National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Synchronous Meteorological Satellite (SMS) 2 Visible Infrared Spin-Scan Radiometer (VISSR) Level 1 Atmospheric and Oceanographic Image Processing System (AOIPS) Data

VISSRSMS2L1AOIPS

Last Revised 05/21/2020

Goddard Earth Sciences Data and Information Services Center (GES DISC)
https://disc.gsfc.nasa.gov
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA

Prepared By:

James E. Johnson	05/21/2020
Name GES DISC GSFC Code 610.2	Date

Reviewed By:

Name	mm/dd/yyyy
Name GSFC Code xxx	Date
Name	mm/dd/yyyy
Name GSFC Code xxx	Date

Goddard Space Flight Center

Greenbelt, Maryland

Revision History

Revision Date	***Changes***	***Author***
05/21/2020	Original	James E. Johnson

Table of Contents

1. Introduction

This document provides basic information on using the Synchronous Meteorological Satellite (SMS) 2 Visible Infrared Spin-Scan Radiometer (VISSR) Level-1 Atmospheric and Oceanographic Image Processing System (AOIPS) product.

1.1 Data Product Description

The SMS 2 Visible Infrared Spin-Scan Radiometer (VISSR) Level-1 Atmospheric and Oceanographic Image Processing System data product typically contains a scene of the Earth with radiances that were measured in the visible (0.55 to 0.70 micrometer) and/or IR (10.5 to 12.6 micrometer) wavelengths with a spatial resolution of 0.9 and 8 km, respectively. Files also include time, geolocation, orbit, attitude, and telemetry information. There are three types of data files in this product: one contains IR data, one contains the IR grid information, and another contains VIS data. Each data file is structured with an AOIPS label, followed by an IPD label, and then an optional 8 telemetry records followed by a set of data records. Visible data are typically 3904 pixels by either 4000 or 2000 scan lines (5 or 2.5 minute scenes respectively). IR data are typically 976 pixels by either 500 or 250 scan lines (5 or 2.5 minute scenes respectively). A full scan of the Earth was made every 20 minutes. The data were used to make 70mm film negatives and 9.5” positive prints on a Dicomed Image Recording System.

Data for this product are available for dates 1975/04/27 – 28 (IR only); 1975/05/29; 1975/07/23 (IR only); 1975/07/24; 1975/07/26 (IR only); 1975/07/29 – 31 (IR only); 1979/05/10; 1979/05/18 – 19; 1979/06/05; 1979/06/07 – 08; 1979/06/15; 1979/09/04; 1979/09/12 – 13; 1979/09/23; 1979/10/22; 1980/02/01; 1980/07/05 (IR only); and 1980/08/22 (IR only). The SMS 2 satellite was initially parked over the equator at longitude 105W on Feb. 22, 1975 viewing the hemisphere below the satellite. It was moved to its operational position at 135W on Dec. 19, 1975. The VISSR experiment was operated by the NOAA National Environmental Satellite Data and Information Service (NESDIS), as well as scientists from NASA Goddard Space Flight Center.

This product was previously available from the NSSDC with the identifier ESAD-00095 (old ID 75-011A-04D).

1.1.1 The Visible Infrared Spin-Scan Radiometer

The Visible Infrared Spin-Scan Radiometer (VISSR) flown on SMS 2 was basically identical to that flown on SMS 1, and provided day and night observations of cloudcover and earth/cloud radiance temperature measurements from a synchronous, spin-stabilized, geostationary satellite for use in operational weather analysis and forecasting. The two-channel instrument was able to take both full and partial pictures of the earth's disk. The infrared channel (10.5 to 12.6 micrometers) and the

visible channel (0.55 to 0.70 micrometer) used a common optics system. Incoming radiation was received by an elliptically shaped scan mirror and collected by a Ritchey-Chretien optical system. The scan mirror was set at a nominal angle of 45 deg to the VISSR optical axis, which was aligned parallel to the spin axis of the spacecraft. The spinning motion of the spacecraft (approximately 100 rpm) provided a west-to-east scan motion when the spin axis of the spacecraft was oriented parallel to the earth's axis. The latitudinal scan was accomplished by sequentially tilting the scanning mirror north to south at the completion of each spin. A full picture took 18.2 min to complete and about 2 min to retrace. During each scan, the field of view on the earth was swept by a linear array of eight visible-spectrum detectors, each with a ground resolution of 0.9 km at zero nadir angle. The infrared portion of the detector measured radiance temperatures between 180 and 315 deg K with a proposed sensitivity between 0.4 and 1.4 deg K.

1.1.2 The SMS 2 Satellite

The SMS 2 satellite was successfully launched on February 6, 1975. SMS 2 was the second in a series of geosynchronous meteorological satellites developed by NASA and operated by NOAA, which would evolve into NOAA's GOES system. The spacecraft included three instruments: (1) a visible infrared spin-scan radiometer (VISSR) which provided high-quality day/night cloudcover data and made radiance temperatures of the earth/atmosphere system, (2) a meteorological data collection and transmission system (DCS) which relayed processed data from central weather facilities to small automatic picture transmission (APT) equipped regional stations and collected and retransmitted data from remotely located earth-based platforms, and (3) a space environmental monitor (SEM) which measured proton, electron, and solar X-ray fluxes and magnetic fields.

The orbit of the satellite can be characterized by the following:

Parking Station	**Longitude**	**Date**
Launch		02/06/1975
Original	105° W	02/22/1975
Final	135° W	12/19/1975

Geostationary circular orbit at 35,000 km

Inclination of 1.9 degrees

1.2 Algorithm Background

The SMS 2 VISSR AOIPS data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 360 computers, and copied to 6250 tapes for archival. Further information on the VISSR instrument and data processing can be found in the "VISSR Data Processing Plan for SMS/GOES Satellites" and the "The GOES/SMS User's Guide".

1.3 Data Disclaimer

The data should be used with care and one should first read both the "VISSR Data Processing Plan for SMS/GOES Satellites" and the "GOES/SMS User's Guide". Users should cite this data product in their research.

2. Data Organization

Data from the SMS 2 Visible Infrared Spin-Scan Radiometer (VISSR) AOIPS product are available from April 27, 1975 to August 22, 1980 (with gaps). Each file typically contains a few minutes of data on the order of up to 4000 visible scans and up to 500 IR scans.

2.1 File Naming Convention

The data product files are named according to the following convention:

<Platform>-<Instrument>_<Level>-<Product>-<Type>_<DateTime>_<TapeNumber>-<TapeFile>.<Suffix>

where:
o Platform = name of the platform or satellite (SMS2)
o Instrument = name of the instrument and product (VISSR)
o Level = process level (L1)
o Product = product name (AOIPS)
o Type = type of data (VIS, IR, IRG)
o Date = Data start date and time in UTC in format <YYYY>m<MMDD>t<hhmmss> where

1. YYYY = 4 digit year (1978 – 1979)
2. MM = 2 digit month (01-12)
3. DD = 2 digit day of month (01-31)
4. hh = 2 digit hour of day (00-23)
5. mm = 2 digit minute (00-59)
6. ss = 2 digit second (00-59)

o TapeNumber = 5 digit number of tape (preceded by ‘DD’ - primary or ‘DC’ - backup)
o TapeFile = 1 digit number of file on the tape
o Suffix = the file format (always TAP, indicating tape binary data)

```
File name example: SMS2-VISSR_L1-AOIPS-VIS_1975m0427t183002_DD52938-1.TAP
```

2.2 File Format and Structure

The data are stored as they were originally written in IBM binary (big-endian) record oriented structured files. The files were written on 7-track and 9-track tapes using a blocked FORTRAN format. The first file on the tape is the tape header file with two records containing text encoded information about the tape. This is followed by up to three data files. Each data file on the tape contains an AOIPS label record of size 512 bytes, followed by an IPD label record of size 1244 (IR/IRG) or 4172 (VIS) bytes, followed by either 0, 4 or 8 telemetry records also of size 1244 (IR/IRG) or 4172 (VIS) byte, and then a series of data records also of size 1244 (IR/IRG) or 4172 (VIS) bytes. Each data file typically contains about 5 minutes or less of data, up to 18 minutes for a global image. For the contents and layout of the data, see Appendix B of the “VISSR Data Processing Plan for SMS/GOES Satellites”.

