Radarsat

SYNTHETIC APERTURE RADAR IMAGE CCT
FORMAT SPECIFICATIONS
DPD-TM 81-199C
4 NOVEMBER 1984

PRINCIPAL INVESTIGATOR:
FLORIAN GUERTIN, CCRS

SYNTHETIC APERTURE RADAR IMAGE CCT FORMAT SPECIFICATIONS

DPD-TM 81-199C

4 NOVEMBER 1984

PRINCIPAL INVESTIGATOR:
FLORIAN GUERTIN, CCRS

TABLE OF CONTENTS

LIST OF TABLES

FOREWORD

The SAR image CCT formats should not be confused with the SAR-580 or SEASAT video signal CCT formats specified in CCRS documents DPD-TM-80-172A and DPD-TM-78-015D respectively. The video signal CCT contains the unprocessed microwave data acquired by the Synthetic Aperture Radar (SAR) system. A SAR image CCT contains the actual SAR image generated by processing the video signal data on the generalized SAR processor. While this document is directed at SAR-580, IRIS, SEASAT and SIR-B imagery the format described here is expandable to include imagery from other SAR sensors. Finally this document should not be mistaken with an earlier format document for SAR image CCTs, developed in 1978 specifically for SEASAT-1 and described in DPD-TM-78-015D. The earlier CCT format called the universal Johnson Space Center (JSC) format, was used for CCTs produced by SEASAT-specific SAR processors.

At first glance this specification document could appear complex and involved. But once its organization is understood it is rather simple and easy to use. Each file is defined in terms of its records. For most records three tables are provided: definition, explanation and contents. All three tables refer to the same information and are cross-referenced by the individual field numbers. The first table gives a list of all the fields in the record and it is probably sufficient for most readers. The explanation table provides more detailed information about the fields. The contents table gives the actual alphanumeric string or binary value in each field and can be consulted for record content verification purposes.

This document is self-contained and includes a comprehensive description of the SAR image CCT for several SAR sensors. But readers who desire to obtain more information on the rules and convertions applied in the definition of this CCT format are referred to "LGSOWG CCT Format CCB Document: The Standard CCT Family of Tape Formats", (Reference 2). It would provide more information on the concept of the "superstructure" which is common to all CCTs within the family, and on its implementation using the Volume Directory and the File Descriptor. Also, a more general understanding of the family would lead to the development of software applicable to other formats within the family. For example, SAR imagery and LANDSAT multispectral scanner data CCTs use the same file class and consequently can be read by common software.

CHAPTER 1

SAR IMAGE CCT PRODUCT DEFINITION

1.1 SAR SENSORS

This document specifies the format of Computer Compatible Tapes (CCT) containing Synthetic Aperture Radar (SAR) data which has been fully processed into imagery. The scope of the format described herein includes SAR imagery form the Canadian Convair 580 aircraft (both the SAR-580 and IRIS), the NASA SEASAT-1 satellite and the Shuttle borne Imaging Radar (SIR-B).

The actual pixel size is specified at processing time as a parameter to the general SAR processor. For example: the SAR-580 data it would normally be in the range of 1 to 10 metres where as SEASAT would be 10 to 100 metres. (On the CCT the pixel size and range/azimuth line organization are given in the text record of the volume directory).

On the CCT the record length for the image data file is always constant at 8100 bytes including ancillary data and video data. Multiple consecutive records per image line are used for lines requiring more than 8100 bytes. In this format the maximum number of records per line of video is restricted to 7 records. There is no image repetition or gap for consecutive CCTs generated during the processing of a complete SAR scene requiring more than one CCT.

CCTs can be recorded at 1600 or at 6250 bpi. The actual number of image line records can vary as a function of the recording density, the number of records per image line and the quantity of ancillary data contained in the leader file. But it should not exceed 4200 and 14280 records (numbers divisible by 2, 3, 4, 5, 6, 7; ie. the number of records per image line) at 1600 and 6250 bpi respectively. For image lines requiring multiple records there is always an integral number of lines per CCT and the actual number of records has to be chosen accordingly.

1.2 SAR-580 SENSORS DATA

The SAR-580 mounted in the Convair-580 aircraft, is capable of acquiring SAR data in three possible bands: X, L, or C with parallel or cross polarization, (HH, HV, VV, VH), (References 1, 3) resulting from the operation of the SAR-580 in one of four modes:

1. High Resolution Narrow Swath Dual Channel (HRNS),
2. High Resolution Wide Swath Single Channel (HRWS),
3. Low Resolution Narrow Swath Dual Channel (LRNS),
4. Low Resolution Wide Swath Single Channel (LRWS).

The narrow (NS) and wide (WS) swaths cover a strip which has a nominal 6 km and 11.4 km width respectively. The length of the image is determined by the length of the flight line. In the NS mode the two channels are recorded on separate CCTs as separate data sets. This restriction is imposed by the fact that the SAR processing cannot be performed concurrently on both channels. On a CCT the SAR-580 image is recorded as range lines or as azimuth lines. Range lines cover the full width of the swaths: 6 or 11.4 km; they increase as a function of acquisition time. In principle azimuth lines can be as long as the flight line itself but in practice they are limited to 7*(8100-ancil.bytes) bytes per line irrespective of the pixel size or the number of bytes per image pixel. Azimuth line numbers increase moving away from the aircraft. In the format, when there is a difference in the data organization between range lines and azimuth lines the azimuth line case is treated as the exception.

1.3 IRIS SENSOR DATA

In early 1985 the original SAR-580 (X,L,C) sensor on board the CCRS Convair-580 is scheduled to be replaced with a new SAR sensor, the Canadian Integrated Radar Imaging System (IRIS). Data from this sensor will be available initialy for only C-band, however plans are under way for an X-band capability. Combinations of both parallel or cross polarization, (HH, HV, VH, VV) will be available. The six modes of operations available are:

Sensor Acquisition Mode		Range Samples	Swath Width	Range Resolution
Nadir mode	(Dual pol.) (NDNS)	2048	8km	5m
Nadir mode	(Single pol.) (NDWS)	4096	16km	5m
Hi-Res. Narrow Swath	(Dual pol.) (HRNS)	2048	8km	5m
Hi-Res. Wide Swath	(Single pol.) (HRWS)	4096	16km	5m
Lo-Res. Narrow Swath	(Dual pol.) (LRNS)	2048	16km	18.7m
Lo-Res. Wide Swath	(Single pol.) (NSWS)	4096	63km	18.7m

The narrow (NS) and wide (WS) swaths cover a strip which has a nominal 18 km and 63 km width respectively. The nadir mode (ND) covers the same swath width as the narrow mode. The length of the image, as in the case of the SAR-580, is determined by the length of the flight line. In the dual polarization (DP) modes the two simultaneously acquired channels are recorded on separate CCTs as separate data sets. This restriction is imposed by the fact that the SAR processing cannot be performed concurrently on both channels. On a CCT the IRIS image may also be recorced as range lines or as azimuth lines. Range lines cover the full width of the swaths: 18 or 63 km; they increase as a function of acquisition time. In principle azimuth lines can be as long as the flight line itself but in practice they are limited to 7*(8100-ancil.bytes) bytes per line irrespective of the pixel size or the number of bytes per image pixel. Azimuth line numbers increase moving away from the aircraft.

1.4 SEASAT SENSOR DATA

The SEASAT-1 SAR, which was launched on June 26, 1978 and put into a circular orbit at an altitude of 770 km. operated in the L band and the imagery is framed over 100 km x 100 km maximum areas called SEASAT scenes. The processed images are corrected for earth rotation and slant range to ground range distortions.

1.5 SIR-B SENSOR DATA

The SIR-B sensor, Shuttle Imaging Radar, was flown on the NASA Space Shuttle during the second week of October 1984. The sensor was a redisigned SIR-A SAR sensor operating in L band. Data from this sensor was collected at a variety of orbits and incidence angles. The processed images are corrected for earth rotation and slant range to ground range distortions.

CHAPTER 2

SAR IMAGE CCT LOGICAL VOLUME DEFINITION

The SAR image product is recorded on CCTs in a format derived from the Standard Family of CCT Formats (Reference 2). The entire data set for one SAR band (X, L, or C) scene is referred to as a Volume Set. The data is organized in self-contained logical volumes where each logical volume constitutes a particular segment of the flight line or orbit. Each CCT contains exactly one logical volume, (Figure 1). The first logical volume of the Volume Set consists of a Volume Directory, a leader file and a single image data file. The leader file is absent from the following logical volumes in the Volume Set. The last logical volume (recorded on the last CCT in the Volume Set) is followed by a Null Volume Directory, (Figure 2).

The Volume Directory contains general information about the logical volume and how to read it. The leader file contains definitive position/orbit and attitude data and possibly range line ancillary data, (for azimuth line image organization only). The image data file contains the image data in the X, L or C band. The Null Volume Directory marks the end of the Volume Set. Each CCT is terminated by two E-O-F marks except for the last CCT which ends with three E-O-F marks. Consequently, each CCT contains two or three files except for the last CCT in a Volume Set which has three or four files. In the dual channel mode, as is the case for SAR-580, separate bands are recorded on separate logical volumes on different CCTs and constitute a separate data set. The data organization hierarchy can be summarized as follows. For a multi-channel sensor, such as the SAR-580, a flight line of data can provide one or more Volume Sets depending upon the mode of operation: a single or dual channel. For a single channel sensor, such as SEASAT, the scene constitutes always one single Volume Set. Each Volume Set consists of multiple logical volumes; each logical volume is recorded on a single physical volume or CCT and it consists of two or three files: a Volume Directory, a leader file (first CCT only), and an image data file. The last CCT in a Volume Set is terminated by a Null Volume Directory.

