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PALSAR-IPF SAR Data Products

Product Handbook

Prepared by:	A.M.Smith Phoenix Systems
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1 Introduction

1.1 Purpose of This Document

This document describes the image products generated from ALOS PALSAR SAR sensor data by the ESA PALSAR SAR Instrument Processing Facility (IPF).

The ALOS PALSAR sensor has a wide range of acquisition modes, and there are consequently a wide range of product types available from the ESA PALSAR IPF. In addition, data products are available in either a JAXA-style CEOS format or as an EnviSAT-style format.

This document introduces the range of products available and their characteristics.

Separate documents [AD2],[AD3] describe the contents of the EnviSAT-style and CEOS products in detail.

2 Documentation

2.1 Applicable Documents

[AD-1] ENVISAT-1Product Specifications (Volume 8, Issue 4, Rev. B, PO-RS-MDA-GS-2009)

[AD-2] ALOS PALSAR SAR Products ENVISAT and GEOTIFF/TIFF Format Specifications (PLSR_ENVI v3.1 September 2014)

[AD-3] ALOS PALSAR SAR Products CEOS FORMAT SPECIFICATIONS (PLSR_CEOS v3.2 July 2013)

2.2 Acronyms and Abbreviations

Acronym/Abbreviation	Significance
ADC	Analog to Digital Conversion
ADS	Annotated Data Set
ADSR	Annotated Data Set Record
AEP	Antenna Elevation Pattern
ASAR	Advanced Synthetic Aperture Radar
ASCII	American Standard Code for Information Interchange
CCT	Computer-Compatible Tape
CEOS	Committee on Earth Observations Satellites
DS	Data Set
DSD	Data Set Descriptor
DSSR	Data Set Summary Record
DSR	Data Set Record
ESA	European Space Agency
GADS	Global Annotation Data Set
GEC	Geocoded Ellipsoid Corrected (product)
GMT	Greenwich Mean Time
Hz	Hertz
ISLR	Integrated Side Lobe Ratio
IPF	Instrument Processing Facility
LADS	Localisation ADS (Map related ADSR)
MDS	Measurement Data Set
MDSR	Measurement Data Set Record
MPH	Main Product Header
MR	Medium Resolution
PRF	Pulse Repetition Frequency
PSLR	Peak to Side-Lobe Ratio

RFI	Radio Frequency Interference
SAR	Synthetic Aperture Radar
SBT	Satellite Binary Time
SPH	Specific Product Header
SQ	Summary Quality
SR/GR	Slant Range to Ground Range
SWST	Sampling Window Start Time
TEC	Total Electron Content
TIFF	Tagged Image File Format
UTC	Universal Time Coordinates
UPS	Universal Polar Stereographic
UTM	Universal Transverse Mercator

2.3 Document Overview

Section 3 below gives an introduction to the overall classes of products that are available from the PALSAR-IPF, detailing the product tree and the primary characteristics of all products.

3 PALSAR-IPF SAR Products

3.1 Product Formats

With the exceptions of the RAW unfocussed SAR product, which is only available in (JAXA) CEOS format, and the Wide-swath (SCANSAR) SLC product, which is only available as an EnviSAT-style product, all products may be obtained in either format.

Details of the EnviSAT style format are given in [AD2] and the CEOS format in [AD3].

The PALSAR-IPF EnviSAT-style product format follows, to the extent possible, the ASAR product format specification [AD1]. It differs for PALSAR fully polarimetric products, which require an extra 2 SQ and an extra 2 AEP ADS to be defined. Some detailed additional annotations are also provided in previously unused fields of the SQ ADS to detail Faraday rotation estimates, polarimetric processing options applied and estimates of Radio Frequency Interference (RFI).

The CEOS product format closely follows that provided by JAXA and is intended to be compatible with it. Some unused fields of the Data Set Summary Record have however also been amended to record details of Faraday rotation, polarimetric processing and estimates of RFI levels.

The product image data provided is fundamentally independent of the format in which it is provided, with the difference that, for reasons of radiometric compatibility with products distributed by JAXA, the CEOS products are radiometrically compensated for incidence angle such that the product radiometry is proportional to σ_0 ; products provided in EnviSAT-style however have their radiometry proportional to β_0 and are unscaled for incidence angle variation.