During data recovery a total of 247 data files were extracted from 95 tapes. All of the files appear to be unique, with one file from 1975/02/17 belonging to the SMS-1 collection, and one IR data file SMS2-VISSR_L1-AOIPS-IR_1979m0607t205244_DD59198-2.TAP did not contain an IRG (grid overlay) counterpart. In the end 246 data files were archived for this collection. All files came from tapes designated by a prefix 'DD' (primary) and a five digit number, no files came from tapes with a 'DC' (backup) prefix.

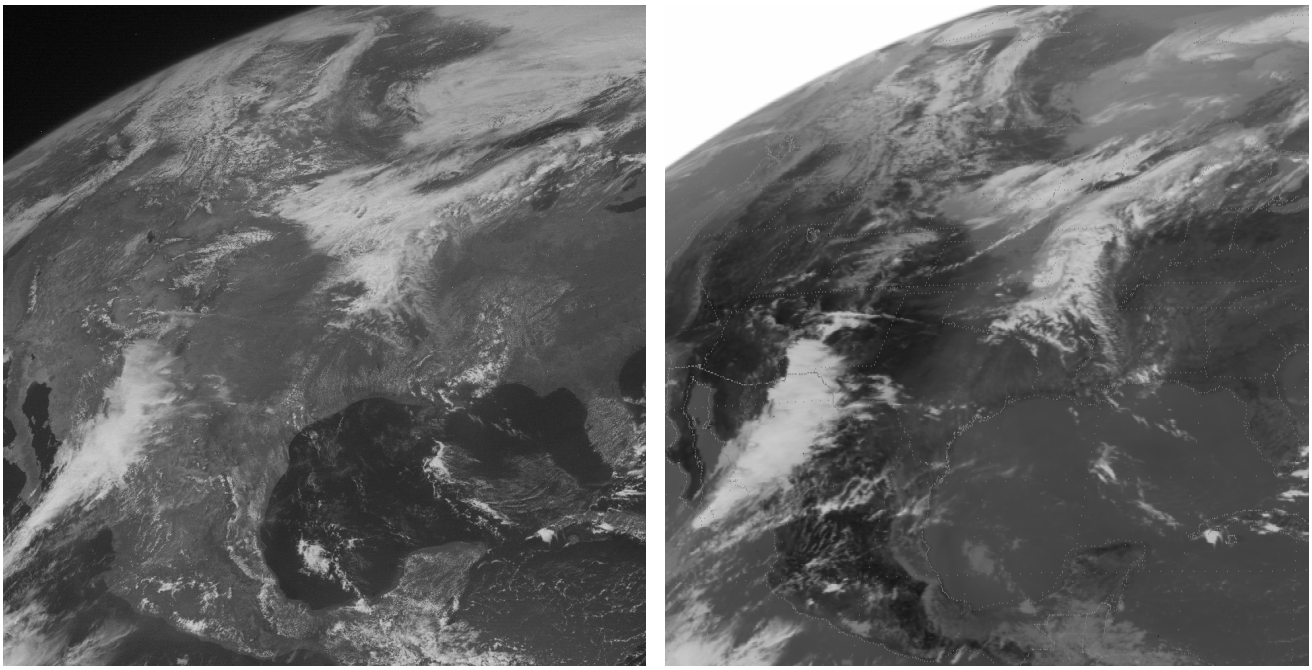
Caution should be taken as some data records contain corrupted records (such as bad bits or bad record sizes).

The visible mode A images are 3904 pixels wide, IR and IRG images are 976 pixels wide, and there were no IR/IRG global images of 3822 pixels wide. All of the recovered SMS 2 VISSR AOIPS files are archived at the GES DISC.

2.3 Key Science Data Fields

The primary science data fields in this data product are the VISSR IR and visible images stored as 8-bit bytes.

Figure 1: Typical SMS 2 VISSR Level 1 AOIPS data files showing a visible scene at left, and an infrared scene with grid overlay (cool = white, warm = black) at right, of North America from May 18, 1979 at 18:32:11 to 18:37:09 UTC.



3. Data Contents

The granularity of this data product is typically around 20 minutes.

3.1 Data Records

The file format is described in various sections of Appendix B of the "VISSR Data Processing Plan for SMS/GOES Satellites" document.

The original tape files each included a tape header file. These were then followed by a set of up to 3 data files. As part of the recovery, the GES DISC has extracted and archived the data files from the tapes. There are 3 types of data files containing either an IR image, and IR grid, or a Visible image. Each data file includes two header label records which is followed by a set of data image records. The original data were written on IBM machines and use big-endian byte order. There were two types of tapes received. The first from University of Wisconsin SSEC contains record blocks preceded by an 8 BCD character indicating the record block size. The second from Redstone contain record blocks preceded by a 4-byte integer word with the record block size.

Table 3-1-1: AOIPS Label Record (512 EBCDIC characters)

Byte	Description	Size	Comments
1 – 8	Image Name	8 EBCDIC	first 4 characters is satellite (ME02)
9 – 16	Parent Name	8 EBCDIC	same as Image Name
17 – 24	Master Name	8 EBCDIC	same as Image Name
25 – 32	Tape Number	8 EBCDIC	6 digit picture number plus 2 digit DECOM reel number
33 – 36	User ID	4 EBCDIC	always IPDM
37 – 38 39 – 40 41 – 42 43 – 44	Start Date/Time of Scan Line 1 (Full Image)	16-bit int 16-bit int 16-bit int 16-bit int	(YY x 100) + MM (DD x 100) + HH (MM x 100) + SS Milliseconds x 10
45 – 46	Access Code	16-bit int	always 0
47 – 48	Application ID	16-bit int	always 1
49 – 50	Data Set Reference Number	16-bit int	always 0
51 – 52	Sequence Number in Data Set	16-bit int	always 0
53 – 54	Label Type	16-bit int	always 0

55 – 56	File Format (Interleaving Code)	16-bit int	always 0
57 – 60	Exchange Format Identification Code	4 EBCDIC	always EFIC
61 – 62	Pixel Format	16-bit int	always 1
63 – 64	Image File Number	16-bit int	
65 – 66	Record Length	16-bit int	in 8-bit bytes
67 – 68	File Length	16-bit int	Max records, excluding this one
69 – 70	Left Edge Fill	16-bit int	8-bit bytes preceding first image pixel
71 – 72	Top Edge Fill	16-bit int	number of IPD and telemetry records
73 – 74	Number of Image Pixels	16-bit int	
75 – 76	Number of Image Lines	16-bit int	
77 – 78	Image Start Pixel	16-bit int	
79 – 80	Image Start Line	16-bit int	
81 – 82	Parent Start Pixel	16-bit int	same as Image Start Pixel
83 – 84	Parent Start Line	16-bit int	same as Image Start Line
85 – 86	Pixel Zoom Factor	16-bit int	always 1
87 – 88	Line Zoom Factor	16-bit int	always 1
89 – 90	Parent Pixel Scale (numerator)	16-bit int	always 1
91 – 92	Parent Pixel Scale (denominator)	16-bit int	always 1
93 – 94	Parent Line Scale (numerator)	16-bit int	always 1
95 – 96	Parent Line Scale (denominator)	16-bit int	always 1
97 – 98	Pixel Offset	16-bit int	always 0
99 – 100	Line Offset	16-bit int	always 0
101 – 106	Not Used	6 bytes	zero filled
107 – 108	Max Number of Secondary Data Records	16-bit int	always 9
109 – 110	Logical Record Length of Secondary Records	16-bit int	always 720
111 – 112	Line Documentation Length	16-bit int	follows image data in each record
113 – 118	Not Used	6 bytes	zero filled
119 – 120	Program ID	16-bit int	Always 1 for files by SMS VISSR DPP
121 – 122	Program Version Creation Date	16-bit int	(MM x 1000) + DD x 10 + Y
123 – 192	Not Used	70 bytes	zero filled
193 – 194	Band Code	16-bit int	1=VIS; 2=IR; 3=IR Grid; 4=Calibration
195 – 196	Pixel Width (1/2 mile units)	16-bit int	4=IR; 2=VIS Mode B; 1=VIS Mode A
197 – 198	Line Height (1/2 mile units)	16-bit int	8=IR; 4=VIS Mode B; 1=VIS Mode A
199 – 200	Number of Orbit/Attitude Blocks	16-bit int	always 0, 1 or 2
201 – 202	Number of File Containing IR Calibration Data	16-bit int	zero if IR calibration file not present
203 – 204	Scaling Table ID	16-bit int	

