A [dB] value (σ'^0) is converted by using following formula:

$$\sigma'^0 = 10 \times \log_{10}\left(\sigma^0\right)$$

4.Summary Information

The summary information on GeoTIFF level 1.1/1.5/3.1 is shown in below.

4.1. Outline of Summary Information

The summary information file includes the information for creating processed data created at ALOS-2 Data Processing System, and it is always made in a pair with its processed data.

4.2. Filename of Summary Information

The filename of summary information is fixed as follows.

summary.txt

4.3. File Format of Summary Information

The summary information file consists of some record lines which use LF (line feed code) as a termination, and does not include header information, footer information, etc. A record line consists of a keyword, an equal mark (=), and a value. A summary information file format outline is shown in Figure 4-1.

Keyword	=	Value	LF
…	…	…	…
Keyword	=	Value	LF

Figure 4-1 Outline of Summary Information File Format

4.3.1. Format Definition of Keyword

(1) The keyword is stored from the head of a record line.

(2) The equal mark ‘=’ is stored after the keyword.

(3) There is no blank character between a keyword and ‘=’, in principle.

4.3.2. Format Definition of Value

(1) The value is a text string bundled with double quotation letters (“).

(2) The value can contain alphabets, digits, and some special characters (except for double quotation). Numerical values are also stored as an ASCII string.

(3) There is no blank character between ‘=’ and the former double quotation letter, in principle.

4.3.3. Contents of Summary Information

The items of the GeoTIFF Level 1.1/1.5/3.1 summary information are described in Table 4.3-1. "b" in a table means blanks.

Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (1/8)

No.	Section	Item name	Keyword	Value
1	Ordering information (Odi)	Scene description ID	Odi_SceneId	ID for specifying a scene uniquely 'AAAAAAAAAAAAAAAA-NNNNN-xxx-nnn' AAAAAAAAAAAAAAAA: Operation Segment No NNNNN: Observation ID xxx: 001～999 nnn: Scene no.
2		Processed Site/Date/Time	Odi_SiteDateTime	Spacecraft Control Mission Operation system = 'PROCESS: JAPAN-JAXA-ALOS2-SCMObbYYYYMMDDbHHMMSS' Earth Intelligence Collection and Shearing System = 'PROCESS: JAPAN-JAXA-ALOS2-EICSbbYYYYMMDDbHHMMSS' YYYYMMDD : Processed date (YYYY: year, MM: month, DD: day) HHMMSS : Processed time (UTC)
3	Scene specification (Scs)	Scene ID	Scs_SceneID	'AAAAABBBBBCCCC-YYMMDD' AAAAA : Satellite name (='ALOS2') BBBBB : Orbit accumulation number of a scene center CCCC : Scene frame number of a scene center - : separator (hyphen) YYMMDD: Observation date of scene center
4		Amount of scene shift	Scs_SceneShift	'-5'～'4' : Except ScanSAR mode '-25'～'20' : ScanSAR mode Zero and positive number have no sign.

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Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (2/8)

No.	Section	Item name	Keyword	Value
5	Product specification (Pds)	Product ID	Pds_ProductID	'DDDEFFFGHI' DDD: Observation mode SBS: Spotlight mode UBS: Ultra-fine mode (Single pol.) UBD: Ultra-fine mode (Dual pol.) HBS: High-sensitive mode (Single pol.) HBD: High-sensitive mode (Dual pol.) HBQ: High-sensitive mode (Full (Quad.) pol.) FBS: Fine mode (Single pol.) FBD: Fine mode (Dual pol.) FBQ: Fine mode (Full (Quad.) pol.) WBS: ScanSAR nominal [14MHz] mode (Single pol.) WBD: ScanSAR nominal [14MHz] mode (Dual pol.) WWS: ScanSR nominal [28MHz] mode (Single pol.) WWD: ScanSAR nominal [28MHz] mode (Dual pol.) VBS: ScanSAR wide mode (Single pol.) VBD: ScanSAR wide mode (Dual pol.) E : Observation direction L: Left looking, R: Right looking FFF: Processing level 1.0: Level 1.0, 1.1: Level 1.1, 1.5: Level 1.5, 3.1: Level 3.1 G : Processing option G: Geo-Coded, R: Geo-Reference, _ : n/a (underscore) H : Map projection type U: UTM, P: PS, M: MER, L: LCC, _ :n/a (underscore) I : Orbit direction A: Ascending, D: Descending

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Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (3/8)

No.	Section	Item name	Keyword	Value
6	Product specification (Pds)	Resampling method	Pds_ResamplingMethod	'NN' / 'BL' / 'CC' (specify only for level 1.5/3.1 product) Nearest Neighbor / Bi-Linear / Cubic Convolution
7		UTM zone no.	Pds_UTM_ZoneNo	'1'～'60' (specify only for level 1.5/3.1 UTM projected product)
8		PS reference latitude	Pds_PS_ReferenceLatitude	Northern Hemisphere: '90.000', Southern Hemisphere: '-90.000' (specify only for level 1.5/3.1 PS projected product)
9		PS reference longitude	Pds_PS_ReferenceLongitude	'-179.999' ≤ reference longitude ≤ '180.000' (specify only for level 1.5/3.1 PS projected product)
10		LCC reference latitudinal line 1	Pds_LCC_ReferenceLatitudinalLine1	'-90.000' < reference latitude < '90.000' (specify only for level 1.5/3.1 LCC projected product)
11		LCC reference latitudinal line 2	Pds_LCC_ReferenceLatitudinalLine2	'-90.000' < reference latitude < '90.000' (specify only for level 1.5/3.1 LCC projected product)
12		Map direction	Pds_MapDirection	'MapNorth' (specify only for level 1.5/3.1 geocoded product)
13		LCC origin latitude	Pds_LCC_OriginLatitude	'-90.000' ≤ origin latitude ≤ '90.000' (specify only for level 1.5/3.1 LCC projected product)
14		LCC origin longitude	Pds_LCC_OriginLongitude	'-179.999' ≤ origin longitude ≤ '180.000' (specify only for level 1.5/3.1 LCC projected product)

