THE GERMAN AND ITALIAN PAFs FOR X−SAR

X−SAR CEOS Format

X−SAR−D−CEOS

D-PAF/DLR Supplemented Version Based On The Original I-PAF/ASI, D-PAF/DLR Version 2.0.

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1.1 List of CEOS Files and Records supported by X−SAR:

Volume Directory File

- Volume Descriptor Record
- File Pointer Record −SAR Leader File
- File Pointer Record − Imagery Options
- Text Record

SAR Leader File

- File Descriptor Record
- Data Set Summary Record
- Map Projection Data Record
- Platform Position Record
- Radiometric Data Record
- Radiometric Compensation Record
- Digital Elevation Model Descriptor Record (For GTC, GIM and GMQ products only)
- Detailed Processing Parameter Data Record
- Ground Control Points Descriptor Record (For GTC, GIM and GMQ products only)
- Facility Related Data Record − GEO Type (For geocoded products only)

Imagery Options File

- File Descriptor Record
- Imagery Options File (Image Data Records or Annotated Raw Data Records)

Null Volume Directory File

- Null Volume Descriptor Record

Acronyms

BIL: Band Interleaved by Line tape organizational method

- Volume Directory File
- Volume Directory File
- Imagery Options File
  - Data Set 1
  - Data Set 2
  - Data Set n
- SAR Trailer File
- Null Volume Directory File

BIP: Band Interleaved by Pixel tape organizational method:

- same as BIL

BSQ: Band Sequential tape organizational method:

- Volume Directory File
- SAR Leader File 1
- Imagery Options File 1
- SAR Trailer File 1
- SAR Leader File 2
- Imagery Options File 2
- SAR Trailer File 2
- Null Volume Directory File
- BSQ is the organization SIR−C and X−SAR will use. (X−SAR has only one channel)

FIXD: Fixed length record

- GEC: Geocoded Ellipsoid Corrected

- GTC: Geocoded Terrain Corrected
- GIM: Geocoded Incidence Angle Mask
- GMQ: Geocoded Map Quadrant
- IMOP: Imagery Options: Class of file in SAR logical volume
- MBAA: Mixed Binary And ASCII
- MGD: Multi−Look Ground Range Detected Image
- RAW: Annotated Raw Data Product
- SARL: SAR Leader file: Class of file in SAR logical volume
- SART: SAR Trailer file: Class of file in SAR logical volume (not supported by X−SAR)
- SSC: Single−Look Slant Range Complex Image
- VARE: Variable record length
- $: space character (blank)
- (n): binary data
- −9..9.9..9: Parameter not supported

1.2 General remarks

Data Representation:

The output data representation throughout the document shall follow the FORTRAN convention. That is, the sign shall be placed in the first significant byte, leading zero shall be omitted. The plus sign can be omitted. Blank filler is used for ASCII non numeric strings and binary zero for binary fields. All numeric ASCII shall be right aligned and all ASCII strings shall be left aligned. The byte sequence for binary data storing shall follow the NO−DEC representation, that is with the first significant byte before the least significant bytes. The internal data representation shall follow the conventions stated in chapter 1.4 of the document CEOS−SAR−CCT is/rev 2/1.

The floating point format is defined as follows: For the *Fm.n* format, the decimal point is located in the *n+1*st field from the right, the plus/minus sign is next to the integer number and any unused spaces are placed on the left. For example, ± 8.52 in F6.2 is stored as $ ± 8.52, where $ stands for space. The + sign can be omitted.

No SAR trailer file is to be provided regardless of the number of physical volumes.

The SAR leader file described in this document is the **complete set of records**. Each product shall be made up by a specified sub−set or complete set (10 records) as specified in the section ”List of CEOS Files used by X−SAR” of this document.

Data File Preamble:

Every data record begins with a 12−byte preamble which contains general information describing the data file including record type, subtype, and record length. The preamble is included in the definition of each record below. Beside this, Annotated Raw Data Records shall also include 32 bytes of sensor specific data, and Geo Image Data Records shall include product prefix data.

Multivolume Structure:

This document addresses products on one physical volume only, nevertheless in case of product generation on CCT media it is possible to have more than one physical volume. In this case, the following conversion applies:

- 1st physical volume (VDF, SAR Leader File, Imagery Options File)
- ...
- last physical volume (VDF, Imagery Options File, Null VDF)

product	medium	data type	data volume
X−SAR.SAR.MGD	1 exabyte, photo	16 bit integer**	UP TO 80 MBYTES
X−SAR.SAR.SSC	1 exabyte, photo*	16 bit complex**	UP TO 358 MBYTES
X−SAR.SAR.GEC	1 exabyte, photo	16 bit signed integer	UP TO 160 MBYTES
X−SAR.SAR.GTC	1 exabyte, photo	16 bit signed integer	UP TO 160 MBYTES
X−SAR.SAR.GIM	1 exabyte, photo	8 bit	UP TO 80 MBYTES
X−SAR.SAR.GMQ	1 exabyte, photo	16 bit signed integer	UP TO 20 MBYTES
X−SAR.SAR.RAW	1 exabyte	8 bit complex	UP TO 250 MBYTES

Table 1 : Product Summary

*It is to be noted that the SSC product on photo medium is only supported by D−PAF.

Additional D−PAF/DLR comment:

** Image pixel representation:

- *MGD product:16 bit signed integer, Most Significant Bit is always zero, amplitude data (0 to 32767)*
- SSC product:
  - *real−part: 2's complement 16 bit integer (−32768 to 32767)*
  - *imaginary−part: 2's complement 16 bit integer (−32768 to 32767)*

This comment applies for I−PAF and D−PAF.

1.3 CEOS Format Definitions

1.3.1 Volume Directory File

Field	Bytes	Format	Contents	Description
1	1−4	B4	(1)	Record sequence number
2	5	B1	(192)	1st record subtype code
3	6	B1	(192)	Record type code
4	7	B1	(18)	2nd record subtype code
5	8	B1	(18)	3rd record subtype code
6	9−12	B4	(360)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blanks
9	17−28	A12	CCB−CCT−0002	Format control document
10	29−30	A2	$E	Format control document version
11	31−32	A2	$A	Record format revision level (for original: ”$A”)
12	33−44	A12	< ... >	CEOS Software release and revision level
13	45−60	A16	< ... >	Physical tape id
14	61-76	A16	XSAR.SAR.xxx$$$$	Logical volume id (xxx:”MGD”, or ”SSC”, or ”RAW”, or ”GEC”, or ”GTC”, or ”GIM”, or ”GMQ”)
15	77−92	A16	< ... >	Volume set id (YYYYMMDDhhmmssdd)
16	93−94	I2	$1	Total number of physical volumes in logical volume
17	95−96	I2	$1	1st physical volume sequence number
18	97−98	I2	$1	Last physical volume sequence number
19	99−100	I2	$1	This physical volume sequence number
20	101−104	I4	$$$1	1st reference file in volume
21	105−108	I4	$$$1	Logical volume in set
22	109−112	I4	$$$1	Logical volume number in physical volume
23	113−120	A8	< ... >	Tape creation date (YYYYMMDD)
24	121–128	A8	< ... >	Tape creation time (hhmmssdd)
25	129–140	A12	GERMANY$$$$$ or ITALY$$$$$$$	Creating country
26	141–148	A8	DLR$$$$ or ASI$$$$$	Creating agency
27	149–160	A12	D–PAF$$$$$$$$$ or I–PAF$(ASI)$$	Creating facility
28	161–164	I4	$$$2	Number of pointer records
29	165–168	I4	$$$4	Number of records
30	169–172	I4	$$$1	Total number of logical volumes in volume set
31	173–260	A88	$..$	Spare
32	261–360	A100	$..$	Spare

Table 2 : Volume Directory File - Volume Descriptor Record

For X−SAR, each logical volume is one physical volume. Logical volumes do not span multiple physical volumes.

Field	Bytes	Format	Contents	Description
1	1−4	B4	(2)	Record sequence number
2	5	B1	(219)	1st record subtype code
3	6	B1	(192)	Record type code
4	7	B1	(18)	2nd record subtype code
5	8	B1	(18)	3rd record subtype code
6	9−12	B4	(360)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blank
9	17−20	I4	$$$1	File number
10	21−36	A16	XSAR.SAR.xxxLEAD	File name (xxx:”MGD”, or ”SSC”, or ”RAW”, or ”GEC”, or ”GTC”, or ”GIM”, or ”GMQ”)
11	37−64	A28	SARLEAD-ER$FILE$$$$$$$$$$$$$$	File class
12	65−68	A4	SARL	File class code
13	69−96	A28	MIXED$BINARY$AND$ASCII$$$$$$	Data type
14	97−100	A4	MBAA	Data type code
15	101−108	I8	< ... >	Number of records (Depends on product type)
16	109−116	I8	$$$$$720	1st record length
17	117−124	I8	< ... >	Max record length (Depends on product type)
18	125−136	A12	VARIABLE$LEN	Record type
19	137−140	A4	VARE	Record type code
20	141−142	I2	$1	Start file volume number
21	143−144	I2	$1	End file volume number
22	145−152	I8	$$$$$$$1	First record number on tape
23	153−160	I8	< ... >	Last record number on tape (Depends on product type)
24	161−260	A100	$..$	Blank
25	261−360	A100	$..$	Blank

Table 3 : Volume Directory File: File Pointer Record - SAR Leader File

Field	Bytes	Format	Contents	Description
1	1−4	B4	(3)	Record sequence number
2	5	B1	(219)	1st record subtype code
3	6	B1	(192)	Record type code
4	7	B1	(18)	2nd record subtype code
5	8	B1	(18)	3 rd record subtype code
6	9−12	B4	(360)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blank
9	17−20	I4	$$$2	File number
10	21−36	A16	XSAR.SAR.xxxIMGY	File name (xxx:”MGD”, or ”SSC”, or ”RAW”, or ”GEC”, or ”GTC”, or ”GIM”, or ”GMQ”)
11	37−64	A28	IMAGERY$OP-TIONS$FILE$$$$$$$$	File class
12	65−68	A4	IMOP	File class code
13	69−96	A28	MIXED$BINARY$AND$AS CII$$$$$$	Data type
14	97−100	A4	MBAA	Data type code
15	101−108	I8	< ... >	Number of records (number of lines + 1)
16	109−116	I8	< ... >	1st record length [2*(number of pixels) + 12]
17	117−124	I8	< ... >	Max record length [2*(number of pixels) + 12]
18	125−136	A12	FIXED$LENGTH	Record type
19	137−140	A4	FIXD	Record type code
20	141−142	I2	$1	Start file volume number
21	143−144	I2	$1	End file volume number
22	145−152	I8	$$$$$$$1	First record number on tape
23	153−160	I8	< ... >	Last record number on tape (number of lines + 1)
24	161−260	A100	$..$	Blank
25	261−360	A100	$..$	Blank