205 – 208	Degree Scale Factor (DSCL)	32-bit int	always 2^{16} = 65536	
209 – 212	Kilometer Scale Factor (KSCL)	32-bit int	always 2^{11} = 2048	
213 – 216	Date of Orbit/Attitude Data	32-bit int	(YY x 1000) + day	First Orbit/Attitude Block
217 – 220	Time of Orbit/Attitude Data	32-bit int	milliseconds	
221 – 224	Attitude ID	32-bit int		
225 – 228	Geodetic Latitude (deg; positive north)	32-bit int	scaled by DSCL	
229 – 232	Longitude (deg; positive east)	32-bit int	scaled by DSCL	
233 – 236	Height Above Oblate Earth (km)	32-bit int	scaled by KSCL	
237 – 240	Right Ascension (R.A.) of Spin Axis (deg)	32-bit int	scaled by DSCL	
241 – 244	Declination of Spin Axis (deg)	32-bit int	scaled by DSCL	
245 – 248	Spin Period (microseconds)	32-bit int		
249 – 252	R.A. of Position Vector w.r.t. Aries (deg)	32-bit int	scaled by DSCL	
253 – 256 257 – 260 261 – 264	X Cartesian Coordinate Position Vector (km) Y “ Z “	32-bit int 32-bit int 32-bit int	scaled by KSCL	
265 – 268 269 – 272 273 – 276	X Cartesian Coordinate Velocity Vector (km/h) Y “ Z “	32-bit int 32-bit int 32-bit int	scaled by KSCL	
277 – 340	Data for Second Block of Orbit/Attitude Data	16 x 32-bit int	Same Format as First Block Above	
341 – 512	Not Used	172 bytes	zero filled	

Table 3-1-2: IPD Label Record (IR/IRG=1244/4092 byte or VIS=4172 byte VIS EBCDIC characters)

Byte	Description	Size	Comments
1 – 7	International Code	7	7501101 for SMS 2
9 – 14	Date of Recording (YYMMDD)	6	
16 – 18	Station Code	3	
20	Analog Tape Deck Identification	1	
22 – 27	Tape Number	6	
29 – 32	Start Time of Analog Tape (HHMM)	4	
34 – 37	Stop Time of Analog Tape (HHMM)	4	
39 – 44	Date of Digitization (YYMMDD)	6	
46	Picture Section Number	1	
48	Buffer Tape Reel Number	1	
50	Buffer Tape File Number	1	
52	Buffer Tape Section File Number	1	
54 – 55	Pass Two Line Identification	2	

57	Pre-Edit Tape Reel Number	1	
59	Pre-Edit Tape File Number	1	
61	Pre-Edit Tape Selection File Number	1	Section file is relative to first file
63	Master Data Tape Reel Number	1	
65	Master Data Tape File Number	1	
66 – 67	Master Data Tape Section File Number	2	Section file is relative to first file
69 – 71	Start Day of Year (3 digit)	3	
72 – 77	Start Time (HHMMSS)	6	
79 – 84	Stop Time (HHMMSS)	6	
86 – 89	Elapsed Time (MMSS)	4	
91	Data Mode	1	A = Visible Mode A B = Visible Mode B G = IR Grid I = IR Image K = IR Calibration
93	IR Data Only (Y or N)	1	
95 – 98	Initial Image Line Number	4	
100 – 103	Final Image Line Number	4	
105 – 109	DECOM Run Number	5	
111 – 112	DECOM Reel Number	2	
114	DECOM Reel File Number	1	
115 – 116	DECOM Section File Number	2	Section file is relative to first file
122	O/A/TM Data Present (Y or N)	1	
124	GMT Present From Time Track (Y, N or D)	1	Y = Valid GMT N = Flywheel GMT, D = from Documentation Time
126 – 130	Creation Date (YMMDD)	5	
132	Tape Identification	1	A = AOIPS Picture Tape
134 – 137	Start Pixel (Relative to IR)	4	
139	Sector Size Code	1	
141 – 144	Scaling Table ID	4	
145 – 149	Scaling Table Date (YYDDD)	5	
150 – END	Not Used		blank character padded

Table 3-1-3: Telemetry Record (1244/4092 bytes IR/IRG or 4172 bytes VIS)

Byte	Contents
1 – 720	16 telemetry frames of 40 9-bit words per frame packed in 45 8-bit bytes for a total of 640 9-bit words A full normal mode telemetry block contains 64 frames requiring 4 records. Up to 2 blocks per file.
720 – end	Zero filled

Table 3-1-4: Image Data Record (1244/4092 bytes IR/IRG or 4172 bytes VIS)

Byte	Size	Contents
1 – N	N Bytes	Image Data where N is Number of Pixels (see AOIPS label) (IR/IRG = 976; IR/IRG full = 3822; VIS Mode A = 3904)
N+1 – N+256	129 x 16-bit int	IR Documentation (See Table 3-1-5 below)
N+257 - N+258	16-bit int	Day of Year
N+259 - N+262	32-bit int	Milliseconds of Day
N+263 - N+268	6 bytes (48 bits)	Data Flags: F1 PreEdit Data Flags (12 bits) F2 MDT Data Flags (12 bits) F3 Image Line Number (12 bits) F4 Scan Line Number (12 bits)
N+269 - N+270		Pad (Only When Necessary to Make Record Length an Even Multiple of 32 Bits)

Table 3-1-5: IR Documentation

Bytes	Contents
1	Retrace[1] – one indicates scanner retrace
2	Spacecraft Name
3	Unused
4	Frame Code[1] – one indicates picture transmission
5	Change Code[1] – one indicates start of picture if frame code is one or end of picture if frame code is zero
6	Step Code[1] – one indicates normal line transmission; zero indicates that this is not to be used to expose film and facsimile recorder line is not to be incremented (stepped).
7	Line Delay – this number (1 – 8) denotes delay to be introduced by user; expressed in bit in intervals.
8	IR Selection – 000000001 = IR1, 000000010 = IR2, 000000100 = AVG
9	Gray Scale Status[1] – one indicates gray scale information retransmission
10	Direct Transmission Mode[1] – one indicates 28 Mb/sec; zero indicates 14 Mb/sec
11	Image Line Number – BCD value split into 2 characters/word 2 most significant BCD characters
12	2 least significant BCD characters
13	Mode Code – A = 001100100, B = 01011001, C = 010110010, D = 010001111

14	Beta Count *MSB* 0 8 MSB *LSB*
15	0 8 MSB
16	0 8 LSB
17	Grid/No Grid[1] – Zero indicates no grid information
18	Sync Error *MSB* *LSB* 0 8 MSB
19	0 7 LSB 0
20	Bit Error Count - *MSB* *LSB* 0 8 MSB
21	0 5 LSB 000
22	Setup Error[1] – one indicates setup error
23 - 24	Computer Error Message *MSB* 00000001*LSB* 00000010 ⋮ ⋮ 10000000
25	Scan Count – Two most significant BCD characters
26	Two least significant BCD characters
27	Year – 2 MSD in BCD characters
28	Year – 2 LSD in BCD characters
29	Day of Year – 2 MSD in BCD characters
30	Day of Year – 2 MSD in BCD characters
31	Hour – 2 BCD characters)
32	Minute – 2 BCD characters
33	Second – 2 BCD characters)
34	Millisecond × 10 – 2 BCD characters
35	Black Enable1 – one indicates annotation transmission
36	Mode C-Calibrate[1] – one indicates C-Cal is not used; otherwise: *MSB* V_1 00000001 V_2 00000010 V_3 00000100 V_4 00001000 V_5 00010000 V_6 00100000 V_7 01000000 V_8 10000000
37	Bit/Frame Sync Lock *MSB LSB* 00000001X Bit Lock 1 loss 00000010X Frame Lock X = 1 for any 00000100X Bit Freq Lock of lock

