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RADARSAT CONSTELLATION MISSION

Image Product Format Definition

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ACRONYMS AND ABBREVIATIONS

AP	Alternating Polarizations (Dual HH-VV)
ARC	Equal Arc
BAQ	Block Adaptive Quantization
BCS	Basic Character Set
BIB	Band Interleaved Per Block
BIP	Band Interleaved Per Pixel
BLOCKA	Image Block Information Extension Format Support Data Extension Record for NITF
BSQ	Band Sequential
CH	Circular [1]Transmit Horizontal Receive (Polarization)
cm	centimetre
COPG	Common Output Pixel Grid
CP	Compact Polarizations (CH & CV)
CSA	Canadian Space Agency
CV	Circular [1] Transmit Vertical Receive (Polarization).
deg	degrees
DES	Data Extension Segment
DMD	Description Information (category of Manifest file metadata)
ECR	Earth Centered Rotational (geographic coordinate system)
EXPLTB	Exploitation Related Information Extension Format Support Data Extension Record for NITF
GCC	GeoCoded Complex
GCD	GeoCoded Detected
GRC	GRound range georeferenced Complex
GRD	GRound range georeferenced Detected
HD	Horizontal Dual Polarization (HH & HV)

[1] Right Hand has been chosen as the circular transmit mode for compact polarization for the RCM mission.

HTML	Hypertext Markup Language
IEEE	Institute of Electrical and Electronics Engineers
IPDF	Image Pixel Data File
KML	Keyhole Markup Language
LUT	Look-up Table
MLC	Multi-Look Complex
N/A	Not Applicable
NGA	USA National Geospatial-Intelligence Agency
NITF	National Imagery Transmission Format
NSP	National System Projection
PE2	Polar Epsilon 2
PDF	Portable Document Format
PIF	Product Information File
PNG	Portable Network Graphics
pole	Polarization channel
PRJPSB	Map Projection Parameters Support Data Extension Record for NITF
QP	Quad Polarization (HH & HV & VH & VV)
RPC00B	Rational Function Positioning Support Data Extension Record for NITF
rad	radians
RADAR	Radio Detection and Ranging
RADARSAT	Radar Satellite
RCM	RADARSAT Constellation Mission
RGB	Red, Green and Blue
RGBE	Red, Green, and Blue with a shared Exponent
s	second
SAFE	Standard Archive Format for Europe
ScanSAR	Scanning Synthetic Aperture Radar
SCN	ScanSAR Narrow
SCW	ScanSAR Wide
SLC	Single-Look Complex
SPG	SAR Precision Geocorrected

SSG	SAR Systematic Geocorrected
STPL	State Plane
TEC	Total Electron Content
TECU	Total Electron Content Unit
TIFF	Tagged Image File Format
TRE	Tagged Record Extension
us	microsecond
USA	United States of America
VD	Vertical Dual Polarization (VV & VH)
XC	Polarization ID for the off-diagonal element channel of covariance matrix
XFDU	XML Formatted Data Unit
XML	eXtensible Markup Language
XSL	eXtensible Stylesheet Language
XSLT	XSL for Transformations

1 INTRODUCTION

1.1 Purpose

This document defines the RADARSAT Constellation Mission (RCM) Image Product format.

1.2 Scope

This document specifies the content, formats and organization of RCM Image Products as generated by the RCM System. Information on the classification of RCM products and sensor characteristics are provided in the RCM Product Specification (Document A-1).This document is intended for use by MDA, CSA and the end users of RCM products.

1.3 Document Structure

This document is organized with the following sections:

- **Section 1** describes the purpose and scope of this document
- **Section 2** provides applicable and reference documents
- **Section 3** provides an overview of the RCM Image Product Format Definition
- **Section 4** describes the Product Composition
- **Section 5** describes the GeoTIFF Image Pixel Data File
- **Section 6** describes the NITF 2.1 Image Pixel Data File
- **Section 7** provides the Product Metadata Definition
- **Appendix A** provides an example structure of an RCM Image Product
- **Appendix B** describes the Image Coordinate Reference Systems

2 DOCUMENTS

2.1 Applicable Documents

The following documents form part of this document to the extent referenced herein. Where a revision number is not provided, the latest revision in the RCM configuration management baseline is applicable.

A-1	RCM-SP-52-9092 /P	RCM Product Specification, MDA (public version).
A-2		TIFF Revision 6.0, Aldus Corporation, June 3, 1992.
A-3		GeoTIFF Format Specification, GeoTIFF Revision 1.0, Version 1.8.2, November 10, 1995, Niles Ritter and Mike Ruth.
A-4		BigTIFF websites: http://www.remotesensing.org/libtiff/ and http://www.awaresystems.be/imaging/tiff/bigtiff.html
A-5	MIL-STD-2500C	National Imagery Transmission Format (NITF). Version 2.1, May 6, 2006. Department of Defense.
A-6	STDI-0002-1	The Compendium of Controlled Extensions (CE) for the National Imagery Transmission Format (NITF), Volume 1, Tagged Record Extensions. Version 4.0 August 1, 2011. NGA.
A-7	STDI-0002-2	The Compendium of Controlled Extensions (CE) for the National Imagery Transmission Format (NITF), Volume 2, Data Extension Segments. Version 1.0, December 3, 2012. NGA.
A-8		The Digital Geographic Information Exchange Standard (DIGEST) Part 2 – Annex D. Edition 2.1, September 2000, NGA.
A-9		The Digital Geographic Information Exchange Standard (DIGEST) Part 3, September 2000, NGA.
A-10		Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation, 5 February, 2008.

A-11		XSL Transformations (XSLT) Version 2.0, W3C Recommendation, 23 January, 2007.
A-12		XML Schema Part 1: Structures (Second Edition), W3C Candidate Recommendation, October 28, 2004.
A-13		XML Schema Part 2: Datatypes (Second Edition), W3C Candidate Recommendation, October 28, 2004.
A-14	OGC 07-147r2	KML, Version 2.2, April 14, 2008, Open Geospatial Consortium Inc.
A-15		Google extensions to KML 2.2: http://code.google.com/apis/kml/schema/kml22gx.xsd Google Inc.

2.2 Reference Documents

R-1	RN-RP-51-2713	RADARSAT-2 Product Format Definition, MDA.
R-2	S1-RS-MDA-52-7441	Sentinel-1 Product Specification, MDA.
R-3	PGSI-GSEG-EOPG-FS-05-0001	Standard Archive Format for Europe (SAFE) Control Book 1 - Core Specifications XFDU schema, Version 1.8, 28 June, 2009, ESA.
R-4	PGSI-GSEG-EOPG-FS-05-0002	Standard Archive Format for Europe (SAFE) Control Book 2 - Recommendation for Specialisations, Version 1.7, 28 June, 2009, ESA.
R-5	STDI-0006	NITF Version 2.1 Commercial Dataset Requirements Document (NCDRD). December 20, 2006. NGA.

3 RCM IMAGE PRODUCT FORMAT DEFINITION OVERVIEW

3.1 Image Product Format Definition Objectives

The key design objectives of the RCM Image Product format definition are:

1. to keep the RCM Image Product format similar to the RADARSAT-2 product format;
2. to provide compatibility with the Sentinel-1 Image Product format (to the extent allowed by compatibility with the RADARSAT-2 product format);
3. to make the format easily extensible;
4. to allow easy product exploitation by end users by ensuring that the format is based on widely supported and current technologies.

3.2 Image Product Format Concept

The RCM Image Product format definition is based upon the following concepts:

- The RCM Image Product format is based on the RADARSAT-2 product format [Document R-1], with modifications introduced to satisfy RCM mission requirements and to provide compatibility with the Sentinel-1 product format [Document R-2].
- An Image Product is a collection of information comprising image data, accompanying metadata, and other support files which help to interpret the Image Product.
- The RCM Image Products' metadata is captured in standalone Extensible Markup Language (XML) [Documents A-10, A-12, and A-13] files, and optionally additionally as embedded elements in the product's Image Pixel Data File(s). XML is an industry accepted standard for the interchange of information, is easy to use and understand by both human and machine, and is recognized by many third-party tools such as translators, browsers, databases and image analysis software.
- The RCM Image Products use either the GeoTIFF format [Document A-3] or the NITF 2.1 format [Documents A-5 through A-9]. Both are industry accepted standards which are already supported by many image analysis and exploitation tools.

3.3 Image Product Types

There are a total of five RCM Image Product types as listed in Table 3-1.

Table 3-1 RCM Image Products Types

Data type	**Projection**		
	SLant range georeferenced	**Ground Range georeferenced**	**GeoCoded**
Complex (**C**)	SLC/MLC[2]	GRC	GCC
Detected (**D**)	N/A	GRD	GCD

Where:

- **SLC** represents a SLant range georeferenced single-look Complex product (i.e., equivalent to a Single-Look Complex product for RADARSAT-1 or RADARSAT-2).
- **MLC** represents slant range georeferenced Multiple-Look Complex product.
- **GRD** or **GRC** represents GRound range georeferenced Detected or Complex product (GRD is equivalent to an SGX, SCN or SCW product for RADARSAT-1 or RADARSAT-2).
- **GCD** or **GCC** represent GeoCoded Detected or Complex products (GCD is equivalent to an SSG or SPG product for RADARSAT-1 or RADARSAT-2).

Note: the description of RCM Image Products and imaging modes can be found in Document A-1.

3.4 The Concept of Common Output Pixel Grid

RCM ScanSAR SLC Image Products comprise a set of independently processed bursts, spanning multiple beams. Within this set, each burst is processed into an image such that it comprises slant-range and azimuth image pixels which are coincident with an overall slant-range Common Output Pixel Grid (COPG) covering the entire set of processed bursts spanning all beams.

Resultantly, and specifically as it pertains to the metadata associated with ScanSAR SLC Image Pixel Data Files (IPDF), such as Doppler Anomaly Grid File, LUT Files, Incidence Angle File, Noise Level Files, and many image attributes in the Product

[2] Per Document A-1 , MLC only applicable to ScanSAR Dual Co/Cross Polarization and Compact Polarization.

Information File (PIF), all metadata indexed with respect to image pixel and/or line values are defined using pixel and/or line indices belonging to the Common Output Pixel Grid.

The origin of the COPG is always defined as the top-left corner pixel (line, sample) of the image, as (0, 0) (even if the image has been flipped, as described in Section 4.2). Then any pixel in the image has COPG coordinates:

$$(i, j) \;\; i, j \in \boldsymbol{N}, i \geq 0, j \geq 0.$$

Where:

i is the 'line' (or 'azimuth sample') index

j is the 'sample' (or 'range sample') index.

Note that all other RCM georeferenced images are by definition aligned to a COPG.

4 PRODUCT COMPOSITION

All RCM Image Products contain a Manifest File, a License File, one or more Image Pixel Data Files, four Preview Files, some support files and a Product Information File. The Image Products could have additional files to help the end user to interpret the Image Pixel Data Files. The high-level composition of RCM Image Products is shown in Figure 4-1.

This section describes all files included within RCM Image Products, including the file naming convention, content, formats and its applicability to different RCM Image Product types.

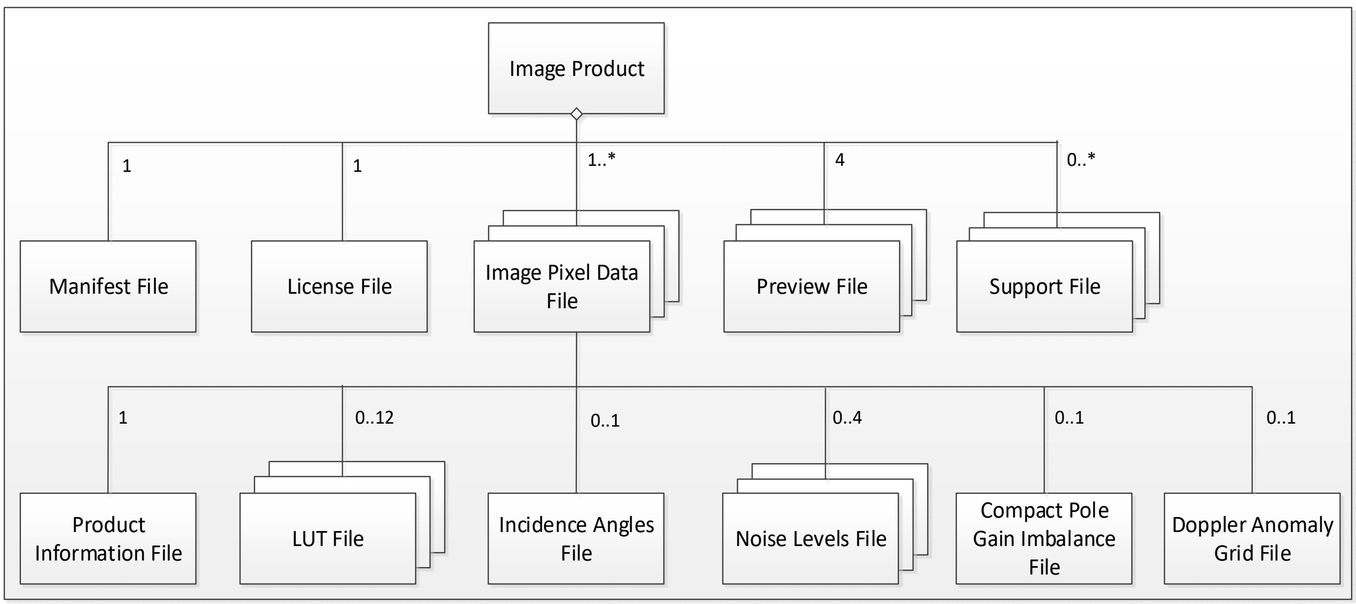

Figure 4-1 Image Product High-Level Composition

Table 4-1 presents the summary of all files, with the reference to the applicable section for further details.

Throughout the document the following notations are being used:

- <*productId*> corresponds to the Product ID in the PIF and is defined in Table 7-10.
- <*polId*> corresponds to the Polarization ID (i.e., HH, HV, VV, VH, CH, CV or XC). XC is defined for MLC off-diagonal covariance matrix elements.
- <*burstId*> corresponds to the image burst number starting from 0 and incrementing by 1 from one burst to the next in the order of acquisition.

Table 4-1 RCM Image Product Composition Summary

Component	Section 4 Reference
Manifest File	4.1
Image Pixel Data Files	4.2
Product Information File (PIF)	4.3
Doppler Anomaly Grid File	4.4
LUT Files	4.5
Incidence Angles File	4.6
Noise Level Files	4.7
Compact Pol Gain Imbalance File	4.8
License File	4.9
Product Overview	4.10.1
Map Overlay File	4.10.2
Product Preview File	4.10.3
Logo Image File	4.10.4
Readme File	4.11
Label File	4.11
Security Attributes File	4.11
XML Schema Files	4.11
XSL Stylesheet File	4.11

4.1 Manifest File

The RCM Manifest File is an XML file that contains information about the collection of files (except Manifest File itself) that comprise the product, the nature of each file and how the files relate to one another. It can be thought of as the map of each RCM Image Product.

The Manifest File in RCM Image Product complies with the SAFE Core specification (Document R-3) and also complies with the recommendation for Mission Specialisation (Document R-4) in order to be compatible with the Sentinel-1 product[3]. The Manifest

[3] The Sentinel-1 product format (Document R-2) is a specialization of the SAFE format (Document R-3).

File applies to all RCM Image Products. There is one Manifest File present in every RCM Image Product.

Table 4-2 Number of Manifest File for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF/NITF 2.1	1
Note: Manifest File is NOT embedded in NITF 2.1 IPDF	

4.1.1 Manifest File Name

The Manifest File filename is set to *manifest.safe* for all RCM Image Products.

4.2 Image Pixel Data Files

The Image Pixel Data Files represent either continuous scene, or separately areas from each individual acquired burst. For GeoTIFF ScanSAR SLC products[4], one individual IPDF will be produced for each processed burst per each polarization, resulting in multiple files per polarization. For NITF 2.1 ScanSAR SLC products, one IPDF (containing all polarization channel data) will be produced for each processed burst. Therefore, the number of IPDFs depends on multiple factors, such as imaging mode, polarization type, product type and also the IPDF's format.

Table 4-3 present the number of IPDFs for Image Products.

In the tables below:

- N_B = Number of bursts processed in the ScanSAR product,
- N_P[5] = Number of processed Polarizations (Single-Pol: 1; Dual-Co/Cross Pol: 1 or 2; Compact-Pol: 2; Dual HH-VV: 2; Quad-Pol: 1 to 4), and
- N_{beam} = Number of ScanSAR beams.

For MLC, the three IPDFs represent two real diagonal covariance matrix elements and one complex off-diagonal covariance matrix element, respectively. The covariance matrix can be described as a 2×2 Hermitian matrix C:

[4] For ScanSAR SLC products, the individual Image Pixel Data Files generated from each acquired burst within the same beam includes sufficient azimuth overlap that a continuous image can be formed.

[5] For Dual-Co/Cross and Quad-Pol, N_P depends on how many polarizations are selected by user. $N_P = 1$ when only one polarization is selected.

$$C = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix} = \begin{bmatrix} xH * conj(xH) & xH * conj(xV) \\ xV * conj(xH) & xV * conj(xV) \end{bmatrix}$$

where x is either Circular, H or V depending on its polarization mode and conj(*) denotes the complex conjugate.

The pixel values in the two detected IPDFs correspond to the square root of the scaled C_{11} and C_{22}, respectively. The pixel values in the complex IPDF correspond to the principal square root of the scaled C_{12}.

Table 4-3 Number of IPDFs for Image Products

	Georeferenced					Geocoded	
Product Format	**ScanSAR SLC**	**Single Beam SLC, Spotlight SLC**	**GRD**	**GRC**	**MLC**	**GCD**	**GCC**
GeoTIFF	$N_B \times N_P$	N_P	N_P	N_P	N_P+1	N_P	N_P
NITF 2.1	N_B	1	1	1	1	1	1

Table 4-4 present the applicable image pixel data types for RCM Image Products.

Table 4-4 Image Pixel Data Types for RCM Image Products

	Georeferenced				Geocoded	
Pixel Representation / Product Type	**SLC**	**GRD**	**GRC**	**MLC**	**GCD**	**GCC**
Integer (16-bit pixels)	(signed) 16-bit I & 16-bit Q	(unsigned) 16-bit	(signed) 16-bit I & 16-bit Q	(unsigned) 16-bit for detected image, (signed) 16-bit I & 16-bit Q for complex image	(unsigned) 16-bit	(signed) 16-bit I & 16-bit Q
IEEE Floating-Point (32-bit pixels)	32-bit I & 32-bit Q	32-bit	32-bit I & 32-bit Q	32-bit for detected image, 32-bit I & 32-bit Q for complex image	N/A	N/A

Within all RCM IPDFs, any occurrence of black fill pixels is represented by assigning such pixels a value of zero.

4.2.1 Image Orientation

All RCM Geo-Referenced images are oriented such that north is nominally up and east is nominally on the right. The horizontal axis is aligned with the zero Doppler direction. In order to achieve the desired orientation, the generated images could be flipped in range and azimuth direction (i.e., Left-Right flipping and Top-Bottom flipping) prior to their inclusion in the products. The Left-Right flipping operation affects the pixel time ordering and the Top-Bottom flipping affects the line time ordering (both are specified in PIF by the metadata fields *pixelTimeOrdering* and *lineTimeOrdering* in Table 7-30, respectively) of the product image. The flipping operation depends on the pass direction of the satellite as indicated in Table 4-5. (In general, image flipping also depends on the antenna pointing direction, but for RCM this is always right-looking; this fact is reflected in the values presented.)

Table 4-5 Flipping Operations on Image Products

Pass Direction	Left-Right Flipping	Top-Bottom Flipping	lineTimeOrdering	pixelTimeOrdering
Ascending	no	yes	“Decreasing”	“Increasing”
Descending	yes	no	“Increasing”	“Decreasing”

All RCM Geocoded images, on the other hand, are not flipped but are resampled to the desired map orientation.

4.2.2 Image Pixel Data File Names

The name of IPDFs depends on product type, product format (Refer to Table 4-3 and Table 4-4), and the polarization type. For ScanSAR SLC products, the name also depends on one extra piece (*_burstId)* to identify all individual IPDFs with the acquired burst index. Table 4-6 defines the IPDF names.

Table 4-6 Image Pixel Data File Names

Product Format	ScanSAR SLC	All Other Products
GeoTIFF	*<productId>_<polId>_<burstId>.tif*	*<productId>_<polId>.tif*
NITF 2.1	*<productId>_<burstId>.ntf*	*<productId>.ntf*

4.3 Product Information File

The PIF logically groups all metadata information related to the Image Product in one file.

The format of a PIF is ASCII encoded in XML and its contents are described in detail in Section 7.3. The PIF applies to all RCM Image Products.

Table 4-7 Number of PIF for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF / NITF2.1	1
Note: for NITF2.1 format, a simplified version of PIF is also embedded into the corresponding IPDF. Refer to Table 6-2 and Section 6.3.4.1 for details.	

4.3.1 Product Information File Name

The filename of PIF is set to *product.xml* for all RCM Image Products.

4.4 Doppler Anomaly Grid File

The Doppler Anomaly Grid File contains both Doppler centroid values from orbit and attitude data and Doppler centroid values adaptively estimated from the signal data, as well as individual quality measures of each Doppler centroid estimate. All Doppler centroid values are on a grid with pre-defined sample spacing in both ground range and azimuth directions.

The format of a Doppler Anomaly Grid File is ASCII encoded in XML. The contents of the Doppler Anomaly Grid File are described in detail in Section 7.3.2.6. The Doppler Anomaly Grid File applies to all Image Products except a few cases (refer to Table 4-8 for details).

Table 4-8 Number of Doppler Anomaly Grid File for RCM Image Products

Product Format	Image Products for which: Radar Mode = "Spotlight"; Processing Mode = "NRT" or "Expedited"; DCE Method = "Orbit and Attitude"; Include Doppler Grid = "False" or not specified;	All other Image Products
GeoTIFF / NITF2.1	0	1
Note: for NITF2.1 format, a simplified version of Doppler Anomaly Grid file is also embedded into the corresponding IPDF. Refer to Table 6-2 and Section 6.3.4.2 for details.		

4.4.1 Doppler Anomaly Grid File Name

The Doppler Anomaly Grid File filename is set to *doppler_grid.xml* for all RCM Image Products where applicable.

4.5 LUT Files

LUT files contain scaling Look-up Tables (LUTs) which allow the conversion of the digital numbers found in the output product to sigma-nought, beta-nought, or gamma values by applying a constant offset and range dependent gain to the SAR image pixel values.

The format of a LUT file is ASCII encoded in XML. The content of a LUT file is described in detail in Section 7.5.

LUT values are polarization dependent. RCM Image Products will have one LUT file for each polarization. For example, a Quad-Pol product will contain four sets of LUT files. One set of LUT files will contain sigma-nought, beta-nought, and gamma LUT file for one particular polarization (HH, HV, VH, VV, CH or CV). For MLC products, besides the two sets of receive polarization dependent LUT files, there is another set of LUT files for the off-diagonal element channel(C_{12}), as described in Section 4.2.

LUT files are applicable to georeferenced products only, not applicable to geocoded products as described in Table 4-9. The number of sets of the LUT Files depends on product type and imaging mode, as summarized in Table 4-9.

Table 4-9 Number of LUT Files for RCM Image Products

	Georeferenced					Geocoded	
Product Format	**ScanSAR SLC**	**Single Beam SLC Spotlight SLC**	**GRD**	**GRC**	**MLC**	**GCD**	**GCC**
GeoTIFF / NITF 2.1	$3*N_P$	$3*N_P$	$3*N_P$	$3*N_P$	$3*(N_P+1)$	N/A	N/A

Note:

1. For all products except MLC, there are 3 LUT files (Sigma Nought, Beta Nought, and Gamma) per Pole. For MLC products, there is another set of LUT files for the off-diagonal element channel, whose scaling factors represent the geometric mean of the scaling factors applied to the diagonal elements, i.e. *sqrt*(a1 * a2) where a1 and a2 are the scaling factors applied to the diagonal elements channels.
2. When per pole scaling is disabled (indicated by *perPolarizationScaling* = *false* in the PIF), the same scaling is applied to all polarization channels, so the content of each pole-dependent LUT file (for example, lutSigma_<polId>.xml) is identical.
3. Each individual LUT file spans the complete range extent to cover the entire product.
4. For NITF2.1 format, a simplified version of LUT files is also embedded into each IPDF. Refer to Table 6-2 and Section 6.3.4.3 for details.

4.5.1 LUT Files Names

The LUT File filename depends on the polarization type and the LUT type.

Table 4-10 LUT File Names

Product Format	All Products
GeoTIFF/NITF2.1	*<lutSigma>_<polId>.xml,* *<lutBeta>_<polId>.xml,* *<lutGamma>_<polId>.xml*

4.6 Incidence Angles File

Incidence Angles File contains the incidence angle for each range sample in the imagery. The format of the Incidence Angles file is ASCII encoded in XML. The content of an Incidence Angles file is described in detail in Section 7.6.

Incidence Angles File applies to all Georeferenced products, but does not apply to Geocoded products, as summarized in Table 4-11.

Table 4-11 Number of Incidence Angles File for RCM Image Product

	Georeferenced					Geocoded	
Product Format	**ScanSAR SLC**	**Single Beam SLC Spotlight SLC**	**GRD**	**GRC**	**MLC**	**GCD**	**GCC**
GeoTIFF/NITF2.1	1	1	1	1	1	N/A	N/A

Note:

1. For ScanSAR SLC, the single Incidence Angle File spans the complete range extent to cover the full product.
2. For NITF2.1 format, a simplified version of Incidence Angles File is also embedded into the corresponding IPDF. Refer to Table 6-2 and Section 6.3.4.4 for details.

4.6.1 Incidence Angles File Names

The Incidence Angles File filename is set to *incidenceAngles.xml*.

4.7 Noise Level Files

The Noise Level Files include the following information:

- Reference Noise Level, which is the estimated instrument noise (beta-nought, sigma-nought, and gamma) as a function of image pixel. This information applies for all image products except ScanSAR SLC products and corresponds to the field *referenceNoiseLevel* in Table 7-55.
- Per-beam Reference Noise Level, which is the estimated beam-dependent instrument noise (beta-nought, sigma-nought, and gamma) as a function of pixel per beam. This information applies for ScanSAR SLC, ScanSAR MLC, and ScanSAR GRD products and corresponds to the field *perBeamReferenceNoiseLevel* in Table 7-55.
- Beam-dependent azimuth noise level scaling: Provided only when the noise typically varies in azimuth. This information applies only to ScanSAR products and Dual HH-VV Polarization mode products with a single azimuth look, and Spotlight products and corresponds to the field *azimuthNoiseLevelScaling* in Table 7-55.

The information provided in this record applies to georeferenced products only.

The format of a Noise Level File is ASCII encoded in XML. The content of a Noise Level File is described in detail in Section 7.7

Table 4-12 Number of Noise Level Files for RCM Image Product

	Georeferenced					Geocoded	
Product Format	**ScanSAR SLC**	**Single Beam SLC Spotlight SLC**	**GRD**	**GRC**	**MLC**	**GCD**	**GCC**
GeoTIFF/NITF2.1	N_P	N_P	N_P	N_P	N_P	N/A	N/A
	Note: 1. For NITF 2.1 format, a simplified version of Noise Level Files is also embedded into the corresponding IPDF. Refer to Table 6-2 and Section 6.3.4.5 for details. 2. For MLC, there are no noise level files for the off-diagonal element channel.						

4.7.1 Noise Level File Names

The filename of Noise Level Files is specified as *noiseLevels_<polId>.xml.*

4.8 Compact Pol Gain Imbalance File

Compact Pol Gain Imbalance File applies to all Image Products for which “polarizationDataMode” = “Compact”.

Compact Pol Gain Imbalance File contains the compact polarization Imbalance (V relative to H) on Transmit and the Imbalance (V relative to H) on Receive. Both Imbalances on Transmit and on Receive include the gain values (in dB) and the phase values (in degrees) as a function of elevation angle, as follows:

- Imbalance on Transmit: provided for each applicable combination of beam and polarization = “CV” only.
- Imbalance on Receive: provided for each applicable combination of beam, sub beam ID and polarization=”CV” only. Sub beam ID identifies the stepped receive pointing step when stepped receive imaging was used in the data acquisition. For non-stepped receive case, only one sub beam ID is present.

The format of a Compact Pol Gain Imbalance File is ASCII encoded in XML. The content of a Compact Pol Gain Imbalance File is described in detail in Section 7.8.

Table 4-13 Number of Compact Pol Gain Imbalance Files for RCM Image Product

Product Format	Products For Which“polarizationDataMode” = “Compact”	Products For Which“polarizationDataMode” != “Compact”
GeoTIFF / NITF 2.1	1	0
Note: 1) For NITF2.1 format, the Compact Pol Gain Imbalance File is not embedded into the IPDF(s).		

4.8.1 Compact Pol Gain Imbalance File Name

The filename of the Compact Pol Gain Imbalance File is specified as *compactPolGainImbalance.xml.*

4.9 License File

A License File is included in every Image Product. The format of the file is either text or Portable Document Format (PDF).

Table 4-14 Number of License Files for RCM Image Product

Product Format	All RCM Image Products
GeoTIFF / NITF 2.1	1
Note: for NITF2.1 format, the License File is also embedded into the corresponding IPDF. Refer to Table 6-1 for details.	

4.9.1 License File Name

The filename of the License File is either *license.txt* or *license.pdf.*

4.10 Preview Files

Product Overview File, Map Overlay File, Product Preview File, and the Logo Image File comprise the types of preview files.

4.10.1 Product Overview

The Product Overview is a reduced resolution image of the full-resolution product image and is always in GeoTIFF format. All Image Products, including ScanSAR SLC

Image Products, shall have a Product Overview Image, whereas the Product Overview Image for ScanSAR SLC Image Products is for the overall scene not for each individual burst.

