

EPO/80-545/SB/gg

EUROPEAN SPACE AGENCY

EARTHNET PROGRAMME

FORMAT SPECIFICATIONS FOR
LANDSAT MSS SYSTEM CORRECTED
COMPUTER COMPATIBLE TAPES
PRODUCED AT KIRUNA (SWEDEN)

20 December, 1979.

CCT FORMAT

The MSS CCTs produced at Kiruna are available on 9-track tapes only at 1600 bpi density. CCTs include both the radiometric and the geometric corrections.

At Kiruna LANDSAT images are framed consistently with the Worldwide Reference System for LANDSAT data retrieval. This system specifies the nominal values for latitude and longitude of images taken over any region of the world.

The corrected MSS CCT is made up of five basic types of records: JSC Header Record, LANDSAT Header Record, Geometric Transformation Record, Radiometric Look-Up Table Records and MSS Data Records. The first record on the CCT, JSC Header Record, is a mixture of EBCDIC form as specified by a user. The MSS data records contain binary data only.

The JSC Header Record contains information about the Sun elevation and azimuth angles, the Earth rotation angle and the satellite altitude. An end of file mark is written at the end of this record.

The LANDSAT Header Record contains the information required to identify the LANDSAT frame and the type of processing which was performed on scene data. The geometric transformation record contains the information pertaining to the geometric corrections that were applied. The Radiometric Look-Up Tables define the radiometric transformations which were applied to the data by the Kiruna station. The last of the look-up table records is followed by an end of file mark.

The MSS data records, which are written in binary, contain an ancillary data block and scene video data blocks. Data organisation on a MSS CCT is shown in Fig.1.

FILE	8 TRACK INTERCHANGE CODE	RECORD	RECORD SIZE
JSC	EBCDIC <i>& BINARY</i>	BOT	
		JSC HEADER	3060 Bytes
LANDSAT	EBCDIC OR ASCII	EOF	
		LANDSAT HEADER	1440 Bytes
		EOR	
		GEOMETRIC TRANSFORMATION	720 Bytes
		EOR	
		RADIOMETRIC CALIBRATION BAND 4	1620 Bytes
		EOR	
		RADIOMETRIC CALIBRATION BAND 5	1620 Bytes
		EOR	
		RADIOMETRIC CALIBRATION BAND 6	1620 Bytes
VIDEO	BINARY	EOR	
		RADIOMETRIC CALIBRATION BAND 7	1620 Bytes
		EOR	
		RADIOMETRIC CALIBRATION BAND 8	1620 Bytes
		EOF	
		VIDEO DATA LINE 1 BAND 4	3780 Bytes
		EOR	
		VIDEO DATA LINE 1 BAND 5	3780 Bytes
		EOR	
		VIDEO DATA LINE 1 BAND 6	3780 Bytes
EOR			
VIDEO DATA LINE 1 BAND 7	3780 Bytes		
EOR			
VIDEO DATA LINE 2 BAND 4	3780 Bytes		
EOR			
...			
EOR			
VIDEO DATA LINE 2280 BAND 7	3780 Bytes		
EOR			
LEOT			
...			
EOT			

Figure 1. - Data Organisation on CCT.

The data contained in the JSC Header Record is meant to identify a number of parameters which are useful for any remote sensing mission, including LANDSAT, airborne missions and future satellite missions. Most of the record is presently filled with zeros. The data is either in EBCDIC or binary as specified below. Binary data will be right justified in the field defined. For example, a two byte binary word would have the following format.

	MSB								LSB							
Bit No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Most Significant Byte								Least Significant Byte							
One two-byte word																

The JSC Header Record is 3060 bytes in length. The format of the JSC header record is described in Annex 1.

2. LANDSAT HEADER RECORD.

The LANDSAT Header is a physical record of 1440 bytes. It contains eighteen 80-character lines as shown in the sample Header Block in Fig. 2. The eighteen integer variables and their descriptions can be reproduced using a format equivalent to (I10, 70A1). The code is EBCDIC or, optionally, ASCII.