Table 4 : Volume Directory File: File Pointer Record - Imagery Options

Field	Bytes	Format	Contens	Description
1	1−4	B4	(4)	Record sequence number
2	5	B1	(18)	1st record subtype code
3	6	B1	(63)	Record type code
4	7	B1	(18)	2nd record subtype code
5	8	B1	(18)	3rd record subtype code
6	9−12	B4	(360)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Continuation flag (”$$”) for ”not continued”
9	17−56	A40	< ... >	Product type specifier (see footnote)
10	57−116	A60	< ... >	Location, date/time of CEOS product creation (see footnote)
11	117−156	A40	< ... >	Physical volumes identification (see footnote)
12	157−196	A40	< ... >	Site identification
13	197−236	A40	LATITUDE$:$±nnn.nnn$LONGI-TUDE$:$±nnn.nnn	Site location
14	237−256	A20	$..$	Spares
15	257−360	A104	$..$	Spares

Table 5 : Volume Directory File: Text Record

The purpose of this record is to allow the reader of the CEOS tape to simply print out a short description of the data.

Field #	Value
9	possible values are: MULTI–LOOK$GROUND$RANGE$DETECTED$...$ SINGLE–LOOK$SLANT$RANGE$COMPLEX$...$ ANNOTATEDRAWDATA$...$ GEOCODED$ELLIPSOID$CORRECTED$...$ GEOCODED$TERRAIN$CORRECTED$...$ GEOCODED$INCIDENCE$ANGLE$MASK$...$ GEOCODEDMAPQUADRANT$...$
10	PRODUCEDATDLR/GERMANY/D–PAF$...$ON$dd–MMM–yyyy$hh:mm:ss.ddd or PRODUCEDATASI/ITALY/I–PAF$..$ON$dd–MMM–yyyy$hh:mm:ss.ddd
11	TAPEID:$xxxxxxxxxxxxxxxx$,$TAPE$nOFm$...$(xxxxxxxxxxxxxxxx is the internal tape id, field 13 Volume Descriptor Record)

Table 6 : Footnote to fields 9-11 of the Text Record

In field 10 the date (dd−MMM−yyyy$hh:mm:ss.ddd) must begin at byte 37 of the 60−byte string.

1.3.2 SAR Leader File

Field	Bytes	Format	Contents	Description
1	1−4	B4	(1)	Record sequence number
2	5	Bl	(63)	1st rec.subtype code
3	6	Bl	(192)	Record type code
4	7	Bl	(18)	2nd rec. subtype code
5	8	Bl	(18)	3rd rec. subtype code
6	9−12	B4	(720)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blank
9	17−28	A12	CEOS−SAR−CCT	Format control document
10	29−30	A2	$B	Format control document version
11	31−32	A2	$B	Record format rev. level
12	33−44	A12	< ... >	Software id
13	45−48	I4	$$$1	File number
14	49−64	A16	XSAR.SAR.xxxLEAD	File name (same as field 10 of file pointer record)
15	65−68	A4	FSEQ	Record sequence and location type flag
16	69−76	I8	$$$$$$$1	Sequence number location
17	77−80	I4	$$$4	Sequence number field length
18	81−84	A4	FTYP	Record code and location type flag
19	85−92	I8	$$$$$$$5	Record code location
20	93−96	I4	$$$4	Record code field length
21	97−100	A4	FLGT	Record length and location type flag
22	101−108	I8	$$$$$$$9	Record length location
23	109−112	I4	$$$4	Record length field length
24	113	Al	$	Blank
25	114	Al	$	Blank
26	115	Al	$	Blank
27	116	Al	$	Blank
28	117−180	A64	$..$	Blanks
VARIABLE SEGMENT CONTENTS				
29	181−186	I6	$$$$$1	Number of data set summary records
30	187−192	I6	$$2432	Record length (12 annotations points)
31	193−198	I6	$$$$$1	Number of map projection data records
32	199−204	I6	$$1620	Record length
33	205−210	I6	$$$$$1	Number of platform position data records
34	211−216	I6	< ... >	Record length (MGD, SSC, RAW: 1046; Geocoded: 1442)
35	217−222	I6	$$$$$0	Number of attitude data records
36	223−228	I6	$$$$$0	Record length
37	229−234	I6	$$$$$1	Number of radiometric data records
38	235−240	I6	$$$560	Record length (including antenna gains table)
39	241−246	I6	$$$$$1	Number of radiometric compensation records
40	247−252	I6	< ... >	Record length (RAW: 2016; Others: 8600)
41	253−258	I6	$$$$$0	Number of data quality summary records
42	259−264	I6	$$$$$0	Record length
43	265−270	I6	$$$$$0	Number of data histogram records
44	271−276	I6	$$$$$0	Record length
45	277−282	I6	$$$$$0	Number of range spectra records
46	283−288	I6	$$$$$0	Record length
47	289−294	I6	$$$$$1	Number of digital elevation model descriptor records (only for geocoded products)
48	295−300	I6	< ... >	Record length
49	301−306	I6	$$$$$0	Number of radar parameter update records
50	307−312	I6	$$$$$0	Record length
51	313−318	I6	$$$$$0	Number of annotation data records
52	319−324	I6	$$$$$0	Record length

53	324−330	I6	$$$$$1	Number of detailed processing records
54	331−336	I6	$$$720	Record length
55	337−342	I6	$$$$$0	Number of calibration data records
56	343−348	I6	$$$$$0	Record length
57	349−354	I6	$$$$$1	Number of ground control points descriptor records (only for geocoded products)
58	355−360	I6	< ... >	Record length
59	361−366	I6	$..$	Blanks
60	367−372	I6	$..$	Blanks
61	373−378	I6	$..$	Blanks
62	379−384	I6	$..$	Blanks
63	385−390	I6	$..$	Blanks
64	391−396	I6	$..$	Blanks
65	397−402	I6	$..$	Blanks
66	403−408	I6	$..$	Blanks
67	409−414	I6	$..$	Blanks
68	415−420	I6	$..$	Blanks
69	421−426	I6	$$$$$1	Number of facility data records (only for geo-coded products)
70	427−432	I6	840	Record length
71	433−720	A288	$..$	Blanks

Table 7 : SAR Leader File: File Descriptor Record

Field	Bytes	Format	Contents	Description
1	1−4	B4	(2)	Record Sequence Number
2	5	Bl	(10)	lst record subtype code
3	6	Bl	(10)	Record type code
4	7	Bl	(51)	2nd record subtype code
5	8	Bl	(20)	3rd record subtype code
6	9−12	B4	(2432)	Length of this record
7	13−16	I4	$$$1	Data set Summary Record sequence number
8	17−20	I4	$$00	SAR channel indicator (X−SAR: XVV= 00)
SCENE PARAMETERS				
9	21−36	A16	< ... >	Site identifier (3−letter ID)
10	37−68	A32	< ... >	Site name (English name)
11	69−100	A32	< ... >	Scene GMT center time (DD−MMM−YYYY/ hh:mm:ss.ttt) where: DD = day MMM = month (JAN ... DEC) YYYY = year hh = hours (00 to 23) mm = minutes (00 to 59) ss = seconds (00 to 59) ttt = milliseconds (000 to 999)
12	101−116	A16	< ... >	Scene MET center time (DDD:hh:mm:ss.ttt)
13	117−132	F16.7	< ... >	Processed/RAW data scene center geodetic latitude defined as positive to the north of the equator and negative to the south (degrees)
14	133−148	F16.7	< ... >	Processed/RAW data scene center geodetic longitude defined as positive to
15	149−164	F16.7	< ... >	Processed/RAW data Scene Center true heading as calculated relative to the east of the prime meridian and negative to the west.(degrees) true North (degrees): Track angle at scene center
16	165−180	A16	< ... >	Ellipsoid designator
17	181−196	F16.7	< ... >	Ellipsoid semimajor axis (km)
18	197−212	F16.7	< ... >	Ellipsoid semiminor axis (km)
19	213−228	F16.7	−9..9.9..9	Earth's mass∗Gravitational constant