38	Limited Scan Mode Indicator[1] – one indicates limited scan mode
39	Sample Control Mode *(LSB)*IR – 2 PT IR – 1 PT IR – EMP VIS – 4 PT VIS – 2 PT VIS – 1 PT VIS - EMT
40	Visible Channel Connection *(LSB)*V1 V2 V3 Coding for each channel is V4 as follows: V5 0 = normal V6 1 = patched input is used V7 V8
41	Scan Direction[1] – one indicates normal North-South direction (may not be used)
42	Bi-phase Modulator On/Off[1] – one indicates modulator is on
43	Unused
44	PLL Error Light[1] – one indicates error condition
45	Test Data *MSB LSB* 000000000 Normal 000000001 Local 000000010 Remote 000000100 Comp Gen IR
46	Data Randomization[1] – one indicates on
47	Sun Pulse Select[1] – one indicates digital, zero indicates analog
48	Ness Mode Select *MSB LSB* 000000000 4 x 4 IR 000000001 Max SV 000000010 4 x 2 IR
49	Limited Scan Command Encoder Enable[1] – one indicates on
50	Digital Sun Pulse – 8 LSB's contain the digital sun pulse
51	Bit Error Light[1] – one indicates on
52	Mean IR Difference
53	RMS IR Difference
54 – 55	Correction Table ID
56	Left Horizon Point – 8 MSB
57	8 LSB
58	Right Horizon Point – 8 MSB
59	8 LSB
60	Equatorial Scan Count – 8 MSB

61	8 LSB
62 – 79	Unused
80	Telemetry Code Word *MSB* *LSB* 0 A B C D E F G H A and B Unused; always zero C = D = 0 Indicates frame sync search; no valid telemetry, three or more bad sync patterns since lock C = 0, D = 1 Indicates frame sync in check1; one good sync since search or two bad syncs since lock C = 1, D = 0 Indicates frame sync in check2; two good sync since search or one bad sync since lock C = D = 1 Indicates frame sync in lock; three or more good sync patterns found EFG = 0-3 Telemetry quarter-frame number 4 First output without telemetry 5 Second output without telemetry 6 Third output without telemetry 7 Fourth or greater output without telemetry H Parity bit, exclusive or of B, D and F
81 – 98	One quarter of telemetry frame; 16 9-bit words packed into the 8 LSBs of each 9-bit IR doc word
99	O/A block number (1 – 10) One quarter of an orbit/attitude data block; contents are as follows[2]: First Quarter Second Quarter Third Quarter Fourth Quarter
100	1 2 3 4
101 – 104	Date (YYYDD) X Position Vector (km) x 2^{13} Spin Period (µsec) B_Φ
105 – 108	GMT Time (ms) x 10 Y Position Vector (km) x 2^{13} Spin Axis RA (deg) x 2^{21} $\dot{B}*2^{30}$
109 – 112	RA from 0° Meridian Z Position Vector (km) x 2^{13} Spin Axis Dec (deg) x 2^{21} τ_Φ (HHMMSS) *2
113 – 116	S/C Lat (deg) x 2^{21} X´Velocity Vector(km/h) x 2^{13} Pitch (deg) x 2^{21} (odd block) RA S/C-Sun (deg) x 2^{21} N-S Step Angle 2^{21} (even block)
117 – 120	S/C Lon (deg) x 2^{21} Y´Velocity Vector(km/h) x 2^{13} Roll (deg) x 2^{21} (odd block) Dec S/C-Sun (deg) x 2^{21} E-W Step Angle 2^{21} (even block)
121 – 124	S/C Height (km) x 2^{13} Z´Velocity Vector(km/h) x 2^{13} Yaw (deg) x 2^{21} (odd block) GMT Time (ms) x 10 Attitude ID: 0 = other method 1 = sun/earth sensor 2 = landmark (2-mile imagery) 3 = PICATT (earth edge data) 4 = etc., for later use
125 – 127	Unused
128	Longitudinal Parity Check (ODD)

Note 1 All but the last bit in each code is identical, e.g., 00000001 (zero) or 11111110 (one)

Note 2 Regarding O/A data blocks, however words 100 to 124:

a) If no O/A is present, word 100 will be zero

b) B_Φ, $\dot{B}$, τ_Φ are the coefficients of the equation for beta count, words 14-16.
The units of $\dot{B}$ are counts per milliseconds,
and the second bit of $\dot{B}$ is set to 1 to indicate a negative value.

3.2 Metadata

The metadata are contained in a separate XML formatted file having the same name as the data file with .xml appended to

Table 3-2: Metadata attributes associated with the data file.dad

Name	Description
LongName	Long name of the data product.
ShortName	Short name of the data product.
VersionID	Product or collection version.
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
CheckSumType	Type of checksum used.
CheckSumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
InsertDateTime	Date and time when the granule was inserted into the archive. The format for date is YYYY-MM-DD and time is hh-mm-ss.
RangeBeginningDate	Begin date when the data was collected in YYYY-MM-DD format.
RangeBeginningTime	Begin time of the date when the data was collected in hh-mm-ss format.
RangeEndingDate	End date when the data was collected in YYYY-MM-DD format.
RangeEndingTime	End time of the date when the data was collected in hh-mm-ss format.
PlatformShortName	Short name or acronym of the platform or satellite
InstrumentShortName	Short name or acronym of the instrument
SensorShortName	Short name or acronym of the sensor
Gpolygon: PointLatitude	Latitudes of the polygon points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
Gpolygon: PointLongitude	Longitudes of the polygon points that represent the satellite coverage. Each point is identified by its latitude and longitude pair.
Recovering_Institute_Tape_ID	The Tape ID used by the data recovery institute
ElapsedMinTime	Duration in minutes of data collected during an orbit.

4. Reading the Data

The data are written in a binary record-oriented format. Using the record format specification in the section above, users can write software to read the data files. Please note that the data were originally written using a big-endian order, and characters use the old IBM EBCDIC encoding, thus users will have to reconstruct the data values accordingly

A sample FORTRAN program is included in the Appendix section which will read in the data records. Additionally a FORTRAN function is included to perform byte swapping.

5. Data Services

5.1 GES DISC Search

The GES DISC provides a keyword, spatial, temporal and advanced (event) searches through its unified search and download interface:

https://disc.gsfc.nasa.gov/

5.2 Documentation

The data product landing pages provide information about these data products, as well as links to download the data files and relevant documentation:

https://disc.gsfc.nasa.gov/datacollection/VISSRSMS2L1AOIPS_001.html

5.3 Direct Download

These data products are available for users to download directly using HTTPS:

https://acdisc.gesdisc.eosdis.nasa.gov/data/SMS_GOES/VISSRSMS2L1AOIPS.001/

6. More Information

6.1 Contact Information

Name: GES DISC Help Desk
URL: https://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

6.2 References

"The GOES/SMS User's Guide", ed. Corbell R., Callahan, C, Kotsch, W., NOAA National Environmental Satellite Services, 1976

"VISSR Data Processing Plan for SMS/GOES Satellites" by McCowan, P. L., NASA Goddard Space Flight Center, September 1977

7. Appendices

Acknowledgments

The data recovery task at the GES DISC is funded by NASA's Earth Science Data and Information System program.

Acronyms

AOIPS: Atmospheric and Oceanographic Information Processing System

EOS: Earth Observing System

ESDIS: Earth Science and Data Information System

GES DISC: Goddard Earth Sciences Data and Information Services Center

GSFC: Goddard Space Flight Center

L1: Level-1 Data

NASA: National Aeronautics and Space Administration

QA: Quality Assessment

SMS: Synchronous Meteorological Satellite

VISSR: Visible Infrared Spin-Scan Radiometer

FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_SMSAOIPS
C   This program will read an SMS VISSR AOIPS Level-1 data file.
C
C   The SMS VISSR AOIPS files contain a header record of size 512 bytes,
C   followed by a series of data records of size 1244 bytes (IR scenes),
C   4092 bytes (IR global), or 4172 bytes (Visible Mode A). The data files
C   will contain either VIS scan lines, IR scans, or the grids for IR scans
C   for either a section of the earth, or full earth. Scan records contain
C   the IR or visible image, as well as time, and other ancillary values.
C   This program will print the contents of each record.