808	TIPS/LANDSAT-IPS	
2	LANDSAT B	
186	DAY NUMBER SINCE LAUNCH	
2575	ORBIT NUMBER	
2214030011	FRAME ID	
4309	CENTRE LATITUDE N	
-72	CENTRE LONGITUDE W	
31	UTM ZONE NUMBER	
214	TRACK NUMBER	
30	FRAME NUMBER	
11	CYCLE NUMBER	
260775	FRAME IMAGED	26JUL75
130476	MASTER GENERATED	13APR76
200476	COPY PRODUCED	20APR76
800	RECORDING DENSITY	
1	SEQUENTIAL NUMBER OF TAPE	
0	TAPE START TIME	
1111011	PROCESS FLAGS	

Figure 2. – LANDSAT Header Record

PRODUCTION SYSTEM IDENTIFICATION CODE. This is in the form of 100 x (originating centre code) + (duplicating centre code).

- 0 = ELS/SSC
- 1 = NASA, GSFC
- 2 = NASA, JSC
- 3 = EROS, U.S. Dept. of Interior
- 4 = CCRS, Ottawa
- 5 = CCRS, PASS
- 6 = CCRS, East Coast
- 7 = CCRS, West Coast
- 8 = TELESPAZIO, Fucino.

MISSION

- 1 = LANDSAT-1
- 2 = LANDSAT-2
- 3 = LANDSAT-C
- 12 = NOAA-2
- 13 = NOAA-3
- 21 = HCMM-1
- 32 = EOS-A
- 41 = SEASAT-A
- 1001 = Experimental DC-3
- 1002 = Production DC-3
- 1003 = Falcon
- 1004 = CF-100
- 1005 = Convair .

DAY NUMBER SINCE LAUNCH. These are the second through fifth digits of the frame identification number.

ORBIT NUMBER. This specifies the orbit number after launch.

FRAME IDENTIFICATION. In the new Worldwide Reference System a frame is identified by specifying the mission number, the track and frame number, and the cycle at which it was imaged.

FRAME CENTRE LATITUDE. The latitude of the frame centre is given in degrees and minutes (right-justified - ~~South~~ latitudes negative, ~~North~~ latitudes positive).

FRAME CENTRE LONGITUDE. The longitude of the frame centre is given in degrees and minutes (DDDMM). (East longitudes positive, west longitudes negative).

UTM ZONE NUMBER. This item defines the UTM zone in which the frame centre lies.

TRACK NUMBER. The orbital track number (1-251) is provided in order to correlate data with the Worldwide Reference System for LANDSAT data retrieval.

FRAME NUMBER. The frame centre positions are numbered sequentially, as specified in the Worldwide Reference System.

CYCLE NUMBER. This identifies the 18-day orbital cycle from which data was acquired.

DATE OF DATA ACQUISITION. The date is in the form: day, month, year (DDMMYY).

DATE MASTER CCT PRODUCED. The date is in the form: day, month, year (DDMMYY).

DATE COPY PRODUCED. The date is in the form: day, month, year (DDMMYY).

RECORDING DENSITY. The recording density of this tape, in bits per inch, is of 1600 bpi.

SEQUENTIAL NUMBER OF TAPE. This will always be 1 for 1600 bpi tapes. Of the two 800 bpi tapes required for a single scene, it will be 1 for the first tape and 2 for the second.

TIME OF TAPE START SINCE BEGINNING OF FRAME. This is the time, in terms of microseconds, at which the CCT data recording was started with respect to the beginning of the standard LANDSAT Frame image product. It is equal to zero for standard frames.