The Product Overview image is created by averaging image pixels from the available polarization channel images down to the final Product Overview Image's size.

- For single polarization products the Product Overview Images are output as a grey image (Black/White) in a single channel.
- For Dual polarization products, the Product Overview Images are output as a coloured image by mapping the two polarizations into three RGB channels. The assignment of polarization to channel is configurable, for example (R, G, B) = (HH, VV, HH). For MLC products, the off-diagonal element channel is assignable to one of the RGB channels, for example (R, G, B) = (HH, HV, XC).
- For Quad polarization products, the Product Overview Images are output as a coloured image by mapping four polarizations into a RGB image with extra channels. The assignment of polarization to channel is configurable, for example (R, G, B, E) = (HH, VV, HV, VH).

  In general, colour Product Overview Images for multi-polarization RCM Image Products visualize the product in a better way because it conveys more information while it is subject to the following notes:
- Some colour Product Overview Images which have multiple channels may look noisier than the corresponding grey Product Overview Images which have only one co-polarization channel, because the signal-to-noise ratio in the cross-polarization channels is lower than in co-polarization channels,
- Some features in the grey Product Overview Images could become a bit more difficult to detect in the corresponding colour Product Overview Images, because the human being's eye is less sensitive to subtle changes in color than to shades of grey.

Table 4-15 Product Overview Applicability for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF / NITF 2.1	1
Note: Product Overview File is NOT embedded in NITF 2.1 IPDF	

4.10.1.1 Product Overview File Name

The Product Overview File filename is set to *productOverview.tif* for all RCM Image Products.

4.10.2 Map Overlay File

The RCM Map Overlay File is a Keyhole Markup Language (KML) file [A-14]. The Map Overlay file describes the product coverage area and is suitable for viewing in applications that supports KML format.

A Map Overlay File is applicable to all RCM Image Products. The content of a Map Overlay File is described in detail in Section 7.8. For RCM Image Products the format allows for displaying the area of the product coverage in Google Earth as a Product Overview image overlay.

Table 4-16 Map Overlay Files Applicability for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF / NITF 2.1	1
Note: Map Overlay File is NOT embedded into NITF 2.1 IPDF	

4.10.2.1 Map Overlay File Name

The Map Overlay File filename is set to *mapOverlay.kml* for all RCM Image Products.

4.10.3 Product Preview File

A Product Preview File presents a graphical overview of the product file contents. It provided an accessible link to the product files contained in the product folder.

The format of a Product Preview File is ASCII encoded in HTML. The content of a Product Preview File is described in detail in Section 7.10.

The Product Preview File is applicable to all RCM Image Products.

Table 4-17 Product Preview Files Applicability for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF / NITF 2.1	1
Note: Product Preview File is NOT embedded into NITF 2.1 IPDF	

4.10.3.1 Product Preview File Name

The Product Preview File filename is set to *productPreview.html* for all RCM Image Products.

4.10.4 Logo Image File

A Logo Image File is a small Portable Network Graphics (PNG) file which can be displayed with the Product Preview File (*productPreview.html*). The Logo Image File is applicable to all RCM Image Products.

Table 4-18 Logo Image File Applicability for RCM Image Products

Product Format	All RCM Image Products
GeoTIFF / NITF 2.1	1
Note: Logo Image File is NOT embedded into NITF 2.1 IPDF	

4.10.4.1 Logo Image File Name

The Logo Image File filename is set to *logo.png* for all RCM Image Products.

4.11 Support Files

Additional support files will be provided to compose a complete RCM Image Product. They are applicable to all RCM products, but are not added into the NITF 2.1 IPDFs.

- A Readme File ("*readme.txt*") to further describe the contents of the product.
- A Label File ("*label.txt*"), which provides text information, may be printed out for products transcribed to physical media.
- A Security Attributes File ("classification.txt"), which may contain information such as security classification and other information such as whether the image product requires special handling or not.

  For unclassified products, the Security Attributes File may contain

  Security Classification: Non classifié / Unclassified

  Special Handling Required: true/false

  Special Handling Instructions: <a string to provide special handling instructions>

- XML Schema Files ("*.xsd", see Table 4-19 for the full list of schema files) that impose constraints on the metadata in XML format, such as the PIF.
- An XSL Stylesheet File ("*rcm_prod_product.xslt*") [Document A-11] to convert the PIF from XML format into HTML.

4.12 Product Structure and Product Naming Convention

4.12.1 Product Structure

An RCM Image Product is organized in a directory structure as described in Table 4-19, which also presents a summary of the component filenames as presented in previous sections.

Table 4-19 RCM Image Product Structure

File/Folder Name
manifest.safe
license.txt or license.pdf
metadata/
product.xml
doppler_grid.xml
calibration/
lutSigma_<*polId*>].xml
lutBeta _<*polId*>.xml
lutGamma _<*polId*>.xml
incidenceAngles.xml
noiseLevels_<*polId*>.xml
compactPolGainImbalance.xml
imagery/
<*productId*> _<*polId*>[_<*burstId*>].tif
<*productId*>[_<*burstId*>].ntf
preview/
productPreview.html
mapOverlay.kml
productOverview.tif

File/Folder Name
icons/
logo.png
support/
readme.txt
label.txt
classification.txt
rcm_prod_product.xslt
schemas/
rcm_prod_doppler_grid.xsd
rcm_prod_lut.xsd
rcm_prod_incidenceAngles.xsd
rcm_prod_noiseLevels.xsd
rcm_prod_compactPoleGainImb.xsd
rcm_prod_mapOverlay.xsd
rcm_prod_product.xsd
rcm_prod_dataTypes.xsd
rcm_prod_geodeticCoordinate.xsd
rcm_prod_identifiers.xsd
rcm_prod_lists.xsd
rcm_prod_manifest.xsd
rcm_prod_units.xsd

4.12.2 Image Product Naming Convention

The naming convention for the product directory of an Image Product is the following:

RCM<*SatelliteId*>_OK<*OrderId*>_*PK*<*ProductId*>_<*BeamModeMnemonic*>_ <*Date*>_<*Time*>_<*Polarizations*>_<*ProductType*>

Where:

- **<*SatelliteId*>** corresponds to 1, 2 or 3
- **<*OrderId*>** corresponds to the order ID of the Order submitted by an Order Client
- **<*ProductId*>** corresponds to the *productId* in the PIF.
- **<*BeamModeMnemonic*>** corresponds to the *beamModeMnemonic* in the PIF (Refer to Table 7-12)
- **<*Date* >** corresponds to the acquisition date in UTC (YYYYMMDD)
- **<*Time*>** corresponds to the acquisition time in UTC (hhmmss)
- **<*Polarizations*>** corresponds to all the polarizations present in the Image Product (Refer to *polarizations* in the PIF, as described in Table 7-13). For multiple polarizations, each polarization identifier will be separated by an underscore ('_') within the "Polarizations" part. For MLC products, <Polarizations> will omit "XC" for the off-diagonal element channel.
- **<*ProductType*>** corresponds to the *productType* in the PIF (Refer to Table 7-23)

For example, if an RCM Image Product is generated from beam mode mnemonic *QP26* data from *RCM2*, processed as *SLC*, and its associated *Order Id = CSM-TARG-35-0, Production Request Id= PGS_TD_PR_GenIm_QP0_PT, Product Sequence ID = 1*, the final product directory will be:

RCM2_OKCSM-TARG-35-0_PKPGS_TD_PR_GenIm_QP0_PT_1_QP26_20160417_011157_HH_VV_HV_VH_SLC

where *PGS_TD_PR_GenIm_QP0_PT_1* is the *ProductId.* The detailed list of files corresponding to this Product is provided for reference in Appendix A.

4.13 Compatibility with Sentinel-1 Products

When evaluating compatibility of RCM Image Products with Sentinel-1 products, the following criteria are considered:

- product composition, i.e., type of information file(s) included,
- product directory structure,
- format of the imagery file(s),
- format of the metadata file(s), and
- inclusion of and format of a Manifest file.

The Sentinel-1 product format (Document R-2) is a specialization of the SAFE format (Document R-4). Every Sentinel-1 product contains a “Manifest file” (in XML format), which can be thought of as the map of each product as it contains information about the collection of files that comprise the product, the nature of each files, how the files relate to one another and general information about the product that is useful for cataloguing and identification purposes.

Besides the top-level Manifest File, Sentinel-1 products categorize all other files as three types of data sets:

- Measurement Data Sets[6]: Binary encoded files that contain images derived from instrument data in GeoTIFF format.
- Annotation Data Sets: Files that contain metadata which describe characteristics of the product (i.e., product metadata, Calibration LUTs, thermal noise LUTs, Map overlay).
- Representation Data Sets: XML schema files that define the detailed format and content of the data sets within the Sentinel-1 products and implement the Sentinel-1 specializations of the SAFE specification.

Compatibility of RCM Image Products with the Sentinel-1 product format is achieved by having a top-level Manifest File as Sentinel-1 products do, having the similar product directory structure, and having a similar set of product files. The mapping of Sentinel-1 Data Sets to RCM Image Product files is provided in Table 4-20 and Table 4-21.

Table 4-20 Mapping of RCM Image Product Structure to Sentinel-1 Product Structure

RCM Product Folder	Sentinel-1 Product Folder
• manifest.safe	manifest.safe
• ./imagery	./measurement
• ./metadata • ./metadata/calibration	./annotation ./annotation/calibration
• ./preview • ./preview/icons	./preview ./preview/icons
• ./support • ./support/schemas	./support

[6] Sentinel-1 product support only GeoTIFF format. It does not support NITF format.

Table 4-21 Mapping of RCM Image Product Files to Sentinel-1 Data Sets

RCM Product Files	Type of Data Set in Sentinel-1 Product
• Manifest File	Manifest File
• Image Pixel Data Files • Product Overview File	Measurement Data Sets
• PIF • LUT Files • Incidence Angles File • Noise level Files • Compact Pol Gain Imbalance File • Doppler Anomaly Grid File • Product Preview HTML File • Map Overlay File • Label File • Security Attributes File • Readme File • License File • Logo File in PNG format	Annotation Data Sets
• XML Schema Files • XSL Stylesheet Files	Representation Data Sets

5 GEOTIFF IMAGE PIXEL DATA FILES

GeoTIFF extends Aldus-Adobe's raster Tagged Image File Format (TIFF) (Document A-2) with a set of fields that provide additional geographic information. GeoTIFF is described in the GeoTIFF Format Specification (Document A-3).

This section contains three tables. Table 5-1 describes the content of the TIFF fields used by all the RCM Image Products generated in this format. Table 5-2 describes the GeoTIFF fields used for all products that are georeferenced, but not geocoded (i.e., specified in slant range or ground range coordinate systems). SLC, MLC, GRD and GRC products fall into this category and since these products are not geographically corrected, the geographic metadata included in GeoTIFF will be limited to a set of points tying image location to geographic location. Table 5-3 describes the GeoTIFF fields used for all products that have been geocoded to a map projection. GCD and GCC products fall into this category.

GeoTIFF images are generated in TIFF strip format. Multi-polarization images will be generated as separate GeoTIFF image files as Section 4.2 describes. The exact number of IPDFs for RCM Image Products in GeoTIFF format is described in Section 4.2.

5.1 TIFF Fields

Endianness of the host that generated the TIFF image file is indicated in the first two bytes of the file, thus allowing alternate endian machines to properly interpret the data. For big endian the first two bytes of the file are "MM" (for Motorola), and for little endian the two bytes of the file are "II" (for Intel).

Depending on the file size of RCM product's IPDF, GeoTIFF products can use either the classic TIFF file format (which is described in Document A-2) or BigTIFF. BigTIFF is a TIFF variant file format that uses 64-bit offsets in order to support file sizes beyond the 4 GB file size limitation of classic TIFF, which uses 32-bit offsets. The use of BigTIFF is indicated by the TIFF version number, which is found in the second two bytes of a TIFF file. For classic TIFF the second two bytes of the file is "0x2a" (42 in decimal), and for BigTIFF the second two bytes of the file is "0x2b" (43 in decimal). A reduced-resolution browse image is always a classic TIFF. Further details on how BigTIFF modifies the classic TIFF file formats may be found at the following reference [Document A-4].

Note that with reference to the TIFF format specification [Document A-2] Section 2 (Image File Directory), the TIFF format currently allows more than 1 valid type for some fields, regardless of whether classic TIFF or BigTIFF is employed. A TIFF format reader must check the type to verify that it contains an expected value. For example, StripOffsets are usually specified as having type LONG, but BigTIFF images must use the LONG8 field type. Additional details can be found in [Document A-2].

Table 5-1 TIFF Field Description

TIFF Field Name	TIFF Field Code	TIFF Field Type	Description
ImageWidth	256	SHORT or LONG	Pixels per line.
ImageLength	257	SHORT or LONG	Lines per band.
BitsPerSample	258	SHORT	Number of bits per Sample: • Set to 16 for all IPDFs with Integer output data type, or • Set to 32 for all IPDFs with Floating-Point output data type
Compression	259	SHORT	Set to 1, meaning uncompressed.
PhotometricInterpretation	262	SHORT	Set to 1 (black is zero) since multipolar products not represented as RGB
ImageDescription	270	ASCII	Contains a string to identify the polarization in the file.
StripOffsets	273	Array of LONG or Array of LONG8	Offsets to image strips in the file. LONG is used for classic TIFF and LONG8 is used for BigTIFF.
Orientation	274	SHORT	The orientation of the image with respect to rows and columns • Set to 1 to indicate that the first sample is the upper left corner.
SamplesPerPixel	277	SHORT	Number of samples per pixel: • Set to 2 for I and Q in complex IPDFs • Set to 1 in all other cases
RowsPerStrip	278	SHORT or LONG	Number of lines per image strip within the file.
StripByteCounts	279	Array of LONG or ARRAY of LONG8	Sizes of the image strips in the file. LONG is used for classic TIFF and LONG8 is used for BigTIFF.
PlanarConfiguration	284	SHORT	Set to 1 (Chunky format) to indicate I and Q values are interleaved for SLC, GRC, MLC and GCC complex IPDFs. Irrelevant in all other cases as SamplesPerPixel is 1.
DateTime	306	ASCII	Null terminated string indicating the date and time of file generation in "YYYY:MM:DD HH:MM:SS" format.

TIFF Field Name	TIFF Field Code	TIFF Field Type	Description
SampleFormat	339	Array of SHORT	The array will have *SamplesPerPixel* elements. • Integer Products: Set to [1] for unsigned integer detected IPDFs (i.e., GRD, GCD, and detected IPDFs of MLC products) Set to [2,2] for complex integer IPDFs, where I and Q values are signed integer (i.e., SLC, GRC, GCC, and the complex IPDFs of MLC products) • Floating Point Products: Set to [3] for IEEE floating point detected IPDFs (i.e., GRD and detected IPDFs of MLC products) Set to [3,3] for IEEE format complex floating point IPDFs (i.e., SLC, GRC, and the complex IPDFs of MLC products)

5.2 GeoTIFF Fields

5.2.1 GeoTIFF Fields for Georeferenced Products

Table 5-2 GeoTIFF Fields for Georeferenced Products

Field Name	Value	Description
ModelTiepointTag	Array of 6-tuples (column, row, 0, longitude, latitude, height)	This field is used to map raster coordinates to model coordinates. For Non ScanSAR SLC products, the field contains the full list of image tie points from the *geolocationGrid* record (Table 7-32) in the PIF. For ScanSAR SLC products, the field contains only four tie points for its four corners respectively. These four tie points are derived from the *geolocationGrid* record (Table 7-32) in the PIF. Column and row indices are consistent with the raster type, as described below. See also the description of image coordinate systems in Appendix B.
GTModelTypeGeoKey	ModelTypeGeographic	Indicates that the model coordinates are geodetic latitude, longitude, and height (above the reference ellipsoid).
GTRasterTypeGeoKey	RasterPixelIsArea	Indicates that raster coordinates model a pixel as having an area, rather than being a point sample. The (0,0) origin of the raster coordinate system is in the upper left corner of the upper left pixel.
GTCitationGeoKey	"Uncorrected Satellite Data"	This field gives an ASCII representation of the overall configuration of the GeoTIFF file.

Field Name	Value	Description
GeographicTypeGeoKey	GCS_WGS_84	Indicates that model coordinates are referenced to the WGS 1984 datum.

5.2.2 GeoTIFF Fields for Geocoded Products

Table 5-3 GeoTIFF Fields For Geocoded Products

Field Name	Value	Description
ModelTiePointTag	Single 6-tuple (column row, 0, x, y, height)	This field is used to map a single raster coordinate to model coordinate. The mapping will be done at the upper left corner of the image. This field will only be present when the image is map north up. See also the description of image coordinate systems in Appendix B.
ModelPixelScaleTag	Single 3-tuple (pixel scale, line scale, 0)	This field is used to specify the scale factors used when converting between raster and model coordinates. This field will only be present when the image is map north up.
ModelTransformationTag	Single 4x4 double precision transformation matrix	This field is used to transform raster coordinates to model coordinates. This field will only be present when the image is not map north up – images that are in a satellite heading, for example.
GTModelTypeGeoKey	ModelTypeProjected	Indicates that the model coordinates are map projection x and y.
GTRasterTypeGeoKey	RasterPixelIsArea	Indicates that raster coordinates model a pixel as having area, rather than being a point sample. The (0,0) origin of the raster coordinate system is in the upper left corner of the upper left pixel.
GTCitationGeoKey	"Corrected Satellite Data"	This field gives an ASCII representation of the overall configuration of the GeoTIFF file.
ProjectedCSTypeGeoKey	Projected coordinate system code	Code indicating the map projection and datum of the corrected image.
PCSCitationGeokey	String	This field gives an ASCII representation of the projected coordinate system. The name of the map projection and ellipsoid are used.
The following fields must be included when ProjectedCSTypeGeoKey is user defined.		
ProjectionGeoKey	Map projection code	Code indicating the map projection of the corrected image.
The following fields must be included when ProjectionGeoKey is user defined.		
ProjLinearUnitsGeoKey	Linear units code	Code indicating which units are used for map projection distances.

Field Name	Value	Description
ProjCoordTransGeoKey	Map projection type code.	Code indicating the type of map projection used to correct the data.
The following fields must be included when necessary for the type of map projection.		
ProjStdParallel1GeoKey	Latitude	First standard parallel for the projection, in degrees.
ProjStdParallel2GeoKey	Latitude	Second standard parallel for the projection, in degrees.
ProjNatOriginLatGeoKey	Latitude	Projection origin latitude, in degrees.
ProjNatOriginLongGeoKey	Longitude	Projection origin longitude, in degrees.
ProjFalseEastingGeoKey	Distance	Easting (x) value at the projection origin.
ProjFalseNorthingGeoKey	Distance	Northing (y) value at the projection origin.
ProjCenterLongGeoKey	Longitude	Projection centre longitude, in degrees.
ProjCenterLatGeoKey	Latitude	Projection centre latitude, in degrees.
ProjScaleAtCenterGeoKey	Scale factor	Scale factor at projection centre.
ProjAzimuthAngleGeoKey	Angle	Projection azimuth angle in degrees.
ProjStraightVertPoleLongGeoKey	Longitude	Longitude below the pole, in degrees.
The following fields must be included when ProjectedCSTypeGeoKey is user defined.		
GeographicTypeGeoKey	Geographic type code	Code indicating which ellipsoid/datum pair is used to correct the data.
The following fields must be included when GeographicTypeGeoKey is user defined.		
GeogGeodeticDatumGeoKey	User defined code	Indicates that the datum is user defined.
GeogCitationGeoKey	String	Name of the ellipsoid and possibly earth center offset parameters.
GeogEllipsoidGeoKey	Ellipsoid code	Code indicating which ellipsoid was used to correct the data.
The following fields must be included when GeogEllipsoidGeoKey is user defined.		
GeogSemiMajorAxisGeoKey	Distance	Semi-major axis of the ellipsoid in meters.
GeogSemiMinorAxisGeoKey	Distance	Semi-minor axis of the ellipsoid in meters.

6 NITF 2.1 IMAGE PIXEL DATA FILES

The National Imagery Transmission Format (NITF) is a standard used among members of the Geo Intelligence community as well as Defense organizations to distribute and exchange digital imagery and imagery-related products. NITF 2.1 is a highly scalable image format that allows multiple images to be represented in a single file together with relevant metadata and support information. The detailed format of an NITF 2.1 file is specified in [Document A-5] with additional NITF record definitions specified in [Document A-6] and XML data content extensions specified in [Document A-7]. This section will focus on the detailed format of RCM IPDFs.

The RCM IPDF has two variants which both comply with NITF 2.1 format. One variant is specifically used for RCM ScanSAR SLC products. The other one, i.e., the generic one, is used for all other RCM product types. ScanSAR SLC product has multiple NITF IPDFs and each file has a single image segment for one particular burst image. For all other products, it has only a single NITF IPDF which contains multiple image segments for all polarization imageries and also contains multiple data extension segments for related metadata.

6.1 The Composition of NITF 2.1 IPDF

For all RCM NITF 2.1 Image Products, with the exception of ScanSAR SLC products, one RCM NITF 2.1 IPDF consists of a file header, one or multiple image segments, one text segment and one or multiple data extension segments (DES). The File Header provides a record of the location and size of all the constituent segments. Image segments are used to represent the imagery. A text segment is used to represent the license. The data extension segments are used to represent the metadata including PIF, LUT files, etc.

The generic structures of RCM NITF 2.1 IPDFs (***<productId>[_<burstId>]*.ntf**) are displayed in Figure 6-1. The constituent segments in each IPDF are listed in Table 6-1 and show how they depend on RCM product type.

The size limit for an entire NITF 2.1 file is 1 TB which is deemed sufficient for all potential products. However, because NITF has a limit of 10 GB for each image segment, longer images (i.e., larger IPDFs) will be broken into N separate image segments, and then be stored in the same NITF file. While the segmentation is driven by the 10 GB size limit, the first N-1 segments must be sized at fewer than 100,000 lines due to NITF lines per segment limitations, and segments must be split on block boundaries. The last segment may be larger than the previous ones. For ScanSAR SLC, an RCM Burst Image will be less than 10 GB, so one image segment will be sufficient for the burst image.

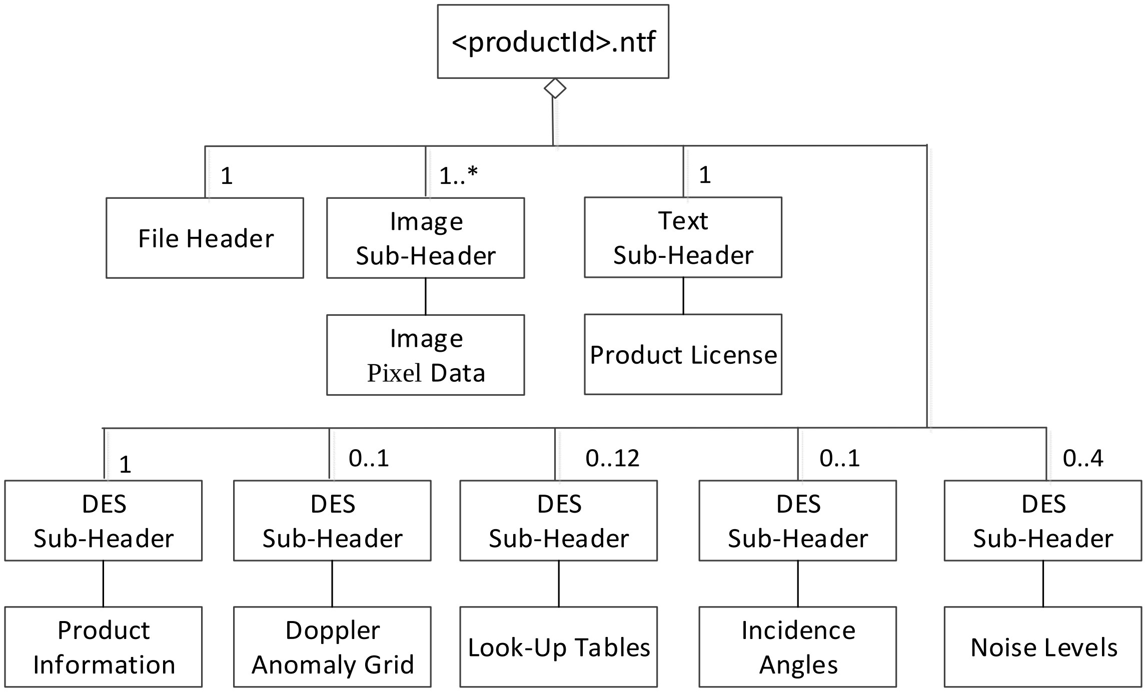

Figure 6-1 RCM NITF 2.1 Image Pixel Data File Composition

In addition, RCM NITF 2.1 IPDFs employ multiple Tagged Record Extensions (TREs) and Data Extension Segment (DES) to embed additional metadata within its File Header, Image Sub-Header(s), and DES Sub-Header(s).

GEOPSB - Geographic Positioning Support, which defines datums and ellipsoids.

PRJPSB - Map Projection Parameters Support, which defines map projection parameters.

MAPLOB - Map Location Support TRE, which define the image to map coordinate transformation.

RPC00B - Rational Function Positioning Support TRE, which lists the rational function for mapping geodetic coordinates to image coordinates.

BLOCKA - Image Block Information Extension Format TRE, which lists image block information.

EXPLTB - Exploitation Related Information Extension Format TRE, which lists SAR parameters.

The GEOPSB, PRJPSB and MAPLOB TREs are only provided with NITF 2.1 Geocoded Products and the RPC00B TRE is only provided with NITF 2.1

Georeferenced (Slant and Ground Range) Products. The BLOCKA and EXPLTB TREs are provided with both NITF 2.1 Geocoded Products and NITF 2.1 Georeferenced Products.

Table 6-1 NITF Records of an RCM NITF 2.1 Image Pixel Data File

		SLC	GRD	GRC	MLC	GCD	GCC
File Header		Yes	Yes	Yes	Yes	Yes	Yes
	Geographic Positioning Support Data Extension Record (GEOPSB)	No	No	No	No	Yes	Yes
	Map Projection Parameters Support Data Extension Record (PRJPSB)	No	No	No	No	Yes	Yes
Image Sub-Header		Yes	Yes	Yes	Yes	Yes	Yes
	Map Location Support Data Extension Record (MAPLOB)	No	No	No	No	Yes	Yes
	Rational Function Positioning Support Data Extension Record (RPC00B)	Yes	Yes	Yes	Yes	No	No
	Image Block Information Tagged Record Extension (BLOCKA)	Yes	Yes	Yes	Yes	Yes	Yes
	Exploitation Related Information Tagged Record Extension (EXPLTB)	Yes	Yes	Yes	Yes	Yes	Yes
Text Sub-Header for License file		Yes	Yes	Yes	Yes	Yes	Yes
DES Sub-Header for PIF		Yes	Yes	Yes	Yes	Yes	Yes
DES Sub-Header for Doppler Anomaly Grid File[7]		Yes	Yes	Yes	Yes	Yes	Yes
DES Sub-Header for LUT Files		Yes	Yes	Yes	Yes	No	No

[7] Applicable (i.e., 'YES/NO') is subject to the conditions described in Table 4-8. Refer to Table 4-8 for details.

	SLC	GRD	GRC	MLC	GCD	GCC
DES Sub-Header for Incidence Angles Files	Yes	Yes	Yes	Yes	No	No
DES Sub-Header for Noise level files	Yes	Yes	Yes	Yes	No	No

Table 6-2 Number of Data Extension Segments (DES) for NITF 2.1 Image Products

DES Sub-Header	Number of Records
PIF	1
Doppler Anomaly Grid File	0..1
LUT Files	All products except MLC: *0..3*N_P*, MLC: *0..3*(N_P +1)*
Incidence Angles Files	*0..1*
Noise Level files	*0..N_P*

For all DESs and their DESSHABS fields, there are two variants:

- For all NITF 2.1 products except ScanSAR SLC products, the DES contains exactly the same contents as being provided in the standalone file (e.g., *incidenceAngles.xml)* which consists of the final product; The DESSHABS field in each DES (as defined in Table 6-13) is filled up with the name of the standalone file.
- For all ScanSAR SLC NITF 2.1 products, the DES does NOT contain the exact contents as being provided in the standalone file. It embeds only a simplified version of the original file for the burst in question (refer to the following sections for details). Likewise, the DESSHABS field is filled up with the burst specific file name, i.e., *incidenceAngles_<burstId>.xml.*

6.2 Bands for NITF 2.1 IPDF Files

For RCM Image Products in NITF 2.1 format, bands are used to represent polarizations of multiple polarization products and/or to represent the real and imaginary components of complex IPDFs. All the available bands within an individual IPDF are interleaved by pixel containing uncompressed image data.

For all products except MLC, a detected IPDF is composed of either one, two or four bands, while a complex IPDF is composed of either two, four or eight bands as the real and imaginary components of each polarization are provided as separate bands. The band ordering in NITF 2.1 IPDF matches the polarization list in the product name defined in section 4.12.2. The Image Sub-Header *IID2* field (Table 6-7) also contains a string of ordered polarizations that match the polarization list in the product name in order to identify which band is for which polarization in the NITF 2.1 product.

For MLC products, an IDPF is always composed of four bands. The first band is for the receiving H channel covariance element. The second band is for its receiving V channel covariance. The third and fourth band are for its off-diagonal covariance matrix element's real and imaginary value of each pixel, respectively.

Table 6-3 shows the number of bands in one NITF IPDF file according to product type and number of polarizations in the product.