The data is recorded in 7-bit ASCII (right-justified in 8-bit bytes), binary and BCD. The record size is a multiple of 180 bytes, (a byte is always 8 bits). In this document blank characters (octal 040 in ASCII) are represented by a $ and <AAAA> is a generic representation for an alphanumeric string consisting of four characters. For multi-byte data types (e.g.: 16-bit pixels), the most significant bytes precede the least significant bytes on the recording medium. Certain computers such as the Digital PDP-11 will store in memory the first byte in the low-order byte and consequently would require bytes swapping for proper interpretation of the data. On most systems this operation is not required.

The CCT format defined here is general, expandable and applicable to other types of SAR data such as MRSE, (Microwave Remote Sensing Experiment). Besides the X, L and C band which are specific to the CCRS SAR-580, the format could also be applicable to other microwave sensors operating in the S, KU and KA bands.

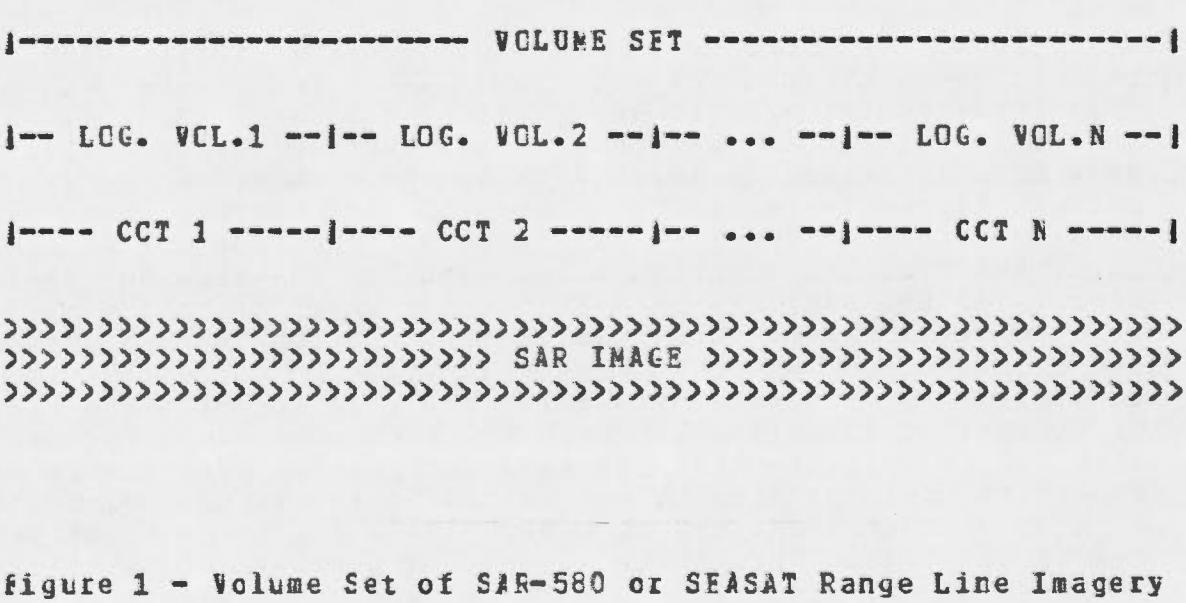
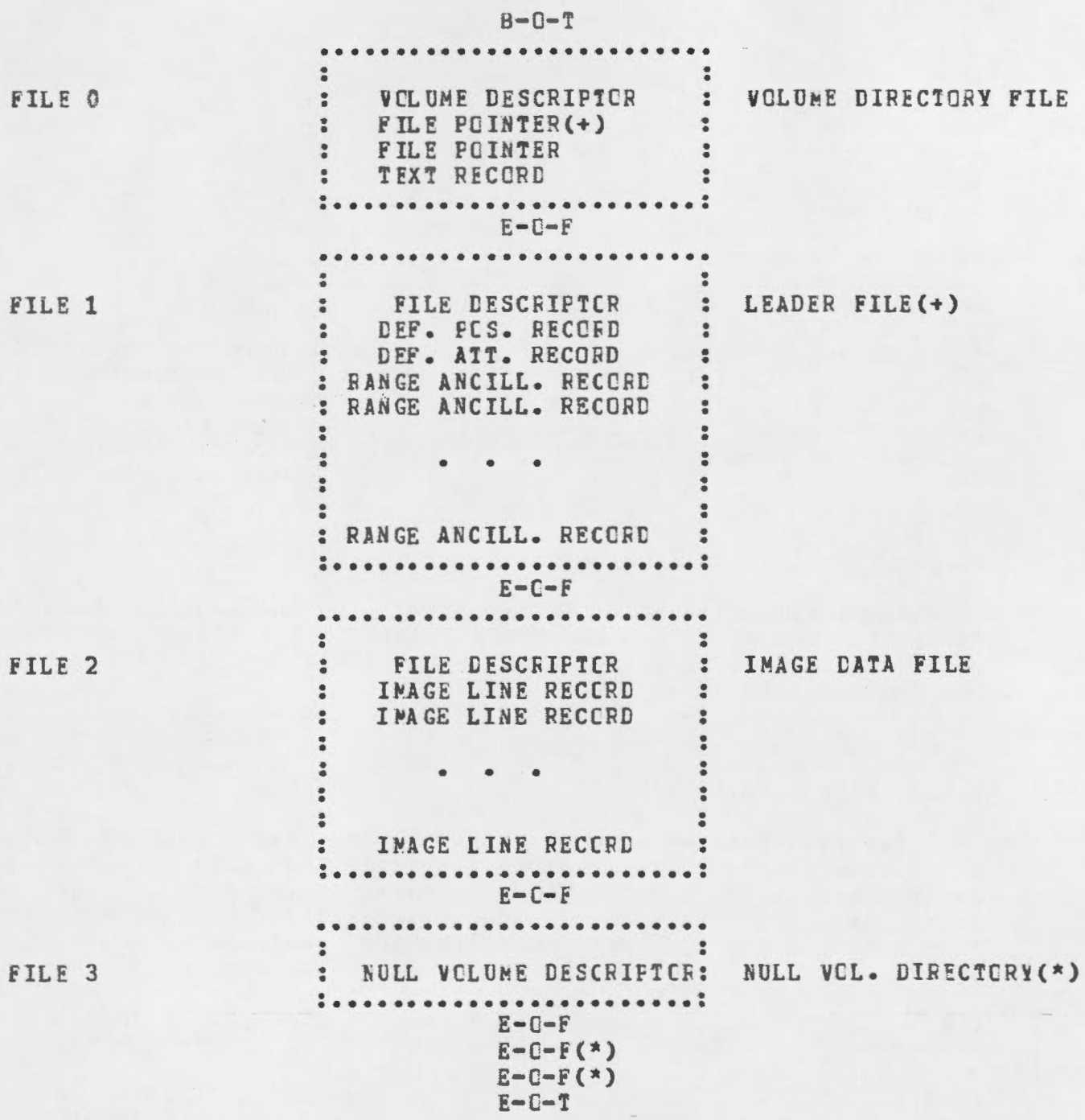


Figure 1 - Volume Set of SAR-580 or SEASAT Range Line Imagery



(+) present on the first CCT of a Volume Set only.
(*) present on the last CCT of a Volume Set only.

Figure 2 - CCT Organization

CHAPTER 3

SAR IMAGE CCT FILE DEFINITIONS

3.1 VOLUME DIRECTORY FILE

The Volume Directory File is the first file of every logical volume and consists of the following records: a Volume Descriptor, one or two File Pointer and a Text Record. These records are written in ASCII except for the first 12 bytes of each record which are in binary. The record length is 360 8-bit bytes.

3.1.1 VOLUME DESCRIPTOR RECORD

The Volume Descriptor Record identifies the logical volume, its documentation and the number of files in the logical volume. This record is defined in Table 3.1.1.1, and explained in Table 3.1.1.2. Its contents are shown in Table 3.1.1.3.

3.1.2 FILE POINTER RECORDS

The File Pointer Records reference the leader file or the image data file in the logical volume, indicate that file's format and tell how to prepare to read the file. There is a leader file pointer record only in the first logical volume (first CCT) of a Volume Set. The File Pointer Record contains the name and code of the corresponding file class. The names and codes are as follows:

CLASS NAME	CLASS CODE	FILE CONTENT
LEADER FILE	LEAD	position, attitude and ancillary data records
IMAGERY FILE	IMGY	image data records

The File Pointer Record is defined in Table 3.1.2.1 and explained in Table 3.1.2.2. The File Pointer Record content is given in Table 3.1.2.3 for the leader file and in Table 3.1.2.4 for the imagery file.

3.1.3 TEXT RECORD

For the SAR image data products referred to in this document, the Volume Directory File contains one and only one Text Record which is always the last record of the Volume Directory. The text record contains information identifying the CCT, with a brief summary of its contents. It has fields for processing flags and user defined annotation. The information is stored in free format in plain English, so that it may readily be displayed at the terminal. Table 3.1.3.1 defines the Text Record, and its contents are shown in Table 3.1.3.3 and explained in Table 3.1.3.2.