All products are radiometrically compensated for antenna gain patterns and spreading loss and are radiometrically calibrated.

A range of products with differing characteristics are available; the primary categories of product and their characteristics are described below and summarized in Table 2 further below.

3.2 RAW (Unfocussed)

RAW unfocussed L1.0 PALSAR products may be obtained from the PALSAR-IPF for all PALSAR acquisition modes. These are only available in (JAXA) CEOS format.

The L1.0 CEOS products are transcribed by the PALSAR-IPF from lower level telemetry and ALOS ground segment files held by the ESA ADEN node. The L1.0 CEOS product provided is compatible with those distributed directly by JAXA, with the exception that the JAXA Facility-Related CEOS records, while present in the CEOS Leader File for syntactic compatibility, are blank filled. Details are given in [AD3].

3.3 Single Look Complex

3.3.1 Stripmode

The PALSAR-IPF stripmode SLC products are comparable to the SLC/IMS images generated by ESA for ERS and ASAR platforms. They are slant-range projected complex images in zero-Doppler SAR coordinates. The data is sampled in natural units of time in range and along track, with the range pixel spacing corresponding to the reciprocal of the platform ADC rate and the along track spacing to the reciprocal of the PRF. Data is processed to an unweighted Doppler bandwidth of 1500Hz. The products are suitable for interferometric, calibration and quality analysis applications.

The SLC products are generated without side-lobe reduction in the interests of providing users with as “natural” a product as possible. They are however calibrated and radiometrically compensated for spreading loss and the elevation antenna beam pattern. The antenna elevation pattern applied is supplied as an ADS to users obtaining products in an EnviSAT-style product format.

Users familiar with SLC products distributed by JAXA should note that the PALSAR-IPF stripmode SLC products are presented in true zero-Doppler coordinates, as opposed to the beam-centred projection adopted by JAXA.

Interferometric users should note that the ALOS-PALSAR PRF is not necessarily invariant between repeat acquisitions and this needs to be accommodated by their interferometric registration software.

3.3.2 SCANSAR

The ALOS PALSAR sensor can acquire data in SCANSAR mode (WB1 and WB2¹) with either 3, 4 or 5 swaths. The PALSAR-IPF allows generation of a complex SCANSAR product in support of interferometric SCANSAR operations; the product format is comparable to the “WSS” product provided by ESA for ASAR SCANSAR data. Complex SCANSAR data is only available from the PALSAR-IPF as an Envisat-style formatted product.

The complex SCANSAR data is presented with:

- separate Measurement Data Sets for each SCANSAR swath, all aligned to a common grid in range and along track
- slant-range/zero-Doppler projection
- sampled at 1/ADC rate in slant range and at 30 metres along track
- radiometrically calibrated and corrected in range and azimuth for antenna gain patterns

Image data associated with each scan is processed to cover 1500 Hz of the Azimuth antenna pattern, with the boundaries between image data from successive scans in the same beam identifiable by the product line counter which restarts at the beginning of image data for each fresh scan. An inherent feature of the product is that the same ground point is multiply imaged in successive scans and in regions of overlap between adjacent swaths.

¹ WB2 mode was never used operationally by JAXA during the ALOS-1 mission for technical reasons.

The complex data is generously sampled in respect of the instantaneous bandwidth at any location; however, as with ASAR WSS products, the full Doppler range is present in the complex image for each scan and users wishing to interpolate the complex image data should use a suitable technique to accommodate the variation in Doppler frequency across the complex image data of each scan along track.

Antenna gain patterns for each beam are also provided as an ADS.

3.4 Multi-looked detected – high resolution.

Multi-looked detected products can be generated in high resolution for all ALOS PALSAR acquisition modes, and are given the mnemonic GDH (Ground-range Detected High resolution). The resolution and pixel dimensions are however a function of acquisition mode and bandwidth:

- All strip mode products acquired in FBS mode (28MHz bandwidth) are processed to a single range look and 2 azimuth looks; the azimuth look Doppler band centres are separated by 700 Hz and overlap slightly with an 800 Hz bandwidth per look. Pixel dimensions are 6.25m in range and azimuth.
- All strip mode products acquired in other modes (14MHz bandwidth) are processed to a single range look and 4 azimuth looks; the azimuth look Doppler band centres are separated by 300 Hz and overlap slightly with a 400 Hz bandwidth per look. Pixel dimensions are 12.5m in range and azimuth.
- WB1 SCANSAR acquisitions (14MHz bandwidth) are processed to 4 non-overlapping range looks spanning the video bandwidth, with image data from 3 scan cycles power accumulated for each image point. Pixel dimensions are 75.0m in range and azimuth.