Table 6-3 Number of Bands Per NITF 2.1 IPDF

# Polarizations / Product Type	ScanSAR SLC	MLC	Single Beam/ Spotlight SLC, GRC, GCC	GRD, GCD
$N_P = 1$	2 bands (I and Q, interleaved by pixel, instead of a single band containing both)	N/A	2 bands (I and Q, interleaved by pixel, instead of a single band containing both)	1 band
$N_P > 1$	$N_P \times 2$ bands (2 bands per polarization, interleaved by pixel)	Always 4 bands (*N_P=2*, interleaved by pixel*)*	$N_P \times 2$ bands (2 bands per polarization, interleaved by pixel)	N_P bands (one band per polarization, interleaved by pixel)

6.3 NITF Record Definitions

Tables in the following subsections provide the definitions of the NITF 2.1 records (see Document A-5). Throughout the tables the following conventions are used in the Format column:

- A<number> - general ASCII field, number characters long, right-padded with spaces.
- N<number> - numeric ASCII field, number characters long, left padded with zeros.
- B<number> - binary field, number bytes long.

Throughout the tables the following conventions are used in the Values column:

- A list of quoted strings showing the allowable values for a general ASCII field[8].
- A list of numbers showing the allowable values for a numeric ASCII field.
- A hyphen separated range of allowable values for a numeric ASCII field.
- Positive and negative numbers specifying a range of allowable values for a numeric ASCII field.
- A list of hexadecimal strings showing the allowable values for a binary field.
- Configuration – indicating the value is defined in a configuration file.
- Generate – indicating that the value is calculated.
- No value – indicates that the field is blank filled with ASCII space characters.

6.3.1 File Header

The NITF 2.1 File Header is included in all NITF 2.1 formatted products.

Table 6-4 NITF 2.1 File Header Record Fields

Field	Name	Format	Values	Description
FHDR	File Type	A4	“NITF”	Identifies the file as an NITF file.
FVER	File Version	N5	02.10	Version of the NITF file.
CLEVEL	Complexity Level	N2	01 03 05 06 07 09	Calculated based on size of image and other factors.
STYPE	System Type	A4	“BF01”	Also referred to as "Standard Type".
OSTAID	Originating Station ID	A10	Generate	Name of facility that created the file.

[8] When the value length is shorter than the specified length, the value will be blank filled to the specified length. As an example, for the IREP field of format A8, a single band (i.e., single polarization, detected) SAR product will contain the ASCII string “MONO” and when written to the NITF 2.1 Image Pixel Data File, the ASCII string will be followed by 4 spaces to fill all of the required 8 characters: “MONO   ”.

Field	Name	Format	Values	Description
FDT	File Date & Time	A14	Generate	UTC time of file creation using the format: CCYYMMDDhhmmss Where: CC is the first two digits of the year YY is the last two digits of the year, MM is the month (01-12), DD is the day of the month (01-31), hh is the hour (00-23), mm is the minute (00-59, ss are the seconds (00-59).
FTITLE	File Title	A80	Generate	Filename of product.
FSCLAS	File Security Classification	A1	Generate	U (=Unclassified) for unclassified products.
FSCLSY	File Security Classification System	A2	Generate	Blank filled when FSCLAS is "U".
FSCODE	File Codewords	A11		Blank filled as no codewords apply to the file
FSCTLH	File Control and Handling	A2		Blank filled when *specialHandlingRequired* is “FALSE”in PIF. “FO” when *specialHandlingRequired* is “TRUE” in PIF.
FSREL	File Releasing Instructions	A20	Generate	Blank filled when FSCLAS is "U"
FSDCTP	File Declassification Type	A2	Generate	Blank filled when FSCLAS is “U”
FSDCDT	File Declassification Date	A8		Blank filled as no file security declassification date applies.
FSDCXM	File Declassification Exemption	A4		Blank filled as declassification exemption does not apply.
FSDG	File Downgrade	A1		Blank filled as file security downgrading does not apply.
FSDGDT	File Downgrade Date	A8		Blank filled as file security downgrading date does not apply.
FSCLTX	File Classification Text	A43		Blank filled as additional information about file classification does not apply.
FSCATP	File Classification Authority Type	A1	Generate	Blank filled when FSCLAS is “U”.
FSCAUT	File Classification Authority	A40	Generate	Blank filled when FSCATP is blank filled.

Field	Name	Format	Values	Description
FSCRSN	File Classification Reason	A1		Blank filled as no file classification reason applies.
FSSRDT	File Security Source Date	A8	Generate	Blank filled when FSCATP is blank filled.
FSCTLN	File Security Control Number	A15		Blank filled as no file security control number applies.
FSCOP	File Copy Number	N5	00000	Zero filled as there is no tracking of numbered file copies
FSCPYS	File Number Of Copies	N5	00000	Zero filled as there is no tracking of numbered file copies
ENCRYP	Encryption	N1	0	Not encrypted.
FBKGC	File Background Color	B3	0x000000	Unsigned binary 3-tuple giving the background color in red, green, blue order. 0x000000 is black and 0xffffff is white.
ONAME	Originator's Name	A24		Blank filled - no operator is assigned responsibility for origination
OPHONE	Originator's Phone Number	A18		Blank filled – phone number of the facility that created the file will not be included.
FL	File Length	N12	Generate	Length of file in bytes.
HL	NITF File Header Length	N6	Generate	Length of this header in bytes. Will depend on the number of image, text, data extension, or user defined segments.
NUMI	Number of Image Segments	N3	Generate	Number of image segments in the file. Typically will be 001. The image will be split into multiple image segments only if the maximum image segment size (approximately 10GB) is exceeded.
LISHn	Length of n^{th} Image Subheader	N6	Generate	Length of the n^{th} image segment sub-header record in bytes, 1 <= n <= NUMI. The length of the image sub-headers is dependent on the product type, which determines the number of support data extension records.
LIn	Length of n^{th} Image Segment	N10	Generate	Length of the n^{th} image segment in bytes, 1 <= n <= NUMI.
NUMS	Number of Graphic Segments	N3	000	No graphic segments.
NUMX	Reserved for Future Use	N3	000	Must be zero filled.

Field	Name	Format	Values	Description
NUMT	Number of Text Segments	N3	001	Number of text segments in the file[9]. Will always be 001 for the product license text segment.
LTSHn	Length of n^{th} Text Subheader	N4	Generate	Length of the n^{th} text subheader in bytes, 1 <= n <= NUMT.
LTn	Length of n^{th} Text Segment	N5	Generate	Length of n^{th} text segment in bytes, 1 <= n <= NUMT.
NUMDES	Number of Data Extension Segments	N3	Generate	Number of data extension segments in the file. One Data Extension Segment per XML file.
LDSHn	Length (in bytes) of n^{th} DES subheader	N4	Generate	Length of the N^{th} DES subheader in bytes, 1 <= n <= NUMDES.
LDn	Length (in bytes) of n^{th} DES	N9	Generate	Length of the N^{th} DES in bytes, 1 <= n <= NUMDES.
NUMRES	Number of Reserved Extension Segments	N3	000	No reserved extension segments.
UDHDL	User Defined Header Data Length	N5	00000	No user defined header data.
XHDL	Extended Header Data Length	N5	Generate	Length of extended header data. Includes 3 bytes for the XHDLOFL field plus the length of each tagged record extension included. Will only exist for Geocoded Products and is calculated as follows: (length of XHDLOFL) + (length of GEOPSB) + (length of PRJPSB) = 3 + 454 + (124 + 15 * numProjParams). The number of tagged record extensions, and their sizes, vary by product type. Will be 00000 for all other product types.
XHDLOFL	Extended Header Data Overflow	N3	000	It is present only for Geocoded products and set to 000 for Geocoded products.

[9] For all RCM products, only a License File is included in the Text Segment, i.e., NUMT = 1

Field	Name	Format	Values	Description
XHD	Extended Header Data	See Table 6-5 and Table 6-6	Tagged Record Extensions	The field will contain tagged record extensions, which are defined in Documents A-6, A-8 and A-9. The format and content of these extensions are described in the following sections. The length of the tagged record extensions is the value of XHDL minus the 3 bytes used for the XHDLOFL field. The tagged record extensions included vary with product type. For Georeferenced products, the length will be set to 0. For Geocoded products, the length is variable, based on projection type, but will be: (length of GEOPSB) + (length of PRJPSB) = 454 + (124 + 15 * numProjParams)

6.3.1.1 GEOPSB Tagged Record Extension

Table 6-5 NITF 2.1 GEOPSB Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	"GEOPSB"	Uniquely identifies this extension.
CEL	Length of Data Field	N5	00443	Gives length of this extension.
TYP	Type	A3	"GEO" "MAP"	Set to the following: • "GEO" – for equirectangular projection • "MAP" –otherwise.
UNI	Units	A3	"DEG" "M"	Set to the following: • "DEG" – degrees, for equirectangular projection • "M" – meters, otherwise.
DAG	Geodetic Datum Name	A80	Generate	Geodetic datum name defined in Document A-9.
DCD	Geodetic Datum Code	A4	Generate	Geodetic datum code defined in Document A-9.
ELL	Ellipsoid Name	A80	Generate	Ellipsoid name defined in Document A-9.
ELC	Ellipsoid Code	A3	Generate	Ellipsoid code defined in Document A-9.
DVR	Vertical Datum Reference	A80	Generate	Vertical datum reference defined in Document A-9.

Field	Name	Format	Values	Description
VDCDVR	Code of Vertical Reference	A4	Generate	Vertical datum reference code defined in Document A-9.
SDA	Sounding Datum Name	A80		Blank filled – no sounding data.
VDCSDA	Code for Sounding Datum	A4		Blank filled – no sounding data.
ZOR	Z values False Origin	N15	000000000000000	No projection false Z origin – zero filled
GRD	Grid Code	A3	"UT" " "	Set to the following: • "UT" – for UTM projection. • blank filled otherwise.
GRN	Grid Description	A80	Generate	Set to the following: • "Northern Hemisphere" or "Southern Hemisphere" – for UTM projection. • Blank filled otherwise.
ZNA	Grid Zone Number	N4	0000 - 0060	Set to the following: • Zone number (1-60) for UTM • Zero otherwise

6.3.1.2 PRJPSB Tagged Record Extension

Table 6-6 NITF 2.1 PRJPSB Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	"PRJPSB"	Uniquely identifies this extension.
CEL	Length of Data Field	N5	Generate	Gives length of this extension. This value depends on the value of the NUM_PRJ field.
PRN	Projection Name	A80	Generate	Map Projection Name defined in Document A-9.
PCO	Units	A2	Generate	Map Projection Code defined in Document A-9.
NUM_PRJ	Number of projection parameters	N1	0 - 9	Number of parameters per projection, as defined in Document A-9.
PRJ1	Projection Parameter	N15	Generate	Projection parameter value defined in Document A-9.
…				
PRJn	Projection Parameter	N15	Generate	Projection parameter value defined in Document A-9.

Field	Name	Format	Values	Description
XOR	False Easting	N15	000000000000000 - 999999999999999	False Easting for projection.
YOR	False Northing	N15	000000000000000 - 999999999999999	False Northing for projection.

6.3.2 Image Sub-Header

The NITF 2.1 Image Sub-Header Record is included in all NITF 2.1 formatted products.

Table 6-7 NITF 2.1 Image Sub-Header Fields

Field	Name	Format	Values	Description
IM	File Part Type	A2	"IM"	Identifies this record as an image sub-header record.
IID1	Image Identifier 1	A10	Generate	As per Document R-5, set to "Px ", where x is the image segment number, starting at 1.
IDATIM	Image Date and Time	A14	Generate	Gives date and time of first line of the product image in UTC using the format: CCYYMMDDhhmmss
TGTID	Target ID	A17		Blank filled.
IID2	Image Identifier 2	A80	Generate	As per Document R-5, set to a string containing the following components: • 7 character date – DDMMMYY • 4 character satellite identifier. For RCM satellites the identifier will be "RCM1", "RCM2" or "RCM3". • 2 character pass – orbit number since midnight UTC, 01 to 99 • 3 character operation – "000" • 48 character unique identifier comprising: o 3-36 character Downlink Segment ID o 1 character delimiter – "-" o 2-11 character polarization list. For multiple polarizations, each polarization is delimited by an underscore. Will be HH_HV_VH_VV for quad polarization products, HH_HV or

Field	Name	Format	Values	Description
				VV_VH for dual polarization products, CH_CV for compact polarization products, HH_VV for Dual HH-VV polarization products, and one of HH, HV, VH or VV for single polarization products. For MLC products, the polarization list will be HH_HV_XC or VV_VH_XC for dual polarization products and CH_CV_XC for compact polarization products. o BCS space (0x20) to fill the remainder of the 48 characters. • 16 space characters: - reserved for Chipping component which shall be space character filled with BCS spaces (0x20).
ISCLAS	Image Security Classification	A1	Generate	U (=Unclassified) for unclassified products.
ISCLSY	Image Security Classification System	A2	Generate	Blank filled when ISCLAS is "U".
ISCODE	Image Codewords	A11		Blank filled as no codewords apply to the image.
ISCTLH	Image Control and Handling	A2		Blank filled as no additional control and handling instructions apply to the image.
ISREL	Image Releasing Instructions	A20	Generate	Blank filled when ISCLAS is "U".
ISDCTP	Image Declassification Type	A2	Generate	Blank filled when ISCLAS is "U".
ISDCDT	Image Declassification Date	A8		Blank filled as no image security declassification date applies.
ISDCXM	Image Declassification Exemption	A4		Blank filled as declassification exemption does not apply.
ISDG	Image Downgrade	A1		Blank filled as image security downgrading does not apply.
ISDGDT	Image Downgrade Date	A8		Blank filled as image security downgrading date does not apply.
ISCLTX	Image Classification Text	A43		Blank filled as additional information about image classification does not apply.
ISCATP	Image Classification Authority Type	A1	Generate	Blank filled when ISCLAS is “U”.

Field	Name	Format	Values	Description
ISCAUT	Image Classification Authority	A40	Generate	Blank filled when ISCATP is blank filled.
ISCRSN	Image Classification Reason	A1		Blank filled as no image classification reason applies.
ISSRDT	Image Security Source Date	A8	Generate	Blank filled when ISCATP is blank filled.
ISCTLN	Image Security Control Number	A15		Blank filled as no image security control number applies.
ENCRYP	Encryption	N1	0	Not encrypted.
ISORCE	Image Source	A42	"RCM-1" "RCM-2" "RCM-3"	Satellite name (RCM-1/2/3).
NROWS	Number of Significant Rows in Image	N8	Generate	Number of rows in the image, not including pad rows.
NCOLS	Number of Significant Columns in Image	N8	Generate	Number of columns in the image, not including pad columns.
PVTYPE	Pixel Value Type	A3	"INT" "SI" "R"	Valid values are: • "INT": Unsigned Integer – GRD/GCD Integer products. • "SI": Signed Integer – SLC/GRC/GCC/MLC Integer products. For MLC, there are four bands, as indicated by NBANDS below. UINT16 is used for the first two bands (IREPBAND01 and IREPBAND02) for the two diagonal channels, respectively. INT16 is used for IREPBAND03 and IREPBAND04 to store the real and imaginary part of the complex pixel values of the off-diagonal element channel. Despite this complexity of MLC, PVTYPE is still set to "SI". • "R": Real – SLC/GRD/GRC floating-point products and MLC floating point products.
IREP	Image Representation	A8	"MONO" "MULTI"	Valid values are: Monochromatic –Single Polarization GRD/GCD products, i.e., single band products.

Field	Name	Format	Values	Description
				MULTI – All SLC/GRC/GCC/MLC or Multi-Polarization products, i.e., multi-band products.
ICAT	Image Category	A8	"SAR"	Valid values are: SAR – for SAR Image Product
ABPP	Actual Bits-Per-Pixel Per Band	N2	Generate	Valid values are: 16 – for integer SAR image data 32 – for floating-point SAR image data
PJUST	Pixel Justification	A1	"R"	Significant bits in the pixel are right justified.
ICORDS	Image Coordinate System	A1	"G" "N" "S"	Approximate location in image is either in geodetic degrees, minutes, and seconds (WGS 1984) for 'G', or UTM coordinates in the northern or southern hemisphere, for 'N' and 'S'.
IGEOLO	Image Geographic Location	A60	Generate	Coordinates of the four corners of the image (upper left, upper right, lower right, and then lower left). IGEOLO is always relative to WGS 1984. The geodetic latitude and longitude is in degrees, minutes, and seconds - ddmmssXdddmmssY. X= N for North or S for South, Y = E for East or W for West.
NICOM	Number Of Image Comments	N1	0	No image comments.
IC	Image Compression	A2	"NC"	Not compressed.
NBANDS	Number Of Bands	N1	Generate	As described in Table 6-3: • N_P (N_P=1 to 4) for GRD/GCD products • N_P×2 (N_P=1 to 4) for SLC /GRC/GCC products (pair of in-phase component and quadrature components) • 4 (N_P=2) for MLC products Where N_P corresponds to the number of polarizations in the product.
IREPBAND01	First Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. M for other image types. M for a monochrome representation of the Band.
IREPBAND02	Second Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. M for other image types. This field is not present for data with less than 2 bands.

Field	Name	Format	Values	Description
IREPBAND03	Third Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. M for other image types. This field is not present for data with less than 3 bands.
IREPBAND04	Fourth Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. M for other image types. This field is not present for data with less than 4 bands.
IREPBAND05	Fifth Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. This field is not present for data with less than 5 bands.
IREPBAND06	Sixth Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. This field is not present for data with less than 6 bands.
IREPBAND07	Seventh Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. This field is not present for data with less than 7 bands.
IREPBAND08	Eighth Band Representation	A2	"M "	Blank for SLC/GRC/GCC data. This field is not present for data with less than 8 bands.
ISUBCAT01	First Band Subcategory	A6	"" "I"	Blank filled for all data types except SLC/GRC/GCC data. In-phase for SLC/GRC/GCC data.
ISUBCAT02	Second Band Subcategory	A6	"" "Q"	Blank filled for all data types except SLC/GRC/GCC. Quadrature for SLC/GRC/GCC data. This field is not present for data with less than 2 bands.
ISUBCAT03	Third Band Subcategory	A6	"" "I"	Blank filled for all data types except SLC/GRC/GCC/MLC. In-phase for SLC/GRC/GCC data and for MLC off-diagonal channel element in-phase data. This field is not present for data with less than 3 bands.
ISUBCAT04	Fourth Band Subcategory	A6	"" "Q"	Blank filled for all data types except SLC/GRC/GCC/MLC. Quadrature for SLC/GRC/GCC data and MLC off-diagonal channel element quadrature data. This field is not present for data with less than 4 bands.
ISUBCAT05	Fifth Band Subcategory	A6	"I"	In-phase for SLC/GRC/GCC data. This field is not present for data with less than 5 bands.

Field	Name	Format	Values	Description
ISUBCAT06	Sixth Band Subcategory	A6	“Q”	Quadrature for SLC/GRC/GCC data. This field is not present for data with less than 6 bands.
ISUBCAT07	Seventh Band Subcategory	A6	“I”	In-phase for SLC/GRC/GCC data. This field is not present for data with less than 7 bands.
ISUBCAT08	Eighth Band Subcategory	A6	“Q”	Quadrature for SLC/GRC/GCC data. This field is not present for data with less than 8 bands.
IFC01	First Band Image Filter Condition	A1	“N”	Must contain “N” meaning none - other values are reserved for future use.
IFC02	Second Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 2 bands.
IFC03	Third Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 3 bands.
IFC04	Fourth Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 4 bands.
IFC05	Fifth Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 5 bands.
IFC06	Sixth Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 6 bands.
IFC07	Seventh Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 7 bands.
IFC08	Eighth Band Image Filter Condition	A1	“N”	Must contain N meaning none - other values are reserved for future use. This field is not present for data with less than 8 bands.
IMFLT01	First Band Standard Image Filter Code	A3		Blank filled.

Field	Name	Format	Values	Description
IMFLT02	Second Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 2 bands.
IMFLT03	Third Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 3 bands.
IMFLT04	Fourth Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 4 bands.
IMFLT05	Fifth Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 5 bands.
IMFLT06	Sixth Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 6 bands.
IMFLT07	Seventh Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 7 bands.
IMFLT08	Eighth Band Standard Image Filter Code	A3		Blank filled. This field is not present for data with less than 8 bands.
NLUTS01	Number of LUTs for the First Image Band	N1	0	No LUTs
NLUTS02	Number of LUTs for the Second Image Band	N1	0	No LUTs. This field is not present for data with less than 2 bands.
NLUTS03	Number of LUTs for the Third Image Band	N1	0	No LUTs. This field is not present for data with less than 3 bands.
NLUTS04	Number of LUTs for the Fourth Image Band	N1	0	No LUTs. This field is not present for data with less than e bands.
NLUTS05	Number of LUTs for the Fifth Image Band	N1	0	No LUTs. This field is not present for data with less than 5 bands.
NLUTS06	Number of LUTs for the Sixth Image Band	N1	0	No LUTs. This field is not present for data with less than 6 bands.

Field	Name	Format	Values	Description
NLUTS07	Number of LUTs for the Seventh Image Band	N1	0	No LUTs. This field is not present for data with less than 7 bands.
NLUTS08	Number of LUTs for the Eighth Image Band	N1	0	No LUTs. This field is not present for data with less than 8 bands.
ISYNC	Image Sync Code	N1	0	Must contain 0.
IMODE	Image Mode	A1	"B" "P"	"B": Band interleaved by Block. Used for single polarization, non-complex data. "P": Band interleaved by pixel. Used for multiple polarization or complex data.
NBPR	Number of Blocks Per Row	N4	Generate	Image consists of a set of blocks.
NPBC	Number of Blocks Per Column	N4	Generate	Image consists of a set of blocks.
NPPBH	Number of Pixels Per Block Horizontal	N4	Generate	Width of an image block (configurable, up to 8192)
NPPBV	Number of Pixels Per Block Vertical	N4	Generate	Length of an image block (configurable, up to 8192).
NBPP	Number of Bits Per Pixel Per Band	N2	16 32	Valid values are: 16 – for integer SAR image data 32 – for floating-point SAR image data
IDLVL	Display Level	N3	Generate	If an image is split into multiple segments, due to size limitations, IDLVL is set to 051 for the first segment of the image, 052 for the second segment of the image, etc. For images that are not split into multiple segments, IDLVL may be set to 999. A full description of IDLVL, IALVL, and ILOC settings for segmented images is defined in Document R-5.
IALVL	Attachment Level	N3	Generate	Where IALVL is set to 000 for the first segment of any image, and is set to the IDLVL of the previous segment for any subsequent segments of an image.
ILOC	Image Location	N10	Generate	The last 5 digits of ILOC are always set to 00000, indicating that we are not segmenting in the column direction. The first 5 digits of ILOC are set to 00000 for the first segment of any image and the number of rows in the

Field	Name	Format	Values	Description
				previous segment for subsequent segments of an image.
IMAG	Image Magnification	A4	"1.0"	No magnification or reduction.
UDIDL	User Defined Image Data Length	N5	00000	No user defined tagged records.
IXSHDL	Extended Sub-Header Data Length	N5	Generate	Length of extended sub-header data. Includes 3 bytes for the IXSOFL field plus the length of each tagged record extension included. The number of tagged record extensions, and their sizes, varies by product type.
IXSOFL	Extended Sub-Header Overflow	N3	000	Extended sub-header does not overflow the IXSHD field.
IXSHD	Extended Sub-Header Data	See Table 6-8, Table 6-9, Table 6-10 and Table 6-11	Tagged Record Extensions	The field will contain tagged record extensions, which are defined in Documents A-6 and A-8. The tagged record extensions included vary with product type. The format and content of these extensions are described in the following sections. The length of the tagged record extensions is the value of IXSHDL minus the 3 bytes used for the IXSOFL field.

6.3.2.1 RPC00B Tagged Record Extension

For georeferenced Image Products except ScanSAR SLC products, RPC00B TRE fields are filled up exactly with fields in the provided Rational Function record (Table 7-36) in PIF.

For ScanSAR SLC products, the Rational Function provided in PIF, which applies to the entire scene, is rendered burst-specific by setting the line and pixel offset fields appropriately based on the *pixelOffset* and *lineOffset* provided in Table 7-43 for the burst in question.

Table 6-8 NITF 2.1 RPC00B Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	RPC00B	Uniquely identifies this extension.
CEL	Length of Data Field	N5	01041	Gives length of this extension.

Field	Name	Format	Values	Description
SUCCESS	Success	N1	1	Indicates that the generation of the rational function was successful.
ERR_BIAS	Error – Bias	N7	0000.00 - 9999.99	Non-time varying error estimate, for correlated images (1-sigma). A nominal value for the satellite and product type will be used.
ERR_RAND	Error – Random	N7	0000.00 - 9999.99	Time varying error estimate, for correlated images (1-sigma). A nominal value for the satellite and product type will be used.
LINE_OFF	Line Offset	N6	000000 - 999999	Identical to the rational function field *lineOffset* in the support metadata as described in Table 7-36 for all products except ScanSAR SLC. For ScanSAR SLC products, the values of *lineOffset* in Table 7-36 is adjusted by adding *lineOffset* in Table 7-43 before setting this field.
SAMP_OFF	Sample Offset	N5	00000 - 99999	Identical to the rational function field *pixelOffset* in the support metadata as described in Table 7-36 for all products except ScanSAR SLC. For ScanSAR SLC products, the values of *pixelOffset* in Table 7-36 is adjusted by adding *pixelOffset* in Table 7-43 before setting this field.
LAT_OFF	Geodetic Latitude Offset	N8	±90.0000	Identical to the rational function field *latitudeOffset* in the support metadata as described in Table 7-36 .
LONG_OFF	Geodetic Longitude Offset	N9	±180.0000	Identical to the rational function field *longitudeOffset* in the support metadata as described in Table 7-36.
HEIGHT_OFF	Geodetic Height Offset	N5	±9999	Height above reference ellipsoid. Identical to the rational function field *heightOffset* in the support metadata as described in Table 7-36.
LINE_SCALE	Line Scale	N6	000001 - 999999	Identical to the rational function field *lineScale* in the support metadata as described in Table 7-36.
SAMP_SCALE	Sample Scale	N5	00001 - 99999	Identical to the rational function field *pixelScale* in the support metadata as described in Table 7-36.
LAT_SCALE	Geodetic Latitude Scale	N8	±90.0000	Value cannot be zero.

Field	Name	Format	Values	Description
				Identical to the rational function field *latitudeScale* in the support metadata as described in Table 7-36.
LONG_SCALE	Geodetic Longitude Scale	N9	±180.0000	Value cannot be zero Identical to the rational function field *longitudeScale* in the support metadata as described in Table 7-36.
HEIGHT_SCALE	Geodetic Height Scale	N5	±9999	Value cannot be zero Identical to the rational function field *heightScale* in the support metadata as described in Table 7-36.
LINE_NUM_COEFF_1 through LINE_NUM_COEFF_20	Line Numerator Coefficients	N12	±9.999999E±9	Identical to the rational function field *lineNumeratorCoefficients* in the support metadata as described in Table 7-36.
LINE_DEN_COEFF_1 through LINE_DEN_COEFF_20	Line Denominator Coefficients	N12	±9.999999E±9	Identical to the rational function field *lineDenominatorCoefficients* in the support metadata as described in Table 7-36.
SAMP_NUM_COEFF_1 through SAMP_NUM_COEFF_20	Sample Numerator Coefficients	N12	±9.999999E±9	Identical to the rational function field *pixelNumeratorCoefficients* in the support metadata as described in Table 7-36.
SAMP_DEN_COEFF_1 through SAMP_DEN_COEFF_20	Sample Denominator Coefficients	N12	±9.999999E±9	Identical to the rational function field *pixelDenominatorCoefficients* in the support metadata as described in Table 7-36.

6.3.2.2 MAPLOB Tagged Record Extension

Table 6-9 NITF 2.1 MAPLOB Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	"MAPLOB"	Uniquely identifies this extension.
CEL	Length of Data Field	N5	00043	Gives length of this extension.
UNILOA	Length Units	A3	"IN" "CM"	Set to the following: • "IN" – inches, when map projection units are feet • "CM" – centimeters, otherwise These units are chosen since the LOD and LAD values must be integers.

Field	Name	Format	Values	Description
LOD	Easting Interval	N5	00001 - 99999	Pixel spacing in specified units.
LAD	Northing Interval	N5	00001 - 99999	Line spacing in specified units.
LSO	Easting of Reference Origin	N15	±999999999999.9	Easting of origin pixel (row, column) = (0,0) in specified units. Origin pixel is treated as a point sample.
PSO	Easting of Reference Origin	N15	±999999999999.9	Easting of origin pixel (row, column) = (0,0) in specified units. Origin pixel is treated as a point sample.

6.3.2.3 BLOCKA Tagged Record Extension

Table 6-10 NITF 2.1 BLOCKA Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	BLOCKA	Uniquely identifies this extension.
CEL	Length of Data Field	N5	00123	Gives length of this extension.
BLOCK_INSTANCE	Block Number of Image Block	N2	01-99	Gives the block number of this segment. Will be 01 for images with a single image segment, and will be n for products greater than 10GB with N image segments.
N_GRAY	Number Gray Fill Pixels	N5	00000	Will be defaulted to 00000 for all products.
L_LINES	Row Count	N5	00001-99999	Number of rows.
LAYOVER_ANGLE	Layover Angle	N3	000-359	The angle in degrees between the first row of pixels and the layover direction in the image, measured in the clockwise direction. For Georeferenced Products, the value will be either 0 or 180 degrees, dependent on pass direction (RCM always has right-looking) For Geocoded Products the layover angle is derived from the satellite heading and assumes a north up map projection.