TABLE 3.1.1.1
VOLUME DESCRIPTOR RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 300(8) **
3	6	Record Type Code = 300(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-28	Superstructure control document number
10	29-30	Superstructure control document revision number
11	31-32	Superstructure record format revision letter
12	33-44	Software release number
13	45-60	Tape ID for physical volume containing this volume descriptor.
14	61-76 *	Logical Volume ID
15	77-92	Volume Set ID
16	93-94	Number of Physical Volumes in the Set
17	95-96	Physical Volume Number, Start of Logical Volume
18	97-98	Physical Volume Number, End of Logical Volume
19	99-100	Physical Volume Number containing this Volume Descriptor
20	101-104	First Referenced File Number in this Physical Volume
21	105-108	Logical Volume Number within Volume Set
22	109-112	Logical Volume Number within Physical Volume
23	113-120 *	Logical Volume Creation Date
24	121-128 *	Logical Volume Creation Time
25	129-140 *	Logical Volume Generating Country
26	141-148 *	Logical Volume Generating Agency
27	149-160 *	Logical Volume Generating Facility
28	161-164 *	Number of Pointer Records in Volume Directory
29	165-168 *	Number of Records in Volume Directory
30	169-260	Volume Descriptor Spare Segment
31	261-360	Local Use Segment

---

* Undefined (Blanks) in Null Volume Directory File
** Numbers followed by (8) are in OCTAL

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with ASCII blanks. Numbers which do not fill the field should be padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file. For the Volume Descriptor Record, this number is always 1.
2	The first record sub-type code for this record is 300(8).
3	The record type code for Superstructure records is 300(8).
4	The second record sub-type code for the Volume Descriptor record is 022(8). For the Null Volume Descriptor record it is 077(8).
5	The third record sub-type code for all Superstructure records is 022(8).
6	This field contains a binary number giving the length of this record in bytes. The value is 360 for all records in the Volume Descriptor file.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the Volume Directory File is in ASCII or EBCDIC. For the SAR image format, ASCII only will be used, so this field will contain A$.
8	Two blanks, $$

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

FIELD	EXPLANATION
9	12 characters giving the Superstructure Format Control Document identifying number: CCB-CCT-0002.
10	2 characters indicating the revision number or letter of the Superstructure Format Control Document. Coded $A, for the original draft.
11	2 characters indicating the revision letter of the Superstructure Record formats. Coded $A for the original draft. This code updates one letter character, alphabetically, each time there is a change to the format of a Superstucture Record (as opposed to a change to the control document which may not have been a change in the actual record format). The 26th revision is coded AA, the 27th AB, and so on.
12	12 characters identifying the software version used to write this Logical Volume, i.e. the program name and version number.
13	This is a 16 character code also written or printed externally on the Physical Volume and used to uniquely reference a particular CCT. Also called the Tape Identifier. When a Logical Volume spans more than one Physical Volume, this code is updated in the Volume Descriptor for the continuation Physical Volumes. For CCRS CCTs this consists of two characters followed by four digits: <CCNNNN>, e.g. RS1234.
14	This is a 16 character code which uniquely identifies the Logical Volume. The logical volume identification will be made up in the following way: T<HHMMSSTTT>-<IIIII> where <HHMMSSTTT> is the hour, minute, second and thousandth of second at which the first image line of data recorded in this logical volume was acquired; <IIIII> is a range/azimuth line offset to mark the start of the logical volume when the time is not precisely determined, or is not uniquely defined in the case of azimuth line images. Otherwise the value of <IIIII> is 00000, e.g. T092437000-00100.

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

FIELD	EXPLANATION
15	A second 16 character field for identifying the Volume Set. The Volume Set identifier is D<YYMMDD>-F<AAAAAAA> where <YYMMDD> is the date (year, month, day) of data acquisition and <AAAAAAA> is a 7-character alphanumeric string identifying the flight line for airborne SAR and orbit number for space borne SAR, e.g.Line 2 Pass 3A is D801006-F002003A or for SEASAT orbit 230 D780713-F000230$.
16	An integer which indicates the total number of Physical Volumes in a Volume Set. A blank field indicates that the information was not available at the time the Logical Volume was recorded.
17	This indicates the Volume Set sequence number of the Physical Volume within a Volume Set, which contains the first record of the Logical Volume.
18	This field indicates the Volume Set sequence number of the Physical Volume within a Volume Set which contains the last record of the Logical Volume. If the Logical Volume is contained on one Physical Volume, this field will have the same value as field 17.
19	This is the Volume Set sequence number of the Physical Volume that contains this Volume Directory File. If the Logical Volume is contained on one Physical Volume, this field will have the same value as field 17. The value in this field must lie within the values for fields 17 and 18, inclusively.
20	This field gives the file number within the Logical Volume which follows this Volume Directory. If the Volume Directory of a Logical Volume is repeated, then this value may be greater than one otherwise it is one. Volume Directory Files are not included in the file sequence number count. For this format this will always be 1.
21	This indicates the sequence number of the present Logical Volume within a Volume Set. The Null Volume Directory is included in this count. The first Logical Volume is denoted as 1.

TABLE 3.1.1.2
VOLUME DESCRIPTOR RECORD - EXPLANATION

FIELD	EXPLANATION
22	This is the sequence number of the present Logical Volume within a Physical Volume. For this format this will always be 1. For the Null Volume Descriptor record this field is one greater than in the previous Volume Descriptor Record.
23	8 characters for the date the Logical Volume was recorded on CCT. The code is of the form: <YYYYMMDD>, where <YYYY> is year, <MM> is month, and <DD> is day.
24	8 characters for the time when the Logical Volume was recorded on CCT. The code is of the form: <HHMMSSXX>, where <HH> is hours, <MM> is minutes, <SS> is seconds, and <XX> is hundredths of second.
25	12 characters for the name of the country generating this Logical Volume
26	8 characters for the laboratory or centre generating this Logical Volume.
27	12 characters identifying the computer facility on which the Logical Volume was recorded
28	The number of File Pointer Records in this Directory File. This gives the number of data files in the Logical Volume.
29	Total number of records in this Volume Directory. This will be the number of File Pointer Records plus the number of text records plus one.
30	92 bytes reserved for future revisions of this record format. This is reserved by the LGSOWG-CCB(*). This field is currently blanked.
31	100 bytes available for local use. This format does not use this field, so it is filled with blanks.

---

* The LGSOWG-CCB is the Landsat Ground Station Operators Working Group Committee which has developed and is maintaining the CCT Format Family Standards.

TABLE 3.1.1.3
VOLUME DESCRIPTOR RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	300(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	CCB-CCT-0002
A	10	$C
A	11	$A
A	12	<PPPPPP>CVF01$
A	13	<CCNNNN>$$$$$$$$$
A	14	T<HHMMSSTTT>-<IIIII>
A	15	D<YYMMDD>-F<AAAAAAA>
N	16	$$
N	17	n
N	18	n
N	19	n
N	20	1
N	21	n
N	22	1
A	23	<YYYYMMDD>
A	24	<HHMMSSXX>
A	25	CANADA$$$$$$ or other countries
A	26	CCRS$$$$ or other centres
A	27	C-SHARP$ or other facilities
N	28	1 or 2
N	29	3 or 4
A	30	Blanks
A	31	Blanks

TABLE 3.1.2.1
FILE POINTER RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 333(8)
3	6	Record Type Code = 300(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-20	Referenced File Number
10	21-36	Referenced File Name
11	37-64	Referenced File Class
12	65-68	Referenced File Class Code
13	69-96	Referenced File Data Type
14	97-100	Referenced File Data Type Code
15	101-108	Number of Records in Referenced File
16	109-116	Referenced File 1st Record Length (ie. File Descriptor record).
17	117-124	Referenced File Maximum Record Length
18	125-136	Referenced File Record Length Type
19	137-140	Referenced File Record Length Type Code
20	141-142	Referenced File Physical Volume Number, Start of File
21	143-144	Referenced File Physical Volume Number, End of File
22	145-152	Referenced File Portion, 1st Record Number for this Physical Volume
23	153-160	Referenced File Portion, last Record Number for this Physical Volume
24	161-260	Pointer Spare Segment
25	261-360	Local Use Segment

TABLE 3.1.2.2
FILE POINTER RECORD - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with blanks. Numbers which do not fill the field should be padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file. This number will lie between 2 and the number specified in field 29 of the Volume Descriptor record.
2	The first record sub-type code for File Pointer records is 333(8).
3	The record type code for Superstructure records is 300(8).
4	The second record sub-type code for File Pointer records is 022(8)
5	The third record sub-type code for all Superstructure records is 022(8)
6	This field contains a binary number giving the length of this record in bytes. This value is 360 for this record.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the referenced file is in ASCII or EBCDIC. For the SAR image format, ASCII only will be used, so this field will contain A$.
8	Two blanks.

TABLE 3.1.2.2
FILE POINTER RECORD - EXPLANATION

FIELD	EXPLANATION
9	Sequence number within the Logical Volume of the file referenced by this pointer. This is also the sequence number of the File Pointer Record within the Volume Directory. The first file following the first Volume Directory is called file number 1. For this format this will always be 1 or 2.
10	A 16 character name which is the unique identification provided when the volume directory is created in order to specify the file referenced by this pointer. SAR580<C><MMMM>-<BB><PP>, IRIS$$<C><MMMM>-<BB><PP>, SEASAT<C>$$$$-<BB><PP> or SIR-B$<C>$$$$-<BB><PP>, where <C> is function of the file class (L, I), <MMMM> is the SAR operation mode (HRNS, HRWS, LRNS, LRWS for SAR-580 and NDWS, NDNS, HRWS, HRNS, LRWS, LRNS for IRIS), <BB> is the band (X$, L$, C$) and <PP> is the polarization (HH, HV, VV, VH), e.g. SAR580L$$$$$$$$$ or SAR580IHRNS-X$HH for SAR-580, SEASATL$$$$$$$$$ or SEASATI$$$$-L$HH for SEASAT. The <MMMM>-<BB><PP> is left blank for the leader file.
11	This is a 28 character description of the class to which the referenced file belongs. The class of a file is based on the nature of its content, i.e. LEADER$FILE or IMAGERY$FILE.
12	The 4-byte code for the class described in field 11, i.e. LEAD or IMGY.
13	This 28-character field indicates the data type contained in the referenced file, i.e. MIXED$BINARY$AND$ASCII.
14	The 4-byte code for the data type described in field 13, i.e. MBAA.
15	This 8 character field indicates the number of records in the referenced file. The File Descriptor Record is included in this count. If this number is not known at the creation time, then this field is blank.
16	8 characters for the length in bytes, of the File Descriptor Record in the referenced file. A blank field indicates that the information was not available at the time the Logical Volume was recorded.