All GDH products are generated using side-lobe reduction to obtain a PSLR of greater than 21dB.

3.5 Multi-looked detected – low resolution.

Multi-looked detected products can also be generated at a lower spatial resolution for all ALOS PALSAR stripmode acquisitions, and are given the mnemonic GDL (Ground-range Detected Low resolution). These have an improved radiometric resolution and a reduced data volume.

All GDL products are generated with a pixel spacing of 75.0m, and are produced by spatially averaging and decimating the corresponding GDH products by factors appropriate to obtain an adequately sampled GDL product with 75.0m pixels, irrespective of acquisition mode. As a consequence the GDL products with the highest effective number of looks and radiometric resolution are obtained from FBS acquisitions.

3.6 Polarimetric Products

All quad polarization (PLR acquisition mode) datasets are corrected for Faraday rotation and are polarimetrically calibrated, and are available either as complex SLC products or as detected products.

The detected polarimetric products can be provided as either GDH or GDL products, and may be obtained in either a conventional detected presentation, with channels $|HH|$, $|HV|$, $|VH|$ and $|VV|$, or in a Pauli presentation $|HH+VV|$, $|HV+VH|$, $|HV-VH|$ and $|HH-VV|$. Products in a Pauli presentation are given a product mnemonic of the form “PLP” to distinguish them from “PLR” products.

Dual polarization acquisitions (FBD mode) cannot be corrected for Faraday rotation or polarimetrically calibrated. An estimate of the Faraday rotation angle is however derived for all data processed by the PALSAR-IPF and reported in product annotations (both CEOS and Envisat-style product formats); this is achieved by analysing TEC maps applicable to the acquisition date/time and location with an earth geomagnetic field model

3.7 Geocoded Products

All GDH detected products may be obtained in an ellipsoid-geocoded projection; the PALSAR-IPF supports either Universal Transverse Mercator or Universal Polar Stereographic image product map projections. Geocoding is undertaken using a representative mean vertical datum re the WGS84 ellipsoid for the scene.

Geocoded GDL products are not currently provided.

3.8 Product Tree

3.9 The overall product tree is illustrated below in

Figure 1 below. All product types are referred to by a mnemonic of the form MMM_PPP_LP, where:

MMM – ALOS PALSAR acquisition mode i.e. FBS/FBD/PLR/DN_/WB1 (and with PLP for PLR detected products in a Pauli presentation)

PPP – Product type i.e. RAW/SLC/GDH/GDL/GEC

L – Level = 0 (unfocussed data) or 1=focussed data.

Products obtained in EnviSAT-style format have the product type mnemonic embedded in the product file name.

Products obtained in CEOS format retain the JAXA nomenclature, extended to describe the increased range of product types available from the PALSAR-IPF. A correspondence table is given in

Table 1 below.