PROCESSING FLAGS. The seven flags, reading from left to right are:

1234567 FLAG	DESCRIPTION
1	RADIOMETRIC DATA RECORD 1 FOR CORRECTED 0 FOR RAW DATA
2	RADIOMETRIC LEVELS 1 FOR 256 LEVELS 0 FOR 64 LEVELS
3	= FLAG 4
4	HIPROF SCAN VELOCITY CORRECTION 1 FOR VELOCITY CORRECTION 0 FOR NO VELOCITY CORRECTION
5	RADIOMETRIC CORRECTIONS 1 FOR COMPRESSED CORRECTIONS 0 FOR LINEAR CORRECTIONS
6	LINE LENGTH CORRECTIONS 1 FOR LENGTH CORRECTED 0 FOR NO LENGTH CORRECTIONS
7	CHARACTER TYPE 1 FOR ASCII 0 FOR EBCDIC

***** END OF RECORD *****

3. TRANSFORMATION RECORD.

The 720 bytes of the transformation record are not used and filled with binary zeroes.

4. RADIOMETRIC LOOK-UP TABLE RECORDS.

There are five radiometric look-up table records, one for each band. Each is 1620 bytes in length. The tables contain the entries used to correct this CCT. There are 64 entries for each of the 26 sensors. As there are six sensors in each of the first four bands, the records are in (384I4, 84X) format or its equivalent. Since there are only two sensors for the thermal band, it is written with a format equivalent to (128I4, 1108X). Each table entry has a value in the range 0-255. Fig.5 shows a sample print out of these records.

These tables are derived from either the calibration data transmitted from the satellite or a statistical analysis of the scene data itself.

The last of the look-up records is followed by an end of file mark.

5. MSS DATA SETS.

A data set is defined as the ancillary data and all of the video data for one scan line for all active channels (bands). For LANDSAT-1 and 2, a data set will consist of four physical records, each 3780 bytes in length. The first two bytes of a physical record give the number of that record within its data set. The ancillary data are given in bytes 3-180 of the first record and in bytes 3603-3780 of the next three records. Band 4 video data are given in bytes 181-3780 of the first physical record. For bands 5,6 and 7, video data are given in bytes 3-3602 of the second, third and fourth records, respectively. The physical format for a typical data set is shown below. All data in the record are in binary.

A video data block is that part of the record containing the actual scene video information. For LANDSAT-1 and 2, each such data block is 3600 bytes long. Byte 1 of the first video data block is byte 181 of physical record 1. Byte 1 of the second, third and fourth video data blocks is byte 3 of the corresponding physical records, namely 2, 3 and 4 respectively.

BYTE COUNT

1	2	3		178	179	180	181	182	183	184	185		3776	3777	3778	3779	3780
0 1 RECORD COUNT			ANCILLARY DATA					VIDEO DATA FOR BAND 4									

INTER RECORD GAP

BYTE COUNT

1	2	3	4	5	6	7		3600	3601	3602	3603	3604	3605		3778	3779	3780
0 2 RECORD COUNT		VIDEO DATA FOR BAND 5										ANCILLARY DATA					

INTER RECORD GAP

BYTE COUNT

1	2	3	4	5	6	7		3600	3601	3602	3603	3604	3605		3778	3779	3780
0 3 RECORD COUNT		VIDEO DATA FOR BAND 6										ANCILLARY DATA					

INTER RECORD GAP

BYTE COUNT

1	2	3	4	5	6	7		3600	3601	3602	3603	3604	3605		3778	3779	3780
0 4 RECORD COUNT		VIDEO DATA FOR BAND 7										ANCILLARY DATA					

INTER RECORD GAP

BYTE COUNT

1	2	3		178	179	180	181	182	183	184	185		3776	3777	3778	3779	3780
0 1 RECORD COUNT			ANCILLARY DATA					VIDEO DATA FOR BAND 4									

INTER RECORD GAP

The correspondence between physical records and data blocks is given below:

Physical Record Number	Physical Record Byte No.	Data Block Descriptor	Data Block Byte No.		No. of Bytes
1	1-2	Counter	-	01	2
1	3-180	Ancillary Data Block	1-178	Ancillary Data	178
1	181-3780	Video Data Block 1	1-3600	Video Data for Band 4	3600
2	1-2	Counter	-	02	2
2	3-3602	Video Data Block 2	1-3600	Video Data for Band 5	3600
2	3603-3780	Ancillary Data Block	1-178	Ancillary Data	178
3	1-2	Counter	-	03	2
3	3-3602	Video Data Block 3	1-3600	Video Data for Band 6	3600
3	3603-3780	Ancillary Data Block	1-178	Ancillary Data	178
4	1-2	Counter	-	04	2
4	3-3602	Video Data Block 4	1-3600	Video Data for Band 7	3600
4	3603-3780	Ancillary Data Block	1-178	Ancillary Data	178

ANCILLARY DATA BLOCK. The data provided in the 178-byte ancillary data block are described in Annex 2.