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Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (4/8)

No.	Section	Item name	Keyword	Value
15	Product specification (Pds)	Pixel spacing	Pds_PixelSpacing	unit: m (specify only for level 1.5/3.1 product)
16		Precision of orbit data	Pds_OrbitDataPrecision	'Precision' / ' Onboard ' / 'RARR_Predict' Precision : High precision orbit information Onboard : Onboard orbit determination RARR_Predict : Predicted orbit information
17		Precision of attitude data	Pds_AttitudeDataPrecision	'Onboard' Onboard : Onboard attitude determination
18	Image information (Img)	Date and time of scene center	Img_SceneCenterDateTime	'YYYYMMDDbhh: mm: ss.ttt'(UT) YYYY : Year (A.D.) MM : Month (01～12) DD : Day (01～31) hh : Hour (00～23) mm : Minute (00～59) ss : Second (00～60) (ss=60 is used only by a leap second.) ttt : Milli-second (000～999)
19		Date and time of scene start	Img_SceneStartDateTime	
20		Date and time of scene end	Img_SceneEndDateTime	
21		Latitude of image scene center	Img_ImageSceneCenterLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
22		Longitude of image scene center	Img_ImageSceneCenterLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
23		Latitude of image scene Left-Top	Img_ImageSceneLeftTopLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
24		Longitude of image scene Left-Top	Img_ImageSceneLeftTopLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
25		Latitude of image scene Right-Top	Img_ImageSceneRightTopLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
26		Longitude of image scene Right-Top	Img_ImageSceneRightTopLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
27		Latitude of image scene Left-Bottom	Img_ImageSceneLeftBottomLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.

Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (5/8)

No.	Section	Item name	Keyword	Value
28	Image information (Img)	Longitude of image scene Left-Bottom	Img_ImageSceneLeftBottomLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
29		Latitude of image scene Right-Bottom	Img_ImageSceneRightBottomLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
30		Longitude of image scene Right-Bottom	Img_ImageSceneRightBottomLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
31		Latitude of frame scene center	Img_FrameSceneCenterLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
32		Longitude of frame scene center	Img_FrameSceneCenterLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
33		Latitude of frame scene Left-Top	Img_FrameSceneLeftTopLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
34		Longitude of frame scene Left-Top	Img_FrameSceneLeftTopLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
35		Latitude of frame scene Right-Top	Img_FrameSceneRightTopLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
36		Longitude of frame scene Right-Top	Img_FrameSceneRightTopLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
37		Latitude of frame scene Left-Bottom	Img_FrameSceneLeftBottomLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
38		Longitude of frame scene Left-Bottom	Img_FrameSceneLeftBottomLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
39		Latitude of frame scene Right-Bottom	Img_FrameSceneRightBottomLatitude	'-90.000'～90.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
40		Longitude of frame scene Right-Bottom	Img_FrameSceneRightBottomLongitude	'-179.999'～180.000' [degree] (specify only for level 1.5/3.1 product) Third decimal places are not omissible. Zero and positive number have no sign.
41		Off-nadir angle	Img_OffNadirAngle	NN.N [degree]

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Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (6/8)

No.	Section	Item name	Keyword	Value
42	Product information (Pdi)	Data size of product	Pdi_ProductDataSize	unit: Mbytes = 1024Kbyte Rounded off by the 2nd place of a decimal point. The first place of a decimal is not omissible.
43		Number of files in level 1.1/1.5/3.1 product	Pdi_CntOfL11ProductFileName Pdi_CntOfL15ProductFileName Pdi_CntOfL31ProductFileName	Spotlight mode: 2 files High-sensitive/Fine modes (Single pol.) : 2 files High-sensitive/Fine modes (Dual pol.) : 4 files ScanSAR mode (Single pol.): 2 files ScanSAR mode (Dual pol.): 4 files High-sensitive/Fine modes (Full (Quad.) pol.): 8 files
44		Filename of level 1.1/1.5/3.1 product	Pdi_L11ProductFileNamenn Pdi_L15ProductFileNamenn Pdi_L31ProductFileNamenn nn: 01～99	GeoTIFF file 'IMG-XX-SSSSSSSSSSSSSSSSSSSS- PPPPPPPPPP.tif' LUT file 'LUT-XX-SSSSSSSSSSSSSSSSSSSS- PPPPPPPPPP.txt' SSSSSSSSSSSSSSSSSSSS : Scene ID PPPPPPPPPP : Product ID XX : Polarization (HH, HV, VH, VV) (in order of Tx-Rx)
45		Bits per pixel	Pdi_BitPixel	'NN' 16: Level 1.5/3.1 (specify only for level 1.5/3.1 product)

Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (7/8)