Field	Name	Format	Values	Description
SHADOW_ANGLE	Shadow Angle	N3	000-359	The angle in degrees between the first row of pixels and the radar shadow in the image, measured in a clockwise direction. The shadow angle is the 180 degree complement of the layover angle.
(reserved-001)		A16		Blank filled reserved segment.
The following four fields repeat the earth coordinates of four image corner locations described by IGEOLO in the NITF image subheader, but provide higher precision. Note that the order of these coordinates is different from IGEOLO. The format Xddmmss.cc represents degrees (00 to 89), minutes (00 to 59), seconds (00 to 59), and hundredths of seconds (00 to 99) of latitude, with X = N for north or S for south, and Ydddmmss.cc represents degrees (000 to 179), minutes (00 to 59), seconds (00 to 59), and hundredths of seconds (00 to 99) of longitude, with Y = E for east or W for west.				
FRLC_LOC	First Row Last Column Location	A21	XDDMMSS.CCY DDDMMSS.CC	First row last column location. Location of the first row, last column of the image block.
LRLC_LOC	Last Row Last Column Location	A21	XDDMMSS.CCY DDDMMSS.CC	Last row last column location. Location of the last row, last column of the image block.
LRFC_LOC	Last Row First Column Location	A21	XDDMMSS.CCY DDDMMSS.CC	Last row first column location. Location of the last row, first column of the image block.
FRFC_LOC	First Row First Column Location	A21	XDDMMSS.CCY DDDMMSS.CC	First row first column location. Location of the first row, first column of the image block.
(reserved-002)		N5	010.0	Constant reserved segment value.

6.3.2.4 EXPLTB Tagged Record Extension

Table 6-11 NITF 2.1 EXPLTB Tagged Record Extension Fields

Field	Name	Format	Values	Description
CETAG	Unique Extension Identifier	A6	EXPLTB	Uniquely identifies this extension.
CEL	Length of Data Field	N5	00101	Gives length of this extension.
ANGLE_TO_NORTH	Angle To North	N7	000.000 - 359.999	Angle in degrees, measured clockwise about the origin of the image, from first row of the image to True North. For Geocoded Products this field is only valid for products with a north up map

Field	Name	Format	Values	Description
				projection and is a best estimate of angle to north. The value is derived using the satellite heading and pass direction. For Georeferenced Products the top left and top right earth centered rotational (ECR) image coordinates are used to determine row direction relative to True North.
ANGLE_TO_NORTH_ACCY	Angle To North Accuracy	N6	00.000 05.000	90% probable error value of angle to north. This field will be default value 00.000 for all Georeferenced Products. This field will have nominal value 05.000 degrees for Geocoded Products.
SQUINT_ANGLE	Squint Angle	N7	+00.000	This squint angle field will have nominal value +00.000 for all product types, as the satellite radar is zero-Doppler steered.
SQUINT_ANGLE_ACCY	Squint Angle Accuracy	N6	00.001	90% probable error value of the squint angle. This field will have nominal value 00.001 for all product types.
MODE	Mode	A3		Blank filled as field not applicable to RCM SAR products. Note: although Document A-6 only allows a non-blank fill value for this field, none of the available options are applicable to RCM.
(reserved-001)		A16		Blank filled reserved segment.
GRAZE_ANG	Graze Angle	N5	00.00 - 90.00	The angle, measured in degrees at the target, between the focus plane and line of sight to the radar.
GRAZE_ANG_ACCY	Graze Angle Accuracy	N5	00.01 - 90.00	90% probable error value of graze angle.
SLOPE_ANG	Slope Angle	N5	00.00 - 90.00	The angle in degrees between the SAR plane and the focus plane. Same as The Graze angle due to zero squint.
POLAR	Polarization	A2	HH HV VH VV HD VD	For single-polarization products the first character indicates the nominal transmit polarization and the second character indicates the nominal receive polarization. Dual-polarization products will either be HD for HH+HV polarizations or VD for VH+VV polarizations.

Field	Name	Format	Values	Description
			AP CP QP	Dual HH-VV (Stripmap and ScanSAR) products will be AP for alternating HH-VV polarization. Compact-polarization products will be CP for CH+CV polarization. Quad-polarization products are an exception. This field is always set as ‘QP’ based on its acquired polarization no matter which polarization(s) are included in the products since there is no clear way to represent all possible combination of four polarizations (HH+HV+VH+VV) polarizations with only two letters. Note: although Document A-6 only allows HH, HV, VH, or VV, the new tokens HD, VD, CP, AP, and QP have been added on to satisfy all RCM product polarization possibilities.
NSAMP	Number of Samples	N5	00001 - 99999	Pixels per line.
(reserved-002)		N1	0	Constant reserved segment value.
SEQ_NUM	Sequence Number	N1	1	Sequence within Coupled Imagery Set.
PRIME_ID	Primary Target ID	A12		Target designator of primary target. Blank filled.
PRIME_BE	Primary Target Basic Encyclopedia ID	A15		Basic Encyclopedia ID/OSUFFIX (target designator) of the primary target. Blank filled.
(reserved-003)		N1	0	Constant reserved segment value.
N_SEC	Number Secondary Targets	N2	00	Number of secondary targets in image. Will be default value of 00 for all products.
IPR	Commanded Impulse Response	N2	00 - 99	Geometric average of the azimuth and range resolution in feet. Will be 00 for those products where the geometric average of the azimuth and range resolutions is greater than 100 feet.

6.3.3 Text Sub-Header

Only one Text Sub-Header is included in the all NITF 2.1 products for its License File.

Table 6-12 NITF 2.1 Text Sub-Header Fields

Field	Name	Format	Values	Description
TE	File Part Type	A2	TE	"TE" identifies the Sub-Header as a text Sub-Header.
TEXTID	Text Identifier	A7	LICENSE	"LICENSE" indicated this text Sub-Header is used to contain the license file.
TXTALVL	Text Attachment Level	N3	000	This field contains a valid value that indicates the attachment level of the text. Set to "000 (BCS zeros (0x30))" for RCM license file.
TXTDT	Text Date and Time	N14	Generate	This field contains the time (UTC) (Zulu) of origination of the text in the format CCYYMMDDhhmmss, where CC is the century (00 to 99), YY is the last two digits of the year (00 to 99), MM is the month (01 to 12), DD is the day (01 to 31), hh is the hour (00 to 23), mm is the minute (00 to 59), and ss is the second (00 to 59). UTC (Zulu) is assumed to be the time zone designator to express the time of day.
TXTITL	Text Title	A80	Configuration	This field contains the title of the text item.
TSCLAS	Text Security Classification	A1	Generate	U (=Unclassified) for unclassified products.
TSCLSY	Text Security Classification System	A2	Generate	Blank filled when TSCLAS is "U".
TSCODE	Text Codewords	A11		Blank filled as no codewords apply to the text.
TSCTLH	Text Control and Handling	A2		Blank filled as no additional control and handling instructions apply to the text.
TSREL	Text Releasing Instructions	A20	Generate	Blank filled when TSCLAS is "U".
TSDCTP	Text Declassification Type	A2	Generate	Blank filled when TSCLAS is "U".
TSDCDT	Text Declassification Date	A8		Blank filled as no text security declassification date applies.
TSDCXM	Text Declassification Exemption	A4		Blank filled as declassification exemption does not apply.
TSDG	Text Downgrade	A1		Blank filled as text security downgrading does not apply.
TSDGDT	Text Downgrade Date	A8		Blank filled as text security downgrading date does not apply.

Field	Name	Format	Values	Description
TSCLTX	Text Classification Text	A43		Blank filled as additional information about text classification does not apply.
TSCATP	Text Classification Authority Type	A1	Generate	Blank filled when TSCLAS is "U".
TSCAUT	Text Classification Authority	A40	Generate	Blank filled when TSCATP is blank filled.
TSCRSN	Text Classification Reason	A1		Blank filled as no text classification reason applies.
TSSRDT	Text Security Source Date	A8	Generate	Blank filled when TSCATP is blank filled.
TSCTLN	Text Security Control Number	A15		Blank filled as no text security control number applies.
ENCRYP	Encryption	N1	0	Set to 0.
TXTFMT	Text Format	A3	U8S	This field shall contain a valid three character code indicating the format or type of text data. "U8S" indicating U8S text formatting, which supports 8-bit ASCII as well as 16-bit special symbols, is employed for RCM. Refer to paragraph 5.7.1 or additional discussion of standards and the BCS.
TXSHDL	Text Extended Subheader Data Length	N5	00000	A value of BCS zeros (0x30) will represent that no TRE are included in the text Sub-Header.

6.3.4 Data Extension Segment (DES) Sub-Header

For all products, one DES (See Document A-7) will be included in its NITF IPDF to embed one individual metadata XML file (i.e., PIF, Doppler Anomaly Grid File, LUT Files, Incidence Angles File, and Noise Level Files as displayed in Figure 6-1).

6.3.4.1 DES for Product Information File

For all products except ScanSAR SLC products, the original PIF is embedded into the NITF2.1 IPDF.

For ScanSAR SLC products, PIF will be renamed *product_<burstId>.xml* when it is embedded into the NITF2.1 IPDF (*<productId>_<burstId>*.ntf). The burst specific file contains all the same information of the original product.xml except

- The burst specific file contains only one Image Attributes record of the *burstId* burst in the original PIF.
- The burst specific file contains only four image tie-points corresponding to the four corners of the *burstId* burst. The values are derived from the full list of image tie points provided in the *geolocationGrid* record (Table 7-32) in in the original PIF.

6.3.4.2 DES for Doppler Anomaly Grid File

For all products except ScanSAR SLC products, the original Doppler Anomaly Grid File is embedded into the NITF2.1 IPDF.

For ScanSAR SLC products, Doppler Anomaly Grid File will be renamed *doppler_grid_<burstId>.xml* when it is embedded into the NITF2.1 IPDF (*<productId>_<burstId>*.ntf). The information in the burst specific file spans only the footprint of the *burstId* burst.

6.3.4.3 DES for LUT File

For all products except ScanSAR SLC products, the original LUT File is embedded into the NITF2.1 IPDF.

For ScanSAR SLC products, LUT File will be renamed *<lutSigma/ lutBeta/lutGamma> _<polId>_<burstId>.xml*, respectively when they are embedded into the NITF2.1 IPDF (*<productId>_<burstId>*.ntf). The information in the burst specific files span only the footprint of the *burstId* burst, and is subsampled in range with a new factor of *stepSize* (Table 7-52). *stepSize* is determined based on the size constraints of the final PIDF file.

6.3.4.4 DES for Incidence Angles File

For all products except ScanSAR SLC products, the original Incidence Angles File is embedded into the NITF2.1 IPDF.

For ScanSAR SLC products, LUT File will be renamed *incidenceAngles_<burstId>.xml* when it is embedded into the NITF2.1 IPDF (*<productId>_<burstId>*.ntf). The information in the burst specific files span only the footprint of the *burstId* burst, and is subsampled in range with a new factor of *stepSize* (Table 7-54). *stepSize* is determined based on the size constraints of the final PIDF file.

6.3.4.5 DES for Noise Level File

For all products except ScanSAR SLC products, the original Noise Level File is embedded into the NITF2.1 IPDF.

For ScanSAR SLC products, LUT File will be renamed *noiseLevels_<polId>_<burstId>.xml* when it is embedded into the NITF2.1 IPDF (*<productId>_<burstId>*.ntf). The information in the burst specific files should span only the footprint of the *burstId* burst, and is subsampled in range with a new factor of *stepSize* (Table 7-56). The *stepSize* is determined based on the size constraints of the final PIDF file.

6.3.4.6 XML_DATA_CONTENT DES Sub-Header Fields

Table 6-13 XML_DATA_CONTENT DES Sub-Header Fields

Field	Name	Format	Values	Description
DE	File Part Type	A2	“DE”	“DE” uniquely identifies this record as a DES Sub-Header.
DESID	Unique DES Type Identifier	A25	“XML_DATA_CONTENT”	Identifies the DES Sub-Header as a XML_DATA_CONTENT Sub-Header.
DESVER	Version of the Data Definition	N2	01	Version of the use of the tag.
DECLAS	Data Extension File Security Classification	A1	Generate	U (=Unclassified) for unclassified products.
DESCLSY	DES Security Classification System	A2	Generate	Blank filled as DECLAS is "U"
DESCODE	DES Codewords	A11		Blank filled as no codewords apply to the DES.
DESCTLH	DES Control and Handling	A2		Blank filled as no additional control and handling instructions apply to the DES.
DESREL	DES Releasing Instructions	A20	Generate	Blank filled as DECLAS is "U"
DESDCTP	DES Declassification Type	A2	Generate	Blank filled when DECLAS is “U”.
DESDCDT	DES Declassification Date	A8		Blank filled as no DES security declassification date applies.
DESDCXM	DES Declassification Exemption	A4		Blank filled as declassification exemption does not apply.
DESDG	DES Downgrade	A1		Blank filled as file security downgrading does not apply.
DESDGDT	DES Downgrade Date	A8		Blank filled as file security downgrading date does not apply.
DESCLTX	DES Classification Text	A43		Blank filled as additional information about file classification does not apply.

Field	Name	Format	Values	Description
DESCATP	DES Classification Authority Type	A1	Generate	Blank filled when DECLAS is “U”.
DESCAUT	DES Classification Authority	A40	Generate	Blank filled when DESCATP is blank filled.
DESCRSN	DES Classification Reason	A1		Blank filled as no file classification reason applies.
DESSRDT	DES Security Source Date	A8	Generate	Blank filled when DESCATP is blank filled.
DESCTLN	DES Security Control Number	A15		Blank filled as no file security control number applies.
DESSHL	DES User-defined Subheader Length	N4	0773	0773 – Complete inclusion of all User-defined Sub-Header fields.
DESCRC	Cyclic Redundancy Check	N5	99999	CRC not calculated.
DESSHFT	XML File Type	A8	“XML”	DESDATA is an XML file.
DESSHDT	Date and Time (UTC time of XML file’s origination)	A20	Generate	This field shall contain the time (UTC) (Zulu) of the XML file’s origination in the format: YYYY-MM-DDThh:mm:ssZ, where YYYY is the year (0000-9999), MM is the month (01 to 12), DD is the day (01 to 31), T is the separator between date and time, hh is the hour (00 to 23), mm is the minute (00 to 59), and ss is the second (00 to 59). Z is the UTC time zone designator to express the time of day. The precision for recording the date and time is dictated by the user application and the field size constraint. Examples: 2007-04-12T11:45:20Z 2007-04-12T11:45Z 2007-04-12
DESSHRP	Responsible Party – Organization Identifier	A40	Configuration	Identification of the organization responsible for the content of the DES.
DESSHSI	Specification Identifier	A60	Configuration	Name of the specification used for the XML data content, i.e., the name of this document.
DESSHSV	Specification Version	A10	Configuration	Version or edition of this specification.

Field	Name	Format	Values	Description
DESSHSD	Specification Date	A20	Configuration	Version or edition date for this specification. See Date and Time description above.
DESSHTN	Target Namespace	A120	Generate	Identification of the *target namespace*, if any, designated within the XML data content. Example: http://www.w3.org/2001/XMLSchema
DESSHLPG	Location - Polygon	A125	Generate	Filling DESSHLPG in the DES for PIF (product.xml) with the scene corners' coordinates. Blank fill DESSHLPG in all other DESs for other XML files. Five pairs of latitude and longitude values (-90 to +90 latitude and -180 to +360 longitude) in the order of ICP1, ICP2, ICP3, ICP4, ICP1. The format will be. +dd.dddddddd+ddd.dddddddd +dd.dddddddd+ddd.dddddddd +dd.dddddddd+ddd.dddddddd +dd.dddddddd+ddd.dddddddd +dd.dddddddd+ddd.dddddddd ICP1(lat, lon): coordinate for pixel (0,0) ICP2(lat, lon): coordinate for pixel (0, NumCols-1) ICP3(lat, lon): coordinate for pixel (NumRows-1, NumCols-1) ICP4(lat, lon): coordinate for pixel (NumRows-1, 0) NOTE: This is only an approximate reference so specifying the coordinate reference system is unnecessary.
DESSHLPT	Location - Point	A25		Blank filled.
DESSHLI	Location - Identifier	A20		Blank filled.
DESSHLIN	Location Identifier Namespace URL	A120		Blank filled.
DESSHABS	Abstract	A200	Generate	Source XML file name.

7 METADATA DEFINITION

This section describes the metadata files of RCM Image Products.

7.1 Table Descriptions

The tables in the following section are used to describe the content of the metadata file and its internal Data Stores. Each Data Store table is preceded by an arrow diagram to indicate the location of the Data Store relative to its "root" element in the metadata file. Example: for PIF, *product→...→<name-of-Data-Store>* will indicate the particular data store *(<name-of-Data-Store>'s* location relative to the PIF's root element.

The columns of the tables are:

- **Name:** A unique XML *tag* name for an *element*. For the Data Store tables, the first row is shaded to indicate that the name of the Data Store does not constitute a valid tag name, but is provided to provide context for any attributes or description that may be applicable to the Data Store.
- **Min,Max:** The minimum and maximum number of times an element can occur in the product. "0,1" implies that the element is optional. The "∞" symbol implies no upper bound. This column is omitted for the Identifiers, Units, and Lists tables.
- **Type:** The content of an element may be one of the following types:
  - *atomic*: an indivisible type within the context of XML Schema, i.e., primitive or built-in derived type (xsd:string, xsd:integer, etc.),
  - *simple*: derived from restrictions on a list or atomic type,
  - *complex*: a user-defined type that is not part of the XML specification (Data Store),
  - *list*: finite-length sequence of atomic values.

  Complex types are expanded in their own table. Simple types are prefixed with namespaces (for example, "xfdu:" within the manifest.safe). Atomic types are selectively prefixed with namespaces: "xsd:" for manifest.safe, "xs:" for *xml files, and none for *.kml files.

  For all types (e.g., xfdu:dataObjectPointerType) from SAFE Specification Document R-3 and Document R-4, they will not be included in this document.
- **Description:** Further details on the element.

In addition, all the common parameters which are used by more than one metadata file or Data Store are described in Section 7.11.

7.2 Manifest File

7.2.1 Layout of the Manifest File

A graphical representation of the top level of the manifest file is shown in Figure 7-1. These structures are further decomposed in Section 7.2.2.

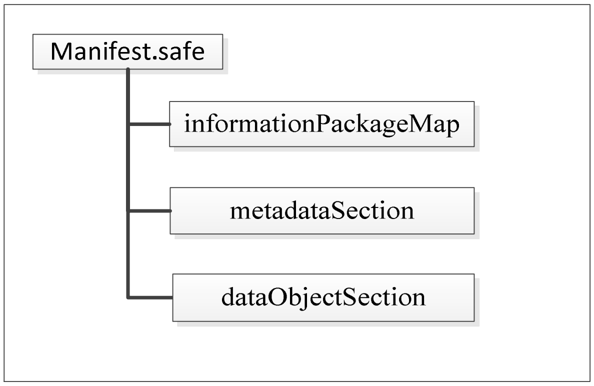

Figure 7-1 Manifest File Structure

7.2.2 Content of the Manifest File

This subsection describes a set of parameters that will be included in the Manifest File. Rows in the tables which are indicated as italicized are attributes.

Table 7-1 Manifest File Description

Name	Min, Max	Type	Description
XFDU	1,1		RCM Image Product Manifest.
version	*1,1*	xfdu:versionType	*The version attribute describes the location within the SAFE schema directory structure where the validating XML Formatted Data Unit (XFDU) schema file for this manifest file resides.*
informationPackageMap	1,1	xfdu:informationPackageMapType	The information package map contains references to all of the imagery files and metadata files contained within the product. The information package map provides a high-level textual description of the product.

Name	Min, Max	Type	Description
metadataSection	1,1	xfdu:metadataSectionType	The metadata section[10] contains references to all physical metadata files and references to their schema files contained within the product.
dataObjectSection	1,1	xfdu:dataObjectSectionType	The dataObject section contains a list of dataObject. Each dataObject represent an individual physical data file (either the imagery files, or the metadata files, or the supported files) contained within the product.

7.2.2.1 Information Package Map

XFDU->informationPackageMap

Table 7-2 xfdu:informationPackageMapType Description

Name	Min, Max	Type	Description
xfdu:informationPackageMap Type			
contentUnit	1,1	xfdu:contentUnitType	This element contains a list of child element which is in the same type (i.e., xfdu:contentUnit), but with different attributes (for RCM Image Products, Table 7-3 describes the exact attributes for this element and Table 7-4 describes the exact attributes for its child element). Each entry of the list provides a reference to either a metadata file or an imagery file contained within the product.

XFDU->informationPackageMap->contentUnit

Table 7-3 informationPackageMap->contentUnit Description

Name	Min, Max	Type	Description
xfdu:contentUnitType			Top level contentUnit in InformationPackageMap
unitType	*1,1*	*xsd:string*	*Attribute of the xfdu:contentUnit. Describes the type of data referenced by this content unit.* *Set to "RCM Product Information Package".*

[10]In contrast to Sentinel-1 Products, the RCM Manifest File's *metadataSection* does not contain a set of wrapped product metadata that was included by Sentinel-1 product.

Name	Min, Max	Type	Description
textInfo	*0,1*	*xsd:string*	*Attribute of the xfdu:contentUnit. A brief textual description of the information or data referenced by this content unit.* *Set to "RCM SLC Product" or "RCM GRD Product", or etc., based on the actual product type.*
contentUnit	1, ∞	xfdu:contentUnitType	One entry of the list corresponding to one metadata file or one imagery file contained within the product.

XFDU->informationPackageMap->contentUnit->contentUnit

Table 7-4 informationPackageMap->contentUnit->contentUnit Description

Name	Min, Max	Type	Description
xfdu:contentUnitType			The second level contentUnit in InformationPackageMap.
unitType	*1,1*	*xsd:string*	*Attribute of the xfdu:contentUnit. Describes the type of data referenced by this content unit.* *The value is one of "Metadata Unit" and "Imagery Unit".*
repID	*0,1*	*xfdu:IDREFS*	*Attribute of the xfdu:contentUnit. Identifier of the schema file(s) applicable to this content unit. This can be a single item or a list with each item separated by a space.* *Present only for the contentUnit for the metadata file that has its own schema file.*
dataObjectPointer	1,1	xfdu:dataObjectPointerType	Through the use of its *dataObjectID* attribute in *xfdu:dataObjectPointerType*, this element points to the data object in the dataObjectSection that this content unit describes.

7.2.2.2 Metadata Section

The metadata section contains a list of metadata objects that contain either a data object pointer that refers to a physical metadata file on disk or a metadata reference that points to a schema file on disk.

XFDU->metadataSection

Table 7-5 xfdu:metadataSectionType Description

Name	Min, Max	Type	Description
xfdu:metadataSectionType			
metadataObject	1, ∞	xfdu:metadataObjectType	Metadata objects can take one of two forms: the first is a reference to a metadata file in the dataObjectSection through a *dataObjectPointer* element; and, the second is a physical reference to a schema files on the filesystem through the use of a *metadataReference* element.

XFDU->metadataSection->metadataObjectType

Table 7-6 xfdu:metadataObjectType Description

Name	Min, Max	Type	Description
xfdu:metadataObjectType			
ID	*1,1*	*xsd:ID*	*Unique identifier of this metadata object. This mandatory ID attribute is used by dmdID attribute in informationPackageMap (Refer to Table 7-4) to link the metadataObjects to the relevant dataObjectPointer.* *For metadata file, set ID to '<ProductName><file base name without extension>Metadata' to build a unique identifier for each metadata file.(Refer to Section 4.12.2 for ProductName)* *For schema files, set ID to' <file base name without extension>Schema' to build a unique identifier for each schema file.*
category	*1,1*	*xsd:string*	*Defines the category of this metadata.* *Set category to "DMD" for the generated metadata files;* *Set the category to "REP" for the schema files.*
classification	*1,1*	*xsd:string*	*A textual description of the classification of this metadata. The classification is linked to the category and provides a more verbose description of the nature of the metadata, whether it is the actual generated metadata information or the standard schema files* *Set classification to "DESCRIPTION" for the generated metadata files;* *Set classification to "SYNTAX" for the schema files.*

Name	Min, Max	Type	Description
dataObjectPointer	0, 1	xfdu:dataObjectPointerType	The *dataObjectPointer* element is used when the metadata object is a generated metadata file. This element is used to point to the applicable metadata file in the *dataObject* section through its *dataObjectID* attribute.
metadataReference	0,1	xfdu:metadataReferenceType	The *metadataReference* element is used when the metadata object is a schema file. This element is used to specify the physical file location of the applicable representation data set.

7.2.2.3 Data Object Section

The data object section contains a list of data objects that contain references to the physical imagery files and metadata files on disk.

XFDU->dataObjectSection

Table 7-7 xfdu:dataObjectSectionType Description

Name	Min, Max	Type	Description
xfdu:dataObjectSection			
dataObject	1, ∞	xfdu:dataObjectType	Each data object refers to one of the files which are contained within the product on the filesystem through the use of its *byteStream* element. • metadata files (in ./metadata) • imagery files (in ./imagery) • preview files (mapOverlay.kml, productPreview.html, quick-look.png) dataObject ‘s mandatory ID attribute is referred by both *informationPackageMap* and *metadataSection* to link back to these dataObjects.

XFDU->dataObjectSection->dataObject

Table 7-8 xfdu:dataObjectType Description

Name	Min, Max	Type	Description
dataObject			
ID	*1, 1*	*xsd:string*	*Attribute of the dataObject. Identifiers of each metadata file, imagery files, or preview files applicable to this dataObject. This will be a single item.* *Set ID to <ProductName><file's base name without extension> to build a unique identifier for each file for RCM (Refer to Section 4.12.2 for ProductName).*
repID	*0,1*	*xfdu:IDREFS*	*Attribute of the dataObject. Identifier of the schema file(s) applicable to this dataObject. This will be a single item.* *Present only for the metadata files. Do not present for the imagery files and preview files.*
byteStream	1, 1	xfdu:byteStream	The *byteStream* element points to the physical file that this data object represents. The *byteStream* element contains the location of the file and associated information like the format of the file and the size.

XFDU -> dataObjectSection->dataObject->byteStream

Table 7-9 byteStream Description

Name	Min, Max	Type	Description
byteStream			
mimeType	*1,1*	*xfdu:mimeTypeType*	*Attribute of the byteStream element. Specifies the format of the file referred to by this byteStream element.* *Set to "text/xml" for XML, KML, XSLT files.* *Set to "text/plain" for TXT files* *Set to "text/html" for HTML files* *Set to "application/octet-stream" for imagery files (.tiff and .ntf files).* *Set to "image/png" for PNG files* *Set to "application/pdf" for PDF files*

Name	Min, Max	Type	Description
size	*1,1*	*xsd:long*	*Attribute of the byteStream element. Indicates the size (in bytes) of the file referred to by this byteStream element.*
fileLocation	1, 1	xfdu:referenceType	The fileLocation element contains the absolute path or URL to associated file through the use of its "href" attribute. The format of *fileLocation* is: <fileLocation locatorType="URL" ref="file:<path>/<filename>"/>

7.3 Product Information File (PIF)

This section describes the format of the PIF. Section 7.3.1 describes the layout of the PIF. Section 7.3.2 contains detailed information which is organized based on the Data Stores. These Data Stores basically describe a schema that is used to control the content and format of the PIF.

7.3.1 Layout of the Product Information File

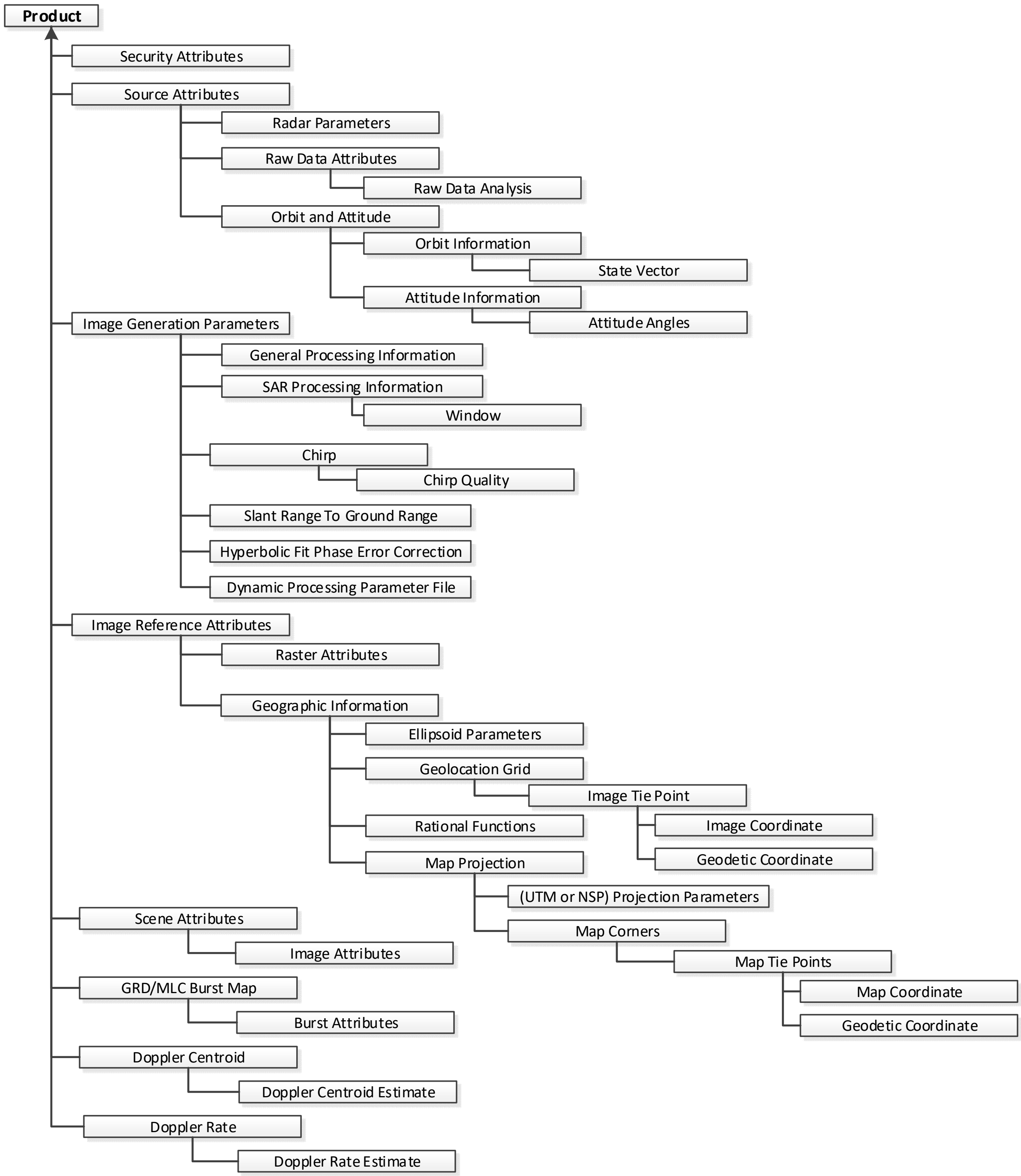

Figure 7-2 PIF Structure

7.3.2 Content of the Product Information File

This subsection describes all sets of parameters that will be included in the Product Information.