C   Please note the record size markers can vary. For SSEC recovered
C   files it is an 8 BCD character value at the beginning of the record.
C   For Redstone recovered files it is a 4-byte integer at the beginning and
C   end of the record. This program checks for both.
C
C ^MAJOR VARIABLES:
C     FNAME  - name of input file
C     BUFF   - buffer for data record
C     TEMP   - buffer for holding temporary 4-byte word
C     WORD   - integer 4-byte word
C     IBLKSZ - size of record block in bytes
C     IOS    - I/O status number
C
C ^NOTES:
C     Compile: gfortran -o READ_SMSAOIPS.EXE READ_SMSAOIPS.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: Apr 02, 2020
C-----------------------------------------------------------------------

      CHARACTER          FNAME*1024     ! Filename
      CHARACTER          BUFF(6000)     ! Buffer for data record (max 4172)
      CHARACTER          CHKIPD*7       ! IPD Label check
      INTEGER*4          IBLKSZ         ! Size of records
      INTEGER*4          IWORD          ! 4-byte word
      LOGICAL*1          RDFLAG         ! Redstone Flag
      CHARACTER          SSEC*8         ! Buffer to hold 8-byte SSEC word
      CHARACTER          TEMP(4)        ! Buffer to hold 4-byte word
      EQUIVALENCE        (TEMP,IWORD)

C     Get the name of the input data file to read
      WRITE (0, *), 'Enter the name of the input file:'
      READ (5,'(A)') FNAME
      PRINT '("File = ",A60)', FNAME
```

```
C     Open the specified input file
      OPEN (UNIT=1, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT',
     &      FORM='UNFORMATTED', RECL=1, ERR=99, IOSTAT=IOS)

C     Initialize N (record number), ND (data record), NT (telem record)
C     and IOFF (byte offset in file)
      N=0
      ND=0
      NT=0
      IOFF=0

C     Loop through the file reading all records in file
   10 DO

C       Read the first 4-byte word or record size header
        DO I=1,4
          READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) TEMP(I)
          SSEC(I:I) = TEMP(I)
        END DO
        IOFF=IOFF+(I-1)

C       Check if this is a Univ Wisc SSEC tape file or one from Redstone
        IF ((ICHAR(TEMP(1)).GE.48.AND.ICHAR(TEMP(1)).LE.57).AND.
     +      (ICHAR(TEMP(2)).GE.48.AND.ICHAR(TEMP(2)).LE.57).AND.
     +      (ICHAR(TEMP(3)).GE.48.AND.ICHAR(TEMP(3)).LE.57).AND.
     +      (ICHAR(TEMP(4)).GE.48.AND.ICHAR(TEMP(4)).LE.57)) THEN
          DO I=1,4
            READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) TEMP(I)
            SSEC(I+4:I+4) = TEMP(I)
          END DO
          IOFF=IOFF+(I-1)
          READ (SSEC,'(I8)') IBLKSZ                          ! SSEC File
          RDFLAG = .FALSE.
        ELSE
          IBLKSZ = IWORD                                     ! Redstone File
          RDFLAG = .TRUE.
        END IF

C       End-of-File (EOF) mark, goto quit
        IF (IBLKSZ .EQ. 0) GOTO 90

C       Next read the block of data
        DO I=1,IBLKSZ
          READ (1, REC=IOFF+I, IOSTAT=IOS) BUFF(I)
          IF (IOS .NE. 0) THEN
            PRINT '("ERROR: BUFF ",I4,X,I4,", IOSTAT: ",I6)', N,I-1,IOS
            IBLKSZ = I-1
            GOTO 90
          END IF
        END DO
        IOFF=IOFF+(I-1)
        N = N+1
```

```
C       Determine Record Type
        IF (N.EQ.1.OR.IBLKSZ.LE.512) THEN                       ! AOIPS Label
          DO I=IBLKSZ,512                                       ! Pad short rec
            BUFF(I) = CHAR(64)
          END DO
          CALL PRAOIP(BUFF(1:512), IRECLN, NPIX)
        ELSE
          IF (IRECLN.NE.1244.AND.IRECLN.NE.4092.AND.IRECLN.NE.4172) THEN
            IF (IBLKSZ.LE.1244) THEN                            ! Fix IR reclen
              IRECLN = 1244
              NPIX = 976
            ELSE IF (IBLKSZ.GT.1244) THEN                       ! Fix VIS reclen
              IRECLN = 4172
              NPIX = 3904
            END IF
          ENDIF

C         First 7 Chars of IPD Label should be IntlCode, Last Chars Blanks
          DO I = 1,7
            CHKIPD(I:I) = CHAR(IEBC(ICHAR(BUFF(I))))            ! EBCDIC text
          END DO
          ML = 0
          DO I=150,IBLKSZ
            IF (ICHAR(BUFF(I)).EQ.64) THEN                      ! Blank char
              ML = ML+1
            END IF
          END DO

C         Check if IPD Label
          IF (N.EQ.2.AND.(CHKIPD.EQ.'7403301'                   ! IPD Label
     +       .OR.ML.EQ.(IBLKSZ-149))) THEN
            DO I=IBLKSZ,149                                     ! Pad short recs
              BUFF(I) = CHAR(64)
            END DO
            CALL PRIPDL(BUFF(1:149))
          ELSE
            DO I=IBLKSZ,IRECLN                                  ! Pad short recs
              BUFF(I) = CHAR(0)
            END DO
            MT = 0
            DO I=721,IRECLN
              IF (ICHAR(BUFF(I)).EQ.0) THEN                     ! Null char
                MT = MT+1
              END IF
            END DO
C           Check if Telemetry or Image Record
            IF (MT.EQ.IRECLN-720) THEN                          ! Telem Record
              NT = NT+1
              CALL PRTREC(BUFF(1:720), NT)
            ELSE                                                ! Image Record
              ND = ND+1
              CALL PRIREC(BUFF(1:IRECLN), IRECLN, NPIX, ND)
            END IF
          END IF
        END IF
```

```
        IF (RDFLAG.EQV..TRUE.) THEN                          ! Redstone uses
          DO I=1,4                                           ! end RecSize
            READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) TEMP(I)
          END DO
          IOFF=IOFF+(I-1)
        END IF

      END DO

C Close the input file
   90 CLOSE(1)
      GOTO 100

   99 PRINT '("ERROR: OPEN FILE, IOSTAT: ",I6)', IOS

  100 STOP
      END

C-----------------------------------------------------------------------
C     This Subroutine will print the AOIPS Label Record
C-----------------------------------------------------------------------
      SUBROUTINE PRAOIP(BUFF, IRECLN, NPIX)

      CHARACTER     BUFF(512)                        ! Buffer for record block
      CHARACTER     ASC*512                          ! Buffer for ascii label
      INTEGER*2     I2SWAP                           ! Function swaps short ints
      INTEGER*4     I4SWAP                           ! Function swaps long ints

      DO I = 1,512
        ASC(I:I) = CHAR(IEBC(ICHAR(BUFF(I))))        ! EBCDIC encoded text
      END DO

      PRINT '("===== AOIPS LABEL =====")'
      PRINT '("ImageName  =",X,A8)', ASC(1:8)
      PRINT '("ParentName =",X,A8)', ASC(9:16)
      PRINT '("MasterName =",X,A8)', ASC(17:24)
      PRINT '("TapeNumber =",X,A8)', ASC(25:32)
      PRINT '("UserID     =",X,A4)', ASC(33:36)
      PRINT '("Scan1Date  =",4(X,I4.4))', I2SWAP(BUFF( 37:38)),
     + I2SWAP(BUFF( 39:40)), I2SWAP(BUFF( 41:42)), I2SWAP(BUFF( 43:44))
      PRINT '("AccessCode = ",I5)', I2SWAP(BUFF( 45:46))
      PRINT '("ApplicatID = ",I5)', I2SWAP(BUFF( 47:48))
      PRINT '("DsetRefNum = ",I5)', I2SWAP(BUFF( 49:50))
      PRINT '("SeqNum     = ",I5)', I2SWAP(BUFF( 51:52))
      PRINT '("LabelType  = ",I5)', I2SWAP(BUFF( 53:54))
      PRINT '("FileFormat = ",I5)', I2SWAP(BUFF( 55:56))
      PRINT '("ExchFormat = ",A4)', ASC(57:60)
      PRINT '("PixlFormat = ",I5)', I2SWAP(BUFF( 61:62))
      PRINT '("ImgFileNum = ",I5)', I2SWAP(BUFF( 63:64))
      IRECLN = I2SWAP(BUFF( 65:66))
      PRINT '("RecLength  = ",I5)', IRECLN
      PRINT '("NumRecords = ",I5)', I2SWAP(BUFF( 67:68))
      PRINT '("LftEdgFill = ",I5)', I2SWAP(BUFF( 69:70))
      PRINT '("TopEdgFill = ",I5)', I2SWAP(BUFF( 71:72))
      NPIX   = I2SWAP(BUFF( 73:74))
      PRINT '("NumPixels  = ",I5)', NPIX
      PRINT '("NumLines   = ",I5)', I2SWAP(BUFF( 75:76))
```