No.	Section	Item name	Keyword	Value
46	Product information (Pdi)	Number of pixels	Pdi_NoOfPixels_0	'0' - '99999' (Zero-suppressible) Same as “ImageWidth” of Common TIFF-tags in All Processing Levels.
47		Number of lines	Pdi_NoOfLines_0	'0' - '99999' (Zero-suppressible) Same as “ImageLength” of Common TIFF-tags in All Processing Levels.
48		Product format	Pdi_ProductFormat	'GeoTIFF' (fixed value)
49	Result of auto check (Ach)	Checking result of Time data	Ach_TimeCheck	'GOOD' / 'POOR' GOOD: All lines are GPS-aligned, POOR: other than GOOD
50		Checking result of attitude data	Ach_AttitudeCheck	'GOOD' / 'POOR' GOOD: other than POOR. POOR: There are two or more lines which the posture and the rate are not converging.
51		Status of absolute navigation	Ach_AbsoluteNavigationStatus	blank
52		Checking result of house keeping data	Ach_HouseKeepingDataCheck	'GOOD' / 'FAIR' FAIR: There are one or more FAIR(s) among check items.
53		Checking result of orbit data	Ach_OrbitCheck	'GOOD' / 'FAIR' GOOD: All values are normal. FAIR: All abnormal values are interpolated correctly.
54		Checking result of on-board attitude data	Ach_OnBoardAttitudeCheck	'GOOD' / 'FAIR' GOOD: All values are normal. FAIR: All abnormal values are interpolated correctly.
55		Loss lines	Ach_LossLines	'GOOD' / 'FAIR' / 'POOR' GOOD: There is no loss line. FAIR: Number of loss line is 1 or more, but is not more than threshold value. POOR: Number of loss line is more than threshold value.
56		Absolute navigation time	Ach_AbsoluteNavigationTime	blank
57		Checking result of PRF change	Ach_PRF_Check	blank

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Table 4.3-1 Summary information for GeoTIFF Level 1.1/1.5/3.1 product (8/8)

No.	Section	Item name	Keyword	Value
58	Result of auto check (Ach)	Checking result of calibration data	Ach_CalibrationDataCheck	blank
59	Result information (Rad)	Practice result code	Rad_PracticeResultCode	'GOOD' / 'FAIR' GOOD: normal FAIR: A product can be created by interpolating
60	Label information (Lbi)	Satellite name	Lbi_Satellite	'ALOS2' (fixed value)
61		Sensor name	Lbi_Sensor	'SAR' (fixed value)
62		Processing level	Lbi_ProcessLevel	'1.1' / '1.5' / '3.1'
63		Processing facility	Lbi_ProcessFacility	'SCMO' / 'EICS' SCMO : Spacecraft Control Mission Operation system EICS : Earth Intelligence Collection and Shearing System
64		Observation date	Lbi_ObservationDate	'YYYYMMDD' YYYYMMDD : (YYYY: year, MM: month, DD: day)

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PALSAR-2
Level 2.1 GeoTIFF Product
Format Description

Japan Aerospace Exploration Agency

ALOS-2 Product Format Description

GeoTIFF Level 2.1 Revision History (1/2)

Rev.	Date	Revision Contents	Remark
NC	2012/12/28	First Edition	
A	2014/5/16	p.5 3.1.1 Common TIFF tag Revised description. Before: 3.1.1 Common TIFF Tag Some TIFF-tags common to all processing levels are..... After: 3.1.1 TIFF Tag TIFF-tags of level 2.1 product are....	
		p.6, p.7 Revised the title name. Before: Common TIFF-tags in All Processing Levels After: TIFF-tags of Level 2.1 Product	
		p.6 Table 3-1 Common TIFF-tags in All Processing Levels (1/2) Revised tag type of 'Image Width' and 'Image Length'. Before: LONG After: SHORT or LONG	
		p.7 Table 3-1 Common TIFF-tags in All Processing Levels (2/2) Revised remark of 'Orientation'. Before: 3 = row: Bottom to Top, column: Left to Right 4 = row: Bottom to Top, column: Right to Left After: 3 = row: Bottom to Top, column: Right to Left 4 = row: Bottom to Top, column: Left to Right	

ALOS-2 Product Format Description

GeoTIFF Level 2.1 Revision History (2/2)

Rev.	Date	Revision Contents	Remark
A Cont.		p.14-23 4.3. File Format of Summary Information Revised description. Before: Referred to “ALOS-2 Product Format Description (CEOS Level 2.1)” After: Added following contents 4.3.1 Format Definition of Keyword 4.3.2 Format Definition of Value 4.3.3 Contents of Summary Information Added “Table 4-1 Summary information for GeoTIFF Level 2.1 product”. Changed ‘Number of files in level 2.1 product’, ‘Filename of level 2.1 product’, and ‘Product format’ in the table to correspond to summary information for GeoTIFF Level 2.1 product.	

ALOS-2 Product Format Description
(GeoTIFF Level 2.1)
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1. Overview

This document describes the format specifications for ALOS-2 GeoTIFF Level 2.1 products which are generated with ALOS-2 Data Processing System.

2. Product Specifications

2.1. Outline of GeoTIFF Standard

GeoTIFF is a metadata standard, which allows geometric information to be embedded within Aldus-Adobe's raster Tagged Image File Format (TIFF) file.

2.2. Composition of Product

ALOS-2 GeoTIFF product is generated from ALOS-2 Level 2.1 processed data. GeoTIFF product contains some pairs of GeoTIFF files and LUT (Look-Up Table) files according to the number of polarizations. The LUT is required in order to convert each pixel value (integer) into a Sigma-Naught value (Real). Figure 2-1 shows a block diagram of GeoTIFF product. Table 2-1 shows the number of GeoTIFF/LUT files in each observation mode.