TABLE 3.1.2.2
FILE POINTER RECORD - EXPLANATION

FIELD	EXPLANATION
17	8 character field for the length in bytes, of the longest record in the referenced file other than the File Descriptor Record.
18	12 characters for the record length type. For this format, variable and fixed length records are used, so this field will contain 'VARIABLE$LEN' or 'FIXED$LENGTH'. The record length is given in field 17.
19	4-byte code for the record length type in field 18. For this format, this is 'VARE' or 'FIXD'.
20	2 characters for the Physical Volume sequence number within a Volume Set which contains the first record of the referenced file. May be left blank if information unknown at time of recording.
21	2 characters for the Physical Volume sequence number within a Volume Set which contains the last record of the referenced file. May be left blank if information unknown at time of recording.
22	When a portion of the referenced file is on the previous Physical Volume, this 8 character number is the record number of the first record of the referenced file to be recorded on this Physical Volume. In all other conditions, this number is 1. This and the following field, are the only fields in a File Pointer Record to be changed on a repeated Volume Directory and are only changed in the File Pointer Record that refers to the split file.
23	This number is the record number of the last record of the referenced file on this Physical Volume. May be left blank if the information is unknown at time of recording.
24	100 bytes reserved for subsequent revisions. This is reserved by the LGSOWG-CCB.
25	100 bytes available for local use. This format does not use this field.

TABLE 3.1.2.3
FILE POINTER RECORD FOR LEADER FILE - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	2
B	2	333(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
N	9	1
A	10	SAR580L$$$$$$$$$, or IRIS$$L$$$$$$$$$ or SEASATL$$$$$$$$$ or SIR-B$L$$$$$$$$$
A	11	LEADER$FILE
A	12	LEAD
A	13	MIXED$BINARY$AND$ASCII
A	14	MBAA
N	15	n+1
N	16	360
N	17	8640
A	18	VARIABLE$LEN
A	19	VARE
N	20	m
N	21	m
N	22	1
N	23	n+1
A	24	Blanks
A	25	Blanks

TABLE 3.1.2.4
FILE POINTER RECORD FOR IMAGE DATA FILE - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	2 or 3
B	2	333(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
N	9	1 or 2
A	10	SAR580I<MMMM>-<BB><PP> or IRIS$$I$$$$-<BB><PP> or SEASATI$$$$-<BB><PP> or SIR-B$I$$$$-<BB><PP>
A	11	IMAGERY$FILE
A	12	IMGY
A	13	MIXED$BINARY$AND$ASCII
A	14	MBAA
N	15	n
N	16	8100
N	17	8100
A	18	FIXED$LENGTH
A	19	FIXD
N	20	m
N	21	m
N	22	1
A	23	Blanks
A	24	Blanks

TABLE 3.1.3.1
TEXT RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 022(8)
3	6	Record type code = 077(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC flag for this record
8	15-16	Continuation flag
9	17-20	Blanks
10	21-70	Product type
11	71-120	CCT generation location and date
12	121-170	Video signal data acquisition flight and date
13	171-220	Physical tape identification
14	221-270	Calibration and processing flags
15	271-320	Annotation
16	321-360	Blanks

TABLE 3.1.3.2
TEXT RECORD - EXPLANATION

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file.
2	The first record sub-type code for Text Records is 022(8)
3	The record type code for Text records is 077(8)
4	The second record sub-type code for text records is 022(8)
5	The third record sub-type code for Text records is 022(8)
6	This field contains a binary number giving the length of this record in bytes. This value is 360 for all records in the Volume Directory file.
7	The ASCII/EBCDIC flag indicates if the alphanumeric data of this record is in ASCII or EBCDIC.
8	This field contains two blanks unless the information of this record is continued on a following text record, in which case, this field would be coded C$.
9	Four blanks
10	The product type includes the SAR operation mode <MMMM>, the band <BB> and the polarization <PP> where: <MMMM> for the SAR-580 is (HRNS, WRWS, LRNS, LRWS) and for the IRIS is(NDWS, NDNS, HRWS, HRNS, LRWS, LRNS); <BB> is (X$, L$, C$) and the polarization is (HH, HV, VH, VV).

TABLE 3.1.3.2
TEXT RECORD - EXPLANATION

FIELD	EXPLANATION
11	The CCT generation location is given by <CCCCCCCCCCCC>, <GGGGGGGG> and <SSSSSSSSSSS> for the country, the agency and the system; (for CCRS they are: CANADA, CCRS, C-SHARP). The date of recording the Logical Volume on CCT is written in the form <YYYYMMDD>, where <YYYY> is the year, <MM> is the month and <DD> is the day.
12	The flight/acquisition date identification is made up in the following way: <AAAAAAA>, <YYYYMMHHMMSSTTT> and <IIIII> where: <AAAAAAA> is the flight line number or orbit number; <YYYYMMDD> is the year, month and day; <HHMMSSTTT> is the hour, minute, second and thousandth of second for the first image line in this logical volume; <IIIII> is an optional range/azimuth line offset to distinguish two logical volume identified by the same time but starting on different lines.
13	The physical tape identification is made up in the following way: 6-character tape identification (e.g.: RS1234) followed by the tape sequence number <II> within the Physical Volume Set containing a total of <JJ> tapes.
14	The process flag <A> is S or G for slant range or ground range coordinates; <B> is A or R for azimuth or range line records. <C> is L or R for Left or Right antenna clock angle.
15	The annotation <LL> and <KK> are the number of azimuth and range looks processed respectively, <LL> and <KK> are right-justified; <AAA.AAAAAA> is the azimuth pixel size in metres; <RRR.RRRRRR> is the range pixel size in metres.

TABLE 3.1.3.3
TEXT RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	3 or 4
B	2	022(8)
B	3	077(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	$$$$
A	10	PRODUCT$SAR580$IMAGE$DATA$<MMMM>-<BB><PP>$$$$$$$$$$$$$$$ or PRODUCT$IRIS$$$IMAGE$DATA$<MMMM>-<BB><PP>$$$$$$$$$$$$ or PRODUCT$SEASAT$IMAGE$DATA$$$$-<BB><PP>$$$$$$$$$$$$$$ or PRODUCT$SIR-B$$IMAGE$DATA$$$$-<BB><PP>$$$$$$$$$$$$$$
A	11	PROCESS$<CCCCCCCCCCCC>$<GGGGGGGG>$<SSSSSSSSSSSS><YYYYMMDI
A	12	FLIGHT$<AAAAAAA>$DATE$<YYYYMMDDHHMMSSTTT>$CFFSET$<IIIII>
A	13	TAPEID<CCNNNN>$TAPE$<II>CF<JJ>$$$$$$$$$$$$$$$$$$$$
A	14	PROCESS$FLAGS$<A>$<B>$<C>$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
A	15	ANNOTATION$<LL>$<KK>$<AAA.AAAAAA>$<RRR.RRRRRR>$$$$$$$$$$
A	16	Blanks

3.2 LEADER FILE

The leader file precedes the image data file of the first logical volume of a volume set. Therefore, it is present on the first CCT only. The leader file provides the following information: definitive position (orbit) and attitude data, and range line ancillary data. The range line ancillary data is present for azimuth line images only. The leader file is of the class LEADER$FILE with the class code LEAD. It contains the following record types:

1. 1 File Descriptor Record,
2. 1 Definitive Position (Orbit) Record,
3. 1 Definitive Attitude Record,
4. "k" Range line Ancillary Records.

The leader file content is in ASCII except for the first 12 bytes of every record which are binary.

3.2.1 FILE DESCRIPTOR RECORD

The file descriptor record is composed of two segments, a fixed and a variable segment. The fixed segment provides information on how to read the file, and the variable segment indicates how to locate key data particular to this file class. The file descriptor record fixed segment is defined in Table 3.2.1.1, it is explained in Table 3.2.1.2, and its contents for the leader file are shown in Table 3.2.1.3. The file descriptor record variable segment for the leader file is defined in Table 3.2.1.4 and its contents are shown in Table 3.2.1.6 and explained in Table 3.2.1.5. The leader file descriptor record variable segment gives the number and length of image records. The length of the file descriptor record for the leader file is 360 bytes.