```
      PRINT '("IStartPixl = ",I5)', I2SWAP(BUFF( 77:78))
      PRINT '("IStartLine = ",I5)', I2SWAP(BUFF( 79:80))
      PRINT '("PStartPixl = ",I5)', I2SWAP(BUFF( 81:82))
      PRINT '("PStartLine = ",I5)', I2SWAP(BUFF( 83:84))
      PRINT '("PixlZoom   = ",I5)', I2SWAP(BUFF( 85:86))
      PRINT '("LineZoom   = ",I5)', I2SWAP(BUFF( 87:88))
      PRINT '("PixlSclNmr = ",I5)', I2SWAP(BUFF( 89:90))
      PRINT '("PixlSclDen = ",I5)', I2SWAP(BUFF( 91:92))
      PRINT '("LineSclNmr = ",I5)', I2SWAP(BUFF( 93:94))
      PRINT '("LineSclDen = ",I5)', I2SWAP(BUFF( 95:96))
      PRINT '("PixlOffset = ",I5)', I2SWAP(BUFF( 97:98))
      PRINT '("LineOffset = ",I5)', I2SWAP(BUFF( 99:100))
c     PRINT '("Unused1    = ",3(X,I5))', I2SWAP(BUFF(101:102)),
c    + I2SWAP(BUFF(103:104)), I2SWAP(BUFF(105:106)),
      PRINT '("Max2ryRecs = ",I5)', I2SWAP(BUFF(107:108))
      PRINT '("Len2ryRecs = ",I5)', I2SWAP(BUFF(109:110))
      PRINT '("LineDocLen = ",I5)', I2SWAP(BUFF(111:112))
c     PRINT '("Unused2    = ",3(X,I5))', I2SWAP(BUFF(113:114)),
c    + I2SWAP(BUFF(115:116)), I2SWAP(BUFF(117:118)),
      PRINT '("ProgID     = ",I5)', I2SWAP(BUFF(119:120))
      PRINT '("ProgVerID  = ",I5)', I2SWAP(BUFF(121:122))
c     PRINT '("Unused3    = ",35(X,I5))', I2SWAP(BUFF(123:124)),
c    + I2SWAP(BUFF(125:126)), I2SWAP(BUFF(127:128)),
c    +  ...
c    + I2SWAP(BUFF(189:190)), I2SWAP(BUFF(191:192))
      PRINT '("BandCode   = ",I5)', I2SWAP(BUFF(193:194))
      PRINT '("PixlWidth  = ",I5)', I2SWAP(BUFF(195:196))
      PRINT '("LineHeight = ",I5)', I2SWAP(BUFF(197:198))
      PRINT '("NumOABlks  = ",I5)', I2SWAP(BUFF(199:200))
      PRINT '("FileIRCal  = ",I5)', I2SWAP(BUFF(201:202))
      PRINT '("ScaleTable = ",I5)', I2SWAP(BUFF(203:204))
      PRINT '("DSCL       = ",I5)', I4SWAP(BUFF(205:208))
      PRINT '("KSCL       = ",I5)', I4SWAP(BUFF(209:212))
      DO I=0,1
        PRINT '("------ OA Block ",I1," -----")', I+1
        PRINT '("Date       = ",I10)', I4SWAP(BUFF(213+I*64:216+I*64))
        PRINT '("Time       = ",I10)', I4SWAP(BUFF(217+I*64:220+I*64))
        PRINT '("AttID      = ",I10)', I4SWAP(BUFF(221+I*64:224+I*64))
        PRINT '("Lat        = ",I10)', I4SWAP(BUFF(225+I*64:228+I*64))
        PRINT '("Lon        = ",I10)', I4SWAP(BUFF(229+I*64:232+I*64))
        PRINT '("Height     = ",I10)', I4SWAP(BUFF(233+I*64:236+I*64))
        PRINT '("RASpinAxs  = ",I10)', I4SWAP(BUFF(237+I*64:240+I*64))
        PRINT '("DecSpinAxs = ",I10)', I4SWAP(BUFF(241+I*64:244+I*64))
        PRINT '("SpinPeriod = ",I10)', I4SWAP(BUFF(245+I*64:248+I*64))
        PRINT '("RAPosVect  = ",I10)', I4SWAP(BUFF(249+I*64:252+I*64))
        PRINT '("XPosVect   = ",I10)', I4SWAP(BUFF(253+I*64:256+I*64))
        PRINT '("YPosVect   = ",I10)', I4SWAP(BUFF(257+I*64:260+I*64))
        PRINT '("ZPosVect   = ",I10)', I4SWAP(BUFF(261+I*64:264+I*64))
        PRINT '("XVelVect   = ",I10)', I4SWAP(BUFF(265+I*64:268+I*64))
        PRINT '("YVelVect   = ",I10)', I4SWAP(BUFF(269+I*64:272+I*64))
        PRINT '("ZVelVect   = ",I10)', I4SWAP(BUFF(273+I*64:276+I*64))
      END DO

      RETURN
      END
```

```
C-----------------------------------------------------------------------
C     This Subroutine will print the IPD Label Record
C-----------------------------------------------------------------------
      SUBROUTINE PRIPDL(BUFF)

      CHARACTER     BUFF(149)                        ! Buffer for record block
      CHARACTER     ASC*149                          ! Buffer for ascii label

      DO I = 1,149
        ASC(I:I) = CHAR(IEBC(ICHAR(BUFF(I))))        ! EBCDIC encoded text
      END DO

      PRINT '("====== IPD LABEL ======")'
      PRINT '("IntlCode   = ",A7)', ASC(1:7)
      PRINT '("DateRecd   = ",A6)', ASC(9:14)
      PRINT '("Station    = ",A3)', ASC(16:18)
      PRINT '("TapeDeckID = ",A1)', ASC(20:20)
      PRINT '("TapeNum    = ",A6)', ASC(22:27)
      PRINT '("TapeStart  = ",A4)', ASC(29:32)
      PRINT '("TapeStop   = ",A4)', ASC(34:37)
      PRINT '("DigitzDate = ",A6)', ASC(39:44)
      PRINT '("PicSectNo  = ",A1)', ASC(46:46)
      PRINT '("BuffReelNo = ",A1)', ASC(48:48)
      PRINT '("BuffFileNo = ",A1)', ASC(50:50)
      PRINT '("BuffSectNo = ",A1)', ASC(52:52)
      PRINT '("Pass2Line  = ",A2)', ASC(54:55)
      PRINT '("PredReelNo = ",A1)', ASC(57:57)
      PRINT '("PredFileNo = ",A1)', ASC(59:59)
      PRINT '("PredSectNo = ",A1)', ASC(61:61)
      PRINT '("MDTReelNo  = ",A1)', ASC(63:63)
      PRINT '("MDTFileNo  = ",A1)', ASC(65:65)
      PRINT '("MDTSectNo  = ",A1)', ASC(66:67)
      PRINT '("StartDay   = ",A3)', ASC(69:71)
      PRINT '("StartTime  = ",A6)', ASC(72:77)
      PRINT '("StopTime   = ",A6)', ASC(79:84)
      PRINT '("ElapTime   = ",A4)', ASC(86:89)
      PRINT '("DataMode   = ",A1)', ASC(91:91)
      PRINT '("IRDataFlag = ",A1)', ASC(93:93)
      PRINT '("InitLineNo = ",A4)', ASC(95:98)
      PRINT '("LastLineNo = ",A4)', ASC(100:103)
      PRINT '("DECOMRun   = ",A5)', ASC(105:109)
      PRINT '("DECOMReel  = ",A2)', ASC(111:112)
      PRINT '("DECOMFile  = ",A1)', ASC(114:114)
      PRINT '("DECOMSect  = ",A2)', ASC(115:116)
      PRINT '("PctDatRcov = ",A3)', ASC(118:120)
      PRINT '("TelemFlag  = ",A1)', ASC(122:122)
      PRINT '("GMTFlag    = ",A1)', ASC(124:124)
      PRINT '("CreateDate = ",A5)', ASC(126:130)
      PRINT '("TapeID     = ",A1)', ASC(132:132)
      PRINT '("StartPixel = ",A4)', ASC(134:137)
      PRINT '("SectSzCode = ",A1)', ASC(139:139)
      PRINT '("SclTblID   = ",A4)', ASC(141:144)
      PRINT '("SclTblDate = ",A5)', ASC(145:149)

