AD2-EOC-96-123

ADEOS-II to Ground Station Interface Document

Version 1.0 (Draft B)

October 1999

NASDA

NATIONAL SPACE DEVELOPMENT AGENCY OF JAPAN

ADEOS-II to Ground Station Interface Document

Approved by:

NASDA/Earth Observation System Engineering Department
ADEOS-II Project Manager

NASDA/Earth Observation System Engineering Department
ADEOS-II Ground Segment Project Manager

ADEOS-II to Ground Station Interface Document

Revision History

Version	Date	Update Page	Comment
Draft	Dec. 1996		First draft
Draft 1.0	July 1997	6-1	Add section 6
Draft 2.0	Nov. 1997	through the document	Reflect NASA comments Add Kiruna station as a concerned agency of this document Delete the description related to S band Update attitude stability requirements Update antenna pattern Update link budget analysis Add explanation of bit stream of output data Delete section 7 Add appendix C
Draft 2.1	July 1998	2-2	Update the launch date
		2-2 to 2-4	Change the expression of attitude accuracy and stability
		2-6	Delete COMETS
		5-1	Add a new operation constraint by VMS
		5-2	Update the X band data transfer characteristic
		5-3 to 5-6	Update the X band antenna patterns
		5-7	Add detailed explanation about encoding and decoding scheme
		5-9	Add notes
		A-1, A-2, A-4, A-7	Reflect format changes based on adding of VMS and DMS
		C-1	Add DMS
		C-2	Add VMS
		2-4, 3-3, 4-1, B-1, B-5, B-6, B-8, B-9, B-10	Correct misprints
1.0 (Draft)	Feb. 1999	2-2, 2-6	Add DMS and VMS
		2-2	Correct period of nominal orbit
		2-3	Update attitude stability for GLI
		2-3	Update attitude determination accuracy
		2-4	Correctly describe attitude accuracy for maneuvering
		3-1	Correctly describe data rate of AMSR
		3-2	Correctly describe data rate of GLI

Version	Date	Update Page	Comment
		4-1	Update of recording capacity and BER of ODR
		5-1	Correct misprint
		6-1	Update period of PN data transmission during a downlink segment
1.0 (Draft A)	Feb. 1999	2-3	Reword
		2-5	Correct misprints
		5-2	Update X1 bandwidth
		5-2	Specify H/W degradation about X band carrier
		5-2	Delete spec. values of EIRP
		5-7	Add explanation
		5-9	Add notes
		A-7	Correct misprints
		C-1	Delete COMETS
1.0 (Draft B)	Oct. 1999	2-1	Correct swath width of SeaWinds and POLDER.
		2-1	Correct observation time of ILAS-II.
		3-2/Table 3.1-2	Describe GLI 6km mode characteristics.
		6-1/Fig. 6-1	Update the X band downlink operation scenario.

Contents

ADEOS-II to Ground Station Interface Document

1 General

1.1 Purpose

This document provides the Kiruna station, the NASA ground stations and NOAA/NESDIS with the interface conditions necessary to receive and record mission data from ADEOS-II via X-band.

1.2 Scope

This document could be applied to design the systems of the Kiruna station, the NASA ground stations and NOAA/NESDIS which handle ADEOS-II mission data.

1.3 Approval Authority and Change Control

This document is approved by both signatures of the ADEOS-II project and the ADEOS-II ground segment project managers from Earth Observation System Engineering Department, NASDA.

This document will be issued and maintained by NASDA. Changes of this document will be immediately informed to the Kiruna station, the NASA ground stations and NOAA/NESDIS using ADEOS-II Operation Coordination Letter (OCL).

2 System Characteristic Summary

2.1 ADEOS-II Mission

ADEOS-II which is the successor to the ADEOS mission will take an active part in research of the global climate changes, practical utilization for weather phenomena, fishery, etc., such as seizing the mechanism of global environmental changes including global warming.