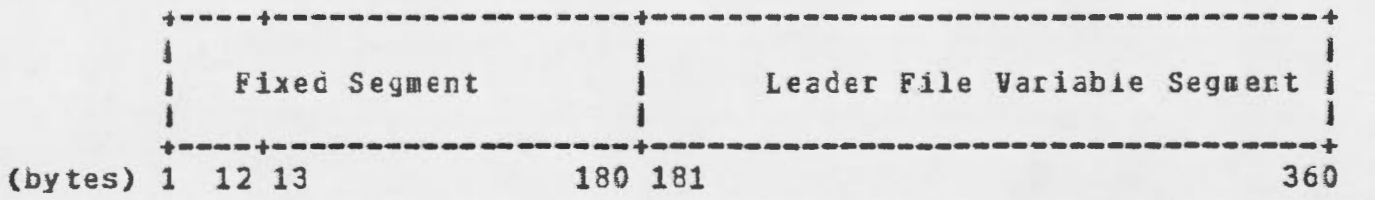


TABLE 3.2.1.1
LEADER FILE DESCRIPTOR RECORD FIXED SEGMENT - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 077(8)
3	6	Record Type Code = 300(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-28	Control Document Number for this Data File Format
10	29-30	Control Document Revision Number
11	31-32	File Design Descriptor Revision Letter
12	33-44	Software Release Number
13	45-48	File Number
14	49-64	File Name
15	65-68	Record Sequence and Location Type Flag
16	69-76	Sequence Number Location
17	77-80	Sequence Number Field Length
18	81-84	Record Code and Location Type Flag
19	85-92	Record Code Location
20	93-96	Record Code Field Length
21	97-100	Record Length and Location Type Flag
22	101-108	Record Length Location
23	109-112	Record Length Field Length
24	113	Flag indicating that data interpretation information is included within the file descriptor record.
25	114	Flag indicating that data interpretation information is included within the file in record(s) other than the descriptor
26	115	Flag indicating that data display information is included within the file descriptor record.
27	116	Flag indicating that data display information is included within the file in record(s) other than the file descriptor.
28	117-180	Reserved (blanks)
29	181-EOR	File Descriptor Variable Segment (EOR = End-of-Record)

TABLE 3.2.1.2
LEADER FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with blanks. Numbers which do not fill the field are padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file. For the File Descriptor record, this number is always 1.
2	The first record sub-type code for File Descriptor records is 077(8)
3	The record type code for Superstructure records is 300(8).
4	The second record sub-type code for File Descriptor records is 022(8)
5	The third record sub-type code for all Superstructure records is 022(8).
6	This field contains a binary number giving the length of this record in bytes.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the referenced file is in ASCII or EBCDIC. For the SAR image format, ASCII only will be used, so this field will contain A$.
8	Two blanks.

TABLE 3.2.1.2
LEADER FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

FIELD	EXPLANATION
9	12 characters containing the number for the document that controls this file format, i.e. DPDTM$81-199 for CCRS document.
10	2-bytes giving the revision number of the control document defining the current file format.
11	2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format).
12	12 characters identifying the software version used to write this file.
13	4-byte sequence number of this file within the Logical Volume, excluding the volume directory.
14	This is the unique 16 character identification of the present file as stated in field 10 of the File Pointer Record of the Volume Directory File.
15	This 4-byte field indicates if the other records in the file have sequence numbers. FSEQ indicates the record sequence numbers present in the same location in all data records of the file.
16	These eight bytes give the location of the start of the sequence number field. They give the record byte number of the first byte of the field.
17	Four bytes indicating the length, in bytes, of the record sequence number field.
18	This 4-byte flag indicates if the other records in the file have a record type code, and if the location of the code is fixed or variable. FTYP indicates the record type code is present in the same location in all the data records of the file.

TABLE 3.2.1.2
LEADER FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

FIELD	EXPLANATION
19	These eight bytes give the location of the start of the record type code field. They give the record byte number of the first byte of the field.
20	Four bytes, indicating the length , in bytes, of the record type code field
21	This 4-byte flag indicates if the other records in the file contain their record lengths. FLGT indicates the record length is present in the same location in all the data records of the file.
22	These eight bytes give the location of the start of the record length field. They give the record byte number of the first byte of the field.
23	Four bytes, indicating the length, in bytes , of the record length field.
24	A Y/N indicates the presence/absence of data interpretation information in the file descriptor record variable segment.
25	A Y/N indicates the presence/absence of data interpretation information in other places of the file.
26	A Y/N indicates the presence/absence of data display information in the file descriptor record variable segment.
27	A Y/N indicates the presence/absence of data display information in other places of the file.
28	64 bytes for future expansion. Reserved by the LGSOWG-CCB.
29	File descriptor variable segment (see Table 3.2.1.4)

TABLE 3.2.1.3
LEADER FILE DESCRIPTOR RECORD FIXED SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	077(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	DPDTM$81-199
A	10	$A
A	11	$A
A	12	<PPPPPP>CVF01$
N	13	1
A	14	SAR580L$$$$$$$$$ or IRIS$$L$$$$$$$$$ or SEASATL$$$$$$$$$ or SIR-B$L$$$$$$$$$
A	15	FSEQ
N	16	1
N	17	4
A	18	FTYP
N	19	5
N	20	4
N	21	FLGT
N	22	9
N	23	4
A	24	N
A	25	N
A	26	N
A	27	N
A	28	Blanks

TABLE 3.2.1.4
LEADER FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

NO.	BYTE NOS.	DEFINITION
1*	1-6**	Number of group 1 records
2	7-12	Group 1 record length
3	13-18	Number of group 2 records
4	19-24	Group 2 record length
5	25-30	Number of group 3 records
6	31-36	Group 3 record length
7-16	37-196	Reserved (blanks)
17	197-BCR	Blanks

---

* Field 1 of the variable segment is field 29 of the complete record.

** Byte 1 of the variable segment is byte 181 of the complete record.

TABLE 3.2.1.5
LEADER FILE DESCRIPTOR RECORD VARIABLE SEGMENT - EXPLANATION

FIELD	EXPLANATION
1	The number of definitive position or orbit records in the file, for this format this is always 1.
2	The length in bytes of the definitive position or orbit records.
3	The number of definitive attitude records in the file, for this format this is always 1.
4	The length in bytes of the definitive attitude records.
5	The number of range line ancillary records in the file, for the azimuth line image format it is variable; for the range line image format there are no range line ancillary records.
6	The length in bytes of the range line ancillary records.
7-16	Reserved; it is not used in this format, (blanks).
17	Blanks to fill the rest of the record.

TABLE 3.2.1.6
LEADER FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
N	1*	1
N	2	8640
N	3	1
N	4	4320
N	5	K
N	6	4140
A	7-17	Blanks

* Field 1 of variable segment is field 29 of the complete record.

3.2.2 DEFINITIVE POSITION RECORD

The definitive position/orbit record (DPR/DOR) provides position/orbit information for the aircraft/spacecraft. Although the format is identical, the contents of the record differ for airborne and spaceborne sensors. The airborne case (DPR) has data recorded in terms of distance from the Earth's centre, latitude and longitude while the spaceborne case (DOR) has data recorded in the GSFC inertial coordinate system, (Reference 4). For defining the position and time in the DPR the units used are metres, degrees and seconds whereas in the DOR the units used are DUL (10**7 metres) and DUT (864 seconds).

The record is 8640 bytes long, consisting of 12 bytes of record introductory data, followed by 60 bytes of general ancillary data, followed by up to 64 position and velocity or 'vector pairs' of length 132 bytes, and followed by 120 bytes of filler zeros. Any unused position and velocity data sets are filled with zeros in the following FORTRAN compatible ASCII format: 6D22.15. The format of the record is defined in Table 3.2.2, all numeric fields are right justified.

TABLE 3.2.2
DEFINITIVE POSITION RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 022(8)
3	6	Record Type Code = 044(8)
4	7	2nd record sub-type code = 022(8))
5	8	3rd record sub-type code = 033(8)
6	9-12	Length of this record, (8640 bytes)
7	13-16	Year of first data point: $$YY; Format: I4
8	17-20	Month of first data point: $$MM; Format: I4
9	21-24	Day of first data point: $$DD; Format: I4
10	25-28	Day count of year (GMT) of first data point; Format: I4
11	29-50	Seconds of day (GMT) of first data point; Format D22.15
12	51-72	Time Interval between data points in seconds; Format: D22.15
13-15	73-138	First data point position vector (R, Phi, Theta) where R is the distance between the Earth's geocentric centre and the aircraft in metres, Phi is the signed latitude in degrees (N+, S-), Theta is the East longitude in degrees (0 - 360). In spaceborne GSFC inertial coordinates: (X, Y, Z); the units are DUL and DU1. Format: 3D22.15
16-18	139-204	First data point velocity vector: (R', Phi', Theta') in airborne coordinates (metres/second and degrees/second) or (X', Y', Z')in GSFC inertial coordinates (DUL/DUT); Format: 3D22.15
19-396	205-8520	Position and velocity vector pairs for data points 2-64; Format: 63(3D22.15, 3D22.15)
397	8521-8640	Filler zeros; Format: 30I4

3.2.3 DEFINITIVE ATTITUDE RECORD

The definitive attitude record (DAR) contains attitude information of the sensor platform over the time spanning the image data. The record is 4320 bytes in length, consisting of 12 bytes of record introductory data followed by 64 data sets of 66 bytes each, followed by 84 bytes of filler zeros. For the SAR-580 the data quality flags have not been defined and hence are set to zero. Any trailing unused data sets are filled with zeros in the appropriate FORTRAN compatible ASCII format. The format of the DAR is defined in Table 3.2.3.