      RETURN
      END
```

```
C-----------------------------------------------------------------------
C     This Subroutine will print the Telemetry Data Record
C-----------------------------------------------------------------------
      SUBROUTINE PRTREC(BUFF, M)

      CHARACTER     BUFF(720)                        ! Buffer for Record Block
      INTEGER*2     TFRAME(40,16)                    ! Telemtry Frame Array

C     THERE ARE 16 TELEMETRY FRAMES OF 40 9-BIT WORDS PER FRAME
      DO N=1,720,9
        I = (N-1)/45+1
        J = MOD(N/9*8,40)+1
        TFRAME(J+0,I) = ISHFT(IAND(ICHAR(BUFF(N+0)),'FF'Z),1)+
     +                  ISHFT(ICHAR(BUFF(N+1)),-7)
        TFRAME(J+1,I) = ISHFT(IAND(ICHAR(BUFF(N+1)),'7F'Z),2)+
     +                  ISHFT(ICHAR(BUFF(N+2)),-6)
        TFRAME(J+2,I) = ISHFT(IAND(ICHAR(BUFF(N+2)),'3F'Z),3)+
     +                  ISHFT(ICHAR(BUFF(N+3)),-5)
        TFRAME(J+3,I) = ISHFT(IAND(ICHAR(BUFF(N+3)),'1F'Z),4)+
     +                  ISHFT(ICHAR(BUFF(N+4)),-4)
        TFRAME(J+4,I) = ISHFT(IAND(ICHAR(BUFF(N+4)),'0F'Z),5)+
     +                  ISHFT(ICHAR(BUFF(N+5)),-3)
        TFRAME(J+5,I) = ISHFT(IAND(ICHAR(BUFF(N+5)),'07'Z),6)+
     +                  ISHFT(ICHAR(BUFF(N+6)),-2)
        TFRAME(J+6,I) = ISHFT(IAND(ICHAR(BUFF(N+6)),'03'Z),7)+
     +                  ISHFT(ICHAR(BUFF(N+7)),-1)
        TFRAME(J+7,I) = ISHFT(IAND(ICHAR(BUFF(N+7)),'01'Z),8)+
     +                  ISHFT(ICHAR(BUFF(N+8)),-0)
      END DO

      PRINT '("===== TELEM REC ",I2," ====")', M
      DO I=1,16
        PRINT '("Frame ",I2,"   =",17(X,I3))',I,TFRAME(1:17,I)
        PRINT '(20(X,I3))',TFRAME(18:40,I)
      END DO

      RETURN
      END

C-----------------------------------------------------------------------
C     This Subroutine will print the Image Data Record
C-----------------------------------------------------------------------
      SUBROUTINE PRIREC(BUFF, IRECLN, NPIX, M)

      CHARACTER     BUFF(IRECLN)                     ! Buffer for record block
      INTEGER*2     IMDATA(NPIX)                     ! Image Scan line data
      INTEGER*2     IDFLAG(4)                        ! Data Flags
      INTEGER*2     I2SWAP                           ! Function swaps short ints
      INTEGER*4     I4SWAP                           ! Function swaps long ints

C     No. Pixels depends on IR/IRG(normal)=976, IR/IRG(global)=3822, or VIS=3904
      PRINT '("==== IMAGE REC ",I4," ===")', M
      PRINT '("Pixel Data = ")'
      DO N=1,NPIX
        IMDATA(N) = ICHAR(BUFF(N))
      END DO
      PRINT '(16(X,I4))', IMDATA
```

```
C     IR DOCUMENTATION
      IF (ISHFT(ICHAR(BUFF(NPIX+1)),-7).EQ.1) THEN
        CALL PRIDOC(BUFF(NPIX+1:NPIX+256))
      END IF

C     GMT FLYWHEEL TIME
      PRINT '("DayOfYear  = ",I8)', I2SWAP(BUFF(NPIX+256+1:NPIX+256+2))
      PRINT '("MilliSecs  = ",I8)', I4SWAP(BUFF(NPIX+258+1:NPIX+258+4))

C     FLAGS (12 BITS): F1 = PREEDIT DATA FLAGS, F2 = MDT DATA FLAGS
C                      F3 = IMAGE LINE NUMBER,  F4 = SCAN LINE NUMBER
      IDFLAG(1) = ISHFT(ICHAR(BUFF(NPIX+262+1)),4)+
     +            ISHFT(ICHAR(BUFF(NPIX+262+2)),-4)
      IDFLAG(2) = ISHFT(IAND(ICHAR(BUFF(N+262+2)),'0F'Z),8)+
     +            ICHAR(BUFF(NPIX+262+3))
      IDFLAG(3) = ISHFT(ICHAR(BUFF(NPIX+262+4)),4)+
     +            ISHFT(ICHAR(BUFF(NPIX+262+5)),-4)
      IDFLAG(4) = ISHFT(IAND(ICHAR(BUFF(NPIX+262+5)),'0F'Z),8)+
     +            ICHAR(BUFF(NPIX+262+6))
      PRINT '("DataFlags  =",4(X,I4))', IDFLAG

      RETURN
      END

C-----------------------------------------------------------------------
C     This Subroutine will print the IR Documentation
C-----------------------------------------------------------------------
      SUBROUTINE PRIDOC(BUFF)

      CHARACTER     BUFF(256)                        ! Buffer for record block
      INTEGER*2     IRDOC(128)                       ! IR Documentation
      INTEGER*4     OABLK(6)                         ! Orbit/Attitude Block
      INTEGER*4     ITMP

C Convert to 16-Bit Integers
      DO I=1,128
        IRDOC(I) = ISHFT(IAND(ICHAR(BUFF(2*I-1)),'01'Z),8)+
     +             ICHAR(BUFF(2*I))
      END DO
C Orbit/Attitude Block are in 32-Bit Integers
      DO I=1,6
        ITMP = IRDOC(100+4*I-3)
        ITMP = IRDOC(100+4*I-2)+ISHFT(ITMP,8)
        ITMP = IRDOC(100+4*I-1)+ISHFT(ITMP,8)
        ITMP = IRDOC(100+4*I-0)+ISHFT(ITMP,8)
        OABLK(I) = ITMP
      END DO

      PRINT '("---- IR Doc ----")'
      PRINT '("Retrace    =",X,I3)', IRDOC(1)
      PRINT '("Spacecraft =",X,I3)', IRDOC(2)
C     PRINT '("Unused     =",X,I3)', IRDOC(3)
      PRINT '("FrameCode  =",X,I3)', IRDOC(4)
      PRINT '("ChangeCode =",X,I3)', IRDOC(5)
      PRINT '("StepCode   =",X,I3)', IRDOC(6)
      PRINT '("LineDelay  =",X,I3)', IRDOC(7)
```