Figure 1. PALSAR-IPF Product Tree

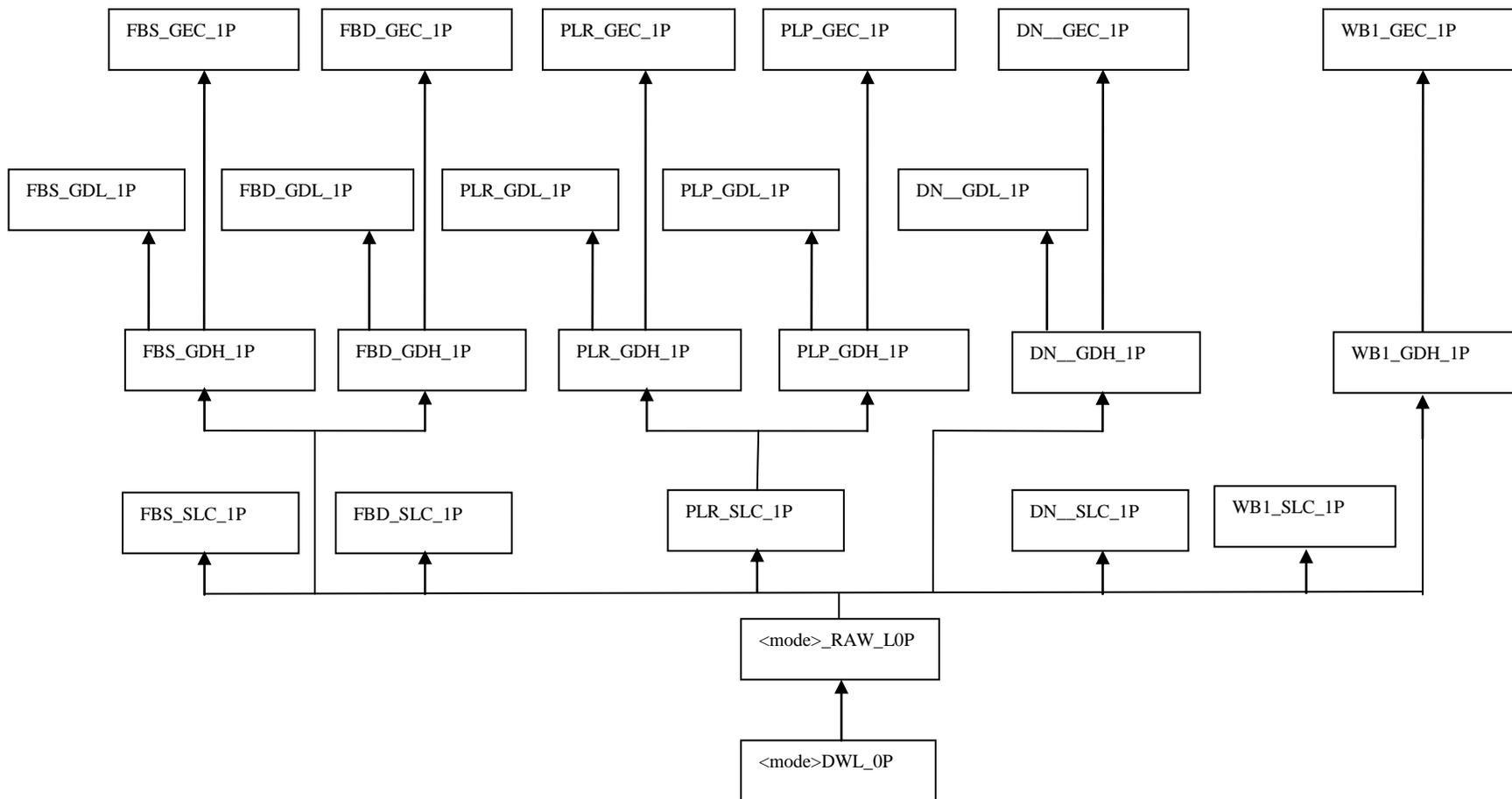


Table 1. Correspondence between JAXA CEOS product ID code and PALSAR-IPF product types

Generic Type	JAXA Product ID code	Corresponding ESA Product Type
RAW	H1.0__	PSR_RAW_L0P
	W1.0__	PSR_RAW_L0P
	D1.0__	PSR_RAW_L0P
	P1.0__	PSR_RAW_L0P
SLC (Single Look, Slant Range Complex)	H ² 1.1__	FBS_SLC_L1P
		FBD_SLC_L1P
	P1.1__	PLR_SLC_L1P
	D1.1__	DN__SLC_L1P
GDH (Ground range Detected, Normal resolution)	H1.5__	FBS_GDH_L1P
		FBD_GDH_L1P
	P1.5__	PLR_GDH_L1P
	D1.5__	DN__GDH_L1P
	P1.5E_	PLP_GDH_L1P
	W1.5__	WB1_GDH_L1P
GDL (Ground range Detected Low resolution)	H1.5D_	FBS_GDL_L1P
		FBD_GDL_L1P
	P1.5D_	PLR_GDL_L1P
	D1.5D_	DN__GDL_L1P
	P1.5F_	PLP_GDL_L1P
GEC Mercator	H1.5GU	FBS_GEC_L1P
		FBD_GEC_L1P
	P1.5GU	PLR_GEC_L1P
	D1.5GU	DN__GEC_L1P

² Some JAXA product types map to two corresponding MMFI ML product types, according to the data acquisition mode.