TABLE 3.2.3
DEFINITIVE ATTITUDE RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence number
2	5	1st record sub-type code = 022(8)
3	6	Record Type Code = 044(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 044(8)
6	9-12	Length of this record, (4320 bytes)
7	13-78	DAR data set 1 consisting of 66 bytes
7.1	13-16	Day of year (GMT); Format: I4
7.2	17-24	Millisecond of day (GMT); Format: I8
7.3	25-28	Pitch data quality flag; Format: I4
7.4	29-32	Roll data quality flag; Format: I4
7.5	33-36	Yaw data quality flag; Format: I4
7.6	37-50	Pitch (degrees); Format: E14.6
7.7	51-64	Roll (degrees); Format: E14.6
7.8	65-78	Yaw (degrees); Format: E14.6
8	79-144	DAR data set 2 consisting of 66 bytes
9-70	145-4236	DAR data sets 3 to 64 consisting of 66 bytes each
71	4237-4320	Filler zeros; Format: 21I4

3.2.4 RANGE LINE ANCILLARY RECORDS

For image CCTs recorded in azimuth line order, the range line ancillary records (RLAR) contain sets of orbit/position data, each set corresponding to a unique azimuth pixel of the image CCT. RLARs are present only on CCTs that have the image data recorded in azimuth line order. Each data set contains sufficient position data to uniquely determine the earth centered rotating (ECR) coordinates or time-code marks for imaging each pixel in the line, for both slant range and ground range presentation of the image data in the image data file.

There are n*220 records, where n is the number of physical records used for each image line of the image data file. The first group of 220 RLARs contains the data sets for the first physical record of each image line with subsequent RLAR groups corresponding to subsequent image records. As there are 3960 data sets in each RLAR group, but only 3954 pixels in each image record, the last six data sets are blanks. Each RLAR is 4140 bytes long and contains 12 bytes of introductory data followed by 18 data sets of 220 bytes each, corresponding to 18 consecutive range lines (or azimuth pixels) and terminated by 168 bytes of filler zeros. The format of the RLAR is defined in Table 3.2.4.

TABLE 3.2.4
RANGE LINE ANCILLARY RECORD - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence number
2	5	1st record sub-type code = 022(8)
3	6	Record Type Code = 044(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 055(8)
6	9-12	Length of this record, (4140 bytes)
7	13-232	RLAR data set 1 consisting of 220 bytes
7.1	13-16	Range line number; Format: I4
7.2	17-20	Day of year (GMT); Format: I4
7.3	21-42	Seconds of day (GMT); Format: D22.15
7.4	43-64	Slant range of first range point (metres); Format: D22.15
7.5	65-86	Platform orbit radius, (H) (metres); Format: D22.15
7.6	87-108	Platform ECR polar angle, (Phi) (radians); Format D22.15
7.7	109-130	Platform ECR azimuth angle, (Theta) (radians); Format D22.15
7.8	131-144	Associated Heading angle, (Psi) (radians); Format: E14.6
7.9	145-158	dH/dT; Format: E14.6
7.10	159-172	Rotating frequency, (W1) (radians/second); Format: E14.6
7.11	173-194	Unused
7.12	195-216	Real track heading, (Head) (radians); Format: D22.15

7.13	217-218	SAR pointing flag; Format: I2
7.14	219-220	Zero fill; Format: I2
7.15	221-222	Zero fill; Format: I2
7.16	223-224	Zero fill; Format: I2
7.17	225-226	Zero fill; Format: I2
7.18	227-228	Zero fill; Format: I2
7.19	229-230	Zero fill; Format: I2
7.20	231-232	Zero fill; Format: I2
8	233-452	RLAR data set 2 consisting of 220 bytes
9-24	453-3972	RLAR data sets 3 to 18 consisting of 220 bytes each
25	3973-4140	Filler zeros; Format 42I4

3.3 IMAGE DATA FILE

There is one image data file per logical volume and it contains all the ancillary and image data for one SAR band over a portion of the flight line or the SEASAT scene. The file class is IMAGERY$FILE with the class code IMGY. The file class and its code are the unique and generic pieces of information which differentiate this type of data from any other CCT format. It is used by the software to determine how the CCT can be read and interpreted.

The image data file contains the following records: one file descriptor record followed by the image records. For SAR-580, IRIS, SEASAT and SIR-B, each record is 8100-bytes long irrespective of the SAR mode of operation. There is usually more than one record per image line.

3.3.1 FILE DESCRIPTOR RECORD

The file descriptor record is composed of two segments, a fixed and a variable segment. The fixed segment provides information on how to read the file, and the variable segment indicates how to locate key data particular to this file class. The file descriptor record fixed segment is defined in Table 3.3.1.1, it is explained in Table 3.3.1.2 (these two tables are identical to Tables 3.2.1.1 and 3.2.1.2 respectively), and its contents are shown in Table 3.3.1.3. The variable segment is defined in Table 3.3.1.4 and its contents are shown in Table 3.3.1.6 and explained in Table 3.3.1.5. The image data file descriptor record variable segment gives the number and length of the image records; it describes the data format in terms of the data grouping, locates the image within the physical record, and gives the location of specific data fields in the record prefix. For SAR-580, IRIS, SEASAT and SIR-B, the length of the file descriptor record is 8100 bytes.

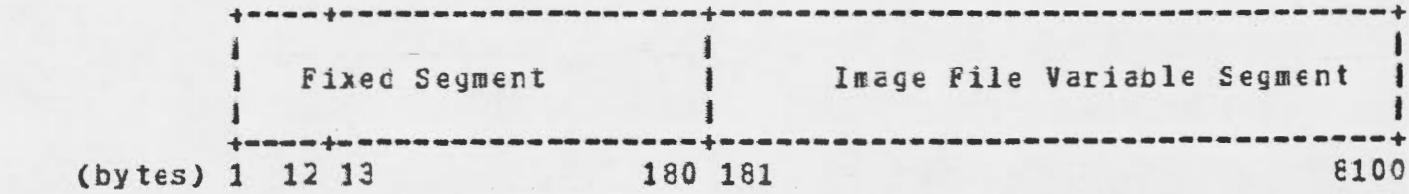


TABLE 3.3.1.1
IMAGE DATA FILE DESCRIPTOR RECORD FIXED SEGMENT - DEFINITION

NO.	BYTE NOS.	DESCRIPTION
1	1-4	Record Sequence Number
2	5	1st record sub-type code = 077(8)
3	6	Record Type Code = 300(8)
4	7	2nd record sub-type code = 022(8)
5	8	3rd record sub-type code = 022(8)
6	9-12	Length of this record
7	13-14	ASCII/EBCDIC Flag
8	15-16	2 Blanks
9	17-28	Control Document Number for this Data File Format
10	29-30	Control Document Revision Number
11	31-32	File Design Descriptor Revision Letter
12	33-44	Software Release Number
13	45-48	File Number
14	49-64	File Name
15	65-68	Record Sequence and Location Type Flag
16	69-76	Sequence Number Location
17	77-80	Sequence Number Field Length
18	81-84	Record Code and Location Type Flag
19	85-92	Record Code Location
20	93-96	Record Code Field Length
21	97-100	Record Length and Location Type Flag
22	101-108	Record Length Location
23	109-112	Record Length Field Length
24	113	Flag indicating that data interpretation information is included within the file descriptor record.
25	114	Flag indicating that data interpretation information is included within the file in record(s) other than the descriptor
26	115	Flag indicating that data display information is included within the file descriptor record.
27	116	Flag indicating that data display information is included within the file in record(s) other than the file descriptor.
28	117-180	Reserved Segment
29	181-EOR	File Descriptor Variable Segment (EOR = End-of-Record)

TABLE 3.3.1.2
IMAGE DATA FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

Fields 1 to 6 are binary encoded fields. All other fields are in ASCII. Alphanumeric character strings are left-justified and numeric character strings are right-justified. Any fields not used are filled with blanks. Numbers which do not fill the field are padded with leading blanks.

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file. For the File Descriptor record, this number is always 1.
2	The first record sub-type code for the File Descriptor record is 077(8).
3	The record type code for Superstructure records is 300(8).
4	The second record sub-type code for the File Descriptor record is 022(8).
5	The third record sub-type code for all Superstructure records is 022(8).
6	This field contains a binary number giving the length of this record in bytes.
7	The ASCII/EBCDIC flag indicates if the alphanumeric information in the Referenced File is in ASCII or EBCDIC. For the SAR image format, ASCII only will be used, so this field will contain A$.
8	Two blanks.

TABLE 3.3.1.2
IMAGE DATA FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

FIELD	EXPLANATION
9	12 characters containing the number for the document that controls this file format, i.e. DPDTM$81-199 for CCRS document.
10	2-bytes giving the revision number of the control document defining the current file format.
11	2-bytes giving the revision letter of the file format (as opposed to revisions which affect the control document without affecting the file format).
12	12 characters identifying the software version used to write this file.
13	4-byte sequence number of this file within the Logical Volume, excluding the volume directory.
14	This is the unique 16 character identification of the present file as stated in field 10 of the File Pointer Record of the Volume Directory File.
15	This 4-byte field indicates if the other records in the file have sequence numbers. FSEQ indicates the record sequence numbers present in the same location in all data records of the file.
16	These eight bytes give the location of the start of the sequence number field. They give the record byte number of the first byte of the field.
17	Four bytes indicating the length, in bytes, of the record sequence number field.
18	This 4-byte flag indicates if the other records in the file have a record type code, and if the location of the code is fixed or variable. FTYP indicates the record type code is present in the same location in all the data records of the file.