Table 7-10 Product Information Attributes

Name	Min, Max	Type	Description
product	1,1		RCM Image Product Attributes
productId	1,1	xsd:string	Unique identifier from 1 to 116 characters. (Possible characters: 0-9A-Za-z._-).
productAnnotation	0,1	xsd:string	Free text (as indicated by Order Client).
productApplication	0,10	xsd:string	The applications for which the Science Data Acquisition was intended to be used. There may be more than one application identified if this Acquisition was shared between multiple Orders (as indicated by Order Client).
documentIdentifier	1,1	xsd:string	Identifies the document and version number which describes this product format, i.e., the name and version of this document.
securityAttributes	1,1	securityAttributesDataStore	Information related to security attributes assigned to the product.
sourceAttributes	1,1	sourceAttributesDataStore	Source (instrument) attributes. Information describing the sensor characteristics, raw data and satellite orbit and attitude.
imageGenerationParameters	1,1	imageGenerationParametersDataStore	Image generation parameters. Information related to SAR processing, chirp, chirp quality, and conversion from slant range to ground range.
imageReferenceAttributes	1,1	imageReferenceAttributes	Image Reference Attributes. Information related to the Image Products' raster attributes, the geographic information, and other attributes which are common for all IPDF types.
sceneAttributes	1,1	sceneAttributesDataStore	Scene attributes. Describes all the IPDFs in the product, obtained from processing the entire acquired scene. It applies to all polarizations in the product.
grdBurstMap	0, 2	burstMapDataStore	GRD burst map attributes. Applicable only to Stripmap Dual HH-VV and ScanSAR GRD products. 1. For Dual HH-VV GRD products, one entry per polarization.

Name	Min, Max	Type	Description
			2. For ScanSAR non-Dual HH-VV GRD products, one entry, valid for all polarizations in the product.
mlcBurstMap	0, 1	burstMapDataStore	MLC burst map attributes. Applicable only to MLC products. One entry, valid for all polarizations in the product.
dopplerCentroid	1, 2	dopplerCentroidDataStore	Doppler centroid parameters for the entire scene. 1. For Dual HH-VV products, one entry per polarization. 2. For all other products, one entry, valid for all polarizations in the product.
dopplerRate	1, 2	dopplerRateDataStore	Doppler rate parameters for the entire scene. 1. For Dual HH-VV products, one entry per polarization. 2. For all other products, one entry, valid for all polarizations in the product.

7.3.2.1 Security Attributes

Security attributes provide information related to security attributes assigned to the product.

product→securityAttributes

Table 7-11 Security Attributes

Name	Min, Max	Type	Description
securityAttributesDataStore			Security Attributes Data Store.
securityClassification	1,1	xsd:string	"Non classifié / Unclassified" for unclassified products.
specialHandlingRequired	0,1	xsd:boolean	"true" for products which need special handling. "false" otherwise.
specialHandlingInstructions	0,1	xsd:string	A string to provide special handling instructions.

7.3.2.2 Source Attributes

Source (instrument) attributes provide information on the sensor characteristics, raw data and satellite orbit and attitude.

product→sourceAttributes

Table 7-12 Source Attributes

Name	Min, Max	Type	Description
sourceAttributesDataStore			Source Attributes Data Store.
satellite	1,1	satelliteIdentifiers	
sensor	1,1	sensorIdentifiers	
polarizationDataMode	1,1	polarizationModeIdentifier	The polarization type of the imagery data.
downlinkSegmentId	1,1	downlinkSegmentIdType	Downlink segment ID.
inputDatasetFacilityId	1,1	inputDatasetFacilityNameType	Name of the facility from which the raw data was received.
beamMode	1,1	beamModeIdentifiers	The expected Beam Mode type.
beamModeDefinitionId	1,1	beamModeDefinitionIdType	Uniquely identifies this Beam Mode within the entire system.
beamModeVersion	1,1	xsd:integer	Identifier for the version of the Beam Mode used to acquire this downlink segment.
beamModeMnemonic	1,1	beamModeMnemonicType	Beam mode mnemonic (a mnemonic which uniquely identifies the satellite imaging configuration, corresponding to the Beam Mode Definition ID).
rawDataStartTime	1,1	utcTimeType	Date/time stamp of first raw data line used during the processing.
radarParameters	1,1	radarParametersDataStore	Information describing the characteristics of the sensor used to acquire the data.

Name	Min, Max	Type	Description
rawDataAttributes	1,1	rawDataAttributesDataStore	Statistics and other analysis on the raw data.
orbitAndAttitude	1,1	orbitAndAttitudeDataStore	Information on the satellite orbit and attitude.

7.3.2.2.1 Radar Parameters

product→sourceAttributes→radarParameters

Table 7-13 Radar Parameters

Name	Min, Max	Type	Description
radarParametersDataStore			Radar Parameters Data Store. Information describing the characteristics of the sensor used to acquire the data.
acquisitionType	1,1	acquisitionIdentifiers	Type of data acquisition (Beam mode type).
beams	1,1	beamList	Radar beams used to produce this product.
polarizations	1,1	polarizationList	Polarizations present in the raw data used to produce this product.
pulses	1,1	pulseList	Radar Pulses used to produce this product, for each beam.
pulsesReceivedPerDwell	0,∞	receivedPulsesPerDwellType	Number of valid pulses received and recorded per dwell (one per beam). Acquired burst parameter for ScanSAR and Dual HH-VV modes only. Beam attribute values are same as those used in the beams list.
numberOfPulseIntervalsPerDwell	0,∞	priPerDwellType	Number of pulse intervals per dwell (one per beam). Acquired burst parameter for ScanSAR and Dual HH-VV modes only. Beam attribute values are same as those used in the beams list.
burstDelay	0,1	xsd:double	The delay inserted by the satellite after each pass through a beam sequence when executing a ScanSAR image. Present for ScanSAR only. (units = us)
rank	1, ∞	rankType	Rank, one entry per beam. The number of transmitted pulse repetition intervals between transmission and reception for each beam. Beam attribute values are same as those used in the beams list.

Name	Min, Max	Type	Description
settableGain	1, ∞	xsd:double	Gain values used on the instrument. Gain values will be specified in terms of polarization and beam. (units = dB) Beam attribute values are same as those used in the beams list.
radarCenterFrequency	1,1	xsd:double	Center frequency of the instrument. (units = Hz)
prfInformation	1,∞	prfInformationDataStore	Transmitted pulse repetition frequency information (PRF). Beam attribute values are same as those used in the beams list. Pole and burst attributes are only included for ScanSAR modes and identify the record in which the PRF changes.
pulseLength	1,∞	pulseDurationType	Time duration of the pulse for each beam. (units = s)
pulseBandwidth	1,∞	pulseBandwidthType	Bandwidth of the pulse for each beam. (units = Hz). Beam attribute values are same as those used in the beams list.
samplingWindowStartTimeFirstRawLine	1, ∞	xsd:double	Sampling window start time for the first line of the raw data ingested. Time between start of transmission of pulse and opening of receive window. (units = s) Use two attributes (pole and beam) to identify each record.
samplingWindowStartTimeLastRawLine	1, ∞	xsd:double	Sampling window start time of the last line of the raw data ingested. Time between start of transmission of pulse and opening of receive window. (units = s) Use two attributes (pole and beam) to identify each record.
numberOfSwstChanges	1,∞	xsd:integer	Number of sampling window start time (SWST) changes in the raw data used to process this scene. Multiple entries for ScanSAR (one per beam) and Stripmap Dual HH-VV (one per polarization).
antennaPointing	1,1	antennaPointingIdentifiers	Antenna pointing direction (always set to “Right” for RCM).

Name	Min, Max	Type	Description
adcSamplingRate	1,∞	rangeSamplingRateType	Sampling rate of the radar analog to digital converter for the pulse, for each beam. (units = Hz) Beam attribute values are same as those used in the beams list.
zeroDopplerSteeringFlag	1,1	zeroDopplerSteeringFlagIdentifiers	Indicate if zero-Doppler steering is used.
satOrientationRefFrame	1,1	satOrientationRefFrameIdentifiers	Indicate what satellite orientation reference frame is used).
rawBitsPerSample	1,1	rawBitsPerSampleIdentifiers	BAQ encoding level.
samplesPerEchoLine	1,∞	xsd:unsignedLong	Number of samples per echo line for each beam. Used to determine sample window length (one per beam).
numPRIsPerPointingStep	0,1	xsd:integer	Number of transmitted pulse repetition intervals per antenna azimuth pointing step during a Spotlight acquisition. This value applies to all pointing steps except the last one, which may have fewer PRIs. Present for Spotlight mode only.
totalNumberOfPointingSteps	0,1	xsd:integer	Total number of antenna azimuth pointing steps during a Spotlight acquisition. Always an odd number. Present for Spotlight mode only.
stepSizeInAntennaPointing	0,1	xsd:double	Step size in antenna azimuth pointing angle. (units = deg) Present for Spotlight mode only.
steppedReceiveMode	1,1	xsd:boolean	If true, stepped receive was used in acquiring the data for this image.

7.3.2.2.2 PRF Information

product→sourceAttributes→radarParameters→prfInformation

Table 7-14 PRF Information

Name	Min, Max	Type	Description
prfInformationDataStore			Pulse Repetition Frequency Information Data Store.
rawLine	1,1	xsd:integer	The first line of the ingested raw data corresponding to this PRF change.
pulseRepetitionFrequency	1,1	prfType	Transmitted pulse repetition frequency (units = Hz).

7.3.2.2.3 Raw Data Attributes

product→sourceAttributes→rawDataAttributes

Table 7-15 Raw Data Attributes

Name	Min, Max	Type	Description
rawDataAttributesDataStore			Describes characteristics of the raw SAR data.
numberOfInputDataGaps	1,1	xsd:unsignedLong	Number of gaps detected in the raw data used to produce this product. A gap is defined as a predetermined number of range lines.
gapSize	1,1	xsd:unsignedLong	Predetermined minimum number of range lines that defines a gap; consecutive missing lines less than this minimum are recorded in numberOfMissingLines.
numberOfMissingLines	1,4	xsd:unsignedLong	Number of missing lines (not including gaps) detected in the raw data used to produce this product (one per polarization).
rawDataAnalysis	1,∞	rawDataAnalysisDataStore	Results from raw data analysis. (one per polarization per beam).

7.3.2.2.3.1 Raw Data Analysis

product→sourceAttributes→rawDataAttributes→rawDataAnalysis

Table 7-16 Raw Data Analysis

Name	Min, Max	Type	Description
rawDataAnalysisDataStore			Raw Data Analysis Data Store.
bias	2,2	xsd:double	Measured mean of the raw data after BAQ decoding (one per data stream, i.e., real and imaginary).
standardDeviation	2,2	xsd:double	Standard deviation of the raw data after BAQ decoding (one per data stream, i.e., real and imaginary).
gainImbalance	1,1	xsd:double	Ratio of variances of real and imaginary channels.
phaseOrthogonality	1,1	xsd:double	Phase Orthogonality (quadrature departure) (units = deg) A positive value represents positive I and Q axes less than 90 degrees apart.
rawDataHistogram	2,2	histogramList	Histogram of the raw data after BAQ decoding (one per data stream, i.e., real and imaginary).

7.3.2.2.4 Orbit and Attitude

product→sourceAttributes→orbitAndAttitude

Table 7-17 Orbit and Attitude

Name	Min, Max	Type	Description
orbitAndAttitudeDataStore			Orbit and Attitude Data Store.
orbitInformation	1,1	orbitInformationDataStore	Spacecraft orbit information used for processing.
attitudeInformation	1,1	attitudeInformationDataStore	Spacecraft attitude data used for processing.

7.3.2.2.4.1 Orbit Information

product→sourceAttributes→orbitAndAttitude→orbitInformation

Table 7-18 Orbit Information

Name	Min, Max	Type	Description
orbitInformationDataStore			Orbit Information Data Store.
passDirection	1,1	passDirectionIdentifiers	Direction of satellite pass defined at the start of the imaging acquisition activity.

Name	Min, Max	Type	Description
orbitDataSource	1,1	orbitDataSourceIdentifiers	Source of orbit data. Note: in the case where the input orbit data source was either requested (in the case of Product Generation) or configured (in the case of Catalogue Processing) as "Downlinked", and where PGS Ingest determined that at least one Downlinked State Vector was deemed unreliable and fell back to the corresponding either Definitive (if available) or Predicted State Vector (for that azimuth time), this field is then set to the fall back source of either "Definitive" (if available) or "Predicted".
withinOrbitTube	1,1	xsd:boolean	True if the spacecraft was predicted to be within the orbit tube at the time of imaging.
orbitDataFileName	1,1	xsd:anyURI	Name of orbit data file used during processing. If *orbitDataSource = Downlinked*, this file was only used for initial framing of the data.
stateVector	1,∞	stateVectorDataStore	State vector entries.

product→sourceAttributes→orbitAndAttitude→orbitInformation→stateVector

Table 7-19 State Vector

Name	Min, Max	Type	Description
stateVectorDataStore			State Vector Data Store. Earth Centered Rotating (ECR) coordinates.
timestamp	1,1	utcTimeType	Date/time stamp of current state vector.
xPosition	1,1	xsd:double	(units = m)
yPosition	1,1	xsd:double	(units = m)
zPosition	1,1	xsd:double	(units = m)
xVelocity	1,1	xsd:double	(units = m/s)
yVelocity	1,1	xsd:double	(units = m/s)
zVelocity	1,1	xsd:double	(units = m/s)

7.3.2.2.4.2 Attitude Information

product→sourceAttributes→orbitAndAttitude→attitudeInformation

Table 7-20 Attitude Information

Name	Min, Max	Type	Description
attitudeInformationDataStore			Attitude Information Data Store.
attitudeDataSource	1,1	attitudeSourceIdentifiers	Source of attitude data used for processing.
attitudeOffsetsApplied	1,1	xsd:boolean	True if Attitude offsets from the Payload Characterization Parameters file were applied prior to use of attitude data.
attitudeAngles	1,∞	attitudeAnglesDataStore	Attitude angles used during processing.

product→sourceAttributes→orbitAndAttitude→attitudeInformation→AttitudeAngles

Table 7-21 Attitude Angles

Name	Min, Max	Type	Description
attitudeAnglesDataStore			Attitude Angles Data Store. The attitude of the spacecraft is defined by its rotation from a state with the mechanical build axes initially parallel to the flight axes (Please refer to Figure 7-3). During imaging, the spacecraft is rolled about the XF axis, then pitched about the YF axis, then yawed about the ZF axis. The roll, pitch and yaw attitude angles are defined according to the right-hand rule. They have positive values when they represent a rotation that appears clockwise when looking in the positive direction of the axis, and negative values when the rotation appears counter-clockwise.
timestamp	1,1	utcTimeType	Date/time stamp of current attitude information.
yaw	1,1	xsd:double	Sensor yaw angle (units = deg)
roll	1,1	xsd:double	Sensor roll angle (units = deg)
pitch	1,1	xsd:double	Sensor pitch angle (units = deg)

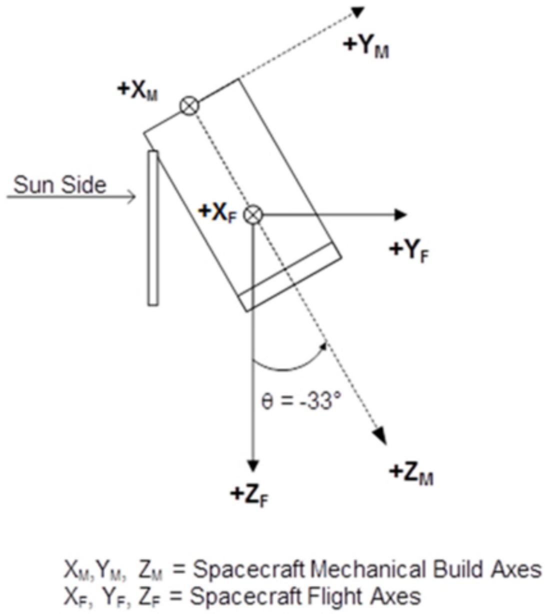

Figure 7-3 Illustration of Spacecraft Attitude Angles

7.3.2.3 Image Generation Parameters

Image generation parameters describe the processing applied to the source data to produce the output product.

product→imageGenerationParameters

Table 7-22 Image Generation Parameters

Name	Min, Max	Type	Description
imageGenerationParametersDataStore			Image Generation Parameters Data Store.
generalProcessingInformation	1,1	generalProcessingInformationDataStore	General information relating to processing location, date and software version
sarProcessingInformation	1,1	sarProcessingInformationDataStore	Detailed information describing the SAR processing parameters.
dopplerAnomalyFileName	0,1	xsd:anyURI	Name of the Doppler Anomaly Grid File See Section 7.3.2.6 for the format of this file. Refer to Table 4-8 for the applicability of this file.

Name	Min, Max	Type	Description
chirp	1, ∞	chirpDataStore	Describes the chirp parameters derived from the calibration pulses. One entry per polarization per beam. One attribute 'pulse' help to identify each chirp by its 'pulseId' which maps to the values of the 'pulses' entry in Radar Parameters. For ScanSAR the order of the entries is from near range to far range.
slantRangeToGroundRange	1,∞	slantRangeToGroundRangeDataStore	Slant Range to Ground Range conversion information.
hyperFitPhaseErrorCorr	0,1	hyperFitPhaseErrorCorrDataStore	Describes the Hyperbolic Fit Phase Error Correction at the time indicated in the record. Spotlight Mode only.
dynamicProcessingParameterFile	5,6	xsd:anyURI	Names of Dynamic Processing Parameter files used during processing. The PCP Spotlight Set file is only applicable to Spotlight mode.

7.3.2.3.1 General Processing Information

product→imageGenerationParameters→generalProcessingInformation

Table 7-23 General Processing Information

Name	Min, Max	Type	Description
generalProcessingInformationDataStore			General Processing Information Data Store.
productType	1,1	productTypeIdentifiers	The type of product.
polarizationsInProduct	1,1	polarizationList	List of all polarizations included in the product.
processingFacility	1,1	processingFacilityNameType	Unique (across the mission) identifier of a Processing Facility.
processingTime	1,1	utcTimeType	Date/time at which processing was performed.
softwareVersion	1,1	xsd:string	Version of software used to process the data.
processingMode	0,1	processingModeIdentifiers	The mode in which the data was processed into an Image Product.

Name	Min, Max	Type	Description
processingPriority	0,1	processingPriorityIdentifiers	The priority with which the data was processed into an Image Product. Not applicable if *processingMode* = "*NRT*" or "*Expedited*".

7.3.2.3.2 SAR Processing Information

product→imageGenerationParameters→sarProcessingInformation

Table 7-24 SAR Processing Information

Name	Min, Max	Type	Description
sarProcessingInformationDataStore			SAR Processing Information Data Store.
lutApplied	1,1	xsd:string	Output scaling LUT applied during processing.
perPolarizationScaling	1,1	xsd:boolean	If true, a polarization dependent application LUT has been applied for each polarization channel. Otherwise the same application LUT has been applied for all polarization channels. Not applicable to *lookupTable* = *"Unity*"* or if *dataType* = *"Floating-Point"*. For MLC off-diagonal element channel, the application LUT is derived from the application LUT applied to the two diagonal element channels (refer to [Table 4-9])
atmosphericCorrection	1,1	xsd:boolean	If true, atmospheric correction has been applied. If false, either not applicable or has not been applied.
elevationPatternCorrection	1,1	xsd:boolean	If true, antenna elevation pattern correction has been applied.
rangeSpreadingLossCorrection	1,1	xsd:boolean	If true, range spreading loss correction has been applied.
pulseDependentGainCorrection	1,1	xsd:boolean	If true, pulse dependent gain correction has been applied.
spotlightRadiometricCorrection	0,1	xsd:boolean	If true, spotlight radiometric correction has been applied. Spotlight mode only.

Name	Min, Max	Type	Description
noiseSubtractionPerformed	0,1	xsd:boolean	If true, the approximate expected mean instrument noise level has been subtracted from the imagery. Applicable only for ScanSAR GRD and ScanSAR GCD products.
receiverSettableGainCorrection	1,1	xsd:boolean	If true, receiver settable gain has been applied during processing.
rawDataCorrection	1,1	xsd:boolean	If true, raw data correction has been applied.
bistaticCorrectionApplied	1,1	xsd:boolean	If true, a bistatic correction has been applied (to account for the satellite's change of position between transmitting and receiving a pulse).
rangeReferenceFunctionSource	1,1	rangeReferenceFunctionSourceIdentifiers	Source of range reference function for this product.
interPolarizationCorrection	0,1	xsd:boolean	If true, inter-polarization correction has been applied. Only present for quad polarization SLC or GRC products.
atmosphericPropagationDelay	1,1	xsd:double	Applied propagation (range) delay attributable to the atmosphere. (units = us)
tecMapFileUsed	0,1	xsd:string	Identifies the TecMap filename which is used to estimate the TEC value for atmospheric correction. Applicable when atmosphericCorrection flag is set to true and subject to the availability of TecMap file corresponding to the date of data acquisition from the International Global Navigation Satellite Systems Service online access portal. Otherwise, tecMapFile is set to the empty string and 'estimatedTecValue' in the next row is set to zero.
estimatedTecValue	0,1	xsd:double	The estimated total electron content (units = TECU) used for atmospheric propagation delay calculation. Applicable when atmosphericCorrection flag is set to true. The value is set to zero if the TecMap file is not available, i.e., when tecFileUsed = ' '.

Name	Min, Max	Type	Description
txRxCorrCentreElevAngle	0, 1	xsd:double	Nominal elevation angle of the beam centre (units = deg), used as origin in the Transmit and Receive Correction amplitude and phase polynomials below. Applicable to quad polarization SLC products only and included if “interPolarizationCorrection” is set to true.
txCorrAmplitude11	0,1	interPoleCorrectionCoefficientList	Amplitude of element (1,1) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrAmplitude12	0,1	interPoleCorrectionCoefficientList	Amplitude of element (1,2) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrAmplitude21	0,1	interPoleCorrectionCoefficientList	Amplitude of element (2,1) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrAmplitude22	0,1	interPoleCorrectionCoefficientList	Amplitude of element (2,2) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.

Name	Min, Max	Type	Description
txCorrPhase11	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (1,1) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative totxRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrPhase12	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (1,2) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrPhase21	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (2,1) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
txCorrPhase22	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (2,2) in transmit correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.

Name	Min, Max	Type	Description
rxCorrAmplitude11	0,1	interPoleCorrectionCoefficientList	Amplitude of element (1,1) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrAmplitude12	0,1	interPoleCorrectionCoefficientList	Amplitude of element (1,2) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrAmplitude21	0,1	interPoleCorrectionCoefficientList	Amplitude of element (2,1) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrAmplitude22	0,1	interPoleCorrectionCoefficientList	Amplitude of element (2,2) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.

Name	Min, Max	Type	Description
rxCorrPhase11	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (1,1) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrPhase12	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (1,2) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrPhase21	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (2,1) in receive correction matrix given as a list of coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
rxCorrPhase22	0,1	interPoleCorrectionCoefficientList	Phase in degrees of element (2,2) in receive correction matrix given as a list of up to 5 coefficients of a polynomial in elevation angle (in degrees) relative to txRxCorrCentreElevAngle. The order of the polynomial coefficients is from constant term to the highest order. Applicable to quad polarization SLC or GRC products only and included if “interPolarizationCorrection” is set to true.
dopplerSource	1,1	dopplerSourceIdentifiers	The source of the Doppler centroid coefficients that has been used to process this product.
estimatedRollAngleUsed	1,1	xsd:boolean	If true, estimated roll angle has been used. Applicable to ScanSAR modes only. Always false for single beam and Spotlight products.

Name	Min, Max	Type	Description
estimatedRollAngle	0,1	xsd:double	Roll angle estimated by the processor. Only included if "estimatedRollAngleUsed" is set to true. (units = deg)
radiometricSmoothingPerformed	0,1	xsd:boolean	If true, radiometric smoothing was performed. Only present for ScanSAR.
zeroDopplerTimeFirstLine	1,1	utcTimeType	Zero Doppler date/time of the very first (top) line of the image data among all IPDFs in the product. Note that this time is the same for all polarizations in the product. For GCD and GCC products, this applies to intermediate image prior to geocoding. If north-south flipping has occurred (See Section 4.2), this value refers to the first line after the flip.
zeroDopplerTimeLastLine	1,1	utcTimeType	Zero Doppler date/time of the very last (bottom) line of the image data among all IPDFs in the product. Note that this time is the same for all polarizations in the product. For GCD and GCC products, this applies to the intermediate image prior to geocoding. If north-south flipping has occurred (See Section 4.2), this value refers to the last line after the flip.
numberOfLinesProcessed	1,4	xsd:integer	Number of input raw data echo lines processed for each polarization. Echo lines are acquired at the rate of one per transmitted pulse, per received polarization.
numberOfRangeLooks	1,1	xsd:integer	Number of looks used in range processing For ScanSAR beam mode products where the number of range looks varies by beam (i.e., perBeamNumberOfRange LooksUsed is true), this is the maximum value across all beams.
rangeLookBandwidth	1,1	xsd:double	Full bandwidth processed per range look. (units = Hz) For ScanSAR beam mode products where the number of range looks varies by beam (i.e., perBeamNumberOfRange LooksUsed is true), this is the maximum value across all beams.

Name	Min, Max	Type	Description
totalProcessedRangeBandwidth	1,1	xsd:double	Total bandwidth used during range processing. (units = Hz) For ScanSAR beam mode products where the number of range looks varies by beam (i.e., perBeamNumberOfRange LooksUsed is true), this is the maximum value across all beams.
perBeamNumberOfRangeLooksUsed	0,1	xsd:boolean	If true, the number of range looks has been applied to each of the ScanSAR beams in the beam list varies by beam. Applicable only for ScanSAR product types processed with a different number of rangelooks for each ScanSAR beam.
perBeamNumberOfRangeLooks	0,∞	xsd:integer	Number of range looks used in range processing for each of the ScanSAR beams in the beam list. Provided only if perBeamNumberOfRangeLooksUsed is true.
perBeamRangeLookBandwidths	0,∞	xsd:double	Full bandwidth processed per range look for each of the ScanSAR beams in the beam list. (units = Hz) Provided only if perBeamNumberOfRangeLooksUsed is true.
perBeamTotalProcessedRangeBand widths	0,∞	xsd:double	Total bandwidth used during range processing for each of the ScanSAR beams in the beam list. (units = Hz) Provided only if perBeamNumberOfRangeLooksUsed is true.
numberOfAzimuthLooks	1,1	xsd:integer	Number of azimuth looks.
scalarLookWeights	0,1	lookWeightList	Scalar weightings used in azimuth look summation, one value per look. Applicable only for Stripmap Non-Dual-HH-VV. Applied in processing only if azimuth antenna pattern compensation correction disabled by PGS configuration.
azimuthLookBandwidth	1,∞	xsd:double	For Continuous Stripmap products: the processed bandwidth per azimuth look. For Spotlight, ScanSAR and Dual HH-VV products: the azimuth bandwidth of each target in the scene (beam dependent for ScanSAR). (units = Hz)

Name	Min, Max	Type	Description
totalProcessedAzimuthBandwidth	1,∞	xsd:double	For Continuous Stripmap products: the total processed azimuth bandwidth. For Spotlight, ScanSAR and Dual HH-VV products: totalProcessedAzimuthBandwidth is equal to azimuthLookBandwidth. (units = Hz)
azimuthWindow	1,∞	windowDataStore	Windowing parameters used for azimuth processing, for each beam.
rangeWindow	1,1	windowDataStore	Windowing parameters used for range processing.
satelliteHeight	1,1	xsd:double	Satellite height above the reference ellipsoid computed by processor at scene center. (units = m)

product→imageGenerationParameters→sarProcessingInformation→window

Table 7-25 Window

Name	Min, Max	Type	Description
windowDataStore			Window Data Store.
windowName	1,1	windowNameIdentifiers	Name of window.
windowCoefficient	1,1	xsd:double	Window coefficient.

7.3.2.3.3 Chirp Parameters

product→imageGenerationParameters→chirp

Table 7-26 Chirp

Name	Min, Max	Type	Description
chirpDataStore			Chirp Data Store.
chirpQuality	1,1	chirpQualityDataStore	
chirpPower	1,1	xsd:double	Replica energy value calculated during processing. (units = dB)
amplitudeCoefficients	1,1	coefficientsList	List of range chirp amplitude coefficients. (1, s^-1, s^-2, s^-3, ...)