Generic Type	JAXA Product ID code	Corresponding ESA Product Type
	P1.5IU	PLP_GEC_L1P
	W1.5GU	WB1_GEC_L1P
GEC Polar Stereo	H1.5GP	FBS_GEC_L1P
		FBD_GEC_L1P
	P1.5GP	PLR_GEC_L1P
	D1.5GP	DN_GEC_L1P
	P1.5IP	PLP_GEC_L1P
	W1.5GP	WB1_GEC_L1P

Table 2. Summary of PALSAR-IPF SAR product characteristics.

Order Type	PALSAR mode	Product Name	Product Parameters		Description
RAW	ALL	PSR_RAW_0P	N/A		Transcribed L1.0 unfocussed RAW ALOS PALSAR data. Only available as a (JAXA) CEOS product.
SLC	FBS	FBS_SLC_1P	Pixel size	Determined by PALSAR ADC rate and PRF	Single look complex (SLC) slant range, products.
	FBD	FBD_SLC_1P	Processing Bandwidth		
	PLR	PLR_SLC_1P			
	DN	DN_SLC_1P			
	WB1	WB1_SLC_1P	Pixel size	Determined by PALSAR PRF in range; 30 metres in Azimuth.	Single look complex (WSS-style) slant range, SCANSAR products. Only available as EnviSAT-style product. Side-lobe reduction is not applied.
GDH	FBS	FBS_GDH_1P	Pixel size	6.25 by 6.25 m	Multi-looked, detected ground range, products. Side-lobe reduction is applied.
			No of looks	1 Range Look 2 Azimuth looks	
			Look Bandwidth	800 Hz	
			Total Bandwidth	1500Hz	
	FBD	FBD_GDH_1P	Pixel size	12.5 by 12.5 m	
	PLR	PLR_GDH_1P	No of looks	1 Range Look 4 Azimuth looks	
	DN	DN_GDH_1P	Look Bandwidth	400 Hz	
	Total Bandwidth	1500Hz			
WB1	WB1_GDH_1P	Pixel size	75 by 75 m	SCANSAR products processed to 3 bursts per pixel (3 independent azimuth looks). Side-lobe reduction is applied.	
No of looks	4 Range looks 3 Azimuth looks				
Look Bandwidth	Equivalent to ~ 75-100 Hz				
Total Bandwidth	1500Hz				
GDL	FBS	FBS_GDL_1P	Pixel size	75 by 75 m	Multi-looked, detected ground range, low

Order Type	PALSAR mode	Product Name	Product Parameters		Description
	FBD	FBD_GDL_1P	No of looks	Approximately equivalent to ~ 6 Range looks (12 for FBS) ~ 20 Azimuth looks Equivalent to ~ 75 Hz 1500Hz	resolution products. Side-lobe reduction is applied. Generated by processing to GDH parameters and then spatially averaging by a factor of 12 (24 for FBS_GDH) to provide a ground range spatial resolution ~ 150m and an ENL>100.
	PLR	PLR_GDL_1P	Look Bandwidth		
	DN	DN_GDL_1P	Total Bandwidth		
Order Type	PALSAR mode	Product Type	Product Parameters		Description
GEC	FBS	FBS_GEC_1P	As per corresponding GDH products, but presented in an ellipsoid corrected, geocoded map projection (UTM or UPS)		Multi-looked, detected ground range, low resolution products. Side-lobe reduction is applied. In a specified map projection.
	FBD	FBD_GEC_1P			
	PLR	PLR_GEC_1P			
	DN	DN_GEC_1P			
	WB1	WB1_GEC_1P	As per corresponding SCANSAR WSM products, but presented in an ellipsoid corrected, geocoded map projection (UTM or UPS)		SCANSAR products processed to 3 bursts per pixel (3 independent azimuth looks). Side-lobe reduction is applied. In a specified map projection.
GDH GDL GEC	PLR	PLP_GDH_1P PLP_GDL_1P PLP_GEC_1P	As per corresponding conventional PLR products, but presented in Pauli format (with detected HH+VV, HH-VV, HV+VH and HV-VH channels)		