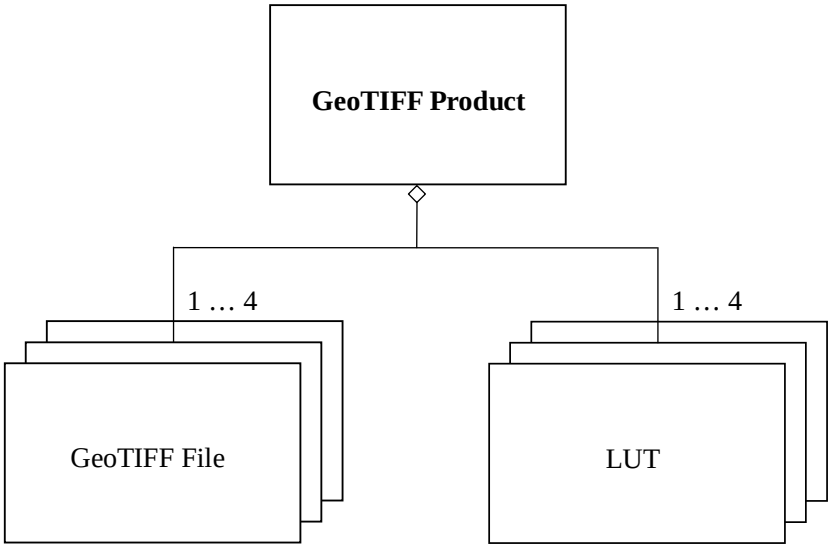

Figure 2-1 Block Diagram of GeoTIFF Product

Table 2-1 Relationship between Number of GeoTIFF/LUT Files and Observation Mode

Observation mode (Number of Polarizations)	Single	Dual	Full (Quad)
GeoTIFF	1	2	4
LUT	1	2	4

2.3. Filename

The filename definition of GeoTIFF product is shown in Table 2-2.

Table 2-2 Filename Definition of ALOS-2 GeoTIFF Product

File Type	Definition of Filename	Contents
GeoTIFF	IMG-XX- Scene ID -Product ID.tif	The file of GeoTIFF form. An integer value is indicated to each pixel. Geographic information and map projection are indicated to the header.
LUT	LUT-XX- Scene ID -Product ID.txt	The text file which summarizes the conversion factor for changing each pixel value (integer) of a GeoTIFF file into a Sigma Naught value (real).

Scene ID = AAAAABBBBBCCCC-YYMMDD

AAAAA : Satellite ID = 'ALOS2'

BBBBB : Orbit accumulation number of a scene center

CCCC : Scene frame number of a scene center

\- : Separator (hyphen)

YYMMDD : Observation date of a scene center

(YY: lower 2 figures of a year, MM: month, DD: day)

Product ID = DDDEFFFGHI

DDD : Observation Mode

SBS : Spotlight mode

UBS : Ultra-fine mode Single polarization

UBD : Ultra-fine mode Dual polarization

HBS : High-sensitive mode Single polarization

HBD : High-sensitive mode Dual polarization

HBQ : High-sensitive mode Full (Quad.) polarimetry

FBS : Fine mode Single polarization

FBD : Fine mode Dual polarization

FBQ : Fine mode Full (Quad.) polarimetry

WBS : ScanSAR nominal [14MHz] mode Single polarization

WBD : ScanSAR nominal [14MHz] mode Dual polarization

WWS: ScanSAR nominal [28MHz] mode Single polarization

WWD: ScanSAR nominal [28MHz] mode Dual polarization

VBS : ScanSAR wide mode Single polarization

VBD : ScanSAR wide mode Dual polarization

E : Observation Direction

L: Left looking, R: Right looking

FFF : Processing Level

2.1: Level 2.1

G : Processing Option

G: Geo-Coded only

H : Map Projection

U: UTM, P: PS, M: MER, L: LCC

I : Orbit Direction

A: Ascending, D: Descending

Polarization (Transmission and Receiving) = XX

HH : Horizontally polarized wave transmission / Horizontally polarized wave receiving

HV :Horizontally polarized wave transmission / Vertically polarized wave receiving

VH :Vertically polarized wave transmission / Horizontally polarized wave receiving

VV : Vertically polarized wave transmission / Vertically polarized wave receiving

3. Format

3.1. GeoTIFF File

GeoTIFF is a metadata standard which allows geometric information to be embedded within a TIFF image file. In ALOS-2 GeoTIFF products, GeoTIFF files are generated in TIFF-Strip format, and some GeoTIFF-tags (identifiers) are different in each processing level. All TIFF files and GeoTIFF-tags are based on TIFF Revision 6.0 and GeoTIFF Revision 1.0 standard, and image data is recorded in little endian.

Since TIFF format supports 4 GB image size in maximum, the image which exceeds 4 GB is stored in BigTIFF format.

3.1.1. Common TIFF Tag

TIFF-tags of level 2.1 product are shown in Table 3-1.

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Table 3-1 TIFF-tags of Level 2.1 Product (1/2)

Tag name	Tag type	Description	Remark
ImageWidth	SHORT or LONG	Number of pixels in one line.	
ImageLength	SHORT or LONG	Number of lines.	
BitsPerSample	SHORT	Number of bits in one sample L2.1 = 16 (fixed value)	L2.1: 16bit (absolute value)
Compression	SHORT	Compression type = 1 (fixed value)	1 = No compression 2 = ITU-T modified Huffman RLE 3 = ITU-T Group 3 fax encoding 4 = ITU-T Group 4 fax encoding 5 = LZW (fixed-length) compression 6 = JPEG compression (old style) 7 = JPEG compression (new style) 8 = ZIP compression 32773 = Packbits compression
PhotometricInterpretation	SHORT	Color space type of bitmap image data = 1 (fixed value)	0 = WhiteIsZero (Pixel value: White=0, Black =(2^BitsPerSample-1)) 1 = BlackIsZero (Pixel value: Black=0, White=(2^BitsPerSample-1)) 2 = RGB direct color (min=0 as black, max=(2^BitsPerSample-1) as white) 3 = Palette color (min=0, max=(2^BitsPerSample-1)) 4 = Transparency Mask (definition of masked region)
ImageDescription	ASCII	Polarization of Tx and Rx = 'HH', 'HV', 'VH', 'VV'	In order of Tx and Rx