MSS data start position is computed as follows:

- Band 4: START=A, where A=value stored in bytes 105-106 *in auxiliary data block*
- Band 5: START=A-178-2
- Band 6: START=A-178-4
- Band 7: START=A-178-6

MSS data stop position is computed as follows:

- Band 4: STOP=B, where B=value stored in bytes 107-108 *in auxiliary data block*
- Band 5: STOP=B-178-2
- Band 6: STOP=B-178-4
- Band 7: STOP=B-178-6

VIDEO DATA BLOCKS. Each video data block contains 3600 data bytes in the format, as previously described. MSS band 4 video data are contained in bytes 181-3780 of physical record 1, band 5, 6 and 7 video data are in bytes 3-3602 of physical records 2,3 and 4 respectively.

EPO/80-545/SB/gg

ANNEX 1 - Pg. 1.

KIRUNA - ELS
 JSC HEADER
 ANCILLARY DATA BLOCK

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
1-32	Computing System ID This will contain: ELS/SSC	EBCDIC	32
33-52	Tape Library ID of master tape, e.g., 770712/1	EBCDIC	20
53-60	Sensor ID, in the case of these tapes: MSS	EBCDIC	8
61-63	Date of master tape generation in form day, month, year		
	Day	binary	1
	Month	binary	1
	Year (last two digits)	binary	1
64	Tape sequence ID: always 1	binary	1
65-66	Mission Number 1 for LANDSAT-1, 2 for LANDSAT-2, 3 for LANDSAT-3	binary	2
67-68	Site Number WRS frame number	binary	2
69	Line Number WRS orbital track number	binary	1
70	Run Number Cycle number	binary	1

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
71-72	Orbit Number	binary	2
73-80	Time of first scan in this job		
	73-74 Tenths of millisec	binary	1
	75 Seconds	binary	1
	76 Minutes	binary	1
	77 Hours	binary	1
	78 Days of Month	binary	1
	79 Month Number	binary	1
	80 Year (last two digits)	binary	1
81-88	Channels active in this job Bits 4, 5, 7 and 7 in Byte 81 are set for LANDSAT-1 and LANDSAT-2. Bit 8 only will be set for a LANDSAT-3 Band 8 CCT.	binary	8
89	Processing flag 0 = Raw Data 1 = Processed Data	binary	1
90	Number of channels on this tape 4 for LANDSAT-1 and -2, 1 or 4 for LANDSAT-3		1
91	Number of bits in a picture element binary 8 for LANDSAT	binary	1
92-93	Byte location of start of effective video data within a scan line 1 for ELS LANDSAT CCT's	binary	2

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
94-95	Byte location of start of first calibration area within scan line 0 for ELS LANDSAT CCT's (since calibration is not given within scan)	binary	2
96-97	Number of video elements per scan within a single channel 3600 for ELS LANDSAT CCT's	binary	2
98-99	Number of calibration elements in the first calibration area within the scan in a single channel 0 for ELS LANDSAT CCT's	binary	2
100-101	Physical Record size in bytes 3780 for ELS LANDSAT CCT's	binary	2
102	Number of channels per physical record 1 for ELS LANDSAT CCT's	binary	1
103	Number of physical records per scan per channel 0 for ELS LANDSAT CCT's	binary	1
104	Number of physical records to make a complete data set 4 for ELS LANDSAT CCT's	binary	1