20	229−244	A16		Spare
21	245−260	F16.7	−9..9.9..9	Ellipsoid J2 parameter
22	261−276	F16.7	−9..9.9..9	Ellipsoid J3 parameter
23	277−292	F16.7	−9..9.9..9	Ellipsoid J4 parameter
24	293−308	A16	$..$	Spare
25	309−324	F16.7	< ... >	Average terrain height above Ellipsoid at scene center (meters)
26	325−332	I8	< ... >	Scene center line number (the line number at the scene center including zero fill)
27	333−340	I8	< ... >	Scene center pixel number (the pixel number at the scene center including zero fill)
28	341−356	F16.7	< ... >	Processed/RAW data scene length (km) including zero fill
29	357−372	F16.7	< ... >	Processed/RAW data scene width (km) including zero fill
30	373−388	A16	$..$	Spare
31	389−392	I4	$$$1	Number of SAR polarization channels
32	393−396	A4	$..$	Spare
33	397−412	A16	< ... >	Sensor platform mission identifier (this field identifies the platform for the sensor that transmitted the SAR data; e.g. ”STS−059$$$$$$$$$” for the first SIR−C mission)
34	413−444	A32	X−SAR$−X$−x$xx−V$V$−SRL−x$$$$$$$	Sensor ID: and mode of operation for this channel: (this field specifies the sensor and its mode of operation in the form of: <AAAAAA−BB−CCDD−EEFF−GGGGG$$$$$$$>, where: AAAAAA= six character sensor ID (SIR−C, X−SAR) BB = SAR band (X$, L$, C$) CC = code for resolution mode (fine (19.0 MHz): F$, coarse (9.5 MHz): C$) DD = SIR−C data acquisition mode ID (eg: mode 0 to 23) EE = transmit polarization (H$, V$, or HV) FF = receive polarization (H$, V$, or HV GGGGG = Mission ID (SRL−1÷3)
35	445−452	A8	< ... >	Data take ID
36	453−460	F8.3	−999.999	Sensor Platform geodetic Latitude at nadir corresponding to Scene Center (degrees)
37	461−468	F8.3	−999.999	Sensor Platform geodetic Longitude at nadir corresponding to Scene Center (degrees)
38	469−476	F8.3	−999.999	Sensor Platform Heading at nadir corresponding to Scene Center (degrees)
39	477−484	F8.3	< ... >	Antenna Direction (Left Looking: −90, Right Looking: +90)
40	485−492	F8.3	< ... >	Incidence angle at scene center as derived from sensor platform orientation, electronic boresight and Earth geometry (degrees)
41	493−500	F8.3	< ... >	Radar Frequency (GHz)
42	501−516	F16.7	< ... >	Radar wavelength (meters)
43	517−518	A2	$$00	Motion compensation indicator
44	519−534	A16	ANA-LOG$CHIRP$$$$	Transmitted pulse code specifier
45	535−550	F16.7	−9..9.9..9	Transmitted pulse amplitude coefficient #0 (Chirp =range chirp constant term (offset from DC))
46	551−566	F16.7	−9..9.9..9	Transmitted pulse amplitude coeff. #1 (Chirp =range chirp linear term)
47	567−582	F16.7	−9..9.9..9	Transmitted pulse amplitude coefficient #2 (quadratic term)
48	583−598	F16.7	−9..9.9..9	Transmitted pulse amplitude coefficient #3 (cubic term)

49	599−614	F16.7	−9..9.9..9	Transmitted pulse amplitude coefficient #4 (quartic term)
50	615−630	F16.7	−9..9.9..9	Transmitted pulse phase coefficient #0 (offset in radians)
51	631−646	F16.7	< ... >	Transmitted chirp start frequency (MHz)
52	647−662	F16.7	< ... >	Transmitted chirp rate (MHz/μsec)
53	663−678	F16.7	−9..9.9..9	Transmitted pulse phase coefficient #3 (cubic term)
54	679−694	F16.7	−9..9.9..9	Transmitted pulse phase coefficient #4 (quadratic term)
55	695−702	I8	$..$0	Down linked data chirp extraction index (in samples)
56	703−710	A8	$..$	Spare
57	711−726	F16.7	< ... >	Range complex sampling rate (MHz)
58	727−742	F16.7	−9..9.9..9	Range gate at near edge at the start of the image (one−way echo delay time)(μsec)
59	743−758	F16.7	< ... >	Range pulse length (μsec)
60	759−762	A4	YES$	Range base band conversion flag
61	763−766	A4	< ... >	Range compressed flag (YES$/NO$$) (NO for RAW product, YES= for all others)
62	767−782	F16.7	< ... >	Receiver gain at early edge at the start of the image (dB)
63	782−798	F16.7	< ... >	Raw data S/N ratio (dB)
64	799−806	I8	< ... >	Quantization in bits per channel (4bit/4bit:4,6bit/6bit:6)
65	807−818	A12	UNIFORM$$$$$	Quantizer descriptor
66	819−834	F16.7	< ... >	Measured DC Bias for I−raw data component
67	835−850	F16.7	< ... >	Measured DC Bias for Q−raw data component
68	851−866	F16.7	< ... >	Measured standard deviation of I−raw data component
69	867−882	F16.7	< ... >	Measured standard deviation of Q−raw data component
70	883−898	F16.7	< ... >	I/Q nonorthogonality
71	899−914	F16.7	< ... >	Antenna electronic boresight relative to platform vertical axis at center of the image (degrees) (positive to the right; negative to the left) (look angle)
72	915−930	F16.7	−9..9.9..9	Antenna mechanical boresight relative to platform vertical axis at the start of the image, positive to the right, negative to the left (degrees)
73	931−934	A4	$$$$	Echo tracker−on/off designator (”ON$$” or ”OFF$”)
74	935−950	F16.7	< ... >	Nominal PRF (Hz)
75	951−966	F16.7	< ... >	Effective two−way antenna elevation 6dB beam width at boresight (degrees)
76	967−982	F16.7	< ... >	Effective two−way antenna azimuth 6dB beam width at electronic bore−sight (degrees)
77	983−998	I16	$..$0	(Satellite encoded binary time code)
78	999−1030	A32	$..$	(Satellite clock time, (YYYYMMDDhhmmssttt$$$...)
79	1031−1038	I8	$..$0	Satellite clock increment (nano−secs))
80	1039−1046	A8	$..$	Spare
GENERAL PROCESSING PARAMETERS				
81	1047−1062	A16	< ... >	Processing facility identifier (”D−PAF/DLR” or ”I−PAF/ASI”)
82	1063−1070	A8	< ... >	Processing system identifier
83	1071−1078	A8	< ... >	Processing version identifier (software version)
84	1079−1094	A16	$..$	Processing facility process code
85	1095−1110	A16	< ... >	Product level code (RAW: ”0.0$$$...”, SSC: ”1.0$$$...”, MGD:”1.5$$$...”, Geocoded data products: ”1.7$$$...”,)
86	1111−1142	A32	< ... >	Product type specifier (”MGD”, or ”SSC”, or ”RAW”, or ”GEC”, or ”GTC”, or ”GIM”)

87	1143−1174	A32	< ... >	Processing algorithm identifier
88	1175−1190	F16.7	< ... >	Total number of looks (Not supported for RAW product)
89	1191−1206	F16.7	< ... >	Nominal effective number of Range looks (Not supp. for RAW product)
90	1207−1222	F16.7	−9..9.9..9	Bandwidth per look in Azimuth (Hz)
91	1223−1238	F16.7	−9..9.9..9	Bandwidth per look in Range (Hz)
92	1239−1254	F16.7	< ... >	Total processor bandwidth in Azimuth (Hz) (Not supp. for RAW product)
93	1255−1270	F16.7	< ... >	Total processor bandwidth in Range (MHz) (Not supp. for RAW product)
94	1271−1302	A32	HAMMING$WIN-DOW,$AZ−COEFF=< ... >	Weighting function designator in Azimuth (MGD; other: ”NONE”)
95	1303−1334	A32	HAMMING$WIN-DOW, $RG−COEFF=< ... >	Weighting function designator in Range (MGD; other: ”NONE”)
96	1335−1350	A16	< ... >	HDDC identifier of the master X−SAR tape (not of duplicate)
97	1351−1366	F16.7	< ... >	Nominal range resolution equal to 3dB (m) (Not supp. for RAW product)
98	1367−1382	F16.7	< ... >	Nominal azimuth resolution equal to 3dB (m) (Not supp. for RAW prod.)
99	1383−1398	F16.7	< ... >	Processor gain for noise data (before radiometric correction) (Not supported for RAW product)
100	1399−1414	F16.7	< ... >	Linear conversion factor (backscatter coefficient to image power conversion) (Not supported for RAW product)
101	1415−1430	F16.7	< ... >	Along track Doppler frequency constant term at early edge of image (Hz) (I−PAF only)
102	1431−1446	F16.7	< ... >	Along track Doppler frequency linear term relative to early edge of the image (Hz/pixel) (I−PAF only)
103	1447−1462	F16.7	−9..9.9..9	Along track Doppler frequency quadratic term relative to early edge of the image (Hz/pixel/pixel)
104	1463−1478	F16.7	< ... >	Doppler centroid at image center (Hz)
105	1479−1494	F16.7	−9..9.9..9	Cross track Doppler freq. constant term at near edge of the image (Hz)
106	1495−1510	F16.7	−9..9.9..9	Cross track Doppler frequency linear term relative to near edge of the image (Hz/pixel)
107	1511−1526	F16.7	−9..9.9..9	Cross track Doppler frequency quadratic term relative to near edge of the image (Hz/pixel/pixel)
108	1527−1534	A8	$..$	Time direction indicator along pixel direction (”INCREASE”−ing)
109	1535−1542	A8	$..$	Time direction indicator along line direction (”INCREASE”−ing)
110	1543−1558	F16.7	−9..9.9..9	Along track Doppler frequency rate constant term at early edge of the image (Hz/sec)
111	1559−1574	F16.7	−9..9.9..9	Along track Doppler frequency rate linear term relative to early edge of the image (Hz/sec/pixel)
112	1575−1590	F16.7	−9..9.9..9	Along track Doppler frequency rate quadratic term relative to early edge of the image (Hz/sec/pixel/pixel)
113	1591−1606	F16.7	< ... >	FM rate at image center (Hz/sec)
114	1607−1622	F16.7	−9..9.9..9	Cross track Doppler frequency rate constant term at near edge of the image (Hz/sec)
115	1623−1638	F16.7	−9..9.9..9	Cross track Doppler frequency rate linear term relative to near edge of the image (Hz/sec/pixel)
116	1639−1654	F16.7	−9..9.9..9	Cross track Doppler frequency rate quadratic term relative to near edge of the image (Hz/sec/pixel/pixel)