Table 3-1 TIFF-tags of Level 2.1 Product (2/2) A

Tag name	Tag type	Description	Remark
Orientation	SHORT	Orientation of image = 1 (fixed value)	1 = row: Top to Bottom, column: Left to Right 2 = row: Top to Bottom, column: Right to Left 3 = row: Bottom to Top, column: Right to Left 4 = row: Bottom to Top, column: Left to Right 5 = row: Left to Right, column: Top to Bottom 6 = row: Right to Left, column: Top to Bottom 7 = row: Right to Left, column: Bottom to Top 8 = row: Left to Right, column: Bottom to Top
SamplesPerPixel	SHORT	Number of samples in one pixel L2.1 = 1 (fixed value)	L2.1: 1 (absolute value)
PlanarConfiguration	SHORT	Storing order of the data = 1 (fixed value)	1 = Chunky format: The component values for each pixel are stored contiguously. 2 = Planar format: The components are stored in separate components.
SampleFormat	Array of SHORT	Type of data L2.1 = 1 (fixed value)	1 = unsigned integer 2 = signed integer 3 = float 4 = undefined 5 = complex integer 6 = complex float The number of elements of the array is equal to the value of “SamplePerPixel” tag

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3.1.2. GeoTIFF tag of level 2.1 Product

GeoTIFF tags of ALOS-2 Level 2.1 GeoTIFF product are shown in Table 3-2.

Table 3-2 GeoTIFF-tags of Level 2.1 Product (1/4)

Tag name	Tag type	Description	Remark
GTCitationGeoKey	ASCII	Processing option Geo-coded = 'Geo-coded'	
GeogLinearUnitsGeoKey	SHORT	Coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogAngularUnitsGeoKey	SHORT	Coordinates unit (angle) = 9102 (fixed value)	9102 = Angular_Degree[deg]
ProjLinearUnitsGeoKey	SHORT	Projection coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogPrimeMeridianGeoKey	SHORT	The position of the standard meridian line = 8901 (fixed value)	8901 = PM_Greenwich (Greenwich meridian)
ModelPixelScaleTag	DOUBLE	The size of a pixel = (pixel width, line width, 0.0)	Units of width are as same as “GeogLinearUnitsGeoKey” and “ProjLinearUnitsGeoKey”. [m]
ModelTiepointTag	DOUBLE	Correspondence of pixel-line coordinates and map coordinates. (Pixel no., Line no, 0.0, Map-addr. X, Map-addr. Y, 0,0) =(0.5, 0.5, 0.0, Map-addr. X, Map-addr. Y, 0,0)	
ModelTransformationTag	DOUBLE	The conversion matrix from a pixel and line coordinates to map coordinates = (a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p) In a two-dimensional coordinate plane, $\begin{vmatrix} \text{Map address X} \\ \text{Map address Y} \\ 0 \\ 1 \end{vmatrix} = \begin{vmatrix} a & b & 0 & d \\ e & f & 0 & h \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} \text{Pixel no.} \\ \text{Line no.} \\ 0 \\ 1 \end{vmatrix}$ = (a, b, 0, d, e, f, 0, g, 0, 0, 0, 0, 0, 0, 0, 1)	When (pixel no., line no.) = (P, L); Map address X = a * P + b * L + d Map address Y = e * P + f * L + h

Table 3-2 GeoTIFF-tags of Level 2.1 Product (2/4)

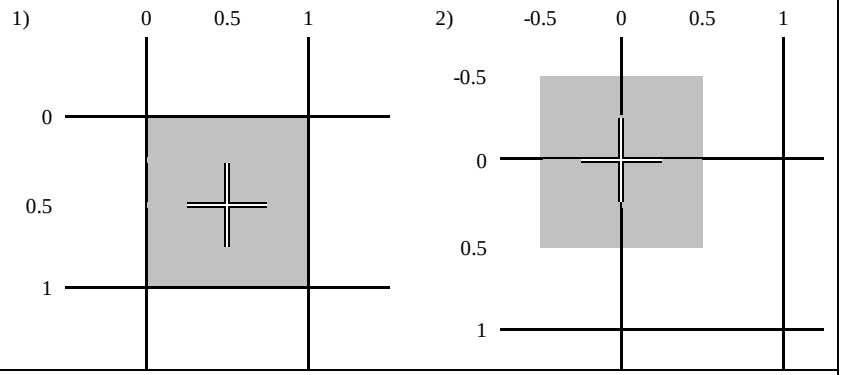
Tag name	Tag type	Description	Remark
GTModelTypeGeoKey	SHORT	Coordinate system type = 1 (fixed value)	1 = ModelTypeProjected (Projection Coordinate System) 2 = ModelTypeGeographic (Geographic Latitude-Longitude System) 3 = ModelTypeGeocentric (Geocentric (X,Y,Z) Coordinate System)
GTRasterTypeGeoKey	SHORT	Alignment of pixel value = 1 (fixed value)	1 = PixelIsArea The first pixel applies the domain surrounded by (0, 0), (0, 1), (1, 0), and (1, 1). The center of pixel is located in (0.5, 0.5). 2 = PixelIsPoint The first pixel applies the domain surrounded by (-0.5,-0.5), (0.5,-0.5), (-0.5, 0.5), (0.5, 0.5). The center of pixel is located in (0,0). 
GeogGeodeticDatumGeoKey	SHORT	Geographic coordinate system = 6655(fixed value)	6655 = The International Terrestrial Reference Frame 1997(ITRF97)
GeogEllipsoidGeoKey	SHORT	Ellipsoid code = 7019 (fixed value)	7019 = Ellipse_GRS_1980(GRS80)
ProjectedCSTypeGeoKey	SHORT	Map projection code User defined = 32767 (fixed value)	In all the projection system, the value “User defined” is set

Table 3-2 GeoTIFF-tags of Level 2.1 Product (3/4)