(1) AMSR (Advanced Microwave Scanning Radiometer)
AMSR is a passive microwave radiometer to acquire radiance data on scanning the Earth's surface conically by antenna rotation along the satellite flight path. It will globally observe sea surface temperature, sea surface wind, precipitation, water vapor content, sea ice, water equivalent of clouds, snow cover, atmospheric temperature, etc. with a swath width of 1600 km.

(2) GLI (Global Imager)
GLI is an optical sensor aiming at observing globally ocean color, sea surface temperature, vegetation distribution, snow, snow and ice, etc. with a swath width of 1600 km by mechanically scanning in the cross-track direction.

(3) SeaWinds (Sea Winds)
SeaWinds is an active microwave radar which radiates and receives microwave pulses. It observes wind speed and direction measurements over global ocean with a swath width of ~~1400~~ 1800 km by conical scanning of the antenna.

(4) POLDER (Polarization and Directionality of the Earth's Reflectances)
POLDER is an optical sensor to observe the polarization, directional and spectral characteristics of the solar light reflected by aerosols, clouds, oceans and land surfaces. It observes shortwave radiation, albedo, reflection characteristic, and the primary products with a FOV of ±43° (along track) and ±51° (cross track), with a swath width of ~~1440×~~1800×~~1920~~ 2400 km. It operates in the range of that sun zenith angle is less than 75 degrees.

(5) ILAS-II (Improved Limb Atmospheric Spectrometer-II)
ILAS-II is a spectrometer which observes the atmospheric limb absorption spectrum using sunlight as a light source (solar occultation technique). It measures the vertical profile of ozone, CO_2, CH_4, H_2O and aerosols. It operates for ~~15~~ 12 minutes at sunset and at sunrise.

(6) DCS (Data Collection System)
DCS is a system to collect ground truth data and determine the locations of Data Collection Platforms(DCPs) using DCPs which are simple transmitter on ground and onboard transponder.

(7) TEDA (Technical Engineering Data Acquisition equipment)
TEDA is a sensor to measure space environment and consists of the following three sensors:

- DOM to monitor spatial distribution and transition of radiation intensity of the electron, proton, α particle and heavy particle;
- SUM to monitor occurrence frequency of software errors in a memory element or in a micro processor caused by heavy ionic particle and proton;
- DOS/DOS-S to monitor accumulation volume of radiation absorption at both outside and inside of the spacecraft.

(8) ODR (Optical Disk Data Recorder)
ODR is a recorder of the optical disc type which will be used for experiments on recording and reproducing of the high data rate and large volume data.

(9) VMS (Visual Monitoring System)
VMS is a CCD camera system to monitor unfolding behaviors and other routine actions of ADEOS-II on-orbit.

(10) DMS (Dynamics Monitoring System)
DMS is an experimental system to monitor dynamic behavior of ADEOS-II on-orbit, which mainly consists of accelerometers and star tracker.

2.2 Launch Date

ADEOS-II will be launched in November (TBD) 2000.

2.3 Mission Period

The period of ADEOS-II mission is 3 years after the launch (5 years goal).

2.4 Orbit

The nominal parameters of the ADEOS-II orbit are as follows:

Table 2.4-1 ADEOS-II Nominal Orbit Parameters

(1) Orbit Category	Sun-Synchronous Sub-Recurrent Orbit
(2) Local Sun Time at Descending Node	10:30 am. ± 15 min.
(3) Revolution Number	14 + 1/4 rev/day
(4) Recurrent Period	4 days
(5) Movement Direction	East
(6) Orbit Altitude above Equator	802.92 km
(7) Orbital Inclination	98.62 degrees
(8) Period	Approx. 101 minutes
(9) Revolution Number in a Recurrence Period	57 revolutions
(10) Minimum Distance between Orbits (above equator)	728.62 km

2.5 Orbit Maneuvering and Repeat Track Maintenance

ADEOS-II spacecraft will be maneuvered to keep the ground track for 5-year mission life.