<u>Code</u>	<u>Description</u>	<u>Type</u>	<u>Number of Pages</u>
105-106	Number of bytes of ancillary data included in each data set. 176 for LANDSAT CCTs	binary	2
107	Data order indicator 0 = video ordered by channel in a record 1 = video ordered by pixel in a record 0 for LANDSAT CCTs	binary	1
108-109	Start pixel number. Number of the first pixel per scan on this tape referenced to original image. The first pixel in the original image is number one. 1 for LANDSAT CCTs	binary	2
110-111	Stop pixel number. Number of last pixel per scan on this tape referenced to original image. 3600 for LANDSAT CCTs	binary	2
112-113		binary	2-0

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
752	Pixel Registration 0 for ELS LANDSAT CCT's	binary	1
753	Word size of generating computer or smallest quantity, in bits, that machine can write on tape 32 for ELS system	binary	1
754-1777	Wavelength of each channel, 8 bytes per limit, 16 bytes per channel (in milli- microns) For LANDSAT-1, -2 and -3	EBCDIC	1024
	754-769 000000 000000		
	.		
	.		
	.		
	802-817 000500 000600		
	818-833 000600 000700		
	834-849 000700 000800		
	850-865 000800 001100		
	866-881 010400 012600 (LANDSAT-3 only)		
	882-897 000000 000000		
	.		
	.		
	1762-1777 000000 000000		

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
1778	Number of data sets per physical record 0 for ELS LANDSAT CCT's	binary	1
1779-1780	Byte address of start of second calibration within scan 0 for ELS LANDSAT CCT's	binary	2
1781-1782	Number of calibration elements in the second calibration area within the scan in a single channel 0 for ELS LANDSAT CCT's	binary	2
1783	Calibration source indicator 0 for ELS LANDSAT CCT's	binary	1
1784	File skip flag: Skip the next "n" end-of-file marks 2 for ELS LANDSAT CCT's	binary	1
1785-1786	Number of bands in the first physical record of the data set 1 for ELS LANDSAT CCT's	binary	2
1787-1788	Total number of bytes per scan per channel 3600 for ELS LANDSAT CCT's	binary	2
1789-1790	Pixel skip factor 1 for ELS LANDSAT CCT's	binary	2

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
1791-1792	Scan skip factor 1 for ELS LANDSAT CCT's	binary	2
1793-1796	High Frequency Filtering: All zeroes	binary	4
1797-2737*	General Information: All blank fill	EBCDIC	957
2738-2745*	Sun elevation angle in milliradians	EBCDIC	8
2746-2753*	Sun azimuth angle in milliradians	EBCDIC	8
2754	Number of Auxiliary Files 1 for ELS LANDSAT CCT's	binary	1
2755-2756	Start Scan Line Number: The number of the first scan line on this tape referenced to the original image. The first scan line in the original image is number 1.	binary	2
2757-2758	Stop Scan Line Number	binary	2
2759	"0" Thousand scan lines per frame 2 for ELS LANDSAT CCT's	binary	1
2760-2789*	Image annotation data: All blanks	EBCDIC	30
2790-2792*	Altitude in metres Unused: contains zero	binary	3

Byte No.	Description	Type	No. of Bytes
2793-2794	Ground speed in metres/second.	binary	2
2795	Scan type: 0 = linear, 1 = smoothed. 0 = uncorrected for LLC 1 = corrected for LLC for LANDSAT CCTs	binary	1
2796	Angle of arc in degrees. 12 for LANDSAT CCTs. (4-5) 15 for (4-5)	binary	1
2797	Camera 0 = 70 mm, 1 = 127 mm (5 inch), 2 = 240 mm (9 1/2 inch), 255 = no camera. 255 for LANDSAT CCTs.	binary	1
2798	Input device 0 - CCT, 1 - High Density Tape. 1 for LANDSAT CCTs.	binary	1
2799	Truncation 0 = 2 low order bits, 1 = 2 high order bits, 2 = no truncation. 2 for LANDSAT CCTs.	binary	1
2800-2807	Channels requested, one bit per channel. 2800 = 00011110 for LANDSAT 1 and 2 2801-2807 = 0 for LANDSAT CCTs.	binary	8
2808	Processing mode 0 = serially, 1 = concurrently. 1 for LANDSAT CCTs.	binary	1