Name	Min, Max	Type	Description
phaseCoefficients	1,1	coefficientsList	List of range chirp phase coefficients. (cycles, Hz, Hz/s, Hz/s^2, ...)

product→imageGenerationParameters→chirp→chirpQuality

Table 7-27 Chirp Quality

Name	Min, Max	Type	Description
ChirpQualityDataStore			Chirp Quality Data Store
replicaQualityValid	1,1	xsd:boolean	False = unable to reconstruct chirp during processing or the quality is below acceptable levels when chirp reconstruction was requested. True = able to reconstruct all chirps or chirp reconstruction not requested (nominal chirp used) and all quality measures were acceptable.
crossCorrelationWidth	1,1	xsd:double	3-dB pulse width of chirp replica cross-correlation function between reconstructed chirp and nominal chirp (units = the original acquired slant range samples derivable from adcSamplingRate).
sideLobeLevel	1,1	xsd:double	First side lobe level of chirp replica cross-correlation function between reconstructed chirp and nominal chirp. (units = dB)
integratedSideLobeRatio	1,1	xsd:double	Integrated Side-Lobe Ratio of chirp replica cross-correlation function between reconstructed chirp and nominal chirp. (units = dB)
crossCorrelationPeakLoc	1,1	xsd:double	Cross correlation peak location. (units = the original acquired slant range samples derivable from adcSamplingRate)

7.3.2.3.4 Slant Range and Ground Range Conversion

product→imageGenerationParameters→slantRangeToGroundRange

Table 7-28 Slant Range to Ground Range

Name	Min, Max	Type	Description
slantRangeToGroundRangeDataStore			Slant Range to Ground Range Conversion Data Store. For GCC and GCD products, these fields apply to intermediate ground range samples prior to geocoding.
zeroDopplerAzimuthTime	1,1	utcTimeType	Zero Doppler date/time at which this entry applies.
slantRangeTimeToFirstRangeSample	1,1	xsd:double	2-way slant range time to first range sample for this entry. (units = s) For all products except ScanSAR SLC products, this first range sample means the nearest range sample of the range line of the image. For ScanSAR SLC products, this first range sample means the nearest range sample of the range line among all images of all beams.
groundRangeOrigin	1,1	xsd:double	Ground range reference position GR0 (see equation definition below). (units = m) Always set to ‘0.0’ for RCM.
groundToSlantRangeCoefficients	1,1	coefficientsList	List of polynomial coefficients for converting ground range to slant range in a ground range product (or from relative image range to slant range in a SLC product or an MLC product). Provided as n coefficients, n less than or equal to 13, s_0, s_1, s_{n-1}, where: Slant Range (units = m) = $s_0 + s_1(R - GR0) + \ldots + s_{n-1}(R\text{-}GR0)^{n-1}$; R is the ground range distance from the nearest-range image sample in a ground range product (or slant range distance from the nearest-range image sample in a SLC product or an MLC product). GR0 is the groundRangeOrigin.

7.3.2.3.5 Hyperbolic Fit Phase Error Correction

product→imageGenerationParameters→hyperFitPhaseErrorCorr

Table 7-29 Hyperbolic Fit Phase Error Correction

Name	Min, Max	Type	Description
hyperFitPhaseErrorCorrDataStore			Hyperbolic Fit Phase Error Correction Data Store (Spotlight only).
midAcquisitionTime	1,1	utcTimeType	Date/Time of Mid-Acquisition.
hyperFitPhaseErrorCorrCoefficients	1,1	coefficientsList	List of coefficients of the hyperbolic fit phase error correction polynomial: h0, h1, h2, h3, ... where: Hyperbolic Fit Phase Error Correction = h0 + h1(AT) + h2(AT)^2 + h3(AT)^3 + ... and AT is the azimuth (slow) time in seconds with respect to the mid-acquisition time. (units of h0, h1, h2, h3, ... are radians*sec^{0}, radians*sec^{-1}, radians*sec^{-2}, radians*sec^{-3}, …)

7.3.2.4 Image Reference Attributes

Image Reference Attributes describe the attributes which apply to all IPDFs.

product→imageReferenceAttributes

Table 7-30 Image Reference Attributes

Name	Min, Max	Type	Description
imageReferenceAttributesDataStore			Image Reference Attributes Data Store.
productFormat	1,1	productFormatIdentifiers	A string to identify the format of the IPDF (s).
outputMediaInterleaving	1,1	outputMediaInterleavingIdentifiers	The interleaving method used in image files. Set to “BSQ” for GeoTIFF format Set to “BSQ” for NITF format with a single polarization detected data in the IPDF(s). Set to “BIP” for NITF format with either multiple polarizations in the IPDF(s) or single polarization complex data in the IPDF(s). Set to “BIP” for GeoTIFF format with complex data in the IPDF(s).
lookupTableFileName	0,12	xsd:anyURI	Name of LUT Files.

Name	Min, Max	Type	Description
			The format of the LUT files is described in Section 7.5. Not available for geocoded (GCD or GCC) products.
incidenceAngleFileName	0, 1	xsd:anyURI	Name of Incidence Angles File. The applicability of Incidence Angle File is described in Section 4.6 and the content of an Incidence Angles file is described in Section 7.6.
noiseLevelFileName	0,4	xsd:anyURI	Name of Noise Level Files. The applicability of Noise Level Files is described in Section 4.6 and the content of a Noise Level File is described in Section 7.7.
compactPoleGainImbalanceFileName	0,1	xsd:anyURI	Name of Compact Pol Gain Imbalance File. The applicability of Compact Pol Gain Imbalance File is described in Section 4.8 and the content of a Compact Pol Gain Imbalance File is described in Section 7.8.
rasterAttributes	1,1	rasterAttributesDataStore	Raster attributes describing image sample type, line/pixel spacing and etc. on the image, Applicable equally to all polarizations.
geographicInformation	1,1	geographicInformationDataStore	Geographic information on the image. Applicable equally to all polarizations.

7.3.2.4.1 Raster Attributes

product→ imageReferenceAttributes→rasterAttributes

Table 7-31 Raster Attributes

Name	Min, Max	Type	Description
rasterAttributesDataStore			Raster Attributes Data Store.
sampleType	1,1	sampleTypeIdentifiers	Indicates the type of the sample. “Magnitude Detected” for GRD/GCD, “Complex” for SLC/GRC/GCC, “Mixed” for MLC.

Name	Min, Max	Type	Description
dataType	1,1	dataTypeIdentifiers	Indicates the value type of the sample.
bitsPerSample	1,3	xsd:unsignedLong	1 entry for GRD/GCD, 2 entries for SLC/GRC/GCC, 3 entries for MLC. One attribute dataStream ("Magnitude", "Real", and "Imaginary") indicating bitsPerSample value for Magnitude of Detected pixels, or Real and Imaginary parts of complex pixels, respectively.
sampledPixelSpacing	1,1	xsd:double	Sampled pixel spacing. (units = m)
sampledLineSpacing	1,1	xsd:double	Sampled line spacing calculated at middle range. (units = m)
sampledPixelSpacingTime	1,1	xsd:double	Sampled pixel spacing. (units = s), calculated at middle range. For GCD and GCC products, this applies to intermediate ground range image data prior to geocoding.
sampledLineSpacingTime	1,1	xsd:double	Sampled line spacing. (units = s) For GCD and GCC products, this applies to intermediate ground range image data prior to geocoding.
lineTimeOrdering	1,1	timeOrderingIdentifiers	Indicates whether line numbers (i.e., azimuth) increase or decrease with azimuth time. For GCD and GCC products, this applies to intermediate ground range image data prior to geocoding.
pixelTimeOrdering	1,1	timeOrderingIdentifiers	Indicates whether pixel number (i.e., range) increases or decreases with range time. For GCD and GCC products, this applies to intermediate ground range image data prior to geocoding.

7.3.2.4.2 Geographic Information

product→imageReferenceAttributes→geographicInformation

Table 7-32 Geographic Information

Name	Min, Max	Type	Description
geographicInformationDataStore			Geographic Information Data Store.
ellipsoidParameters	1,1	ellipsoidParametersDataStore	Parameters of the Earth Ellipsoid used for georeferencing of the image.
geolocationGrid	0,1	geolocationGridDataStore	A grid of tie points is included that relates the line/pixel positions in the image to latitude/longitude. Not included for geocoded products (GCD, GCC).
rationalFunctions	0,1	rationalFunctionsDataStore	Rational function geopositioning models for non-geocoded products. The rational functions provide a simplified mechanism for geo-positioning pixels in the image. They are computed from image tie points and are included for convenience only. Not included for geocoded products (GCD, GCC). For ScanSAR SLC, the *rationalFunctions* spans the range extent covered by the full product.
mapProjection	0,1	mapProjectionDataStore	Map Projections available for geocoded products (GCD, GCC) only.

7.3.2.4.2.1 Ellipsoid Parameters

product→imageReferenceAttributes→geographicInformation→ ellipsoidParameters

Table 7-33 Ellipsoid Parameters

Name	Min, Max	Type	Description
ellipsoidParametersDataStore			Ellipsoid Parameters Data Store.
ellipsoidName	1,1	ellipsoidNameIdentifiers	Name of ellipsoid used to process this product.
semiMajorAxis	1,1	xsd:double	Semi-major axis of the Earth ellipsoid. (units = m)
semiMinorAxis	1,1	xsd:double	Semi-minor axis of the Earth ellipsoid. (units = m)

Name	Min, Max	Type	Description
datumShiftParameters	1,1	datumShiftParametersList	Datum shift parameter referenced to Greenwich Meridian: dx. Datum shift parameter perpendicular to Greenwich Meridian: dy. Datum shift parameter direction of rotation axis: dz.
geodeticTerrainHeight	1,1	xsd:double	Estimated terrain height used as base elevation for geometric calculations and radiometric corrections during processing (units = m above reference ellipsoid). For GCD and GCC products with DEM corrections, this applies before geocoding and does not necessarily represent the elevations used to geocode the final image data.

7.3.2.4.2.2 Geolocation Grid

product→imageReferenceAttributes→geographicInformation→geolocationGrid

Table 7-34 Geolocation Grid

Name	Min, Max	Type	Description
geolocationGridDataStore			Geolocation Grid Datastore
imageTiePoint	0,∞	imageTiePoint	The estimated geodetic coordinates for a 2D grid of points. For all products except ScanSAR SLC the 2D grid includes the image corner pixels and points at regular intervals in between. For ScanSAR SLC products, the 2D grid is a subset of the COPG and fully covers all processed bursts. The 4 tie-points required to set the GeoTIFF tag *ModelTiepointTag* (Table 5-2) for each burst IPDF can be derived from this attribute via interpolation.

product→imageReferenceAttributes→geographicInformation→geolocationGrid→imageTiePoint

Table 7-35 Image Tie Point

Name	Min, Max	Type	Description
imageTiePoint			Image Tie-Point Data Store
imageCoordinate	1,1	imageCoordinate	Image coordinates of this tie point. Image coordinates (line and pixel)
geodeticCoordinate	1,1	geodeticCoordinate	Estimated geodetic coordinates of this tie point in the reference ellipsoid coordinate system. Errors on these estimates include ground range projection errors arising from the difference between the given terrain height and the true terrain height above the ellipsoid. geodeticCoordinate is described in Table 7-71.

7.3.2.4.2.3 Rational Functions

product→imageReferenceAttributes→geographicInformation→rationalFunctions

Table 7-36 Rational Functions

Name	Min, Max	Type	Description
rationalFunctionsDataStore			Rational Functions Data Store.
biasError	1,1	xsd:double	Non-time varying 1-sigma error estimate for correlated images measured in meters. (units = m)
randomError	1,1	xsd:double	Time varying 1-sigma error estimate for correlated images measured in meters. (units = m)
lineFitQuality	1,1	xsd:double	Indicates the quality of the line rational function fit. This value is the RMS line error.
pixelFitQuality	1,1	xsd:double	Indicates the quality of the pixel rational function fit. This value is the RMS pixel error.
lineOffset	1,1	xsd:integer	Offset used, in conjunction with Scale, to linearly transform line values to range of [-1.0,1.0]. The *lineOffset* is the offset measured against the origin of the COPG.

Name	Min, Max	Type	Description
pixelOffset	1,1	xsd:integer	Offset used, in conjunction with Scale, to linearly transform pixel values to range of [-1.0,1.0]. The *pixelOffset* is the offset measured against the origin of the COPG.
latitudeOffset	1,1	xsd:double	Offset used, in conjunction with Scale, to linearly transform latitude values to range of [-1.0,1.0]. (units = deg)
longitudeOffset	1,1	xsd:double	Offset used, in conjunction with Scale, to linearly transform longitude values to range of [-1.0,1.0]. (units = deg)
heightOffset	1,1	xsd:double	Offset used, in conjunction with Scale, to linearly transform height values to range of [-1.0,1.0]. (units = m above reference ellipsoid)
lineScale	1,1	xsd:integer	Scale used, in conjunction with Offset, to linearly transform line values to range of [-1.0,1.0].
pixelScale	1,1	xsd:integer	Scale used, in conjunction with Offset, to linearly transform pixel values to range of [-1.0,1.0].
latitudeScale	1,1	xsd:double	Scale used, in conjunction with Offset, to linearly transform latitude values to range of [-1.0,1.0].
longitudeScale	1,1	xsd:double	Scale used, in conjunction with Offset, to linearly transform longitude values to range of [-1.0,1.0].
heightScale	1,1	xsd:double	Scale used, in conjunction with Offset, to linearly transform height values to range of [-1.0,1.0].
lineNumeratorCoefficients	1,1	rationalFunctionCoefficientList	Coefficients representing the polynomial in the numerator of the rational function mapping latitude, longitude and height to line.
lineDenominatorCoefficients	1,1	rationalFunctionCoefficientList	Coefficients representing the polynomial in the denominator of the rational function mapping latitude longitude and height to line.
pixelNumeratorCoefficients	1,1	rationalFunctionCoefficientList	Coefficients representing the polynomial in the numerator of the rational function mapping latitude, longitude and height to pixel.

Name	Min, Max	Type	Description
pixelDenominatorCoefficients	1,1	rationalFunctionCoefficientList	Coefficients representing the polynomial in the denominator of the rational function mapping latitude, longitude and height to pixel.

The geometric sensor model describing the precise relationship between image coordinates and geodetic coordinates is known as a Rigorous Projection Model. A Rigorous Projection Model expresses the mapping of the image space coordinates of rows and columns (r, c) onto the object space reference surface geodetic coordinates (φ, λ, h).

The RCM product supports a common approximation to the Rigorous Projection Models (same as RADARSAT-2). The approximation used is a set of rational polynomials expressing the normalized row and column values, (r_n, c_n), as a function of normalized geodetic latitude, longitude, and height, (P, L, H), given a set of normalized polynomial coefficients (LINE_NUM_COEF_n, LINE_DEN_COEF_n, SAMP_NUM_COEF_n, SAMP_DEN_COEF_n). Normalized values, rather than actual values are used in order to minimize introduction of errors during the calculations. The transformation between row and column values (r,c), and normalized row and column values (r_n, c_n), and between the geodetic latitude, longitude, and height (φ, λ, h), and normalized geodetic latitude, longitude, and height (P, L, H), is defined by a set of normalizing translations (offsets) and scales that ensure all values are contained in the range -1.0 to +1.0.

P = (Latitude - LAT_OFF) ÷ LAT_SCALE

L = (Longitude - LONG_OFF) ÷ LONG_SCALE

H = (Height - HEIGHT_OFF) ÷ HEIGHT_SCALE

r_n = (Row - LINE_OFF) ÷ LINE_SCALE

c_n = (Column - SAMP_OFF) ÷ SAMP_SCALE

The rational function polynomial equations are defined as:

$$r_n = \frac{\sum_{i=1}^{20} \text{LINE\_NUM\_COEF}_i \cdot \rho_i(P,L,H)}{\sum_{i=1}^{20} \text{LINE\_DEN\_COEF}_i \cdot \rho_i(P,L,H)} \text{ and } c_n = \frac{\sum_{i=1}^{20} \text{SAMP\_NUM\_COEF}_i \cdot \rho_i(P,L,H)}{\sum_{i=1}^{20} \text{SAMP\_DEN\_COEF}_i \cdot \rho_i(P,L,H)}$$

The rational function polynomial equation numerators and denominators each are 20-term cubic polynomial functions of the form:

$$\sum_{i=1}^{20} C_1 \cdot \rho_i(P, L, H) =$$

$$\begin{array}{llll} C_1 & +C_6 \cdot L \cdot H & +C_{11} \cdot P \cdot L \cdot H & +C_{16} \cdot P^3 \\ +C_2 \cdot L & +C_7 \cdot P \cdot H & +C_{12} \cdot L^3 & +C_{17} \cdot P \cdot H^2 \\ +C_3 \cdot P & +C_8 \cdot L^2 & +C_{13} \cdot L \cdot P^2 & +C_{18} \cdot L^2 \cdot H \\ +C_4 \cdot H & +C_9 \cdot P^2 & +C_{14} \cdot L \cdot H^2 & +C_{19} \cdot P^2 \cdot H \\ +C_5 \cdot L \cdot P & +C_{10} \cdot H^2 & +C_{15} \cdot L^2 \cdot P & +C_{20} \cdot H^3 \end{array}$$

where coefficients $C_1 \cdots C_{20}$ represent the following sets of coefficients:

LINE_NUM_COEF_n, LINE_DEN_COEF_n, SAMP_NUM_COEF_n, SAMP_DEN_COEF_n

The image coordinates are in units of pixels. The ground coordinates are latitude and longitude in units of decimal degrees and the geodetic elevation in units of meters. The ground coordinates are referenced to WGS-84, and pixel and line numbers start at 0.

7.3.2.4.2.4 Map Projection

product→imageReferenceAttributes→geographicInformation→mapProjection

Table 7-37 Map Projection

Name	Min, Max	Type	Description
mapProjectionDataStore			Map Projection Data Store.
mapProjectionDescriptor	1,1	mapProjectionDescriptorIdentifiers	Map Projection used during geocoding.
mapProjectionOrientation	1,1	xsd:double	Map Projection Orientation (units = deg). The orientation angle is measured clockwise from the map x axis to the image pixel axis. For an orientation angle of zero, the x and pixel axes are parallel and the y and line axes are opposed.
productOrientation	1,1	productOrientationIdentifiers	Image Orientation of the product.
resamplingKernel	1,1	resamplingKernelIdentifiers	Resampling kernel used during geocoding to map projection. Note: This applies to SAR data resampling only. Interpolation of DEM data during geocoding (if applicable) is always bilinear.

Name	Min, Max	Type	Description
elevationCorrection	1,1	elevationCorrectionIdentifiers	Elevation Correction Method used during geocoding.
baseElevation	0,1	xsd:double	Base Elevation used during geocoding. Provided only when elevationCorrection = “Base”. (units = m)
satelliteHeading	1,1	xsd:double	Satellite ground track heading in degrees east of North. (units = deg)
utmProjectionParameters	0,1	utmProjectionParametersDataStore	Universal Transverse Mercator Projection (UTM). UTM Grid (or coordinate system) makes use of the Universal Polar Stereographic (UPS) NORTH projection, north of 84N, the UPS SOUTH projection, south of 80S, and one of 120 UTM projections elsewhere. Note that the two polar projections are azimuthal, while the other ones are cylindrical. Present when Universal Transverse Mercator Projection is used. Note: one of utmProjectionParameters and nspProjectionParameters must be present.
nspProjectionParameters	0,1	nspProjectionParametersDataStore	National Systems Projection (any others). Present when National Systems Projection is used. Note: one of utmProjectionParameters and nspProjectionParameters must be present.
positioningInformation	1,1	mapCornersDataStore	Corner positioning of output image.

product→imageReferenceAttributes→geographicInformation→mapProjection→utmProjectionParameters

Table 7-38 UTM Projection Parameters

Name	Min, Max	Type	Description
utmProjectionParametersDataStore			UTM Projection Data Store.
utmZone	0,1	xsd:integer	Range from 1 to 60 (applicable to UTM only).
hemisphere	1,1	hemisphereIdentifiers	Northern or Southern. Required for UTM and UPS.
mapOriginFalseEasting	0,1	xsd:double	For UTM, set to ‘500000’; For UPS, set to ‘2000000’. (units = m)

Name	Min, Max	Type	Description
mapOriginFalseNorthing	0,1	xsd:double	For UTM, if Hemisphere = ‘S’, set to ‘10000000’, otherwise set to ‘0’; For UPS, set to ‘2000000’. (units = m)

product→imageReferenceAttributes→geographicInformation→mapProjection→nspProjectionParameters

Table 7-39 NSP Projection Parameters

Name	Min, Max	Type	Description
nspProjectionParametersDataStore			NSP Projection Data Store. To support ARC, LCC, STPL, for which not all the following entries are required.
mapOriginFalseEasting	0,1	xsd:double	(units = m)
mapOriginFalseNorthing	0,1	xsd:double	(units = m)
centerOfProjectionLongitude	0,1	xsd:double	(units = deg)
centerOfProjectionLatitude	0,1	xsd:double	(units = deg)
standardParallels1	0,1	xsd:double	(units = deg)
standardParallels2	0,1	xsd:double	(units = deg)
zone	0,1	xsd:integer	Range 0 to 65535. Applicable for ARC and STPL.

product→imageReferenceAttributes→geographicInformation→mapProjection→mapCorners

Table 7-40 Map Corners

Name	Min, Max	Type	Description
mapCornersDataStore			Map Corners Data Store.
upperLeftCorner	1,1	mapTiePoint	Coordinates of upper left corner of product.
upperRightCorner	1,1	mapTiePoint	Coordinates of upper right corner of product.
lowerRightCorner	1,1	mapTiePoint	Coordinates of lower right corner of product.
lowerLeftCorner	1,1	mapTiePoint	Coordinates of lower left corner of product.

product→imageReferenceAttributes→mapProjection→mapCorners→mapTiePoint

Table 7-41 Map Tie Point

Name	Min, Max	Type	Description
mapTiePoint			Map Tie-Point Data Store.
mapCoordinate	1,1	mapCoordinate	Map coordinates (northing and easting).
geodeticCoordinate	1,1	geodeticCoordinate	Geodetic coordinates (latitude, longitude, height).

7.3.2.5 Scene Attributes

Scene Attributes provide characteristics of the content of all the IPDFs in the product, covering the entire acquired scene.

product→sceneAttributes

Table 7-42 Scene Attributes

Name	Min, Max	Type	Description
sceneAttributesDataStore			Scene Attributes Data Store.
numberOfEntries	1,1	xsd:integer	Number of entries in imageAttributes.
imageAttributes	1, ∞	imageAttributesDataStore	Image attributes. Provides characteristics for the content of all the IPDFs in the product. Applicable to all polarizations in the product. 1. For ScanSAR SLC products, one imageAttributes element per imaged burst. 2. For all other products, a single imageAttributes element for the entire product.

7.3.2.5.1 Image Attributes

Image attributes describe image-related information such as IPDFs' image origin and location (Refer to Appendix B) on the COPG and radiometric information.

product→sceneAttributes->imageAttributes

Table 7-43 Image Attributes

Name	Min, Max	Type	Description
imageAttributesDataStore			Image Attributes Data Store. One attribute *sampleType* indicating the sample type. (e.g., *sampleType="Magnitude Detected " or "Complex" or "Mixed" for MLC*). One attribute *burst* that specifies the burst number (starting at 0) to which the imageAttributesDataStore entry applies. Numbering of bursts is in the order of their acquisition. Applicable to ScanSAR SLC only. One attribute beam, which specifies the beam to which the imageAttributesDataStore entry applies. Applicable to ScanSAR SLC, Single Beam and Spotlight.
ipdf	1,4	xsd:anyURI	File names for full resolution IPDFs. For GeoTIFF format, one entry per pole; For NITF 2.1 format, only one entry. One attribute *pole* indicating the polarization type (e.g., *pole="HH "*). For the complex IPDF of MLC product, *pole* is set to "XC".
pixelOffset	1,1	xsd:integer	Offset of the first (left) range sample of the image with respect to the range origin of the COPG, expressed in range samples. In the case of GCD/GCC products, offset of the first (left) range sample of the image (COPG not applicable).
lineOffset	1,1	xsd:integer	Offset of the first (top) line in the image with respect to the azimuth origin of the COPG, expressed in lines. In the case of GCD/GCC products, offset of the first (top) line in the image (COPG not applicable).
numLines	1,1	xsd:unsignedLong	Number of lines in the image
samplesPerLine	1,1	xsd:unsignedLong	Number of samples (pixels) per line of imagery (including any black-filled samples).

Name	Min, Max	Type	Description
incAngNearRng	1, 1	xsd:double	Incidence angle at near range, measured at mid-azimuth position of the image data. (units = deg) For GCC and GCD products, this applies to intermediate ground range image data prior to geocoding. If Left-Right flipping has occurred (See Section 4.2), this value refers to the last pixel of the range line after the flip.
incAngFarRng	1, 1	xsd:double	Incidence angle at far range, measured at mid-azimuth position of the image data. (units = deg) For GCC and GCD products, this applies to intermediate ground range image data prior to geocoding. If Left-Right flipping has occurred (See Section 4.2), this value refers to the first pixel of the range line after the flip.
slantRangeNearEdge	1, 1	xsd:double	Slant range to near edge closest to the satellite, measured at mid-azimuth position of the image data. (units = m) For GCC and GCD products, this applies to intermediate ground range image data prior to geocoding. If Left-Right flipping has occurred (See Section 4.2), this value refers to the last pixel of the range line after the flip.
slantRangeFarEdge	1, 1	xsd:double	Slant range to far edge furthest from the satellite measured at mid-azimuth position of the image data. (units = m) For GCC and GCD products, this applies to intermediate ground range image data prior to geocoding. If Left-Right flipping has occurred (See Section 4.2), this value refers to the first pixel of the range line after the flip.
mean	1,4	doubleListType	Mean value of output pixels, one entry per pole. For detected product, each entry only has one value for its magnitude. For complex product, each entry has two values (*real*, *imag*) for its real and imagery parts respectively. One attribute *pole* indicating the polarization type (e.g., *pole="HH "*). For the complex IPDF of MLC product, *pole* is set to “XC”.

Name	Min, Max	Type	Description
sigma	1,4	doubleListType	Standard deviation of output pixels, one entry per pole. For detected product, each entry only has one value for its magnitude. For complex product, each entry has two values (*real*, *imag*) for its real and imagery parts respectively. One attribute *pole* indicating the polarization type (e.g., *pole="HH "*). For the complex IPDF of MLC product, *pole* is set to "XC".

7.3.2.6 Burst Map

The Burst Map describes the location of each image burst either within a GRD image obtained from ScanSAR or Stripmap Dual HH-VV data, or within a MLC image obtained from ScanSAR Dual Co/Cross polarization or ScanSAR compact polarization data.

product→burstMap

Table 7-44 Burst Map

Name	Min, Max	Type	Description
burstMapDataStore			Burst Map Data Store. One attribute pole that specifies the polarization to which burstMapDataStore applies. Applicable to Dual HH-VV products only.
numberOfEntries	1,1	xsd:integer	Number of burstAttributes entries.
numberOfBeams	1,1	xsd:integer	The number of beams in the beam list.
burstAttributes	1,∞	burstAttributesDataStore	A list of burst attributes to describe the position of each image burst within the GRD or MLC image.

7.3.2.6.1 Burst Attributes

product→ burstMap→burstAttributes

Table 7-45 Burst Attributes Data Store

Name	Min, Max	Type	Description
burstAttributesDataStore			Burst Attributes Data Store. Describes the position of an image burst within a ScanSAR or Stripmap Dual HH-VV GRD image or within a ScanSAR MLC image. Note that all line and pixel values in this data store refer to the final image (after it has been flipped, if necessary, as per Table 4-5). One attribute, beam, which specifies the beam to which the burstAttributesDataStore entry applies. One attribute, burst, that specifies the bursts number (starting at 0) to which the burstAttributesDataStore entry applies. Numbering of bursts is in the order of their acquisition within a polarization channel (refer to Figure 7-4 and Figure 7-5 for an illustration of the burst numbering convention). Applicable to ScanSAR and Dual HH-VV only.
topLeftLine	1,1	xsd:integer	Line number (starting at 0) of the top-left pixel of the image burst in the final product.
topLeftPixel	1,1	xsd:integer	Pixel number (starting at 0) of the top-left pixel of the image burst in the final product.
bottomRightLine	1,1	xsd:integer	Line number (starting at 0) of the bottom-right pixel of the image burst in the final product.
bottomRightPixel	1,1	xsd:integer	Pixel number (starting at 0) of the bottom-right pixel of the image burst in the final product.

The purpose of the burst map metadata is to identify the location of individual image bursts in the GRD or MLC product images. The use of the term “burst” in this context is attributable to the fact that in a single azimuth look burst mode GRD image, each image burst in the product image originates from a corresponding acquired burst in the raw data.

The bursts in the product image are numbered and are included in the burst map in the order of their acquisition within a polarization channel. Also, as kept within a burstAttributes record:

- The top-left (TL) pixel refers to the top-left pixel of a block to extract the full image burst from the product image.
- The bottom-right (BR) pixel refers to the bottom-right pixel of a block to extract the full image burst from the product image.

Note that due to the East-Right and North-Up nominal orientation of the RCM product images, which is achieved by flipping the generated image prior to its inclusion in the product, as described at the end of Section 4.2 and Table 4-5, the TL and BR pixel values can be different from the index of the corresponding acquired pixels.

As an example, Figure 7-4 and Figure 7-5 below illustrate the burst numbering convention in the image for a (right-looking) Ascending case. In this case, the first image burst which is produced from the first acquired burst is located at the lower left corner of the raster image.

Figure 7-4 and Figure 7-5 also illustrate black-fill pixels at both the near and far range edges of the image. This type of black-fill is introduced when a Sample Window Start Time (SWST) change occurs during the acquisition of the data.

In addition, there may be areas of orphaned imagery along the top or bottom of the imagery which have not been allocated to a ScanSAR or Stripmap Dual HH-VV image burst. This occurs because of the combination of overlap between adjacent beams and the illumination time offset between each beam within a ScanSAR or Stripmap Dual HH-VV cycle.

Stripmap Dual-HH products will be similar to the ScanSAR Dual HH-VV products except Stripmap Dual HH-VV products have only one beam.