Tag name	Tag type	Description	Remark
ProjectionGeoKey	SHORT	Map projection code UTM projection Northern Hemisphere = 16000 + Zone no. Southern Hemisphere = 16100 + Zone no. PS / MER / LCC projection User defined = 32767 (fixed value)	In a case of other than UTM, the value “User defined” is set.
GeographicTypeGeoKey	SHORT	Map coordinate code = 4338 (fixed value)	4338 = ITRF97
GeogCitationGeoKey	ASCII	Specify a geographic coordinate system, an ellipsoid model, and a map projection system. = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=UTM' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=PS' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=MER' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=LCC'	
The following tag is specified only when “ProjectionGeoKey” is set as “user defined” (32767)			
ProjCoordTransGeoKey	SHORT	Map projection code PS projection = 15 (fixed value) MER projection = 7 (fixed value) LCC projection = 8 (fixed value)	PS projection 15 = CT_PolarStereographic MER projection 7 = CT_Mercator LCC projection 8 = CT_LambertConfConic_2SP
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjNatOriginLongGeoKey	DOUBLE	Longitude of the map-projection natural origin In UTM and PS projection: Center longitude of projection is specified In MER and LCC The longitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]. The map-projection natural origin of UTM and PS projection is specified in “ProjFalseEastingGeoKey”. The natural origin of northern hemisphere corresponds to negative value of map coordinate y, and that of southern hemisphere, positive value, in the case of PS projection.
ProjNatOriginLatGeoKey	DOUBLE	Latitude of the map-projection natural origin In UTM and PS projection: The center latitude of projection is specified In MER and LCC The latitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]. The map-projection natural origin of UTM and PS projection is specified in ”ProjFalseNorthingGeoKey”.

Table 3-2 GeoTIFF-tags of Level 2.1 Product (4/4)

Tag name	Tag type	Description	Remark
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjFalseEastingGeoKey	DOUBLE	The easting value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. = 500000.0 (fixed value)	The unit specified in "ProjLinearUnitsGeoKey" is used [m]
ProjFalseNorthingGeoKey	DOUBLE	The northing value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. Northern Hemisphere = 0 (fixed value) Southern Hemisphere = 10000000.0 (fixed value)	The unit specified in "ProjLinearUnitsGeoKey" is used [m]
ProjStdParallel1GeoKey	DOUBLE	Latitude of primary standard parallel. It is specified only in the case of LCC projection	The unit specified in "GeogAngularUnitsGeoKey" is used [deg]
ProjStdParallel2GeoKey	DOUBLE	Latitude of second standard parallel. It is specified only in the case of LCC projection	The unit specified in "GeogAngularUnitsGeoKey" is used [deg]
ProjScaleAtNatOriginGeoKey	DOUBLE	Scale at natural origin It is specified only in the case of UTM and PS projection. UTM = 0.9996 (fixed value) PS = 1.0 (fixed value)	non-dimension

3.2. Look Up Table

The LUT is the text file which records the conversion factor for converting from the integer value stored in each pixel of a GeoTIFF file into a real value (σ^0: Sigma Naught). The conversion equation for the level 2.1 is shown below.

- Level 2.1

$$\sigma^0 = \frac{\left(M^2 + B\right)}{A}$$

Here, *M* is pixel value as unsigned integer. *A* is the coefficient which only depends on range direction. *B* is an offset value and is common to all the pixels.

An example of LUT file is shown in Table 3-3. Here, *N* is the number of pixels in one line.

Table 3-3 Example of LUT format

Line 1	offset value *B*
Line 2	scaling factor *A*[0]
Line 3	scaling factor *A* [1]
...	...
Line (*N*+1)	scaling factor *A* [*N*-1]

However, all *A* is the same value in the geocoded product of the level 2.1.

A [dB] value (σ'^0) is converted by using following formula:

$$\sigma'^0 = 10 \times \log_{10}\left(\sigma^0\right)$$

4. Summary Information

The summary information on GeoTIFF level 2.1 is shown in below.

4.1. Outline of Summary Information

The summary information file includes the information for creating processed data created at ALOS-2 Data Processing System, and it is always made in a pair with its processed data.

4.2. Filename of Summary Information

The filename of summary information is fixed as follows.

summary.txt

4.3. File Format of Summary Information

The summary information file consists of some record lines which use LF (line feed code) as a termination, and does not include header information, footer information, etc. A record line consists of a keyword, a equal mark (=), and a value. A summary information file format outline is shown in Figure 4-1.

Keyword	=	Value	LF
…	…	…	…
Keyword	=	Value	LF

Figure 4-1 Outline of Summary Information File Format

4.3.1. Format Definition of Keyword

(1) The keyword is stored from the head of a record line.

(2) The equal mark ‘=’ is stored after the keyword.

(3) There is no blank character between a keyword and ‘=’, in principle.

4.3.2. Format Definition of Value

(1) The value is a text string bundled with double quotation letters (“).

(2) The value can contain alphabets, digits, and some special characters (except for double quotation). Numerical values are also stored as an ASCII string.

(3) There is no blank character between ‘=’ and the former double quotation letter, in principle.

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4.3.3. Contents of Summary Information

The items of the GeoTIFF Level 2.1 summary information are described in Table 4-1. "b" in a table means blanks.