117	1655−1670	F16.7	< ... >	Time offset of early edge of transmitted chirp from time origin (including electronic delay), microseconds (only for RAW product)
118	1671−1678	A8	< ... >	Line content indicator (MGD, SSC, RAW: RANGE; Geoc.: EASTING)
119	1679−1682	A4	$$$$	Clutter lock applied flag
120	1683−1686	A4	$$$$	Autofocussing applied flag
121	1687−1702	F16.7	< ... >	Line spacing (m) (not supported for RAW product)
122	1703−1718	F16.7	< ... >	Pixel spacing (m) (not supported for RAW product)
123	1719−1734	A16	< ... >	Processor range compression designator (MGD, SSC: ”ANALYTIC$CHIRP”; OTHERS: $..$)
124	1735−1750	A16	< ... >	Orbit direction at image center (”ASCENDING$$$$$$$” OR ”DESCENDING$$$$$$”)
125	1751−1766	F16.7	< ... >	Nominal bias (only for RAW product)
SENSOR SPECIFIC LOCAL USE SEGMENT				
126	1767−1782	F16.7	< ... >	zero doppler range time of first range pixel (not supp. for RAW product)
127	1783−1798	F16.7	< ... >	zero doppler range time of center range pixel (” ” ” ” ” ”)
128	1799−1814	F16.7	< ... >	zero doppler range time of last range pixel (” ” ” ” ” ”)
129	1815−1838	A24	< ... >	zero doppler azimuth time of first line (GMT) (” ” ” ” ” ”)
130	1839−1862	A24	< ... >	zero doppler azimuth time of center line (GMT) (” ” ” ” ” ”)
131	1863−1886	A24	< ... >	zero doppler azimuth time of last line (GMT) (” ” ” ” ” ”)
PROCESSOR SPECIFIC LOCAL USE SEGMENT				
132	1887−2006	A120	$..$	Spares
IMAGE ANNOTATION FIELDS (only GEO products)				
133	2007−2014	I8	$$$$$$$12	Number of Annotation Points
134	2015−2022	A8	$...$	Spare
135	2023−2030	I8	< ... >	Line number of 1st annotation start
136	2031−2038	I8	< ... >	Pixel number of 1st annotation start
137	2039−2054	A16	< ... >	1st annotation text
138	2055−2062	I8	< ... >	Line number of 2nd annotation start
139	2063−2070	I8	< ... >	Pixel number of 2nd annotation start
140	2071−2086	A16	< ... >	2nd annotation text
...			< ... >	...
168	2375−2382	I8	< ... >	Line number of 12 th annotation start
169	2383−2390	I8	< ... >	Pixel number of 12 th annotation start
170	2391−2406	A16	< ... >	12th annotation text
171	2407−2432	A26	$..$	Spares

Table 8 : SAR Leader File: Data Set Summary Record

1	1−4	B4	(3)	Sequence number
2	5	Bl	(10)	lst record subtype code = 10
3	6	B1	(20)	Record type code = 20
4	7	Bl	(51)	2nd record subtype code = 51
5	8	B1	(20)	3rd record subtype code = 20
6	9−12	B4	(1620)	Length of this record = 1620
7	13−28	A16	$..$	Spare
8	29−60	A32	< ... >	Map projection descriptor (MGD: ”GROUND$RANGE$$$...”, SSC, RAW: ”SLANT$RANGE$$$...”)
9	61−76	I16	< ... >	Number of pixels per line of image
10	77−92	I16	< ... >	Number of lines
11	93−108	F16.7	< ... >	Nominal inter−pixel distance in output scene (meters) (no for RAW)

12	109−124	F16.7	< ... >	Nominal inter−line distance in output scene (meters) (no for RAW)
13	125−140	F16.7	< ... >	Orientation at output scene center, only for Geocoded products. This is the convergence of the meridians, ie. the angle between geographic north and map grid north (degrees) (Angle of projection axis from true North)
14	141−156	F16.7	−9..9.9..9	Actual platform orbital inclination (degrees)
15	157−172	F16.7	−9..9.9..9	Actual ascending node (longitude at equator) (degrees)
16	173−188	F16.7	−9..9.9..9	Distance of platform at input scene center from the geo-center (km)
17	189−204	F16.7	−9..9.9..9	Geodetic altitude of the platform relative to the ellipsoid (km)
18	205−220	F16.7	−9..9.9..9	Actual ground speed at nadir at input scene center time (km/sec)
19	221−236	F16.7	−9..9.9..9	Platform heading (degrees): effective subplatform track direction angle relative to true north, including the effects of orbital inclination and skew due to earth rotation.
PROJECTION ELLIPSOID PARAMETERS				
20	237−268	A32	< ... >	Name of reference ellipsoid
21	269−284	F16.7	< ... >	Semimajor axis of ref. ellipsoid (km)
22	285−300	F16.7	< ... >	Semiminor axis of ref. ellipsoid (km) Additional D−PAF/DLR comment: for D−PAF GEO products: Semimajor axis of ref. ellipsoid (m) Semiminor axis of ref. ellipsoid (m)
From Field 23 to Field 55, only applicable to Geocoded Products.				
23	301−316	F16.7	< ... >	Datum shift parameter referenced to Greenwich. dx (meters)
24	317−332	F16.7	< ... >	Datum shift parameter perpendicular to Greenwich. dy (meters)
25	333−348	F16.7	< ... >	Datum shift parameter direction of the rotation axis. dz (meters)
26	349−364	F16.7	< ... >	Additional datum shift parameter 1st rotation angle
27	365−380	F16.7	< ... >	Additional datum shift parameter 2nd rotation angle
28	381−396	F16.7	< ... >	Additional datum shift parameter 3rd rotation angle
29	397−412	F16.7	< ... >MAP PROJECTION DESIGNATOR	Scale factor of reference ellipsoid
30	413−444	A32	< ... >UTM− PROJECTION (1 ST DEFAULT)	Alphanumeric deseription of map projection
31	445−476	A32	< ... >	UTM descriptor
32	477−480	A4	< ... >	Signature of the UTM zone
33	481−496	F16.7	< ... >	Map origin (false easting)
34	497−512	F16.7	< ... >	Map origin (false northing)
35	513−528	F16.7	< ... >	Center of projection Longitude (degrees)
36	529−544	F16.7	< ... >	Center of projection Latitude (degrees)
37	545−560	F16.7	< ... >	l st standard parallel (degrees)
38	561−576	F16.7	< ... >	2nd standard parallel (degrees)
39	577−592	F16.7	< ... >UPS− PROJECTION (2ND DE-FAULT)	Scale factor
40	593−624	A32	< ... >	UPS descriptor
41	625−640	F16.7	< ... >	Center of projection Longitude (degrees)
42	641−656	F16.7	< ... >	Center of projection Latitude (degrees)
43	657−672	F16.7	< ... >	Scale factor
NATIONAL SYSTEMS PROJECTION				

44	673−704	A32	< ... >	Projection descriptor
45	705−720	F16.7	< ... >	Map origin (false easting)
46	721−736	F16.7	< ... >	Map origin (false northing)
47	737−752	F16.7	< ... >	Center of projection Longitude (degrees)
48	753−768	F16.7	< ... >	Center of projection laútude (degrees)
49	769−784	F16.7	< ... >	Standard parallels (deg, default: −9999.99)
50	785−800	F16.7	< ... >	Standard parallels (deg, default: −9999.99)
51	801−816	F16.7	< ... >	Standard parallels (deg, default: −9999.99)
52	817−832	F16.7	< ... >	Standard parallels (deg, default: −9999.99)
53	833−848	F16.7	< ... >	Centrai meridian (deg, default: −9999.99)
54	849−864	F16.7	< ... >	Centrai meridian (deg, default: −9999.99)
55	865−880	F16.7	< ... >	Centrai meridian (deg, default: −9999.99)
56	881−896	A16	$..$	Spares
57	897−912	A16	$..$	Spares
58	913−928	A16	$..$	Spares
59	929−944	A16	$..$	Spares
COORDINATES OF FOUR CORNER POINTS				
60	945−960	F16.7	< ... >	Top left corner northing (meters) (only GEO products)
61	961−976	F16.7	< ... >	Top left corner easting (meters) ” ” ”
62	977−992	F16.7	< ... >	Top right corner northing (meters) ” ” ”
63	993−1008	F16.7	< ... >	Top right corner easting (meters) ” ” ”
64	1009−1024	F16.7	< ... >	Bottom right corner northing (meters)” ” ”
65	1025−1040	F16.7	< ... >	Bottom right corner easting (meters) ” ” ”
66	1041−1056	F16.7	< ... >	Bottom left corner northing (meters) ” ” ”
67	1057−1072	F16.7	< ... >	Bottom left corner easting (meters) ” ” ”
68	1073−1088	F16.7	< ... >	Near range early time latitude (degrees)
69	1089−1104	F16.7	< ... >	Near range early time longitude (degrees)
70	1105−1120	F16.7	< ... >	Far range early time latitude (degrees)
71	1121−1136	F16.7	< ... >	Far range early time longitude (degrees)
72	1137−1152	F16.7	< ... >	Far range late time latitude (degrees)
73	1153−1168	F16.7	< ... >	Far range late time longitude (degrees)
74	1169−1184	F16.7	< ... >	Near range late time latitude (degrees)
75	1185−1200	F16.7	< ... >	Near range late time longitude (degrees)
76	1201−1216	F16.7		Top left corner terrain height relative to ellipsoid (meters) (only GEO products)
77	1217−1232	F16.7		Top right corner terrain height (meters) (only GEO products)
78	1233−1248	F16.7		Bottom right corner height (meters) ” ” ”
79	1249−1264	F16.7		Bottom left corner height (meters) ” ” ”
COEFFS. FOR IMAGE TO MAP TO IMAGE CONVERSION (only GEO products)				
80−87	1265−1424	8E20.10	< ... >	Eight coefficients (AI 1, A 12, ... A24) to convert a line (L) and pixel (P) position to the map projection frame of reference, say (E,N) where: E = A 11 + A12*L+ A13*P A14*L*P *N* = A21 + A22* L+ A23 *P+ A24*L*P
88−95	1425−1584	8E20.10	< ... >	Eight coefficients (B 1 1, B 12, ... B24) to convert from the map projection (E,N) to line (1) and pixel (P) position in the image, say (L,P) where: L = B11 + B12*E+ B13 *N+ B14*E*N P = B21 + B22*E + B23TN+ B24*E*N
96	1585−1620	A36	$..$	Spares