2.6 Attitude Accuracy and Attitude Stability

(1) Attitude Accuracy
The spacecraft attitude accuracy under regular attitude control is as follows:

Table 2.6-1 Attitude Accuracy (3σ)

Roll	± 0.3 (deg)
Pitch	± 0.3 (deg)
Yaw	± 0.3 (deg)

(2) Attitude Stability
The spacecraft attitude stability under regular attitude control is required to meet the requirements from each sensor observation shown in Table 2.6-2:

Table 2.6-2 Requirements on the Attitude Stability from Sensors

Sensor	Requirements on Attitude Accuracy [deg] p-p	Reference Imaging Time [sec]
AMSR	RX: 0.047 RY: 0.018 RZ: 0.044	3.0
GLI	0.0215	1.79
	RX: 1.85E-04 RY: 1.432E-04 RZ: 2.40E-04	17.95E-04
SeaWinds	0.1	3.33
	0.01	6.00E-03
ILAS-II	5.56E-04	3.33E-02

NB-1) These values are not applicable in the following cases:
- While starting and stopping AMSR antenna drive subsystem;
- While starting and stopping GLI scan mirror;
- While starting and stopping ODR;
- While starting and stopping MDR;
- While maneuvering;
- While being interfered of the Earth sensor by the moon.

(3) Attitude Determination Accuracy

Table 2.6-3 Attitude Determination Accuracy (3 s)

Existing Navigation System (backup method in case of GPS anomaly)	Roll: ± 0.155 (deg) Pitch: ± 0.155 (deg) Yaw: ± 0.175 (deg)
Hybrid Navigation System using GPS data (prime method)	Roll: ± 0.100 (deg) Pitch: ± 0.080 (deg) Yaw: ± 0.140 (deg)

NB) The above values are not applicable while the Earth sensor is interfered by the moon.

(4) Attitude Accuracy during Maneuvering
The spacecraft attitude accuracy during maneuvering is specified as follows:

Table 2.6-4 Requirements on the Attitude Accuracy during Maneuvering

	Roll / Pitch	Yaw
Attitude Accuracy	0 ± 2.0 (deg)	0 ± 3.0 (deg); during 0° ±90 ± 5.0 (deg); ± 90° yaw maneuver +180 ± 5.0 (deg); 180° yaw maneuver

2.7 Mission Instruments

The following table shows the basic specification of ADEOS-II mission instruments:

Table 2.7-1 Mission Instruments Specification

Sensor	Observing Object	Outline of Specification
AMSR (Advanced Microwave Scanning Radiometer)	water vapor content, sea surface temperature, precipitation, sea surface wind, sea ice, etc.	Bands : 8 (6 to 89GHz) Observing Swath : about 1600km Temperature Resolution : 0.3 to 2K Spatial Resolution : 5 to 60km
GLI (Global Imager)	ocean color, sea surface temperature, vegetation, clouds, snow and ice, etc.	Bands : VNIR 23 SWIR 6 MTIR 7 Observing Swath : about 1600km Spatial Resolution : 1 km, 250m
SeaWinds (Sea Winds)	Wind speeds and directions over the ice-free global oceans	Bands : 13.402 GHz Spatial Resolution : 50 km Measurement Accuracy : wind speed 2m/s wind direction 20deg
POLDER (Polarization and Directionality of the Earth's Reflectances)	The polarization, directional and spectral characteristics of the solar light reflected by aerosols, clouds oceans and land surfaces	Bands : 8 Wavelength : 443 to 910nm Observing Swath : ± 51deg
ILAS-II (Improved Limb Atmospheric Spectrometer-II)	The vertical profile of ozone, aerosols, $ClONO_2$, NO_2 at the polar stratospheric	Bands : VIR 1 IR 3 Observing Altitude : 10 to 60km Altitude Resolution : 1km

2.8 Communication Data Flow

ADEOS-II spacecraft block diagram is shown in Figure 2.8-1.
ADEOS-II communication data flow is shown in Figure 2.8-2.