TABLE 3.3.1.2
IMAGE DATA FILE DESCRIPTOR RECORD FIXED SEGMENT - EXPLANATION

FIELD	EXPLANATION
19	These eight bytes give the location of the start of the record type code field. They give the record byte number of the first byte of the field.
20	Four bytes, indicating the length , in bytes, of the record type code field
21	This 4-byte flag indicates if the other records in the file contain their record lengths. FLGT indicates the record length is present in the same location in all the data records of the file.
22	These eight bytes give the location of the start of the record length field. They give the record byte number of the first byte of the field.
23	Four bytes, indicating the length, in bytes , of the record length field.
24	A Y/N indicates the presence/absence of data interpretation information in the file descriptor record variable segment.
25	A Y/N indicates the presence/absence of data interpretation information in other places of the file.
26	A Y/N indicates the presence/absence of data display information in the file descriptor record variable segment.
27	A Y/N indicates the presence/absence of data display information in other places of the file.
28	64 bytes for future expansion. Reserved by the LGSOWG-CCB.
29	File descriptor variable segment (see Table 3.3.1.3)

TABLE 3.3.1.3
IMAGE DATA FILE DESCRIPTOR RECORD FIXED SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	077(8)
B	3	300(8)
B	4	022(8)
B	5	022(8)
B	6	8100
A	7	A$
A	8	$$
A	9	DPDTM$81-199
A	10	$A
A	11	$A
A	12	<PPPPPP>CVF01$
N	13	1 or 2
A	14	SAR580I<MMMM>-<BB><PP> or IRIS$$I<MMMM>-<BB><PP> or SEASATI$$$$-<BB><PP> or SIR-B$I$$$$-<BB><PP>
A	15	FSEQ
N	16	1
N	17	4
A	18	FTYP
N	19	5
N	20	4
N	21	FLGT
N	22	9
N	23	4
A	24	Y
A	25	N
A	26	Y
A	27	N
A	28	Blanks

TABLE 3.3.1.4
IMAGE DATA FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

NO.	BYTE NOS.	DEFINITION
1*	1-6**	Number of image records
2	7-12	Image record length
3	13-36	Reserved(blanks)
		PIXEL GROUP DATA
4	37-40	Number of bits per pixel
5	41-44	Number of pixels per data group
6	45-48	Number of bytes per data group
7	49-52	Justification and order of pixels within data group
		IMAGE DATA
8	53-56	Number of bands of imagery in this file
9	57-64	Number of lines per image(one band) excluding top and bottom border lines
10	65-68	Number of left border pixels
11	69-76	Number of image pixels per line
12	77-80	Number of right border pixels
13	81-84	Number of top border lines
14	85-88	Number of bottom border lines
15	89-92	Interleaving indicator
		RECORD DATA
16	93-94	Number of physical records per line
17	95-96	Number of physical records per multiband line in this file
18	97-100	Number of bytes of prefix data per record
19	101-108	Number of bytes of image data per record
20	109-112	Number of bytes of suffix data per record
21	113-116	Prefix/suffix repeat flag
		PREFIX/SUFFIX DATA LOCATORS
22	117-124	Image line number locator
23	125-132	Image(band) number locator
24	133-140	Time of image line locator
25	141-148	Left-fill count locator
26	149-156	Right-fill count locator
27	157-188	Blanks
28	189-196	Image line quality code locator
29	197-204	Calibration information locator
30	205-212	Gain values field locator
31	213-220	Bias values field locator
32	221-252	Blanks

* Field 1 of the variable segment is field 29 of the complete record.

** Byte 1 of the variable segment is byte 181 of the complete record.

TABLE 3.3.1.4
FILE DESCRIPTOR RECORD VARIABLE SEGMENT - DEFINITION

BYTE PACKING DATA

33	253-256	Number of left-fill bits within pixel
34	257-260	Number of right-fill bits within pixel
35	261-268	Maximum data range of pixel
36	269-ECR	Blanks

LOCATOR FORMAT

Locators for the image data file consist of 8 bytes, made up as follows: Bytes 1-4: Byte number within prefix (or suffix) of the start of the field being located; Bytes 5-6: Length in bytes of the field being located; Byte 7: P for prefix, S for suffix Byte 8: Type of field: A (alphanumeric), B (binary), N (numeric). Because there are 12 bytes of record introductory data, an offset of 12 has to be added to the byte number value in order to determine the offset within the record.

TABLE 3.3.1.5
IMAGE DATA FILE DESCRIPTOR RECORD VARIABLE SEGMENT - EXPLANATION

FIELD	EXPLANATION
1	The actual number of image records in the image data file is variable, (Field 1 = Field 16 * Field 9 * Field 8)
2	The image record length for SAR-580, IRIS, SEASAT and SIR-B is 8100 bytes.
3	Reserved.
4	The number of bits per pixel, 16 bits.
5	There is 1 pixel per data group.
6	A data group occupies 2 bytes.
7	There is no justification because Field 4 * Field 5 = Field 6 * (8 bits)
8	There is only one SAR band per CCT.
9	This is the actual number of image data lines in this file.
10	Number of left border pixels for image framing.
11	This is the nominal maximum number of image pixels contained in a line; it does not account for variation that can happen on a line to line basis.
12	Number of right border pixels for image framing.
13	Number of top border pixels for image framing.
14	Number of bottom border pixels for image framing.
15	There is only one SAR band per CCT; same as BSQ$ (band sequential).

TABLE 3.3.1.5
IMAGE DATA FILE DESCRIPTOR RECORD VARIABLE SEGMENT - EXPLANATION

FIELD	EXPLANATION
16	This is the number of records required to contain one complete image line; (Field 16 = Field 11 * Field 6 / (Field 5 * Field 19)
17	Same as Field 16 because (Field 17 = Field 16 * Field 8).
18	The prefix excludes the 12 bytes for the record number, the record type code and the record length. It is 180 bytes.
19	The number of bytes of image data per record is 7908.
20	There is no suffix data.
21	It contains 4 blanks to indicate prefix and suffix repeat. That is the prefix information is updated and repeated for each record in the image line where there are multiple records per line.
22	This is the locator pointing to the image line number field in the prefix.
23	This the locator pointing to the SAR band indicator field in the prefix.
24	This is the locator pointing to time field in milliseconds for this image line.
25	This is the locator pointing to the left-fill pixel count.
26	This is the locator pointing to the right-fill pixel count.
27	Blanks

TABLE 3.3.1.5
IMAGE DATA FILE DESCRIPTOR RECORD VARIABLE SEGMENT - EXPLANATION

FIELD	EXPLANATION
28	Reserved.
29	Reserved.
30	Reserved.
31	Reserved.
32	Blanks
33	There are no left-fill bits within each pixel.
34	There are no right-fill bits within each pixel.
35	The pixel values can vary from 0 to +65535.

TABLE 3.3.1.6
IMAGE DATA FILE DESCRIPTOR RECORD VARIABLE SEGMENT - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
N	1**	m * n * 1
N	2	8100
A	3	Blanks
N	4	16
N	5	1
N	6	2
N	7	$$$$
N	8	1
N	9	n
N	10	0
N	11	k
N	12	0
N	13	0
N	14	0
A	15	BS&$
N	16	m = k * 2 / (1 * 7908)
N	17	m * 1
N	18	180
N	19	7908
N	20	0
N	21	$$$$
A	22	$$69$4PB
A	23	$111$2PB
A	24	$133$4PB
A	25	$105$2PB
A	26	$107$2PB
A	27	Blanks
A	28	Blanks
A	29	Blanks
A	30	Blanks
A	31	Blanks
A	32	Blanks
N	33	0
N	34	0
N	35	65535
A	36	Blanks

** Field 1 of variable segment is field 29 of the complete record.

3.3.2 IMAGE RECORDS

For SAR-580, IRIS, SEASAT and SIR-B, each image record contains the following data:

1. 12 bytes of standard record introductory data (i.e. record number, record type and sub-type codes, and record length).

2. 180 bytes of prefix data containing ancillary information.

3. 7908 bytes of image data; each pixel occupies 2 bytes with the higher order byte preceding the lower order byte on the recording medium. For lines having more than 3954 pixels, two or more records are required per line, (Figure 3).

4. 0 bytes of suffix data.

The content of image records is defined in Table 3.3.2.1 and explained in Table 3.3.2.2.