Table 9 : SAR Leader File: Map Projection Data Record

Field	Bytes	Format	Contents	Description
1	1−4	B4	(4)	Sequence number
2	5	Bl	(10)	lst record subtype code
3	6	Bl	(30)	Record type code
4	7	Bl	(51)	2nd record subtype code
5	8	B1	(20)	3rd record subtype code
6	9−12	B4	(...)	Length of this record (MGD, SSC, RAW: 1046; Geocoded: 1442)
7	13−44	A32	$..$	Orbital elements designator
8	45−60	F16.7	−9..9.9..9	lst orbital element
9	61−76	F16.7	−9..9.9..9	2nd orbital element
10	77−92	F16.7	−9..9.9..9	3rd orbital element
11	93−108	F16.7	−9..9.9..9	4th orbital element
12	109−124	F16.7	−9..9.9..9	5th orbital element
13	125−140	F16.7	−9..9.9..9	6th orbital element
14	141−144	I4	< ... >	Number of data sets (MGD, SSC, RAW: 5; Geocoded: 8)
15	145−148	I4	< ... >	Year of first data point (YYYY)
16	149−152	I4	< ... >	Month of first data point (MM)
17	153−156	I4	< ... >	Day of first data point (DD)
18	157−160	I4	< ... >	Days of the year (GMT) for first data point
19	161−182	D22.15	< ... >	Seconds of day (GMT) for first data point
20	183−204	D22.15	< ... >	Time interval between data sets (data points) (sec)
21	205−268	A64	< ... >	Reference coordinate system
22	269−290	D22.15	−9..9.9..9	Angle between +x−axis of coordinate system and the Prime Meridian
23	291−306	F16.7	−9..9.9..9	Along track position error (meters)
24	307−322	F16.7	−9..9.9..9	Across track position error (meters)
25	323−338	F16.7	−9..9.9..9	Radial position error (meters/sec)
26	339−354	F16.7	−9..9.9..9	Along track velocity error (meters/sec)
27	355−370	F16.7	−9..9.9..9	Across track velocity error (meters/sec)
28	371−386	F16.7	−9..9.9..9	Radial velocity error (meters/sec)
PLATFORM POSITION DATA SET				
29	387−452	3D22.15	< ... >	1st data point (X,Y,Z) position vector (km)
30	453−518	3D22.15	< ... >	1st data point (X,Y,Z) velocity vector (km/sec)

Table 10 : SAR Leader File: Platform Position Record

Repeat fields 29−30 for the other data points (in total 5 for MGD, SSC, RAW products and 8 for geocoded products).

Note: For MGD, SSC, RAW Products:

The position and velocity vectors are given for five orbit positions, equally spaced, and so positioned within the scene:

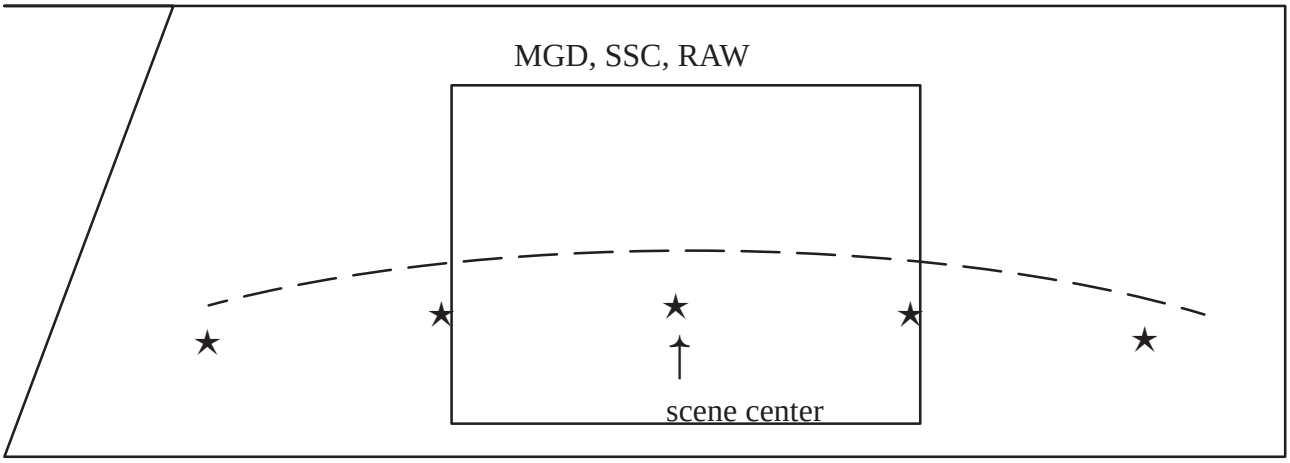

Figure 1 : Position and velocity vectors of a scene

Field	Bytes	Format	Contents	Description
1	1−4	B4	(5)	Sequence number
2	5	Bl	(10)	Record subtype code
3	6	Bl	(50)	Record type code
4	7	Bl	(51)	2nd record subtype code
5	8	Bl	(20)	3rd record subtype code
6	9−12	B4	(560)	Length of this record
7	13−16	I4	$$$1	Radiometric data record sequence number
8	17−20	I4	$$$1	Number of radiometric data sets in the record
RADIOMETRIC DATA SET				
9	21−28	I8	$$$$$540	Radiometric data set size in bytes
10	29−32	A4	XVV$	SAR channel indicator
11	33−36	A4	$..$	Spare
12	37−60	A24	ACTUAL RECEIVER GAIN$...$	Look up table designator
13	61−68	I8	$$$$$$21	Number of samples in the look up table
14	69−84	A16	REC GAIN VALUE$$	Sample type designator
15	85−100	F16.7	< ... >	Raw data noise power estimate (reference)
16	101−116	F16.7	< ... >	Linear conversion factor (backscatter coefficient to image power conversion) (not supported for RAW product)
17	117−132	F16.7	< ... >	Processor gain for noise data (before radiometric correction) (not supported for RAW product)
18	133−136	A4	$..$	Spares
19	137−140	I4	$$$0	First Receiver Gain Code.
20	141−156	F16.7	< ... >	Difference between actual and mid gain (60 db) for first gain code.
59	537−540	I4	$$20	Last Receiver Gain Code.
60	541−556	F16.7	< ... >	Difference between actual and mid gain (60 db) for last gain code.
61	557−560	A4	$..$	Spares

Table 11 : SAR Leader File: Radiometric Data Record

Please note that the gain codes in table 11 are in the range 0...20 and refer to gain setting ranges of 40...80 (2 db steps).

Field	Bytes	Format	Contents	Description
1	1−4	B4	(6)	Sequence number
2	5	Bl	(10)	lst record subtype code
3	6	Bl	(51)	Record type code
4	7	Bl	(51)	2nd record subtype code
5	8	Bl	(20)	3rd record subtype code
6	9−12	B4	(...)	Length of this record (RAW: 2016; Others: 8600)
7	13−16	I4	$$$1	Radiometric compensation record sequence number
8	17−20	A4	XVV$	SAR channel indicator(”XVV$”)
9	21−28	I8	$$$$$$$1	Number of radiometric compensation data sets in the record
10	29−36	I8	< ... >	Compensation data set size (in bytes)
RADIOMETRIC COMPENSATION DATA SET				
11	37−44	A8	< ... >	Compensation data type designatorr (RAW: TWO−WAY; OTHERS: RANGE)
12	45−76	A32	< ... >	Compensation data descriptor (RAW: ELEVATION$ANTENNA$ PATTERN; OTHERS: RG$RADIOMETRIC$CORRECTION$VECTOR)
13	77−80	I4	$$$1	Number of compensation records required to compensate table
14	81−84	I4	$$$1	Sequence number in the full compensation table of the table contained in this record
15	85−92	I8	< ... >	Total number of compensation pairs in the full compensation table
16	93−100	I8	$$$$$$$1	Range sample index (RAW: look angle) corresponding to first correction value in compensation table
17	101−108	I8	< ... >	Range sample index (RAW: look angle) corresponding to last correction value in compensation table
18	109−116	I8	< ... >	Compensation pixel group size (m pixels). This is the number of pixels for which each of the compensation samples is applicable (no for RAW)
19	117−132	F16.7	< ... >	Min. sample index (1.0) only MGD
20	133−148	F16.7	< ... >	Min. radiometric compensation value (I−PAF only) only MGD
21	149−164	F16.7	< ... >	Max. sample index only MGD
22	165−180	F16.7	< ... >	Max. radiometric compensation value (I−PAF only) only MGD
23	181−196	A16	$..$	Spare
24	197−204	I8	< ... >	Number of compensation table entries
RADIOMETRIC COMPENSATION TABLE				
25	205−220	F16.7	< ... >	1st compensation sample index (increment by 20: 1, 21, 41,...) (RAW: 1st look angle value)
26	221−236	F16.7	< ... >	1st compensation sample value (MGD, SSC, GEO: linear scale; RAW: dB) (RAW: 1st antenna pattern sample value)

Table 12 : SAR Leader File: Radiometric Compensation Record

Repeat fields 25−26 for each sample value in the Radiometric Compensation / Elevation Antenna Pattern File (max 256 samples).

536	8395-8600	A204	$..$	Spares

The Elevation Antenna Pattern (two way) is given as a function of the look angle relative to the local z−direction, and is given in dB (for RAW product only).

Field	Bytes	Format	Contents	Description
1	1−4	B4	(7)	record sequence number
2	5	B1	(10)	record subtype code 1
3	6	B1	(90)	record type code
4	7	B1	(51)	record subtype code 2
5	8	B1	(20)	record subtype code 3
6	9−12	B4	< ... >	record length (=348 +number of polygons*(16+32 * number of corner points))
7	13−16	I4	$$$1	dem descriptor record sequence number
8	17−24	I8	< ... >	number of dem descriptor data sets
9	25−28	I4	$$$1	dem descriptor segment sequence number
10	29−60	A32	< ... >	dem source (copyright info)
11	61−92	A32	< ... >	height datum reference name
12	93−124	A32	< ... >	dem generation method
13	125−136	A12	< ... >	raster spacing unit
14	137−168	A32	< ... >	dem projection
15	169−184	F16.7	< ... >	north south raster spacing (in unit as per field 13)
16	185−200	F16.7	< ... >	east west raster spacing (in unit as per field 13)
17	201−232	A32	< ... >	resampling method (BILINEAR, SPLINE, etc.)
18	233−248	F16.7	< ... >	rms height error
19	249−264	F16.7	< ... >	rms north south location error (meters)
20	265−280	F16.7	< ... >	rms east west location error (meters)
21	281−296	F16.7	< ... >	max height in dem (meters)
22	297−312	F16.7	< ... >	min height in dem (meters)
23	313−328	F16.7	< ... >	mean height in dem
24	329−344	F16.7	< ... >	standard deviation of heights
25	345−348	I4	< ... >	number of polygons (max 5)
REPEAT I=1, number of polygons				
26	349−352	I4	< ... >	polygon sequence number
27	353−356	I4	< ... >	number of corner points
28	357−364	I8	< ... >	spare
REPEAT J=1,number of corner points				
29	313−328	F16.7	< ... >	corner_point_lat
30	329−344	F16.7	< ... >	corner_point_long
END REPEAT (J=1, number of corner points)				
END REPEAT (J=1, number of polygons)				