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (1/8)

Section	Item name	Keyword	Value	Remark
Ordering information (Odi)	Scene description ID	Odi_SceneId	ID for specifying a scene uniquely 'AAAAAAAAAAAAAAAA-NNNNN-xxx-nnn' AAAAAAAAAAAAAAAA: Operation Segment No NNNNN: Observation ID xxx: 001～999 nnn: Scene no.	Copy the value of L1.1
	Processed Site/Date/Time	Odi_SiteDateTime	Spacecraft Control Mission Operation system ='PROCESS: JAPAN-JAXA-ALOS2-SCMObbYYYYMMDDbHHMMSS' Earth Intelligence Collection and Shearing System = 'PROCESS: JAPAN-JAXA-ALOS2-EICSbbYYYYMMDDbHHMMSS' YYYYMMDD : Processed date (YYYY: year, MM: month, DD: day) HHMMSS : Processed time (UTC)	
Scene specification (Scs)	Scene ID	Scs_SceneID	'AAAAABBBBBCCCC-YYMMDD' AAAAA : Satellite name (='ALOS2') BBBBB : Orbit accumulation number of a scene center CCCC : Scene frame number of a scene center - : separator (hyphen) YYMMDD: Observation date of scene center (YY: lower 2 figures of a year, MM: month, DD: day)	Copy the value of L1.1
	Amount of scene shift	Scs_SceneShift	'-5'～'4' : Except ScanSAR mode '-25'～'20' : ScanSAR mode Zero and positive number have no sign.	Copy the value of L1.1

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (2/8)

Section	Item name	Keyword	Value	Remark
Product specification (Pds)	Product ID	Pds_ProductID	'DDDEFFFGHI' DDD: Observation mode (*) SBS: Spotlight mode (Single pol.) UBS: Ultra-Fine mode (Single pol.) UBD: Ultra-Fine mode (Dual pol.) HBS: High-sensitive mode (Single pol.) HBD: High-sensitive mode (Dual pol.) HBQ: High-sensitive mode (Full (Quad.) pol.) FBS: Fine mode (Single pol.) FBD: Fine mode (Dual pol.) FBQ: Fine mode (Full (Quad.) pol.) WBS: ScanSAR nominal [14MHz] mode (Single pol.) WBD: ScanSAR nominal [14MHz] mode (Dual pol.) WWS: ScanSAR nominal [28MHz] mode (Single pol.) WWD: ScanSAR nominal [28MHz] mode (Dual pol.) VBS: ScanSAR wide mode (Single pol.) VBD: ScanSAR wide mode (Dual pol.) E : Observation direction (*) L: Left looking, R: Right looking FFF: Processing level 2.1: Level 2.1 G : Processing option G: Geo-Coded H : Map projection type U: UTM, P: PS, M: MER, L: LCC I : Orbit direction (*) A: Ascending, D: Descending	(*) Copy the value of L1.1
	Resampling method	Pds_ResamplingMethod	'NN' / 'BL' / 'CC' Nearest Neighbor / Bi-Linear / Cubic Convolution	
	UTM zone no.	Pds_UTM_ZoneNo	'1'～'60' (specify only for UTM projected product)	

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (3/8)

Section	Item name	Keyword	Value	Remark
Product specification (Pds)	PS reference latitude	Pds_PS_ReferenceLatitude	Northern Hemisphere: ’25.000 <= reference latitude <='90.000' Southern Hemisphere: '-90.000' <= reference latitude <= ‘-25.000’ (specify only for PS projected product)	
	PS reference longitude	Pds_PS_ReferenceLongitude	'-179.999' ≤ reference longitude ≤ '180.000' (specify only for PS projected product)	
	LCC reference latitudinal line 1	Pds_LCC_ReferenceLatitudinalLine1	'-90.000' < reference latitude < '90.000' (specify only for LCC projected product)	
	LCC reference latitudinal line 2	Pds_LCC_ReferenceLatitudinalLine2	'-90.000' < reference latitude < '90.000' (specify only for LCC projected product)	
	Map direction	Pds_MapDirection	'MapNorth'	
	LCC origin latitude	Pds_LCC_OriginLatitude	'-90.000' ≤ origin latitude ≤ '90.000' (specify only for LCC projected product)	
	LCC origin longitude	Pds_LCC_OriginLongitude	'-179.999' ≤ origin longitude ≤ '180.000' (specify only for LCC projected product)	
	Pixel spacing	Pds_PixelSpacing	Spotlight mode: ‘0.625’/’1.25’/’2.5’ [m] Ultra-Fine mode: ‘2.5’/’5.0’/’10.0’ [m] High-sensitive mode: ‘3.125’/’6.25’/’12.5’ [m] Fine beam mode: ‘6.25’/’12.5’ [m] ScanSAR mode: ’25.0’/’50.0’/’100.0’ [m]	
	Precision of orbit data	Pds_OrbitDataPrecision	'Precision' / ' Onboard ' / 'RARR_Predict' Precision : High precision orbit information Onboard : Onboard orbit determination RARR_Predict : Predicted orbit information	Copy the value of L1.1
	Precision of attitude data	Pds_AttitudeDataPrecision	'Onboard' Onboard : Onboard attitude determination	Copy the value of L1.1
	Digital Elevation Model	Pds_DigitalElevationModel	‘GISMAP_Terrain’/’SRTM90m_v4.1’ GISMAP_Terrain: GIS MAP Terrain (Hokkaido-Chizu Company Ltd.) SRTM90m_v4.1: SRTM 90m Digital Elevation Database v4.1 (CSI)	
	Geoid Model	Pds_GeoidModel	‘GSIGEO2000’/’EGM96’ GSIGEO2000: Japanese Geoid Model (Geospatial Information Authority of Japan) EGM96: Earth Gravitational Model 1996 (NGA)	

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (4/8)

Section	Item name	Keyword	Value	Remark
Image information (Img)	Date and time of scene center	Img_SceneCenterDateTime	'YYYYMMDDbhh: mm: ss.ttt'(UT) YYYY : Year (A.D.) MM : Month (01～12) DD : Day (01～31) hh : Hour (00～23) mm : Minute (00～59) ss : Second (00～60) (ss=60 is used only by a leap second.) ttt : Milli-second (000～999)	Copy the value of L1.1
	Date and time of scene start	Img_SceneStartDateTime		Copy the value of L1.1
	Date and time of scene end	Img_SceneEndDateTime		Copy the value of L1.1
	Latitude of image scene center	Img_ImageSceneCenterLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of image scene center	Img_ImageSceneCenterLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of image scene Left-Top	Img_ImageSceneLeftTopLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of image scene Left-Top	Img_ImageSceneLeftTopLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of image scene Right-Top	Img_ImageSceneRightTopLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of image scene Right-Top	Img_ImageSceneRightTopLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of image scene Left-Bottom	Img_ImageSceneLeftBottomLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of image scene Left-Bottom	Img_ImageSceneLeftBottomLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of image scene Right-Bottom	Img_ImageSceneRightBottomLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of image scene Right-Bottom	Img_ImageSceneRightBottomLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (5/8)