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
2809-2873*	Overlay Image Factors Unused: contains zero	binary	65
2874	Color Select 2 for ELS LANDSAT CCT's	binary	1
2875	Image format 2 for ELS LANDSAT CCT's	binary	1
2876	Repeat of pixels per scan 0 for ELS LANDSAT CCT's	binary	1
2877	Repeat of scan 0 for ELS LANDSAT CCT's	binary	1
2878-2881	Partial Scan 0 for ELS LANDSAT CCT's	binary	4
2882-2883	Sensor scan rate in scans per second 82 for LANDSAT CCT's	binary	2
2884	Pixel size 1 for LANDSAT CCT's	binary	1
2885-2886*	Angle of drift in degrees Unused: contains zero	binary	2

<u>Byte Number</u>	<u>Description</u>	<u>Type</u>	<u>No. of Bytes</u>
2887-2940	Fill zeroes	binary	54
2941-3000	Fill blanks	EBCDIC	60
3001-3060	Fill zeroes	binary	60

ANCILLARY DATA BLOCK IMPLEMENTATION.

<u>Byte Number</u>	<u>Description</u>	<u>No. of Bytes</u>
1-4	Time in GMT at start of scan, in ten of milliseconds	4
5-14	Bytes 8 through 12 indicate the status of the channels (Bands 4 through 8) 0 indicates channel in sync 1 indicates sync lost for channel Bytes 5 through 7 and 12 and 13 contain 0	10
15-16*	Minor frame sync loss count	2
17-68	Zero fill	52
69-70	Scan line number: For LANDSAT this is equivalent to data set number	2
71-102*	Zero fill	32
103-104	Sun angle in milliradians	2
105-106	Data start position within the scan, referenced to Byte 1 of the video data block. This is given for Band 4. The start position for Band 5 will be two less; for Band 6, four less; and for Band 7, six less than the number given here due to sensor offset.	2

If this is a LANDSAT-3 Band 8 tape, this is the position within the scan of the start of Band 8 data.

<u>Byte Number</u>	<u>Description</u>	<u>No. of Bytes</u>
107-108	Data stop position within the scan, referenced to Byte 1 of the video data block. This position is given for Band 7. The stop position for Band 4 will be six greater; for Band 5, four greater; and for Band 6, two greater than the number given here due to sensor offset. If a LANDSAT-3 Band 8 tape, this is the stop position for Band 8 data.	2
109-111	Line Length Code	3
112-116	Satellite Time Code 112 = tens of day, days 113 = tens of hours, hours 114 = tens of minutes, minutes 115 = tens of seconds, seconds 116 = tenths of seconds, hundredths of seconds	5
	<u>Note:</u> hundreds of days digit is not provided	
117	Sensor set for this swath 1 = Sensors 1,2,13,14,25 2 = Sensors 3,4,15,16 3 = Sensors 5,6,17,18 4 = Sensors 7,8,19,20,26 5 = Sensors 9,10,21,22 6 = Sensors 11,12,23,24	1

<u>Byte Number</u>	<u>Description</u>	<u>No. of Bytes</u>
118-147	Calibration Wedge Data: Six samples of the calibration wedge are provided for each band 118-123 Cal. Data for Band 4 124-129 Cal. Data for Band 5 130-135 Cal. Data for Band 6 136-141 Cal. Data for Band 7 142-147 Cal. Data for Band 8	30
	<u>Note:</u> All above data is given <u>after</u> corrections applied by radiometric look-up tables	
148-162*	Sum of first 3000 pixel values for each band (1000 values for Band 8) 148-150 Sum Data for Band 4 151-153 Sum Data for Band 5 154-156 Sum Data for Band 6 157-159 Sum Data for Band 7 160-162 Sum Data for Band 8	15
163-177*	Sum of squares of first 3000 pixel values for each band (1000 values for Band 8) *163-165 Sum of squares for Band 4 166-168 Sum of squares for Band 5 169-171 Sum of squares for Band 6 172-174 Sum of squares for Band 7 175-177 Sum of squares for Band 8	15
178	Zero fill	