Table 13 : SAR Leader File: DEM Descriptor Record (for GTC, GIM and GMQ products only)

Field	Bytes	Format	Contents	Description
1	1−4	B4	(7)	Sequence number
2	5	Bl	(10)	1st record subtype code
3	6	Bl	(120)	Record type code
4	7	Bl	(51)	2nd record subtype code
5	8	Bl	(..)	3rd record subtype code (DLR:80, ASI:100)
6	9−12	B4	(720)	Length of this record
7	13−16	I4	$$$1	Detailed processing parameters record sequence number
8	17−20	A4	$$$$	Blanks
9	21−36	F16.7	< ... >	Near slant range (km) (not supported for RAW product)
10	37−52	F16.7	< ... >	Radius of the earth at nadir (km) (not supported for RAW product)
11	53−68	F16.7	< ... >	Radius of the earth at image center (km) (not supported for RAW product)
12	69−84	A16	< ... >	Receiver gain mode indicator (AUTOMATIC, MANUAL)
13	85−100	F16.7	< ... >	I Channel Oversaturation Percentage (only supported by I−PAF)
14	101−116	F16.7	< ... >	Q Channel Oversaturation Percentage (only supported by I−PAF)

15	117−132	F16.7	< ... >	Incidence angle at near range
16	133−148	F16.7	< ... >	Incidence angle at image center
17	149−164	F16.7	< ... >	Incidence angle at far range
18	165−180	F16.7	< ... >	Roll angle estimate at scene center
19	181−196	F16.7	< ... >	Mean value of data magnitude (MGD, SSC only)
20	197−212	F16.7	< ... >	Standard deviation of data magnitude (MGD, SSC only)
21	213−236	A24	< ... >	GMT of first line (DD−MMM−YYYY/ hh:mm:ss.ttt)
22	237−260	A24	< ... >	GMT of center line
23	261−284	A24	< ... >	GMT of last line
24	285−300	A16	< ... >	MET of first line (DDD:hh:mm:ss.ttt)
25	301−316	A16	< ... >	MET of center line
26	317−332	A16	< ... >	MET of last line
27	333−336	I4	< ... >	GR to SL conversion polynomial degree (only MGD, GEO)
28	337−358	E22.15	< ... >	Slant range of first pixel (meters) (only MGD, GEO)
29	359−380	E22.15	< ... >	SL to GR conv formula, linear coefficient (m/pixel) (only MGD, GEO)
30	381−402	E22.15	< ... >	SL to GR conv formula, quadratic coeff. ($m/pixel^2$) (only MGD, GEO)
31	403−424	E22.15	< ... >	SL to GR conv formula, cubic coefficient ($m/pixel^3$) (only MGD, GEO)
32	425−440	F16.7	< ... >	Tx calibration chirp energy
33	441−456	F16.7	< ... >	Total missing lines percentage
34	457−472	I16	< ... >	Max number of adjacent missing lines
35	473−488	F16.7	−9..9.9..9	Bit Error Rate
36	489−504	F16.7	< ... >	Doppler centroid confidence measure (only supported by I−PAF)
37	505−520	F16.7	< ... >	Doppler ambiguity confidence measure (only supported by I−PAF)
38	521−536	F16.7	< ... >	Doppler ambiguity number (only supported by I−PAF)
39	537−552	F16.7	−9..9.9..9	Track angle at near range
40	553−568	F16.7	−9..9.9..9	Track angle at far range
41	569−632	A64	< ... >	Type of applied calibration (see note) (not supported for RAW product)
42	633−644	A12	< ... >	K generation date (DD−MMM−YYYY$) (not supported for RAW product)
43	645−660	F16.7	< ... >	Image min. value (only supported by I−PAF)
44	661−676	F16.7	< ... >	Image max. value (only supported by I−PAF)
45	677−720	A44	$..$	Spare

Table 14 : SAR Leader File: Detailed Processing Parameters Data Record

The detailed processing parameters record length, format, and data content (of table 14) are completely facility-defined with the exception of the 12 byte preamble.

Note:

The calibration applied to the product can be either a combination of the following:

EAP: Elevation Antenna Pattern

RSL: Range Spread Loss

IAN: Incidence ANgle for ref. ellipsoid

or:

CAL: Absolutely Calibrated

or:

NOC: No Calibration Applied

Field	Bytes	Format	Contents	Description
1	1−4	B4	(9)	record sequence number
2	5	B1	(10)	record subtype code 1
3	6	B1	(140)	record type code
4	7	B1	(51)	record subtype code 2
5	8	B1	(20)	record subtype code 3
6	9−12	B4	< ... >	record length(=96+numb_of_gcps*264)
7	13−16	I4	$$$1	gcp record sequence number
8	17−20	I4	$$$$	spare
9	21−24	I4	< ... >	number of gcps (max 50)
10	25−28	I4	< ... >	number of gcps for adjustment
11	29−32	I4	< ... >	number of gcps for quality
12	33−96	A64		spare
REPEAT I=1, numb_of_gcps				
13	97−100	I4	< ... >	gcp sequence number
14	101−106	A6	< ... >	adjust or test flag
15	107−138	A32	< ... >	gcp generation method (MAP$...$)
16	139−154	A16	< ... >	matching method
17	155−170	A16	GEOCODED	geocoded image flag
18	171−186	F16.7	< ... >	gcp latitude
19	187−202	F16.7	< ... >	gcp longitude
20	203−218	F16.7	< ... >	gcp height
21	219−234	F16.7	< ... >	matching pixel first coordinate (pixel range line)
22	235−250	F16.7	< ... >	matching pixel second coordinate (pixel azimuth line)
23	251−266	F16.7	< ... >	transformed pixel 1st coordinate (pixel range line)
24	267−282	F16.7	< ... >	transformed pixel 2nd coordinate(pixel azimuth line)
25	283−298	F16.7	< ... >	first coordinate difference
26	299−314	F16.7	< ... >	second coordinate difference
27	315−330	F16.7	< ... >	correlation coefficient
28	331−346	F16.7	< ... >	reliability measure (site and software specific)
29	347−360	A14	< ... >	spare
END REPEAT(I=1,number_of_gcps)				

Table 15 : SAR Leader File: Ground Control Points Descriptor record (for GTC, GIM and GMQ products only)

Field	Bytes	Format	Contents	Description
1	1−4	B4	(10)	Record sequence number
2	5	B1	(10)	1st record subtype code
3	6	B1	(200)	Record type code
4	7	B1	(51)	2nd record subtype code
5	8	B1	(50)	3rd record subtype code (50: ESA defined)
6	9−12	B4	(840)	Length of this record
7	13−16	I4	$$$1	Facility related data record sequence no.
8	17−20	A4	$$$$	blanks
9	21−84	A64	GEOCOD-INGANDQUAL-ITY$INFORMA-TION$...$	Facility related data record contents
10	85−88	I4	$$16	Number of key−value pairs in this record
11	89−92	I4	$$16	Length of ”key” field in bytes
12	93−96	I4	$$20	Length of ”value” field in bytes
13	97−104	A8	$$$$$$$$	spare
14	105−120	A16	< ... >	key_field_pair_1
15	121−140	A20	< ... >	value_field_pair_1
...				
44	645−660	A16	< ... >	key_field_pair_16
45	661−680	A20	< ... >	value_field_pair_16
INPUT DATA SET CORNER PIXEL COORDINATES IN OUTPUT IMAGE				
46	681−696	F16.7	< ... >	Easting of early azimuth near range position in geo-coded data set (pixel)
47	697−712	F16.7	< ... >	Northing of early azimuth near range position in geo-coded data set (lines)
48	713−728	F16.7	< ... >	Easting of late azimuth near range position in geocoded data set (pixel)
49	729−744	F16.7	< ... >	Northing of late azimuth near range position in geo-coded data set (lines)
50	745−760	F16.7	< ... >	Easting of early azimuth far range position in geocoded data set (pixel)
51	761−776	F16.7	< ... >	Northing of early azimuth far range position in geocoded data set (lines)
52	777−792	F16.7	< ... >	Easting of late azimuth far range position in geocoded data set (pixel)
53	793−808	F16.7	< ... >	Northing of late azimuth far range position in geocoded data set (lines)
54	809−824	F16.7	< ... >	Number of columns in processed input product (MGD)
55	825−840	F16.7	< ... >	Number of lines in processed input product (MGD)

Table 16 : SAR Leader File: Facility Related Data Record (GEO−CODED Type Definition)

1.3.3 Imagery Options File

Field	Bytes	Format	Contents	Description
1	1−4	B4	(1)	Record sequence number
2	5	B1	(63)	1st record subtype code
3	6	B1	(192)	Record type code
4	7	B1	(18)	2nd record subtype code
5	8	B1	(18)	3rd record subtype code
6	9−12	B4	< ... >	Length of this record
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blanks
9	17−28	A12	CEOS−SAR−CCT	Control Document Number for this file
10	29−30	A2	$B	Control Document revision number (”A$”, then ”B$”,... and so on)
11	31−32	A2	$B	File design descriptor revision number (”A$”, then ”B$”,... and so on)
12	33−44	A12	< ... >	Software ID (same as field 12 of the Volume Descriptor Record)
13	45−48	I4	$$$2	File number
14	49−64	A16	XSAR.SAR.xxxIMGY	File name (xxx: ”MGD”, or ”SSC”, or ”RAW”, or ”GEC”, or ”GTC”, or ”GIM”, or ”GMQ”)
15	65−68	A4	FSEQ	Record sequence and location type flag
16	69−76	I8	$$$$$$$1	Sequence number location
17	77−80	I4	$$$4	Sequence number field length
18	81−84	A4	FTYP	Record code and location type flag
19	85−92	I8	$$$$$$$5	Record code location
20	93−96	I4	$$$4	Record code field length
21	97−100	A4	FLGT	Record length and location type flag
22	101−108	I8	$$$$$$$9	Record length location
23	109−112	I4	$$$4	Record length field length
24−27	113−116	4A1	$..$	Reserved
28	117−180	A64	$..$	Reserved