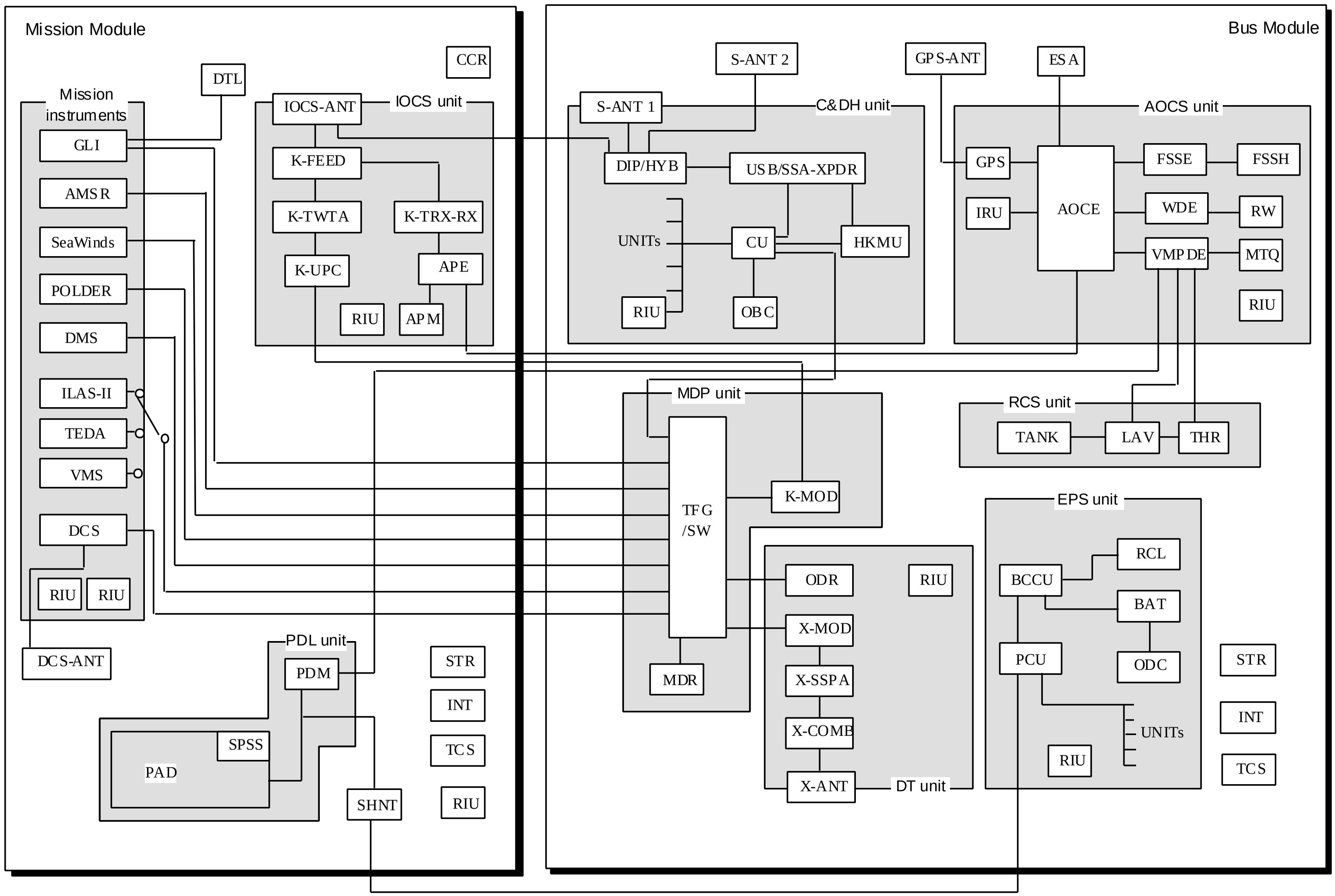


Fig. 2.8-1 ADEOS-II Spacecraft Block Diagram

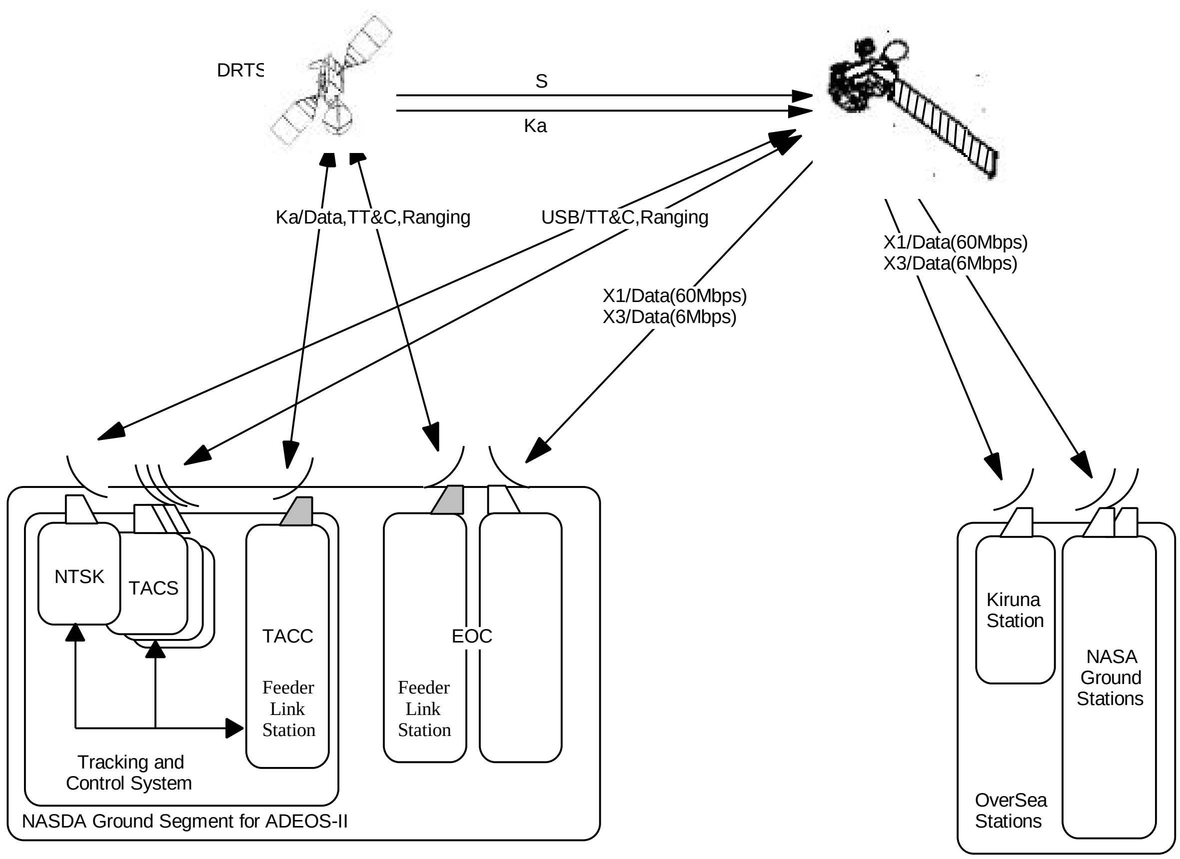


Fig. 2.8-2 ADEOS-II Communication Data Flow

3 Mission Instrument Interfaces

3.1 Characteristics

This section describes the main characteristics of AMSR and GLI sensors. Data from these NASDA sensors are to be processed at NASA/NOAA.

3.1.1 AMSR Characteristics

Table 3.1-1 AMSR Main Characteristics

ITEM	DESCRIPTION				
Frequency	Center (GHz)	Polarization	Band Width (MHz)	Spatial Resolution (km)	Observation Object
	6.925	H & V	350	50	sea surface temperature
	10.65	H & V	100	50	sea surface wind
	18.7	H & V	200	25	precipitation (ocean)
	23.8	H & V	400	25	water vapor content
	36.5	H & V	1000	15	sea ice / water equivalent of clouds / snow cover
	89.0	H & V	3000	5	precipitation (land)
	50.3	V	200	10	atmospheric temperature
	52.8	V	400	10	atmospheric temperature
Swath Width	1600 km				
Observation Duty Cycle	100% (global)				
Revolution	40 rpm				
Quantum Bits	10 bits/pixel (12 bits/pixel for 6 GHz)				
Data Rate	111.09 kbps (Ver. 1 CCSDS packet)				