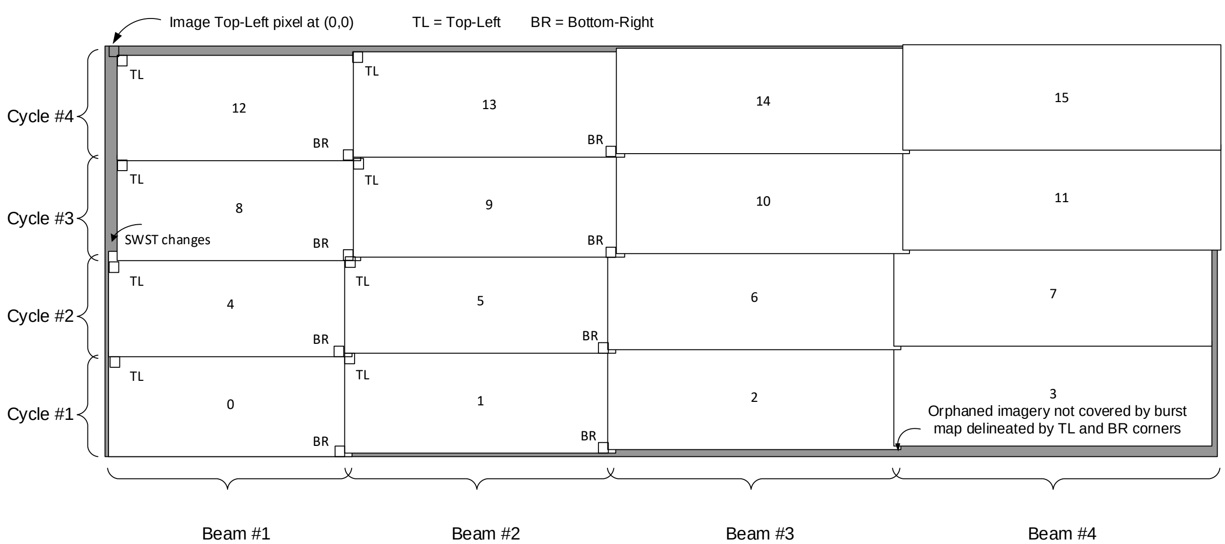

Figure 7-4 Illustration of One ScanSAR Non-Dual HH-VV Image Burst Map Example

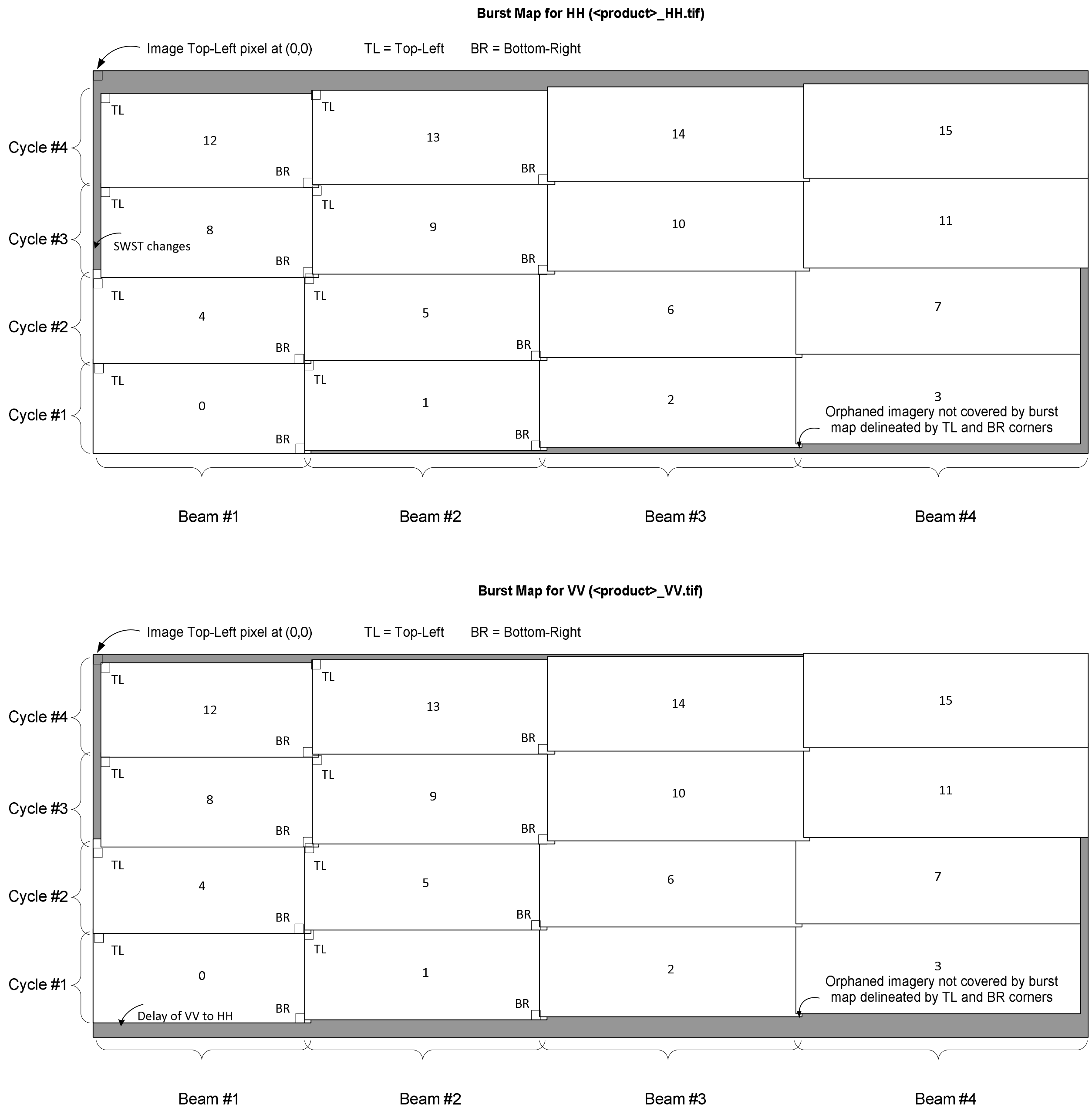

Figure 7-5 Illustration of one ScanSAR Dual HH-VV Image Burst Map Example

7.3.2.7 Doppler Centroid

product→dopplerCentroid

Table 7-46 Doppler Centroid

Name	Min, Max	Type	Description
dopplerCentroidDataStore			Doppler Centroid Data Store. One attribute, pole, that specifies the polarization to which dopplerCentroidDataStore applies. Applies to Dual HH-VV products only.
numberOfEstimates	1,1	xsd:integer	Number of dopplerCentroidEstimate entries.
dopplerCentroidEstimate	1,∞	dopplerCentroidEstimateDataStore	Doppler centroid estimate.

7.3.2.7.1 Doppler Centroid Estimate

product→dopplerCentroid->dopplerCentroidEstimate

Table 7-47 Doppler Centroid Estimate

Name	Min, Max	Type	Description
dopplerCentroidEstimateDataStore			Doppler Centroid Estimate Data Store. 1. For Scansar and Stripmap Dual HH-VV, valid over the range extent of the burst specified by the *burst* XML attribute. 2. For all other modes, valid over the entire range extent of the image The range of validity is derivable from: 1. The Burst Attributes of the same *burst*, for ScanSAR, Stripmap Dual HH-VV GRD products and ScanSAR MLC products (see Table 7-45). 2. The Image Attributes, for all other products (see Table 7-43). One attribute, *burst*, that specifies the burst number (starting at 0) to which the dopplerCentroidDataStore entry applies. Numbering of bursts is in the order of their acquisition. Applicable to Scansar and Stripmap Dual HH-VV only.
timeOfDopplerCentroidEstimate	1,1	utcTimeType	Zero-Doppler time of the Doppler centroid estimate.

Name	Min, Max	Type	Description
dopplerAmbiguity	1,1	xsd:integer	Doppler ambiguity number used during processing.
dopplerCentroidReferenceTime	1,1	xsd:double	2-way slant range time (t0) used as reference in Doppler centroid polynomial calculation. (units = s)
dopplerCentroidCoefficients	1,1	coefficientsList	List of up to 5 coefficients (d0 to d4) of a polynomial that defines the Doppler centroid, fdc, as a function of slant range time, t: fdc(t) = d0 + d1*(t-t0) + d2*(t-t0)^2 + d3*(t-t0)^3 + d4*(t-t0)^4. (units = Hz)
dopplerCentroidConfidence	1,1	xsd:double	Doppler centroid confidence estimate. Range from 0.0 (no confidence) to 1.0 (highest confidence).

7.3.2.8 Doppler Rate

product→dopplerRate

Table 7-48 Doppler Rate

Name	Min, Max	Type	Description
dopplerRateDataStore			Doppler Rate Data Store. One attribute, pole, that specifies the polarization to which dopplerRateDataStore applies. This attribute is applicable to Dual HH-VV products only.
numberOfEstimates	1,1	xsd:integer	Number of dopplerRateEstimate entries. For Scansar SLC, must be equal to the number of imaged bursts.
dopplerRateEstimate	1, ∞	dopplerRateEstimateDataStore	Doppler rate Estimate.

7.3.2.8.1 Doppler Rate Estimate

product→dopplerRate->DopplerRateEstimate

Table 7-49 Doppler Rate Estimate

Name	Min, Max	Type	Description
dopplerRateEstimateDataStore			Doppler Rate Data Store. One attribute, *burst*, that specifies the burst number (starting at 0) to which the dopplerRateEstimateDataStore entry applies. Numbering of bursts is in the order of their acquisition. This attribute is only applicable to Strimap Dual HH-VV and Scansar.
timeOfDopplerRateEstimate	1,1	utcTimeType	Date/time stamp of the Doppler rate estimate. For ScanSAR SLC products, must coincide with the burst center time (at start of transmit) that was used during processing.
dopplerRateReferenceTime	1,1	xsd:double	2-way slant range time (t0) used as reference in Doppler rate polynomial calculation. (units = s)
dopplerRateCoefficients	1,1	coefficientsList	List of up to 5 coefficients (r0 to r4) of a polynomial that defines the Doppler frequency rate, Ka, as a function of slant range time, t: Ka(t)= r0 + r1*(t- t0) + r2*(t-t0)^2 + r3*(t-t0)^3 + r4*(t-t0)^4. (units = Hz/s)

7.4 Doppler Anomaly Grid File

The Doppler Anomaly Grid contains Doppler centroid values from orbit and attitude data, Doppler centroid values adaptively estimated from the signal data and related quality measures (see also Section 4.4). The sample spacing of this grid is no greater than 2 km in both ground range and azimuth directions. *Note that the 2 km grid size does not represent independent post spacing.*

Table 7-50 Doppler Anomaly Grid

Name	Min, Max	Type	Description
DopplerAnomalyGrid	1,1		RCM Doppler Anomaly Grid.
DopplerAnomalyGridCell	1, ∞	DopplerAnomalyGridCellDataStore	Elements of the Doppler Anomaly Grid.

Table 7-51 Doppler Anomaly Grid Cell

Name	Min, Max	Type	Description
DopplerAnomalyGridCellDataStore			Doppler Anomaly Grid Cell.
geodeticCellCentre	1,1	geodeticCoordinate	Geodetic coordinates at the center of the cell.
geometryDopplerCentroid	1,1	xsd:double	Doppler centroid frequency from geometry. (unit = Hz)
estimatedDopplerCentroid	1,1	xsd:double	Doppler centroid frequency adaptively estimated from the signal data. (unit = Hz)
estimatedDopplerCentroidQuality	1,1	xsd:double	Quality of Doppler centroid estimate which is measured as the reciprocal of the scaled RMS difference between the measured Look-Power-Ratio (LPR) and the theoretical LPR. A high/low value means the associated Doppler estimate is more/less reliable respectively. The measure is dimensionless.
cellSlantRangeTime	1,1	xsd:double	2-way slant range time corresponding to geodeticCellCentre. (units = s)
cellAzimuthTime	1,1	utcTimeType	Azimuth UTC time corresponding to geodeticCellCentre.

7.5 Look-Up Tables (LUT) Files

LUTs allow one to convert the digital numbers found in the output product to *sigma-nought*, *beta-nought*, or *gamma* values (depending on which LUT is used) by applying a constant offset and range dependent gain to the SAR imagery.

7.5.1 Schema Details

The format of a LUT file is shown in Table 7-52.

Table 7-52 LUT

Name	Min,Max	Type	Description
lut			RCM LUT
pixelFirstLutValue	1,1	xsd:integer	Pixel number corresponding to the first value of the *gains* list. The pixel is indexed from the leftmost range sample of the full range line and starts with '0' with respect to the range start of the COPG.
stepSize	1,1	xsd:integer	Number of range pixels between *gains* entries. The sign of stepSize (positive or negative) depends on *pixelTimeOrdering* which indicates the samples increase or decrease with range time order.
numberOfValues	1,1	xsd:integer	Number of entries in *gains*.
offset	1,1	xsd:double	Constant offset (B).
gains	1,1	gainList	Range dependent gain list (A) (linear amplitude scale factors).
Note: 1. The *gains* list spans the range extent covered by all beams (if applicable). *2.* The mapping between the entry of *gains* list and the range sample index is: *the range sample index = gains entry index * stepSize + pixelFirstLutValue, where the gains entry index starts with '0'*. For ScanSAR SLC, *the range sample index* refers to the index on the COPG.			

For detected products (GRD), in order to convert the digital number of a given range sample to a calibrated value, the digital value is first *squared*, then the *offset* (*B*) is added and the result is divided by the gains value (*A*) corresponding to the range sample.

$$calibrated\ value = \frac{digital\ value^2 + B}{A}$$

The offset (B) is nominally set to zero, except for ScanSAR products of type GRD with noise subtraction applied, for which the offset (B) is typically set to a negative value, as described in the next section.

For complex products including SLC and GRC, the *square* of the modulus of the complex digital value is divided by the *square* of the gain value (*A*) corresponding to the range sample according to the following formula:

$$calibrated\ value = \frac{|digital\ value|^2}{A^2}$$

For MLC products, in order to convert the digital number of a given range sample to a calibrated value for all three covariance channels (C_{11}, C_{22} and C_{12}), the digital value is first *squared*, then divided by the gains value (*A*) corresponding to the range sample. The same process applies to both the detected IPDFs and the complex IPDF. The only difference for the complex IPDF is that the modulus of the complex digital value is taken before it is squared and divided by A.

$$calibrated\ value = \frac{|digital\ value|^2}{A}$$

In all cases above, the calibrated value is a real number representing power and is one of *sigma-nought*, *beta-nought*, or *gamma*, depending on the selected LUT.

The calibrated value includes contributions from both radar backscatter and various sources of noise. For georeferenced products, the PIF provides estimates of the expected additive instrument noise equivalent contribution. For ScanSAR products of type GRD with noise subtraction applied, these estimates are subtracted from the image data during processing, and the resulting calibrated values are reduced accordingly (see Section 7.5.2).

The values in these output scaling LUTs depend, among other factors, on the user-selected application look-up table (application LUT) that is used to convert the processor determined calibrated values into the digital values stored in the product.

7.5.2 Calibrated Values in Noise Subtracted ScanSAR Products

For ScanSAR products of type GRD with noise subtraction applied, an estimate of the expected contribution from additive thermal instrument noise has been subtracted from each image pixel, and the resulting calibrated values are reduced accordingly. Due to the statistical nature of SAR imaging and the randomness of the noise, for some pixels the digital value before noise subtraction may be lower than the subtracted noise estimate, and for such pixels the calibrated value will be negative. If an offset (B) of zero were to be used for such products, these negative calibrated valued pixels would be clipped to zero. Such clipping is undesirable because it has the potential to skew the statistics in areas of low signal. Thus, negative offsets (B) are used.

$$digital\ value = \sqrt{A\ * (pixel\ power\ value - N) - B}$$

where N is the estimated noise power, *A* is the gains value.

The offsets (B) are pre-determined and derived specifically for each application LUT as a function of nominal noise levels (as such, they are not adaptively determined). The offsets (B) are used to reduce the number of clipped pixels, such that the statistics are not excessively skewed given the user selected application LUT and the number of bits per image pixel. Note however that this may not necessarily eliminate all clipped pixels.

When applying an output scaling LUT to a noise subtracted ScanSAR product, thus implicitly including a negative non-zero offset (B), the potentially negative calibrated values may be reconstituted. In particular, with the application of a selected LUT with a higher offset (B) value so as to minimize the number of clipped pixels, it may be necessary to select “Output Pixel Type” = “Floating Point” to reduce potential saturation.

7.5.3 Obtaining Calibrated Values from Geocoded Products

For geocoded (GCD, GCC) products, no output scaling LUT files are provided, as the one-dimensional range scaling method described above does not apply to image data that has been rotated to map coordinates. Thus, in general, calibrated values cannot be obtained from geocoded products.

However, for geocoded products processed with certain application LUTs only, specific calibrated values can be obtained by applying one of the above formulas based on the product type (detected or complex) with the gain value (A) set as per the table below, and the offset (B) set to zero. Thus, for example:

- Referring to the first line of the table, for GCD products processed with the “Constant-sigma” application LUT, calibrated sigma-nought values can be obtained by applying the above formula for detected products with A = 1.3583e7 for 16-bit products, and B = 0.

- Referring to the last line of the table, for GCC products processed with the "Calibration-1" application LUT, calibrated beta-nought values can be obtained by applying the above formula for complex products with A = 398.11 for 16-bit products, and B = 0.

Table 7-53 Gain values (A) for calculating calibrated values in geocoded products

Application LUT	Calibrated value	"A" for 16-bit Products
Constant-Sigma	Sigma-nought	1.3583e7
Constant-Gamma	Gamma	1.3583e7
Constant-Beta	Beta-nought	1.3583e7
Point target	Beta-nought	398.11
Calibration-1	Beta-nought	398.11
Calibration-2	Beta-nought	398.11

7.6 Incidence Angle File

Incidence angles for each range sample in the imagery are included with georeferenced products only. The format of an Incidence Angle File is shown in Table 7-54.

Table 7-54 Incidence Angles

Name	Min,Max	Type	Description
incidenceAngles			Incidence angles.
pixelFirstAnglesValue	1,1	xsd:integer	Pixel number corresponding to the first value of *angles* list. The pixel is indexed from the leftmost range sample of the full range line and starts with '0' with respect to the range start of the COPG.
stepSize	1,1	xsd:integer	Number of range pixels between *angles.* The sign of stepSize (positive or negative) depends on *pixelTimeOrdering* which indicates the samples increase or decrease with range time order.
numberOfValues	1,1	xsd:integer	Number of entries in angles.
angles	1, ∞	xsd:double	Angle for each range sample. (units = deg)

Name	Min,Max	Type	Description
Note: 1. The *angles* list spans the range extent covered by all beams (if applicable). 2. The mapping between the entry of angles list and the range sample index is the range sample index = angles entry index* *stepSize + pixelFirstAnglesValue , where angles entry index starts with '0'*. For ScanSAR SLC, the *range sample index* refers to the index on the COPG.			

7.7 Noise Level File

Noise Level File information per polarization is included with georeferenced products only. For ScanSAR MLC products, two noise level files are supplied for the two diagonal covariance matrix elements respectively. They do not apply to the ScanSAR MLC off-diagonal covariance matrix element.

The format of a Noise Level file is shown in Table 7-55.

Table 7-55 Noise Level File

Name	Min, Max	Type	Description
noiseLevels			Noise level information. *The information provided in this record applies to georeferenced images only.*
referenceNoiseLevel	0, 3	referenceNoiseLevelDataStore	Estimated mean image noise level as a function of georeferenced image pixel in range. One vector for beta nought, sigma nought, and gamma respectively. This field applies to all products except ScanSAR SLC products. For ScanSAR GRD products, if noise subtraction was performed, the beta-nought vector represents a first order approximation to the range dependent reference noise level that was used in the noise subtraction.
perBeamReferenceNoiseLevel	0, ∞	perBeamReferenceNoiseLevelDataStore	Estimated mean image noise levels as a function of georeferenced image pixel in range per beam. One vector for beta nought, sigma nought, and gamma respectively per beam. For each beam, the beta-nought vector represents a first order approximation of the range dependent reference noise level. This field is present only for ScanSAR SLC, ScanSAR MLC and ScanSAR GRD products.

Name	Min, Max	Type	Description
azimuthNoiseLevelScaling	0, ∞	azimuthNoiseLevelScalingDataStore	For each beam, the estimated azimuth dependent scaling factors to be applied to the range dependent reference noise level. This field is present only for Spotlight and burst-mode products (ScanSAR and Single Beam Dual HH-VV Polarization mode). Note that for the Burst azimuth 2-look modes, the azimuth scaling is a constant vector due to the Bamler radiometric correction method. For ScanSAR GRD products, If noise subtraction was performed, these represent a first order approximation to the azimuth dependent scaling factors that were applied. Note: 1) The noise values are defined at the mid-range point of the image (SL) or the burst at the middle cycle (Burst Mode GRD, ScanSAR MLC) while during the application of the noise subtraction for Burst Mode GRD, the processor actually uses azimuth dependent scaling factors that vary slowly with range. 2) The geometrical center of the reported azimuth noise level scaling factor is approximately aligned to the geometrical centre of a burst in azimuth.

Table 7-56 Reference Noise Level Common

Name	Min, Max	Type	Description
referenceNoiseLevelCommon			Reference Noise Level Common. This group contains the fields that are common to both Reference Noise Level Data Store and Per Beam Reference Noise Level Data Store.
sarCalibrationType	1,1	sarCalibrationTypeIdentifiers	“Beta Nought”, “Sigma Nought”, or “Gamma”.
pixelFirstNoiseValue	1,1	xsd:integer	Pixel number corresponding to first noise value. The pixel is indexed from the leftmost range sample of the full range line and starts with ‘0’ with respect to the range start of the COPG.

Name	Min, Max	Type	Description
stepSize	1,1	xsd:integer	Number of range pixels between *noiseLevelValues* entries. The sign of stepSize (positive or negative) depends on *pixelTimeOrdering* which indicates the samples increase or decrease with range time order.
numberOfValues	1,1	xsd:integer	Number of entries in *noiseLevelValues*.
noiseLevelValues	1,1	noiseLevelValuesList	Estimated noise level values as a function of georeferenced image pixel position in range. (units = dB)

Note:

1. The mapping between the entry of *noiseLevelValues* list and the range sample index is: *the range sample index = noiseLevelValues entry index * stepSize + pixelFirstNoiseValue, where noiseLevelValues entry index starts with '0'*. For ScanSAR SLC, *the range sample index* refers to its index on the COPG.

noiseLevels →referenceNoiseLevel

Table 7-57 Reference Noise Level Data Store

Name	Min, Max	Type	Description
referenceNoiseLevelDataStore			Reference Noise Level Data Store.
See Reference Noise Level Common (Table 7-56).			

Note:

1. The *referenceNoiseLevel*, list spans the full range extent covered by all beams.

noiseLevels →perBeamReferenceNoiseLevel

Table 7-58 Per Beam Reference Noise Level Data Store

Name	Min, Max	Type	Description
perBeamReferenceNoiseLevelDataStore			Per Beam Reference Noise Level Data Store.
beam	1,1	xsd:string	Beam for this record. Values are same as those used in the beam list.
See Reference Noise Level Common (Table 7-56).			

Note:

1. The *noiseLevelValues* list spans only the full range extent of the particular beam in question.

noiseLevels →azimuthNoiseLevelScaling

Table 7-59 Azimuth Noise Level Scaling

Name	Min, Max	Type	Description
azimuthNoiseLevelScalingDataStore			Azimuth Noise Level Scaling Factors Data Store.
beam	1,1	xsd:string	Beam for this record. Values are same as those used in the beam list.
lineFirstNoiseScalingValue	0,1	xsd:integer	Line number corresponding to first noise scaling value. The line is indexed from the first range line of the image from 0 to N-1. Applicable only for Spotlight products.
stepSize	1,1	xsd:integer	Number of lines between *noiseLevelScalingValues* entries indicated by the absolute value of *stepSize*. The sign of *stepSize* (positive or negative) depends on *lineTimeOrdering* which indicates the samples increase or decrease with azimuth time order.
numberOfNoiseLevelScalingValues	1,1	xsd:integer	Number of entries in the list.
noiseLevelScalingValues	1,1	noiseLevelValuesList	Scaling factors representing the azimuth dependence of the noise level at the mid-range point of an image burst (or, for Spotlight mode, at the mid-range point of an image) (units = dB). These scaling factors are not necessarily symmetric and are approximately centered about the middle of image burst (or image) in azimuth. See Figure 7-8.

7.8 Compact Pol Gain Imbalance File

The format of a Compact Pol Gain Imbalance file is shown in Table 7-60.

Table 7-60 Compact Pol Gain Imbalance File

Name	Min, Max	Type	Description
compactPoleGainImbalance			Compact Pol Gain Imbalance (V relative to H) on Transmit and Receive. *The information provided in this record corresponds to polarization =* “CV” *only.*
beamImbPattern	1, ∞	BeamImbDataStore	The imbalance (V relative to H) on transmit for each beam and on receive for each Beam (or sub-beam if applicable).

Table 7-61 Beam Gain Imbalance on Transmit Data Store

Name	Min, Max	Type	Description
BeamImbDataStore			The Beam Imbalance Data Store.
beamName	1,1	xsd:string	A name describing the given Beam on the given spacecraft, which is unique within this spacecraft.
imbTxIncrement	1,1	xsd:double	The transmit imbalance (V relative to H) angle increment between each of the gain or phase values given below, in degrees.
imbTxSize	1,1	xsd:integer	The number of gain or phase values given in each of the transmit imbalance (V relative to H) arrays below.
imbTxNominalLookAngle	1,1	xsd:double	The elevation angle at the centre of the transmit imbalance gain or phase values given below.
imbTxGainValues	1,1	compactImbValuesList	The transmit gain imbalance (V relative to H), specified in dB as a function of elevation angle. The number of values is the imbTxSize given above. The values are to be listed in increasing elevation angle order with elevation angle measured from nadir. Only positive values are supported, corresponding to right-looking angles. When imbTxSize is an even number, the elevation angles of the two values in the middle of the transmit gain imbalance are (imbTxNominalLookAngle – imbTxIncrement/2) and (imbTxNominalLookAngle + imbTxIncrement/2) respectively.
imbTxPhaseValues	1,1	compactImbValuesList	The transmit phase imbalance (V relative to H), specified in degrees as a function of elevation angle. The number of values is the imbTxSize given above.
subBeamImbRxPattern	1, ∞	SubBeamImbRxDataStore	The imbalance (V relative to H) on receive for each Sub-Beam. Multiple entries are provided when stepped receive imaging was used in the data acquisition. Sub beam ID identifies the stepped receive pointing step. For non-stepped receive case, only one entry is provided.

Table 7-62 Sub-Beam Gain Imbalance on Receive Data Store

Name	Min, Max	Type	Description
SubBeamImbRxDataStore			Sub-Beam Imbalance on Receive Data Store.
subBeamID	1,1	xsd:integer	Sub Beam ID for the given stepped receive pointing step, from 1 to the Number Of Stepped Receive Pointing Steps.

Name	Min, Max	Type	Description
imbRxIncrement	1,1	xsd:double	The receive imbalance (V relative to H) angle increment between each of the gain or phase values given below, in degrees.
imbRxSize	1,1	xsd:integer	The number of gain or phase values given in each of the receive imbalance (V relative to H) arrays below.
imbRxNominalLookAngle	1,1	xsd:double	The elevation angle at the centre of the receive imbalance gain or phase values given below.
imbRxGainValues	1,1	compactImbValuesList	The receive gain imbalance (V relative to H), specified in dB as a function of elevation angle. The number of values is the imbRxSize given above. The values are to be listed in increasing elevation angle order with elevation angle measured from nadir. Only positive values are supported, corresponding to right-looking angles. When imbRxSize is an even number, the elevation angles of the two values in the middle of the receive gain imbalance are (imbRxNominalLookAngle – imbRxIncrement/2) and (imbRxNominalLookAngle + imbRxIncrement/2) respectively.
imbRxPhaseValues	1,1	compactImbValuesList	The receive phase imbalance (V relative to H), specified in degrees as a function of elevation angle. The number of values is the imbRxSize given above.

7.9 Map Overlay File

Figure 7-6 displays the RCM Map Overlay File’s hierarchy. It contains a *GroundOverlay* entry *which* allows the user to easily display the area of the product coverage in Google Earth as an image.

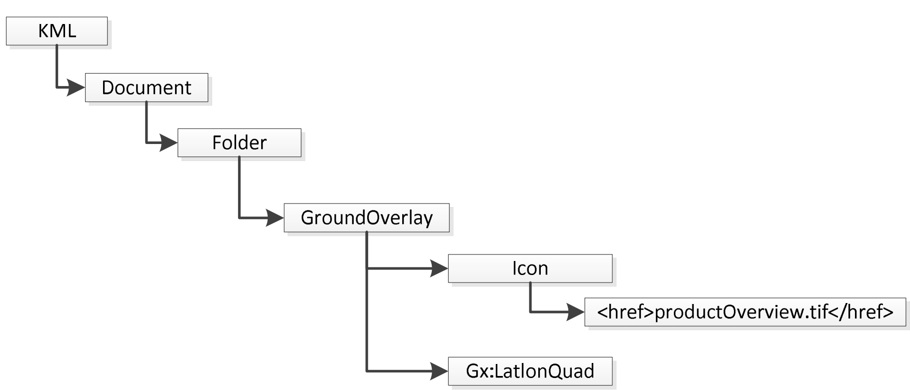

Figure 7-6 MapOverlay KML Structure

Table 7-63 and the subsequent tables present the structure and content of the Map Overlay File. Note that data types in the following tables that are prefixed with “kml:” are part of the KML specification [A-14] and types prefixed with “gx:” are part of the Google extensions to KML [A-15].

Table 7-63 Map Overlay KML File Structure

Name	Min, Max	Type	Description
Kml	1,1		Map Overlay KML File Structure.
Document	1,1	DocumentType	Document container for KML components.

Table 7-64 DocumentType

Name	Min,Max	Type	Description
DocumentType			
Folder	1,1	FolderType	FolderType is a subset of kml:FolderType. Elements in the Folder element in the KML file must comply to kml:FolderType.

Table 7-65 mapOverlayFolderdataStore

Name	Min,Max	Type	Description
FolderType			
Name	1,1	xsd:string	Name of the folder. Set to the product name (Refer to Section 4.12.2).
GroundOverlay	1,1	GroundOverlayType	GroundOverlayType is a subset of kml: GroundOverlay type. It contains the parameters required to specify the footprint of the image and overlay the Product Overview image on a map.