Table 17 : Imagery Options File: File Descriptor Record − Fixed Segment Contents

Field	Bytes	Format	Contents	Description
29	181−186	I6	< ... >	SAR DATA records count (number of lines in image)
30	187−192	I6	< ... >	SAR DATA record length in bytes [2*(number of pixels)+12]
31	193−216	A24	$..$	Reserved (blanks)
SAMPLE GROUP DATA				
32	217−220	I4	< ... >	Number of bits per sample/pixel
33	221−224	I4	$$$1	Number of samples per data group (or pixel)
34	225−228	I4	< ... >	Number of bytes per data group (or pixel)
35	229−232	A4	$$$$	Justification and order of samples/pixels within data group (blank)
SAR DATA				
36	233−236	I4	$$$1	Number of SAR polarization channels
37	237−244	I8	< ... >	Number of lines per data set (excluding border lines) (same as 29 above)
38	245−248	I4	< ... >	Number of left border pixels per line
39	249−256	I8	< ... >	Total number of samples/pixels/data groups allocated per line per SAR channel
40	257−260	I4	< ... >	Right border pixels per line
41	261−264	I4	< ... >	Number of top border scan lines
42	265−268	I4	< ... >	Number of bottom border scan lines
43	269−272	A4	BSQ$	Interleaving indicator

RECORD DATA				
44	273−274	I2	$1	Number of physical records per line
45	275−276	I2	$$	Number of physical records per multichannel line in this file
46	277−280	I4	< ... >	Length of prefix data per line
47	281−288	I8	< ... >	Number of bytes of sample/image data per line (including fill)
48	289−292	I4	$$$0	Length of suffix data per line
49	293−296	A4	$$$$	Prefix/suffix repeat flag
PREFIX/SUFFIX DATA LOCATORS				
50	297−304	A8	($...$ or $$$1$4PB for GEO)	Sample data line number locator
51	305−312	A8	($...$ or $$37$2PB for GEO)	SAR channel number locator (D−PAF only)
52	313−320	A8	($...$ or $337$4PB for GEO)	Time of SAR data locator (D−PAF only)
53	321−328	A8	($...$ or $$$9$4PB for GEO)	Left−filled count locater
54	329−336	A8	($...$ or $$17$4PB for GEO)	Right−filled count locater
55	337−340	A4	$$$$	Pad pixels present indicator: ”$$$$” if present or ”1111” if not present (always ”$$$$” for SAR data)
56	341−368	A28	$..$	Blanks
57	369−376	A8	$$$$$$$	SAR data line quality code locater
58	377−384	A8	$$$$$$$	Calibration information field locater
59	385−392	A8	$$$$$$$	Gain values field locater A8
60	393−400	A8	$$$$$$$	Bias values field locater A8
PIXEL DATA DESCRIPTION				
61	401−428	A28	< ... >	SAR data format type identifier (MGD: INTEGER*2 (no negative values), SSC: COMPLEX$INTEGER*4, RAW: COMPLEX$UNSIGNED$INTEGER GEO: SIGNED$INTEGER*2)
62	429−432	A4	< ... >	SAR data format type code (MGD: I*2, SSC: CI*4, RAW:CIU2,GEO:IS2)
63	433−436	I4	$$$0	Number of left fill bits within pixel
64	437−440	I4	< ... >	Number of right fill bits within pixel (RAW: 4/4 bits→4, 6/6 bits→2; others:0)
65	441−448	I8	< ... >	Maximum data range of pixel
66	449−n	An	$..$	Blanks (Pad record with blanks such that this record is the same length as the Image Data Record (or Annotated Raw Data Record))

Table 18 : Imagery Options Record: File Descriptor Record − Variable Segment Contents

Additional D−PAF/DLR comment: ** Image pixel representation:

- MGD product: 16 bit signed integer, Most Significant Bit is always zero, amplitude data (0 to 32767)
- SSC product:
  - real−part: 2’s complement 16 bit integer (−32768 to 32767)
  - imaginary−part: 2’s complement 16 bit integer (−32768 to 32767), this comment is true for I−PAF and D−PAF.

Field	Bytes	Format	Contents	Description
1	1−4	B4	(...)	Record sequence number
2	5	B1	(50)	1st record subtype code
3	6	B1	(11)	Record type code
4	7	B1	(51)	2nd record subtype code
5	8	B1	(20)	3rd record subtype code
6	9−12	B4	< ... >	Length of this record (variable)
7	13−n			MGD: 2 bytes/pixel SSC: i: 2 bytes/pixel q: 2 bytes/pixel

Table 19 : Imagery Options File: Image Data Records (for MGD, SSC)

Field	Bytes	Format	Contents	Description
1	1−4	B4	(...)	Record sequence number
2	5	B1	(50)	1st record subtype code
3	6	B1	(10)	Record type code
4	7	B1	(51)	2nd record subtype code
5	8	B1	(20)	3rd record subtype code
6	9−12	B4	< ... >	Length of this record (variable)
7	13−44	B32	< ... >	Sensor specif data
8	45−EOR	B2	< ... >	Real byte format (1 byte i+ 1 byte q, left aligned zero padded)

Table 20 : Imagery Options File: Annotated Raw Data Records

Field	Bytes	Format	Contents	Description
1	1−4	B4	(...)	Record sequence number
2	5	B1	(50)	1st record subtype code
3	6	B1	(11)	Record type code
4	7	B1	(51)	2nd record subtype code
5	8	B1	(20)	3rd record subtype code
6	9−12	B4	< ... >	Length of this record
PREFIX DATA − GENERAL				
7	13−16	B4	< ... >	processed data line number
8	17−20	B4	< ... >	processed data record index
9	21−24	B4	< ... >	actual count of left fillers
10	25−28	B4	< ... >	actual count of data pixels
11	29−32	B4	< ... >	actual count of right fillers
PREFIX DATA SENSOR / PROCESSING				
12	33−36	B4	< ... >	sensor parameter update flag
13	37−40	B4	< ... >	sensor acquisition year
14	41−44	B4	< ... >	sensor acquisition day of year
15	45−48	B4	< ... >	sensor acquisition msec of day
16	49−50	B2	< ... >	sar channel indicator
17	51−52	B2	< ... >	sar channel code
18	53−54	B2	< ... >	transmitted polarization
19	55−56	B2	< ... >	received polarization
20	57−60	B4	< ... >	PRF
21	61−64	B4		spare
22	65−68	B4	< ... >	slant/range to first data sample in meters
23	69−72	B4	< ... >	slant/range to mid data sample in meters
24	73−76	B4	< ... >	slant/range to last data sample in meters
25	77−80	B4	< ... >	Doppler Centroid value at first data sample in Hz
26	81−84	B4	< ... >	Doppler Centroid value at mid data sample in Hz
27	85−88	B4	< ... >	Doppler Centroid value at last data sample in Hz
28	89−92	B4	< ... >	azimuth FM rate of the first data sample
29	93−96	B4	< ... >	azimuth FM rate of the mid data sample
30	97−100	B4	< ... >	azimuth FM rate of the last data sample

31	101−104	B4	< ... >	radar look angle of nadir (10^{-6} deg)
32	105−108	B4	< ... >	radar azimuth/squint angle (10^{-6} deg)
33	109−112	B4		spare
34	113−116	B4		spare
35	117−120	B4		spare
36	121−124	B4		spare
37	125−128	B4		spare
PREFIX DATA − GEOGRAPHIC REFERENCE				
38	129−132	B4	< ... >	geographic parameter update flag
39	133−136	B4	< ... >	latitude of first pixel (10^{-6} deg)
40	137−140	B4	< ... >	latitude of mid pixel (10^{-6} deg)
41	141−144	B4	< ... >	latitude of last pixel (10^{-6} deg)
42	145−148	B4	< ... >	longitude of first pixel (10^{-6} deg)
43	149−152	B4	< ... >	longitude of mid pixel (10^{-6} deg)
44	153−156	B4	< ... >	longitude of last pixel (10^{-6} deg)
45	157−160	B4	< ... >	northing of first pixel (meters)
46	161−164	B4		spare
47	165−168	B4	< ... >	northing of last pixel (meters)
48	169−172	B4	< ... >	easting of first pixel (meters)
49	173−176	B4		spare
50	177−180	B4	< ... >	easting of last pixel (meters)
51	181−184	B4	< ... >	orientation of image line (10^{-6} deg)
52	185−188	B4		spare
53	189−192	B4		spare
SAR PROCESSED DATA				
54	193−EOR	Bn	< ... >	Real byte format

Table 21 : Imagery Options File: GEO Image Data Records (for geocoded products)

1.3.4 Null Vector Directory File

Field	Bytes	Format	Contents	Description
1	1−4	B4	(1)	Record sequence number
2	5	B1	(192)	1st record subtype code
3	6	B1	(192)	Record type code
4	7	B1	(63)	2nd record subtype code
5	8	B1	(18)	3rd record subtype code
6	9−12	B4	(360)	Record length
7	13−14	A2	A$	ASCII flag
8	15−16	A2	$$	Blanks
9	17−28	A12	CCB− CCT−0002	Format control doc
10	29−30	A2	$E	Format control version
11	31−32	A2	$A	Format control document version
12	33−44	A12	< ... >	Software id
13	45−60	A16	< ... >	Physical tape id
14	61−76	A16	$..$	Logical set id
15	77−92	A16	$..$	Volume set id
16	93−94	I2	$1	Total number of physical volumes
17	95−96	I2	$1	1st physical volume sequence number
18	97−98	I2	$1	Last physical volume sequence number
19	99−100	I2	$1	This physical volume sequence number
20	101−104	I4	$$$$	1st reference file in volume
21	105−108	I4	$$$2	Logical volume in set
22	109−112	I4	$$$2	Logical volume number in physical volume
23	113−120	A8	$..$	Blanks
24	121−128	A8	$..$	Blanks
25	129−140	A12	$..$	Blanks
26	141−148	A8	$..$	Blanks
27	149−160	A12	$..$	Blanks
28	161−164	I4	$..$	Blanks
29	165−168	I4	$..$	Blanks
30	169−173	I4	$..$	Blanks
31	173−260	A88	$..$	Spare
32	261−360	A100	$..$	Spare

Table 22 : Null Volume Descriptor Record

1.4 Appendix

Calibrated X–SAR Products in CEOS Format:

Deriving σ^0 from MGD SSC, and GEC Products and Processing of RAW Products

Richard Bamler, DLR–DFD
Adelheid Craubner, DLR–DFD

1.4.1 Introduction

This Appendix describes how to derive the radar backscatter coefficient σ^0 from the digital numbers of X–SAR MGD, SSC and GEC products.
Furthermore, it explains where the parameters necessary for processing and radiometrically correcting RAW products are found in the CEOS annotation.