Section	Item name	Keyword	Value	Remark
Image information (Img)	Latitude of frame scene center	Img_FrameSceneCenterLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of frame scene center	Img_FrameSceneCenterLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of frame scene Left-Top	Img_FrameSceneLeftTopLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of frame scene Left-Top	Img_FrameSceneLeftTopLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of frame scene Right-Top	Img_FrameSceneRightTopLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of frame scene Right-Top	Img_FrameSceneRightTopLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of frame scene Left-Bottom	Img_FrameSceneLeftBottomLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of frame scene Left-Bottom	Img_FrameSceneLeftBottomLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Latitude of frame scene Right-Bottom	Img_FrameSceneRightBottomLatitude	'-90.000'～'90.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Longitude of frame scene Right-Bottom	Img_FrameSceneRightBottomLongitude	'-179.999'～'180.000' [degree] Third decimal places are not omissible. Zero and positive number have no sign.	
	Off-nadir angle	Img_OffNadirAngle	NN.N [degree]	Copy the value of L1.1

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (6/8)

Section	Item name	Keyword	Value	Remark
Product information (Pdi)	Data size of product	Pdi_ProductDataSize	unit: Mbyte = 1024Kbyte Rounded off by the 2nd place of a decimal point. The first place of a decimal is not omissible.	
	Number of files in level 2.1 product	Pdi_CntOfL21ProductFileName	Spotlight mode: 2 files High resolution mode (Single pol.) : 2 files High resolution mode (Dual pol.) : 4 files ScanSAR mode (Single pol.) : 2 files ScanSAR mode (Dual pol.) : 4 files High resolution mode (Full (Quad.) pol.) : 8 files	
	Filename of level 2.1 product	Pdi_L21ProductFileNamenn nn: 01～99	GeoTIFF file 'IMG-XX-SSSSSSSSSSSSSSSSSSSS-PPPPPPPPPP.tif' LUT file 'LUT-XX-SSSSSSSSSSSSSSSSSSSS-PPPPPPPPPP.txt' SSSSSSSSSSSSSSSSSSSS : Scene ID PPPPPPPPPP : Product ID XX : Polarization (HH, HV, VH, VV) (in order of Tx-Rx)	
	Bits per pixel	Pdi_BitPixel	'NN' 16: (fixed value)	
	Number of pixels	Pdi_NoOfPixels_0	'0' - '99999' (Zero-suppressible) The number of pixels of the SAR signal data in processed data record (prefix is not included).	
	Number of lines	Pdi_NoOfLines_0	'0' - '99999' (Zero-suppressible) The number of lines of the SAR signal data in processed data record (file descriptor is not included).	
	Product format	Pdi_ProductFormat	'GeoTIFF '	

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (7/8)

Section	Item name	Keyword	Value	Remark
Result of auto check (Ach)	Checking result of time data	Ach_TimeCheck	'GOOD' / 'POOR' GOOD: All lines are GPS-aligned, POOR: other than GOOD	Copy the value of L1.1
	Checking result of attitude data	Ach_AttitudeCheck	'GOOD' / 'POOR' GOOD: other than POOR. POOR: There are two or more lines which the posture and the rate are not converging.	Copy the value of L1.1
	Status of absolute navigation	Ach_AbsoluteNavigationStatus	'OK'/'NG'	Copy the value of L1.1
	Checking result of house keeping data	Ach_HouseKeepingDataCheck	'GOOD' / 'FAIR' FAIR: There are one or more FAIR(s) among check items.	Copy the value of L1.1
	Checking result of orbit data	Ach_OrbitCheck	'GOOD' / 'FAIR' GOOD: All values are normal. FAIR: All abnormal values are interpolated correctly.	Copy the value of L1.1
	Checking result of on-board attitude data	Ach_OnBoardAttitudeCheck	'GOOD' / 'FAIR' GOOD: All values are normal. FAIR: All abnormal values are interpolated correctly.	Copy the value of L1.1
	Loss lines	Ach_LossLines	'GOOD' / 'FAIR' / 'POOR' GOOD: There is no loss line. FAIR: Number of loss line is 1 or more, but is not more than threshold value. POOR: Number of loss line is more than threshold value.	Copy the value of L1.1
	Absolute navigation time	Ach_AbsoluteNavigationTime	blank	Copy the value of L1.1
	Checking result of PRF change	Ach_PRF_Check	blank	Copy the value of L1.1
	Checking result of calibration data	Ach_CalibrationDataCheck	blank	Copy the value of L1.1

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Table 4-1 Summary information for GeoTIFF Level 2.1 product (8/8)

Section	Item name	Keyword	Value	Remark
Result information (Rad)	Practice result code	Rad_PracticeResultCode	'GOOD' GOOD: normal	
Label information (Lbi)	Satellite name	Lbi_Satellite	'ALOS2' (fixed value)	Copy the value of L1.1
	Sensor name	Lbi_Sensor	'SAR' (fixed value)	Copy the value of L1.1
	Processing level	Lbi_ProcessLevel	'2.1'	
	Processing facility	Lbi_ProcessFacility	'SCMO' / 'EICS' SCMO : Spacecraft Control Mission Operation system EICS : Earth Intelligence Collection and Shearing System	
	Observation date	Lbi_ObservationDate	'YYYYMMDD' YYYYMMDD : (YYYY: year, MM: month, DD: day)	Copy the value of L1.1

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