Table 7-66 GroundOverlayDataStore

Name	Min, Max	Type	Description
GroundOverlayDataStore			GroundOverlayDataStore Attributes.
name	1,1	xsd:string	A descriptive name for the map overlay. Set to “RCM Product Overview Image Overlay”
icon	1,1	kml:LinkType	This structure describes the image file used on the map overlay.

Name	Min, Max	Type	Description
gx:LatLonQuad	1,1	gx:LatLonQuadType	Specifies the coordinates of the four corner points of a quadrilateral defining the overlay area.

Table 7-67 LinkType

Name	Min, Max	Type	Description
LinkType			
href	1,1	xsd:anyURI	Defines the name of the image file used on the Map Overlay (productOverview.tif).

Table 7-68 gx:LatLongQuadType

Name	Min, Max	Type	Description
gx:LatLongQuadType			
coordinates	1,1	xsd:string	Four coordinate tuples, each consisting of double-precision floating-point values for longitude and latitude. A space is inserted between tuples. Spaces are not included within a tuple. The coordinates must be specified in counter-clockwise order with the first coordinate corresponding to the lower-left corner of the overlaid image. The format of the coordinate will be: *lon*,*lat lon*,*lat lon*,*lat lon*,*lat*.

7.10 Product Preview File

Figure 7-7 shows an example Product Preview and Table 7-69 lists the content included in the product preview file.

Figure 7-7 Example Product Preview File

Table 7-69 Content of the Product Preview HTML File

Element	Description	Inclusion Criteria
Header Graphic	The Product Preview File should include a header graphic. This element is an image that is meaningful to or identifies the organisation that created the product or for which the product was created. The graphic may include any generally relevant imagery and more specific items such as company logos and copyright notices.	Optional
Product Name	The Product Preview File shall include a field which identifies the name of the product to which this Product Preview File applies.	Mandatory
Manifest	The Product Preview file shall include an accessible link to the product manifest file on the local file system.	Mandatory
Metadata	The Product Preview File shall include an accessible link to each and every metadata file within the product on the local file system.	Mandatory
Imagery	The Product Preview File shall include an accessible link to each and every image file within the product on the local file system.	Mandatory
Preview	The Product Preview File should include an accessible link to each and every preview files within the product on the local file system.	Mandatory
Support	The Product Preview File should include an accessible link to each and every file under support folder (all schema files) within the product on the local file system.	Optional
Product Overview Image	The Product Preview File shall include the Product Overview image to display as a reference for the product (Note: GeoTIFF file may be converted to PNG or JPG prior to display on browser).	Mandatory

7.11 Common Parameters

This section describes the data that can be used by any of the Data Stores. Other than describing the image, geodetic and map coordinate Data Stores, it provides details on the enumerated values of the identifiers, units used for attributes, and information on lists. The tables in this section are not preceded by arrow diagrams since they can occur in multiple locations in the metadata.

Table 7-70 Image Coordinate

Name	Min, Max	Type	Description
imageCoordinate			Image Coordinate Data Store. Each image coordinate represents the centre of the area corresponding to a pixel.
Line	1,1	xsd:double	Image line (row) number starting from zero.
Pixel	1,1	xsd:double	Image pixel (column) number starting from zero.

Table 7-71 Geodetic Coordinate

Name	Min, Max	Type	Description
geodeticCoordinate			Geodetic Coordinate Data Store.
Latitude	1,1	xsd:double	Geodetic latitude. (units = deg)
Longitude	1,1	xsd:double	Geodetic longitude. (units = deg)
Height	1,1	xsd:double	Geodetic height above reference ellipsoid. (units = m)

Table 7-72 Map Coordinate

Name	Min, Max	Type	Description
mapCoordinate			Map Coordinate Data Store.
northing	1,1	xsd:double	(units = m)
easting	1,1	xsd:double	(units = m)

Table 7-73 Identifiers

Name	Type	Description
acquisitionIdentifiers	xsd:string	One of “Low Resolution 100m”, “Medium Resolution 50m”, “Medium Resolution 30m”, “Medium Resolution 16m”, “High Resolution 5m”, “Very High Resolution 3m”, “Low Noise” , “Ship Detection”, “Quad-Polarization”, “Spotlight”.
antennaPointingIdentifiers	xsd:string	“Right”
attitudeSourceIdentifiers	xsd:string	“Downlink”
beamModeIdentifiers	xsd:string	One of “Low Resolution 100m”, “Medium Resolution 50m”, “Medium Resolution 30m”, “Medium Resolution 16m”, “High Resolution 5m”, “Very High Resolution 3m”, “Low Noise”, “Ship Detection”, “Quad-Polarization”, “Spotlight”, “Non-Imaging Calibration”.
dataTypeIdentifiers	xsd:string	One of “Integer”, “Floating-Point”.
dopplerSourceIdentifiers	xsd:string	One of “Adaptive Analysis” ,“Orbit and Attitude”, “Adaptive Analysis-2”.
elevationCorrectionIdentifiers	xsd:string	One of “Base”, “Coarse DEM”, “Fine DEM” .
ellipsoidNameIdentifiers	xsd:string	One of “AIRY 1830”, “AIRY 1849”, “AUSTRALIAN 1965”, “BESSEL 1841”, “BESSEL MODIFIED”, “BESSEL 1841 NAMIBIA”, “CLARKE 1858”, “CLARKE 1866”, “CLARKE 1866 MICHIGAN”, “CLARKE 1880 FOOT”, “CLARKE 1880 ARC”, “CLARKE 1880 BENOIT”, “CLARKE 1880 IGN”, “CLARKE 1880 RGS”, “CLARKE 1880 SGA 1922”, “EVEREST 1830 1937”, “EVEREST 1830 1967”, “EVEREST

Name	Type	Description
		1830 1975”, “EVEREST 1830 MODIFIED”, “GEM 10C”, “GRS 1980”, “HELMERT 1906”, “INDONESIAN 1974”, “INTERNATIONAL 1924”, “INTERNATIONAL 1967”, “KRASSOWSKY 1940”, “NWL 9D”, “NWL 10D”, “OSU 86F”, “OSU 91A”, “PLESSIS 1817”, “STRUVE 1860”, “WAR OFFICE”, “WGS 1984”, “NAD83”, “NAD27”.
hemisphereIdentifiers	xsd:string	One of “N”, “S” (N for Northern, S for Southern).
mapProjectionDescriptorIdentifiers	xsd:string	One of “ARC”, “LCC”, “STPL”, “UTM”, “UPS”.
orbitDataSourceIdentifiers	xsd:string	One of “Predicted”, “Definitive”, “Downlinked”.
outputMediaInterleavingIdentifiers	xsd:string	One of “BIP”, “, “BSQ”.
passDirectionIdentifiers	xsd:string	One of “Ascending”, “Descending”
polarizationIdentifiers	xsd:string	One of “HH”, “VV”, “HV”, “VH”, “CH”, “CV”, and “XC”, where “XC” only applicable to MLC *product type* indicating the complex IPDF for its off-diagonal element channel).
polarizationModeIdentifier	xsd:string	One of “Single”, “Dual Co/Cross”, “Compact”, “Dual HH-VV”, “Quad”.
productFormatIdentifiers	xsd:string	One of “GeoTIFF”, “NITF 2.1”.
productOrientationIdentifiers	xsd:string	One of “Satellite”, “Map North”, “True North”.
productTypeIdentifiers	xsd:string	One of “SLC”, “GRD”, “GRC”, “MLC”, “GCD”, “GCC”.
pulseIdentifiers	xsd:string	String identifying pulse on the given spacecraft, which is unique within this spacecraft.
rangeReferenceFunctionSourceIdentifiers	xsd:string	One of “Nominal Chirp”, “Extracted Chirp Replica”.
resamplingKernelIdentifiers	xsd:string	One of “NN”, “CC”, “DS8”, “DS16”, “KD16”.
rawBitsPerSampleIdentifiers	xsd:integer	BAQ rate for Raw Data Quantization (bits per sample: 1,2,3,4 or 8).
sarCalibrationTypeIdentifiers	xsd:string	One of “Beta Nought”, “Sigma Nought”, “Gamma”.
satelliteIdentifiers	xsd:string	One of "RCM-1", "RCM-2", "RCM-3".
sampleTypeIdentifiers	xsd:string	One of “Complex”, “Magnitude Detected”.
satOrientationRefFrameIdentifiers	xsd:string	“Geocentric”
sensorIdentifiers	xsd:string	"SAR"
timeOrderingIdentifiers	xsd:string	One of “Increasing”, “Decreasing”.
windowNameIdentifiers	xsd:string	One of "Kaiser", "Hamming".
zeroDopplerSteeringFlagIdentifiers	xsd:string	One of ”ZeroDopplerSteeringOn”, “ZeroDopplerSteeringOff”.
processingModeIdentifiers	xsd:string	One of “Standard”, “Expedited”, “NRT”.
processingPriorityIdentifiers	xsd:string	One of “Low”, “Medium”, “High”.

Table 7-74 Units

Name	Type	Description
angularUnits	xsd:string	"deg" or "rad".
angularVelocityUnits	xsd:string	"deg/s" or "rad/s".
distanceUnits	xsd:string	"mm", "cm", "m", or "km".
frequencyUnits	xsd:string	"Hz", "kHz", or "MHz".
powerUnits	xsd:string	"dB" or "W/m^2".
tecUnit	xsd:string	“10^16/m^2”
timeUnits	xsd:string	"s", "ms", "us", or "ns".
velocityUnits	xsd:string	"m/s" or "km/s".

Table 7-75 Lists

Name	Type	From	To	Description
beamList	stringListType	1	∞	This is a declaration of a list of beams whose entries are stringListType.
coefficientsList	doubleListType	1	13	This is a declaration of a list of coefficients whose entries are doubleListType.
datumShiftParametersList	doubleListType	3	3	The format is (dx, dy, dz), (units = m): ECEF coordinates.
histogramList	integerListType	1	∞	This is a declaration of a list of histograms whose entries are integerListType.
compactImbValuesList	doubleListType	1	∞	This is a declaration of a list of gain imbalance values whose entries are doubleListType.
gainList	doubleListType	1	∞	This is a declaration of a list of gains whose entries are doubleListType.
interPoleCorrectionCoefficientList	doubleListType	1	5	This is a declaration of a list of inter-polarization correction coefficients whose entries are doubleListType.
compactPoleCorrectionCoefficientList	doubleListType	1	5	This is a declaration of a list of compact polarization correction coefficients whose entries are doubleListType.
lookWeightList	doubleListType	1	∞	This is a declaration of a list of look weights whose entries are doubleListType.
polarizationList	polarizationListType	1	4	This is a declaration of a list type whose entries are polarizationIdentifiers.

Name	Type	From	To	Description
pulseList	pulseListType	1	∞	This is a declaration of a list type whose entries are pulseIdentifiers.ScanSAR pulse changes over beam.
rationalFunctionCoefficientList	doubleListType	20	20	The order of the coefficients is the same as found in Document R-1.
noiseLevelValuesList	doubleListType	1	∞	This is a declaration of a list of noise level values whose entries are doubleListType.
stringListType	xsd:string			This is a declaration of a list type whose entries are strings.
doubleListType	xsd:double			This is a declaration of a list type whose entries are doubles.
integerListType	xsd:integer			This is a declaration of a list type whose entries are integers.
pulseListType	pulseIdentifiers			This is a declaration of a list type whose entries are pulseIdentifiers.
polarizationListType	polarizationIdentifiers			This is a declaration of a list type whose entries are polarizationIdentifiers.

Table 7-76 Data Types

Name	Type	Min	Max	Regular Pattern (applicable to string and dateTime)	Description
beamModeDefinitionIdType	xsd:integer	0	4294967295		An integer that uniquely identifies this Beam Mode within the entire system.
beamModeMnemonicType	xsd:string	2	16	[0-9A-Za-z_\-]+	A symbolic identifier for the Beam Mode, corresponding to the Beam Mode Definition ID.
downlinkSegmentIdType	xsd:string	3	36	[0-9]+_[0-9A-Za-z_\-]+	Unique (across the constellation, for the life of the mission) identifier of a Downlink Segment. Its format is <Data Segment ID in decimal representation> + "_" + <qualifying string to ensure the ID is unique for each Downlink Segment>. That is, the corresponding Data Segment ID can be derived from the Downlink Segment ID by converting the character substring preceding the first underscore to a decimal number. Because this value is passed out of the classified enclave, its content is restricted by length and possible values so as not to pose a security risk.

Name	Type	Min	Max	Regular Pattern (applicable to string and dateTime)	Description
inputDataSetFacilityNameType	xsd:string	1	36	[0-9A-Za-z_\-]+	A string to indicate the Name of an Archive facility, which maintains Archive Segments (datasets) from which RCM Image Products are produced.
inputDataSetIdType	xsd:string	1	256	[0-9A-Za-z_/:\\\.\-]+	A string to indicate the Identifier of an Archive Segment (dataset). When combined with the archiveFacilityId uniquely identifies a dataset.
prfType	xsd:double	>0.0	10000.0		SAR Pulse Repetition Frequency (units = Hz).
priPerDwellType	xsd:integer	0	65535		Number of PRI per dwell (if Number of Beams > 1)
processingFacilityNameType	xsd:string	1	36	[0-9A-Za-z_\-]+	A string to indicate the Name of the Processing Facility which generated the product.
pulseBandwidthType	xsd:double				In MHz unless overridden by attribute, e.g., units=Hz.
pulseDurationType	xsd:double				In micro-seconds unless overridden by attribute, e.g., units=s.
rangeSamplingRateType	xsd:double				The range sampling rate (sampling rate of echo data within each sample window) (units=Hz).
rankType	xsd:integer	>0	100		Number of PRI between transmission and reception.
receivedPulsesPerDwellType	xsd:integer	0	65535		Number of pulses received per dwell (required if Number of Beams > 1).
transmittedPulsesPerDwellType	xsd:integer	0	65535		Number of pulses Transmitted per dwell (required if Number of Beams > 1) It is assumed that the start of pulse transmissions is the first PRI of the dwell.
utcTimeType	dateTime			\d\d\d\d-\d\d-\d\dT\d\d:\d\d:\d\d(\.\d+)?Z	UTC Time - this is stored in XML dateTime format as "CCYY-MM-DDThh:mm:ss.uuu...uuZ". Decimal fraction of seconds is optional.

7.12 Example Uses of Image Product Metadata

This section provides further understanding of the Image Product metadata format through examples of selected post-processing calculations.

7.12.1 Spotlight Synthetic Aperture Time

In RCM Spotlight mode, the synthetic aperture time can be calculated as:

$$\frac{numberOfLinesProcessed - rank}{pulseRepetitionFrequency}$$

where *numberOfLinesProcessed*, *rank*, and *pulseRepetitionFrequency* represent named fields as described in the tables above.

7.12.2 2D Noise Estimation for Burst Mode Products

In Burst Mode products, the mean image noise level can vary in both range and azimuth. A first order approximation of the expected 2D varying mean noise level for a given image burst can be obtained by cross-multiplying the portion of the Reference Noise Level vector that covers the image burst, with the Azimuth Noise Level Scaling Factor vector (Table 7-59) for the applicable beam, where:

- The Reference Noise Level vector is described in Table 7-57.
- The Azimuth Noise Level Scaling Factor vector is described in Table 7-59.
- The nominal of the image burst are provided in the Burst Map as per Table 7-45.
- The applicable beam number B of the image burst with burst number K is provided in the Burst Map as per Table 7-44 (Burst Mode GRD) or in the Image Attributes as per Table 7-43(Burst Mode SLC).

  An example is given in Figure 7-8 for the special case when the earliest pixel in the image burst corresponds to its top-left corner in the image (other cases can be handled as described per Figure 7-4).

7.12.2.1 Burst Mode GRD Products

Taking into consideration that some overlapping pixels are discarded as part of the Burst Mode image mosaicking process and that there are minor variations in the size of each output image burst from cycle-to-cycle, the actual image burst's geometrical center (used, for example, to align the azimuth noise level scaling) will be only approximately aligned with its arithmetic center.

Note that the 2D mean noise level calculations described above are approximations also because the estimation of the 2D mean noise level neglects complicating factors such as the azimuth dependency of the range-varying mean noise levels, and the range dependency of the azimuth-varying noise scaling factors, among others. Therefore, for applications that are sensitive to 2D mean noise level variations, an alternative to these calculations would be to use products processed with noise subtraction, i.e., with the *noiseSubtractionPerformed* flag (see Table 7-24) set true.

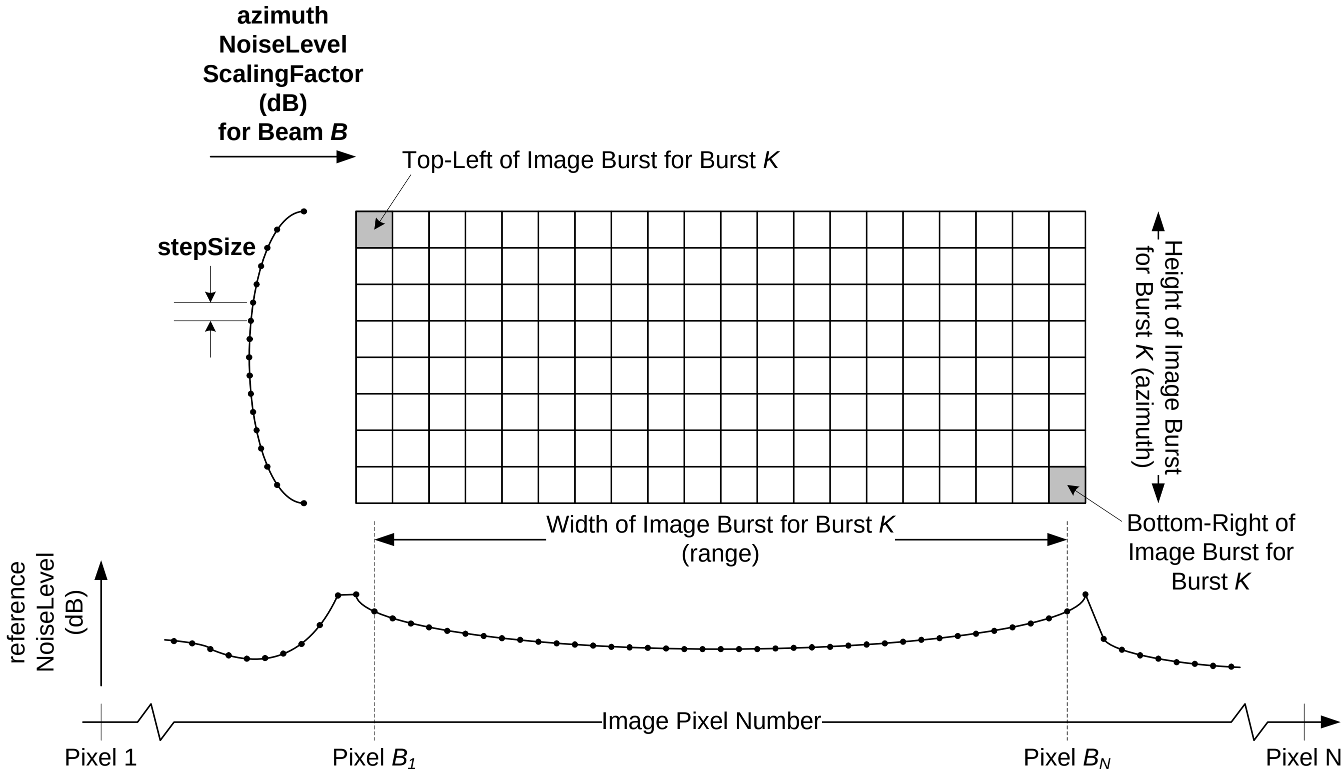

Figure 7-8 Illustration of Approximate Mean 2D Image Burst Noise Level Computation

7.12.2.2 Burst Mode SLC Products

The 2D Noise Estimation for Burst Mode SLC products is similar to the 2D estimation for Burst Mode GRD products; however in this case the Per Beam Reference Noise Levels (Table 7-58) is used to cross-multiplied with the Azimuth Noise Level Scaling Factor vector (Table 7-59). Furthermore, there are also minor variations in the size of Burst SLC image bursts from cycle-to-cycle. Therefore, the actual geometrical center of a burst image is only approximately aligned with its arithmetic center.

Note that noiseSubtractionPerformed flag does not apply to ScanSAR SLC and ScanSAR MLC products.

7.12.2.3 ScanSAR MLC Products

The 2D Noise Estimation for ScanSAR MLC products is similar to the 2D estimation for Burst Mode GRD products; however, in this case, the noise level is defined on slant range, not ground range.

Note that noiseSubtractionPerformed flag does not apply to ScanSAR MLC products.

7.12.3 Azimuth Phase Deramping of ScanSAR SLC Images

Typically, any post processing operation of SLC images that involves interpolation requires that the image data is at baseband. For RCM ScanSAR SLC, the image data is not at baseband in azimuth. To convert the data to baseband, a phase correction, referred to as azimuth phase deramping, has to be applied to the ScanSAR SLC image data. The purpose of this section is to describe the procedure for performing this operation.

For a given ScanSAR SLC image, the parameters required to compute the phase deramp and the corresponding PIF fields from which they can be derived are listed in Table 7-77:

Table 7-77 Azimuth Phase Deramp Calculation Parameters and Symbols

Parameter	Symbol	Units	Derivable from PIF field …	Table
Radar center frequency	f_c	[Hz]	radarCenterFrequency	Table 7-13
Pulse duration	$\Delta\tau$	[s]	pulseLength	Table 7-13
bistaticCorrectionApplied	N/A	N/A	bistaticCorrectionApplied	Table 7-24
Slant range spacing	ΔR	[m]	sampledPixelSpacing	Table 7-31
Azimuth time spacing	$\Delta\eta$	[s]	sampledLineSpacingTime	Table 7-31
First (top) line offset	M	N/A	lineOffset	Table 7-43
First (top) line time offset with respect to the origin of the COPG	η_0	[s]	N/A	Table 7-43
Slant range near edge	R_o	[m]	slantRangeNearEdge	Table 7-43
Doppler rate	K_a	[Hz/s]	dopplerRateCoefficients dopplerRateReferenceTime	Table 7-49
Relative time of the center of the burst with respect to the origin of the COPG	η_c	[s]	zeroDopplerTimeFirstLine timeOfDopplerRateEstimate	Table 7-24 Table 7-49
Speed of light = 299792458 m/s	c	[m/s]	N/A	N/A

The following algorithm describes the derivation of the phase correction (deramp) to be applied to the given SLC image. The algorithm is provided for the case where no image flipping has occurred, and can be adapted easily for the general case.

- For each range sample, n $(n \geq 0)$
    - Calculate the slant range, $R = R_0 + \Delta R * n$
    - Calculate the Doppler rate, $K_a(R)$

- Calculate the bistatic azimuth time correction, Δb:

  If bistaticCorrectionApplied == TRUE, $\Delta b = \Delta\tau/2 + R/c$, else, $\Delta b = 0$
- For each range line, $m (m \geq 0)$
  - Calculate the azimuth time, η, measured relative to the center of the burst:

    $$\eta = \eta_0 + \Delta\eta * m - (\eta_c + \Delta b), \text{ where } \eta_0 = \Delta\eta * \mathrm{M}$$
  - Calculate the phase correction to be applied to the image pixel (m, n),

    $$\varphi(\eta, R) = \frac{4\pi R}{\lambda}\left(\sqrt{1 + \lambda K_a(R)\frac{\eta^2}{2R}} - 1\right), \text{ where } \lambda = c/f_c\ .$$
- End

A An Example of the RCM Image Products

An example of an RCM product based on Quad Pol mode data from RCM2 and processed as SLC is shown in Figure A-1 below. This product (with Product Sequence ID = 1, Production Request ID= PGS_TD_PR_GenIm_QP0_PT) was generated from OrderID CSM-TARG-35-0. The final product directory is

RCM2_OKCSM-TARG-35-0_PKPGS_TD_PR_GenIm_QP0_PT_1_QP26_20160417_011157_HH_VV_HV_VH_SLC

where *PGS_TD_PR_GenIm_QP0_PT_1* is the *ProductId.*

RCM2_OKCSM-TARG-35-0_PKPGS_TD_PR_GenIm_QP0_PT_1_QP26_20160417_011157_HH_VV_HV_VH_SLC

```
manifest.safe
license.pdf
metadata/
    product.xml
    doppler_grid.xml
    calibration/
        lutSigma_HH.xml
        lutSigma_HV.xml
        lutSigma_VH.xml
        lutSigma_VV.xml
        lutBeta _HH.xml
        lutBeta _HV.xml
        lutBeta _VH.xml
        lutBeta _VV.xml
        lutGamma_HH.xml
        lutGamma_HV.xml
        lutGamma_VH.xml
        lutGamma_VV.xml
        noiseLevels_HH.xml
```

RCM2_OKCSM-TARG-35-0_PKPGS_TD_PR_GenIm_QP0_PT_1_QP26_20160417_011157_HH_VV_HV_VH_SLC

- noiseLevels_HV.xml
- noiseLevels_VH.xml
- noiseLevels_VV.xml
- incidenceAngles.xml

- imagery/
  - *PGS_TD_PR_GenIm_QP0_PT_1_HH*.tif
  - *PGS_TD_PR_GenIm_QP0_PT_1_HV*.tif
  - *PGS_TD_PR_GenIm_QP0_PT_1_VH*.tif
  - *PGS_TD_PR_GenIm_QP0_PT_1_VV*.tif
- preview/
  - mapOverlay.kml
  - productPreview.html
  - productOverview.tif
  - productOverview.png
  - icons/
    - logo.png
- support/
  - readme.txt
  - label.txt
  - classification.txt
  - rcm_prod_product.xslt
  - schemas/
    - rcm_prod_dataTypes.xsd
    - rcm_prod_doppler_grid.xsd
    - rcm_prod_geodeticCoordinate.xsd
    - rcm_prod_identifiers.xsd
    - rcm_prod_incidenceAngles.xsd

RCM2_OKCSM-TARG-35-0_PKPGS_TD_PR_GenIm_QP0_PT_1_QP26_20160417_011157_HH_VV_HV_VH_SLC

- rcm_prod_lists.xsd
- rcm_prod_lut.xsd
- rcm_prod_manifest.xsd
- rcm_prod_mapOverlay.xsd
- rcm_prod_noiseLevels.xsd
- rcm_prod_product.xsd
- rcm_prod_units.xsd

Figure A-1 Example of content and naming convention of RCM Image Product

B Image Coordinate Reference Systems

Each image pixel in an RCM product corresponds to an area on the Earth. By convention, the location associated with each pixel is the determined location of the centre of that corresponding area.

Except within GeoTIFF image file fields, the origin of the image coordinate system (line 0, pixel 0) is by definition the location of the first image data value, which is the centre of the upper left pixel.

However, within GeoTIFF image file fields, the origin of the image coordinate system is shifted by one half (0.5) of a line and one half (0.5) of a pixel. This is because the GeoTIFF format specification (Document A-3) allows for the interpretation of pixels as points or as an area with dimensions by use of the GTRasterTypeGeoKey field being set as either RasterPixelIsPoint or RasterPixelIsArea. For RCM GeoTIFF Image Products, the GTRasterTypeGeoKey is always set and defined to be RasterPixelIsArea. Therefore, in the coordinate system represented within the GeoTIFF image file fields, pixels are interpreted as having dimensions/area. The origin (0,0) of the GeoTIFF image coordinate system used if pixels are to be interpreted as RasterPixelIsArea is defined to be the upper left corner of the upper left pixel cell. The diagram below illustrates this coordinate system with increasing pixel number to the right and increasing line number down.

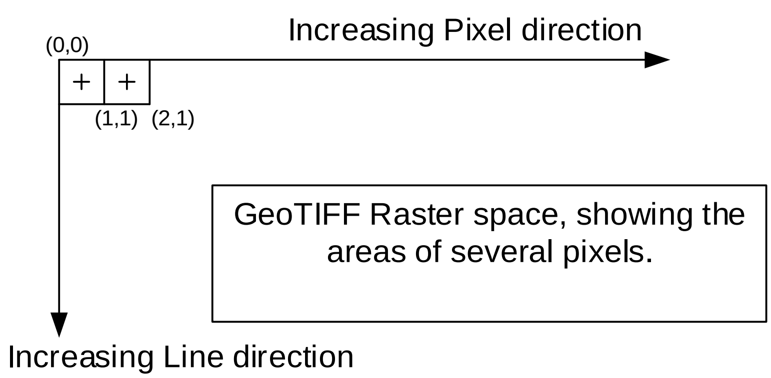

Figure B-1 Illustration of the GeoTIFF RasterPixelIsAreaCoordinate System Represented Within RCM GeoTIFF Image File Fields

Therefore the center of the upper left pixel cell (depicted in the above diagram with a '+') is located at (0.5, 0.5) in the GeoTIFF RasterPixelIsArea coordinate system. Then, with respect to the product image coordinate system, the coordinate system within the GeoTIFF fields is shifted by +0.5 lines and +0.5 pixels for the same geolocation tie-point. The following equations summarize the pixel (*P*) and line (*L*) relationship between the product image coordinates and the coordinates of those tie-points found within the GeoTIFF fields:

$$P_{GeoTIFFtag} = P_{product} + 0.5$$
$$L_{GeoTIFFtag} = L_{product} + 0.5$$

For example, in the coordinate system represented by the GeoTIFF image file fields, the centre of the upper left pixel is located at row 0.5, column 0.5 instead of line 0 and pixel 0.

This difference affects the image tie-points, which are used to provide geolocation information at various locations in the image. In the PIF, the tie-point image coordinates start at (0,0), but in the GeoTIFF image file fields, the tie-point image coordinates start at (0.5, 0.5). Despite their different image coordinates, the two sets of tie-points represent the same locations in space.