1.4.2 Data Representation

MGD, GEC: 16 bit amplitude: $A = \sqrt{\mathrm{Re}^2 + \mathrm{Im}^2}$ **and GTC**

SSC: 16/16 bit real and imaginary parts: *Re, Im*

RAW: 8/8bit I and Q raw data: *I, Q*

The original 4/4 bit or 6/6 bit X–SAR raw data samples have been expanded to 8/8 bit by appending 4 or 2 zeroes to the least significant bits. All raw data characteristics reported in the CEOS format (like raw data standard deviation, biases, chirp energy, raw data noise power) apply to this representation. The nominal DC offset of of the raw data is therefore:

$$\frac{2^4 - 1}{2} \times 2^{8-4} = 120.0 \rightarrow \quad \text{for the 4/4 bit case}$$

For the 6/6 bit case:

$$\frac{2^6 - 1}{2} \times 2^{8-6} = 126.0$$

1.4.3 Calibration Equation for MGD, SSC

The relationship between backscatter coefficient and image pixel power is:

$$< I > = K_S \cdot \sin(\theta_i) \cdot \frac{\sigma^0}{\sin(\theta_i - \alpha)} + < N_{raw} > \cdot K_{N,0} \cdot K_N(i)$$

where:

$< I >$ = expectation value of image pixel power (A^2 or $\mathrm{Re}^2 + \mathrm{Im}^2$)

K_S = calibration constant:
SAR Leader File, Radiometric Data Record, field 16 = ”Linear conversion factor (backscatter coefficient to image power ...)”

θ_i = nominal incidence angle on reference ellipsoid corrected by average terrain height:
SAR Leader File, Data Set Summary Record, field 16 = ”Ellipsoid designator”
SAR Leader File, Data Set Summary Record, fields 17, 18 = ”Ellipsoid semimajor axis (km)”, ”Ellipsoid semiminor axis (km)”
SAR Leader File, Data Set Summary Record, field 25 = ”Average terrain height above ellipsoid (meters)”

α = local terrain slope

$< N_{raw} >$ = reference (average) raw data noise power determined once per mission:
SAR Leader File, Radiometric Data Record, field 15 = ”Raw data noise power estimate (reference)”

$K_{N,0}$ = processor noise gain:
SAR Leader File, Radiometric Data Record, field 17 = ”Processor gain for noise data (before radiometric correction)”

$K_N(i)$ = cross–track radiometric correction vector as a function of range pixel ”i”:
SAR Leader File, Radiometric Compensation Record, fields 25, 26, ff

Local terrain slope α is not accounted for in the MGD, SSC and GEC products; the $\sin(\theta_i)$ – correction is based on the nominal incidence angle on the reference ellipsoid. If local terrain slopes are known to the user, he may easily reverse the correction and apply his own $\sin(\theta_i - \alpha)$ term. For this purpose the nominal incidence angles θ_i at near, mid, and far range are given in the CEOS format annotation. From these three values a second order polynomial is easily derived to describe the incidence angle dependence on range:

SAR Leader File, Detailed Processing Parameters Data Record, fields 15, 16, 17 → ”Incidence angle at near, (mid, far) range”

1.4.4 Processing and Radiometric Correction of RAW Data

1.4.4.1 Raw Data Correction

First, subtract from the RAW data the nominal DC offset of 120.0 or 126.0 for 4/4bit or 6/6bit, respectively. Then the data can be corrected for ADC nonperfections using the following parameters:

SAR Leader File, Data Set Summary Record, fields 66 through 70

”Measured DC bias for I–raw data component”

”Measured DC bias for Q–raw data component”

”Measured standard deviation for I–raw data component”

”Measured standard deviation for Q–raw data component”

”I/Q nonorthogonality”

1.4.4.2 Range Compression and Range Timing

The appropriate range compression chirp is described by the following parameters:

SAR Leader File, Data Set Summary Record, fields 51, 52, 57, 59

”Transmitted chirp start frequency (MHz)”

”Transmitted chirp rate (MHz/μsec)”

”Range complex sampling rate (MHz)”

”Range pulse length (μsec)”

Provided that the first sample of the range reference function vector corresponds to the early edge of the said chirp, the fast time of the first sample of the range compressed data is for fine (coarse) resolution mode, respectively,

$$\tau_{min,RC} = \frac{echo\ index}{PRF} + \frac{224\ (112)}{range\ sampling\ frequency} \times DWP - time\ offset\ ,$$

where the echo index and the data window position (DWP) are found in the raw data header while the PRF and the time offset can be taken from:

SAR Leader File, Data Set Summary Record, field 74 → ”Nominal PRF (Hz)”

SAR Leader File, Data Set Summary Record, field 117 →”Time offset of early edge of transmitted chirp from time origin, incl. electronic delay (μsec)”

1.4.4.3 Radiometric Correction

The actual receiver gain code is found in the raw data header. A look–up table relating gain codes to gains in dB is provided in:
SAR Leader File, Radiometric Data Record, fields 19 ÷ 61.

Additionally, the receiver gain for the first raw data line is given. This gain value also serves as the reference for the ”Raw data noise power estimate (reference)” from the SAR Leader File, Radiometric Data Record, field 15:
SAR Leader File, Data Set Summary Record, field 62
”Receiver gain at early edge at the start of the image (dB)”

The actual transmit chirp power (relative to the mid–gain of 60.0 dB) is recorded in:
SAR Leader File, Detailed Processing Parameters Record, field 32
”TX calibration chirp energy”

Cross–track radiometric correction requires the elevation antenna pattern together with antenna mounting angle, mechanical tilt, and shuttle roll. To facilitate radiometric correction the antenna pattern is given as a function of look angle between line of sight and connecting line between Earth center and sensor (z–axis), including all the said contributions:
SAR Leader File, Radiometric Compensation Record Record, fields 25, 26, ff

1.4.4.4 Azimuth Processing and Azimuth Timing

The X–SAR radar frequency is given in:
SAR Leader File, Data Set Summary Record, field 41 = ”Radar Frequency (GHz)”

The raw data are annotated with Mission Elapsed Time (MET), while state vectors will be given in Greenwich Mean Time (GMT). The relationship between MET and GMT is provided by:
SAR Leader File, Detailed Processing Parameters Record, fields 21 through 26
”GMT of first, center, last line (DD–MMM–YYYY/hh:mm:ss.ttt)”
”MET of first, center, last line (DDD:hh:mm:ss.ttt)”

Five state vectors relative to the rotating Greenwich True of Date coordinate system are given (for MGD, SSC, RAW products). They are equally spaced in time and cover an interval twice as long as the raw data duration. The 2nd, 3rd, and 4th state vectors coincide with the first, center, and last range lines, respectively:
SAR Leader File, Platform Position Record, fields 15 through 19, 20, 29, 30, ff
”Year, Month, Day, Days of the Year, Seconds of the day of first data point”
”Time interval between data sets (data points) (sec)”
”1st data point (X, Y, Z) position vector (km)”
”1st data point (X, Y, Z) velocity vector (km/sec)”, etc.

In order to find the correct PRF band, the absolute (unwrapped) Doppler centroid corresponding to the center raw data line and the center pixel (after range compression) is provided:
SAR Leader File, Data Set Summary Record, field 104 → ”Doppler centroid at image center (Hz)”

1.4.5 Transformation From GEC – Coordinates To SAR Groundrange Geometry

Roughly speaking, the GEC product is a rotated version of the MGD product. The resampling kernel used to refine the GEC product from the MGD product has been normalized to unity gain. Therefore, all radiometric parameters in the CEOS annotation are just passed from the MGD to the GEC product and are still applicable.

For interpretation of the range dependend parameters $K_N(i)$ (’cross track radiometric correction vector ...’) and θ_i (nominal incidence angle ...’) the GEC pixel positions must be converted to the original range– azimuth coordinates of the generating MGD product.

The following CEOS parameters are used for this transformation:

SAR leader file, Facility Related Record, FRR fields 46, 47, ff

Representing three corners of the image scene in GEC coordinates:

X_{EANR} :	pixel,	early azimuth + near range
Y_{EANR}:	line,	early azimuth + near range
X_{LANR}:	pixel,	late azimuth + near range
Y_{LANR}:	line,	late azimuth + near range
X_{EAFR}:	pixel,	early azimuth + far range
Y_{EAFR}:	line,	early azimuth + far range

SAR leader file, Facility Related Record, FRR fields 54, 55
G_COLS: number of pixel in groundrange image
G_LINS: number of lines in groundrange image

The approximate pixel U and line V in the original ground range MGD product corresponds to any GEC pixel coordinates X and Y and can be found via:

$$U = G\_COLS * \frac{(X - X_{EANR}) * (Y_{LANR} - Y_{EANR}) - (Y - Y_{EANR}) * (X_{LANR} - X_{EANR})}{(X_{LANR} - X_{EANR}) * (Y_{LANR} - Y_{EANR}) - (Y_{LANR} - Y_{EANR}) * (X_{LANR} - X_{EANR})}$$

$$V = G\_LINS * \frac{(X - X_{EANR}) * (Y_{EAFR} - Y_{EANR}) - (Y - Y_{EANR}) * (X_{EAFR} - X_{EANR})}{(X_{LANR} - X_{EANR}) * (Y_{EAFR} - Y_{EANR}) - (Y_{LANR} - Y_{EANR}) * (X_{EAFR} - X_{EANR})}$$