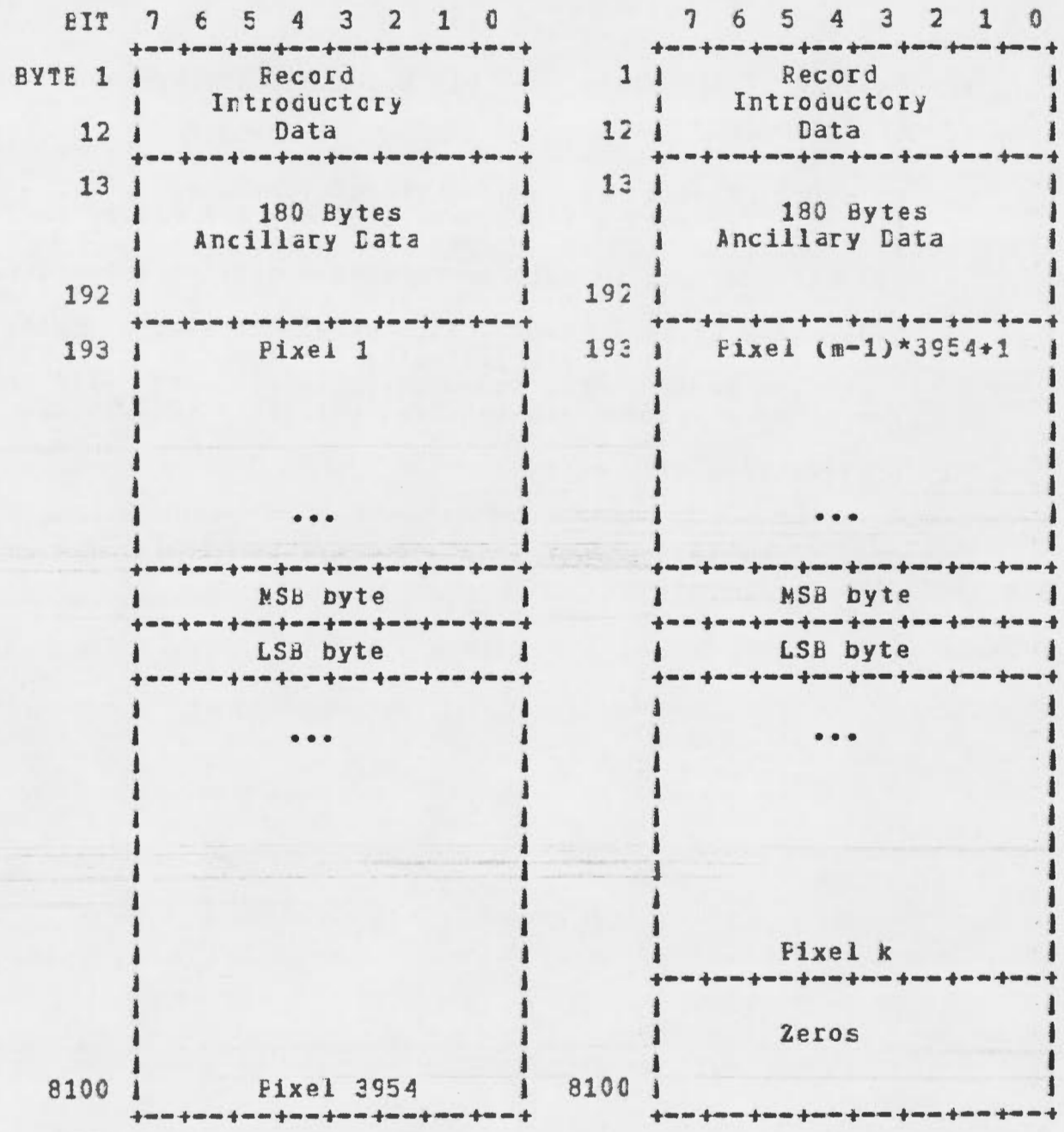


Figure 3 - Image Data Record Layout, (Multiple Records per Line)

TABLE 3.3.2.1
IMAGE DATA RECORD - DEFINITION

FIELD TYPE	FIELD NUMBER	BYTE NUMBER	DESCRIPTION
B	1	1-4	Record sequence number = 2,3,4,...
B	2	5	1st record sub-type code = 355(8)
B	3	6	Record type code = 355(8)
B	4	7	2nd record sub-type code = 022(8)
B	5	8	3rd record sub-type code = 022(8)
B	6	9-12	Record length = 8100 bytes
			PREFIX DATA
B	7	13-16	Reserved
B	8	17-80	Reserved
B	9	81-84	Image line number in the Volume Set
B	10	85-88	Image line record index
B	11	89-92	Latitude at centre of image line in millionths of degrees
B	12	93-96	East longitude at centre of image line in millionths of degrees.
B	13	97-100	Northing of first pixel of image line in metres.
B	14	101-104	Northing of last pixel of image line in metres.
B	15	105-108	Easting of first pixel of image line in metres.
B	16	109-112	Easting of last pixel of image line in metres.
B	17	113-116	Orientation of image line, in millionths of degrees at middle of line.
B	18	117-118	Left-fill pixel count.
B	19	119-120	Right-fill pixel count.
B	20	121-122	Number of image data pixels.
B	21	123-124	SAR band indicator.
B	22	125-126	SAR polarization.
B	23	127-132	Reserved
B	24	133-134	Day of year
B	25	135-144	Reserved
B	26	145-148	Milliseconds of day (GMT)
B	27	149-150	Thousandth's milliseconds of day (GMT)
B	28	151-160	Reserved
B	29	161-192	Zero Fill
			IMAGE DATA
B	30	193-8100	Image line pixels

TABLE 3.3.2.2
IMAGE DATA RECORD - EXPLANATION

FIELD	EXPLANATION
1	A binary number containing the sequence number of this record within the file.
2	The first record sub-type code for the Image Data record is 355(8).
3	The record type code for Image Data records is 355(8).
4	The second record sub-type code for Image Data records is 022(8).
5	The third record sub-type code for Image Data records is 022(8).
6	This field contains a binary number giving the length of this record in bytes.
7	Zero Fill
8	Zero Fill
9	Sequential image line counter numbering the consecutive range lines contained in the entire Volume Set. The first line is one.

TABLE 3.3.2.2
IMAGE DATA RECORD - EXPLANATION

FIELD	EXPLANATION
10	Cyclic record index counter (1,...,7) indicating the record number within each image line. The first record in a line is 1.
11	The range of latitudes is from -90,000,000 to +90,000,000.
12	The range of longitudes (East direction) is from 0 to 359,999,999.
13	This is the Northing of the first pixel for the complete image line.
14	This is the Northing of the last pixel for the complete image line.
15	This is the Easting of the first pixel for the complete image line.
16	This is the Easting of the last pixel for the complete image line.
17	This is the orientation measured clockwise starting from North, range from 0 to 359,999,999 millionths of degrees.
18	This is the actual number of left-fill pixels in this line before the first true pixel. In multi-record lines this applies to the first record only.
19	This is the actual number of right-fill pixels in this line after the last true pixel. In multi-record lines this applies to the last record only.

TABLE 3.3.2.2
IMAGE DATA RECORD - EXPLANATION

FIELD	EXPLANATION
20	The number of left-fill pixels plus the number of right-fill pixels plus the actual number of image data pixels should be equal to Field 11 of the image data file descriptor record variable segment, (Table 3.3.1.4).
21	The SAR band indicator is 0, 1, 2, 3, 4, 5 for L, S, C, X, KU, KA band respectively.
22	The first byte is the transmitted pulse polarization and the second byte is the received pulse polarization; 0 or 1 for horizontal or vertical respectively.
23	Reserved.
24	The day of the year in GMT since January 1st of acquisition year.
25	Reserved.
26	GMT time in milliseconds since midnight.
27	Thousandth's of millisecond.
28	Reserved.
29	Zero Fill
30	Each pixel is represented as a 16-bit unsigned integer value. There is a maximum of 3954 pixels per record. For multi-record lines, left-fill pixels and right-fill pixels can only appear on the first and last record respectively; all other records in a multi-record line have exactly 3954 true pixels.

3.4 NULL VOLUME DIRECTORY FILE

The last file of the Volume Set is the Null Volume Directory File, consisting of one record only, the Null Volume Descriptor Record. Its purpose is twofold: firstly, to mark the end of the Volume Set, and secondly to facilitate the addition of a new logical volume at a later date by the user. In the latter case the Null Volume Directory File would be overwritten by a second E-O-F mark or would be converted to a Volume Directory File by overwriting the Null Volume Descriptor Record with a Volume Descriptor Record and appending the appropriate File Pointer Records. It takes the value 1 greater than the associated Volume Descriptor record of the previous logical volume. The Null Volume Directory File consisting of one Null Volume Descriptor Record and an E-O-F as a terminator is always followed by two E-O-F marks.

3.4.1 NULL VOLUME DESCRIPTOR RECORD

The Null Volume Descriptor Record identifies the physical volume and its documentation. Its definition and contents are shown in Tables 3.1.1.1 and 3.4.1.1, respectively.

TABLE 3.4.1.1
NULL VOLUME DIRECTORY - VOLUME DESCRIPTOR RECORD - CONTENTS

FIELD TYPE	FIELD NUMBER	VALUE
B	1	1
B	2	300(8)
B	3	300(8)
B	4	077(8)
B	5	022(8)
B	6	360
A	7	A$
A	8	$$
A	9	CCB-CCT-0002
A	10	$C
A	11	$A
A	12	<PPPPPP>CVF01$
A	13	<CCNNNN>$$$$$$$$$
A	14	Blanks
A	15	D<YYMMDD>-F<AAAAAAA>
N	16	$$
N	17	n
N	18	n
N	19	n
N	20	1
N	21	n+1
N	22	2
A	23	Blanks
A	24	Blanks
A	25	Blanks
A	26	Blanks
A	27	Blanks
A	28	Blanks
A	29	Blanks
A	30	Blanks
A	31	Blanks

ACKNOWLEDGEMENTS

The author gratefully acknowledges the important contributions from Ronald L. Fielden, Macdonald Dettwiler & Associates Ltd, in the definition of this format.

REFERENCES

1. T. Gatfield et al., SYSTEM DESCRIPTION OF CANADIAN SAR 580 DIGITAL RECORDING SYSTEM, ERIM, January 1979.

2. L. Buhler (ed), LGSOWG CCT FORMAT CCB DOCUMENT: THE STANDARD CCT FAMILY OF TAPE FORMATS, CCB-CCT-002C, February 1980.

3. F. E. Guertin, SAR-580 VIDEO SIGNAL CCT FORMAT SPECIFICATIONS, DPD-TM-80-172A (CCRS Internal Document), February 6, 1981.

4. SEASAT-A GROUND DATA SYSTEM INTERFACE CONTROL DOCUMENT: ATTITUDE AND ORBIT TRACKING TAPE, Revision 0, NASA-Goddard Space Flight Center, May 1, 1977.

REVISIONS

Last document revision: 21 March 1981.

Last document revision: 8 April 1981.

Last document revision: 9 April 1981.

Last document revision: 15 April 1981.

Last document revision: 12 May 1981.

Last document revision: 4 December 1981.