```
      PRINT '("IRSelect   =",X,I3)', IRDOC(8)
      PRINT '("GrySclStat =",X,I3)', IRDOC(9)
      PRINT '("XmitMode   =",X,I3)', IRDOC(10)
      PRINT '("ImgLineNo  =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(11),-4),'0F'Z),IAND(IRDOC(11),'0F'Z),
     +  IAND(ISHFT(IRDOC(12),-4),'0F'Z),IAND(IRDOC(12),'0F'Z)
      PRINT '("ModeCount  =",I3)', IRDOC(13)
      PRINT '("BetaCount  =",3(X,I3))', IRDOC(14:16)
      PRINT '("GridNoGrid =",X,I3)', IRDOC(17)
      PRINT '("SyncError  =",2(X,I3))', IRDOC(18:19)
      PRINT '("BitErrCnt  =",2(X,I3))', IRDOC(20:21)
      PRINT '("SetupError =",X,I3)', IRDOC(22)
      PRINT '("CompError  =",2(X,I3))', IRDOC(23:24)
      PRINT '("ScanCount  =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(25),-4),'0F'Z),IAND(IRDOC(25),'0F'Z),
     +  IAND(ISHFT(IRDOC(26),-4),'0F'Z),IAND(IRDOC(26),'0F'Z)
      PRINT '("XmitMode   =",X,I3)', IRDOC(10)
      PRINT '("ImgLineNo  =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(11),-4),'0F'Z),IAND(IRDOC(11),'0F'Z),
     +  IAND(ISHFT(IRDOC(12),-4),'0F'Z),IAND(IRDOC(12),'0F'Z)
      PRINT '("ModeCount  =",I3)', IRDOC(13)
      PRINT '("BetaCount  =",3(X,I3))', IRDOC(14:16)
      PRINT '("GridNoGrid =",X,I3)', IRDOC(17)
      PRINT '("SyncError  =",2(X,I3))', IRDOC(18:19)
      PRINT '("BitErrCnt  =",2(X,I3))', IRDOC(20:21)
      PRINT '("SetupError =",X,I3)', IRDOC(22)
      PRINT '("CompError  =",2(X,I3))', IRDOC(23:24)
      PRINT '("ScanCount  =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(25),-4),'0F'Z),IAND(IRDOC(25),'0F'Z),
     +  IAND(ISHFT(IRDOC(26),-4),'0F'Z),IAND(IRDOC(26),'0F'Z)
      PRINT '("CorrYear   =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(27),-4),'0F'Z),IAND(IRDOC(27),'0F'Z),
     +  IAND(ISHFT(IRDOC(28),-4),'0F'Z),IAND(IRDOC(28),'0F'Z)
      PRINT '("CorrDay    =",4(X,I3))',
     +  IAND(ISHFT(IRDOC(29),-4),'0F'Z),IAND(IRDOC(29),'0F'Z),
     +  IAND(ISHFT(IRDOC(30),-4),'0F'Z),IAND(IRDOC(30),'0F'Z)
      PRINT '("CorrHour   =",2(X,I3))',
     +  IAND(ISHFT(IRDOC(31),-4),'0F'Z),IAND(IRDOC(31),'0F'Z)
      PRINT '("CorrMin    =",2(X,I3))',
     +  IAND(ISHFT(IRDOC(32),-4),'0F'Z),IAND(IRDOC(32),'0F'Z)
      PRINT '("CorrSec    =",2(X,I3))',
     +  IAND(ISHFT(IRDOC(33),-4),'0F'Z),IAND(IRDOC(33),'0F'Z)
      PRINT '("CorrMSec   =",2(X,I3))',
     +  IAND(ISHFT(IRDOC(34),-4),'0F'Z),IAND(IRDOC(34),'0F'Z)
      PRINT '("BlkEnable  =",X,I3)', IRDOC(35)
      PRINT '("ModeC_Cal  =",X,I3)', IRDOC(36)
      PRINT '("BFSyncLock =",X,I3)', IRDOC(37)
      PRINT '("LimScnMode =",X,I3)', IRDOC(38)
      PRINT '("SmpScnMode =",X,I3)', IRDOC(39)
      PRINT '("VisChCnnct =",X,I3)', IRDOC(40)
      PRINT '("ScanDir    =",X,I3)', IRDOC(41)
      PRINT '("BiPhaseMod =",X,I3)', IRDOC(42)
C     PRINT '("Unused     =",X,I3)', IRDOC(43)
      PRINT '("PLLError   =",X,I3)', IRDOC(44)
      PRINT '("TestData   =",X,I3)', IRDOC(45)
      PRINT '("DataRandom =",X,I3)', IRDOC(46)
      PRINT '("SunPulsSel =",X,I3)', IRDOC(47)
```

```
      PRINT '("NessMode   =",X,I3)', IRDOC(48)
      PRINT '("LimScnCmd  =",X,I3)', IRDOC(49)
      PRINT '("DigSunPuls =",X,I3)', IRDOC(50)
      PRINT '("BitErrLght =",X,I3)', IRDOC(51)
      PRINT '("MeanIRDiff =",X,I3)', IRDOC(52)
      PRINT '("RMSIRDiff  =",X,I3)', IRDOC(53)
      PRINT '("CorrectTbl =",X,I6)', ISHFT(IRDOC(54),8)+IRDOC(55)
      PRINT '("LfHorizPt  =",X,I6)', ISHFT(IRDOC(56),8)+IRDOC(57)
      PRINT '("RtHorizPt  =",X,I6)', ISHFT(IRDOC(58),8)+IRDOC(59)
      PRINT '("EqScanCnt  =",X,I6)', ISHFT(IRDOC(60),8)+IRDOC(61)
C     PRINT '("Unused     =",2(X,I3))', IRDOC(62:79)
      PRINT '("TelemCode  =",X,I3)', IRDOC(80)
      PRINT '("QtrTelem   =",18(X,I3))', IRDOC(81:98)
      PRINT '("OABlkNum   =",X,I3)', IRDOC(99)
      PRINT '("QtrNum     =",X,I3)', IRDOC(100)
      PRINT '("OABlock    =",6(X,I10))', OABLK
C     PRINT '("Unused     =",3(X,I3))', IRDOC(125:127)
      PRINT '("LonParChk  =",X,I3)', IRDOC(128)
      PRINT '("----------------")'

      RETURN
      END

C-----------------------------------------------------------------------
C     This Function returns EBCDIC to ASCII character index
C-----------------------------------------------------------------------
      FUNCTION IEBC(I)

      INTEGER   EBCTBL(256)

      DATA EBCTBL /
     + 000,001,002,003,255,009,255,127,255,255,255,011,012,013,014,015, ! 0_
     + 016,017,018,019,255,133,008,255,024,025,255,255,028,029,030,031, ! 1_
     + 255,255,255,255,255,010,023,027,255,255,255,255,255,005,006,007, ! 2_
     + 255,255,022,255,255,255,255,004,255,255,255,255,020,021,255,026, ! 3_
     + 032,255,255,255,255,255,255,255,255,255,162,046,060,040,043,124, ! 4_
     + 038,255,255,255,255,255,255,255,255,255,033,036,042,041,059,172, ! 5_
     + 045,047,255,255,255,255,255,255,255,255,166,044,037,095,062,063, ! 6_
     + 255,255,255,255,255,255,255,255,255,096,058,035,064,039,061,034, ! 7_
     + 255,097,098,099,100,101,102,103,104,105,255,255,255,255,255,177, ! 8_
     + 255,106,107,108,109,110,111,112,113,114,255,255,255,255,255,255, ! 9_
     + 255,126,115,116,117,118,119,120,121,122,255,255,255,255,255,255, ! a_
     + 094,255,255,255,255,255,255,255,255,255,091,093,255,255,255,255, ! b_
     + 123,065,066,067,068,069,070,071,072,073,255,255,255,255,255,255, ! c_
     + 125,074,075,076,077,078,079,080,081,082,255,255,255,255,255,255, ! d_
     + 092,255,083,084,085,086,087,088,089,090,255,255,255,255,255,255, ! e_
     + 048,049,050,051,052,053,054,055,056,057,255,255,255,255,255,159/ ! f_
C       _0  _1  _2  _3  _4  _5  _6  _7  _8  _9  _A  _B  _C  _D  _E  _F

      IEBC = EBCTBL(I+1)

      RETURN
      END
```

```
C-----------------------------------------------------------------------
C ^FUNCTION: I2SWAP
C
C     This function will swap the bytes of a 2-byte word
C-----------------------------------------------------------------------

      INTEGER*2 FUNCTION I2SWAP(BUFF)

      CHARACTER          BUFF(2)        ! Input data buffer
      CHARACTER          TEMP(2)        ! Output swapped buffer
      INTEGER*2          I2BUFF
      EQUIVALENCE        (TEMP, I2BUFF)

      TEMP(1) = BUFF(2)
      TEMP(2) = BUFF(1)
      I2SWAP = I2BUFF

      RETURN
      END

C-----------------------------------------------------------------------
C ^FUNCTION: I4SWAP
C
C     This function will swap the bytes of a 4-byte word
C-----------------------------------------------------------------------

      INTEGER*4 FUNCTION I4SWAP(BUFF)

      CHARACTER          BUFF(4)        ! Input data buffer
      CHARACTER          TEMP(4)        ! Output swapped buffer
      INTEGER*4          I4BUFF
      EQUIVALENCE        (TEMP, I4BUFF)

      TEMP(1) = BUFF(4)
      TEMP(2) = BUFF(3)
      TEMP(3) = BUFF(2)
      TEMP(4) = BUFF(1)
      I4SWAP = I4BUFF

      RETURN
      END
```