3.1.2 GLI Characteristics

Table 3.1-2 GLI Main Characteristics

ITEM	DESCRIPTION	
Spectral Range ~~(nm)~~	VNIR (nm)	1km resol.: 380, 400, 412, 443, 460, 490, 520, 545, 565, 625, 666, 680, 678, 710, 710, 749, 763, 865, 865 250m resol.: 460, 545, 660, 825 6 km : 443, 565, 666
	SWIR (nm)	1km resol.: 1050, 1135, 1240, 1380 250m resol.: 1640, 2210
	MTIR (µm)	1km resol.: 3.715, 6.7, 7.3, 7.5, 8.6, 10.8, 12.0 6 km : 12.0
Spatial Resolution	1 km / 250 m 6km (Subsampled data for DTL)	
Swath Width	1600 km	
Observation Duty	VNIR, SWIR : Daytime only MTIR : 100 % (global)	
Quantum Bits	1km, 6km: 12 bits/pixel (+1 bit (ID code of PWL or dummy data) = 13 bits) 250m: 12 bits/pixel	
Data Rate	3.8676 Mbps (1 km) 16 Mbps (250 m, downlink data rate is 60Mbps with dummy data) 23.5294 kbps (6 km)	

3.2 Mission Data Format

This section describes the overview about the data format of the GLI that is a NASDA sensor to be processed from level 0 data by NASA/NOAA. The AMSR data format will be provided by other document because NASA processes AMSR data from a processed data like a level 1 data, not level 0 data.

3.2.1 GLI Data Format

GLI has three types of the data formats depending on the spatial resolution modes, which are 1km Data, 250m Data and 6km Data. GLI 1 km data is multiplexed with other ADEOS-II instruments data on the CCSDS packets format and recorded on mission data recorders (MDR) at 6Mbps. The multiplexed data is also broadcast on the X3 channel as Mission Real Time (MRT) data.

The ADEOS-II CCSDS mission data format is shown in Appendix A.

The number of packets on the 1km data format and the number of lines on the 250m and 6km data formats are synchronous with the scanning cycle of the GLI scanning mirror. Packet spacing (d') of the 1km data format and the length of dummy data of 250m and 6km data formats depend on a deviation of the revolution cycle of the scanning mirror (1.7947sec $\pm$ 400µsec).

(1) 1km Data Format
GLI 1km data format includes following data:

- GLI 1km resolution image data (total 30channels)
- 2km sampling data from 250m resolution image data (total 2channels)
- Calibration data (deep space, blackbody, sunlight or internal lamp)
- PCD (Payload Correction Data)
- ID code of image correction data

The operation modes (Observation mode (day/night), Electrical calibration mode, Internal lamp calibration mode and Solar calibration mode) can be identified by 4bits flagof the GLI operation mode in the first packet and then the valid data can be distinguished in the data format.

The detailed formats of GLI 1km data are shown in Appendix B.

(2) 250m Data Format
GLI 250m data format includes following data:

- GLI 250m resolution image data (total 6channels)
- Calibration data (deep space, sunlight or internal lamp)
- PCD (Payload Correction Data)
- ID code of image correction data

The operation modes (Observation mode (day), Electrical calibration mode, Internal lamp calibration mode and Solar calibration mode) can be identified by 4bits flag and then the valid data can be distinguished in the data format.

The data format specification of GLI 250m data is shown in Table 3.2-1. The GLI 250m output data includes dummy data without frame sync code regularly as illustrated in Fig. 3.2-1.

Table 3.2-1 GLI 250m Data Format Specification

ITEM	DESCRIPTION
Data Rate	30 Mbps x 2 ; (60 Mbps)
Data Format	12 bits / word 446 words / minor frame (valid data : 288 words, except PCD and Correction data) 14120 minor frames / frame (line)
Sync Code Minor Frame Line	 2 words (1101 0010 0001 0101 1101 1000) 2 words (1011 0010 1011 1011 1101 0100)
Encoding Method Power Polynomial Preset Coding Theory	PN coding (except for minor / line sync codes) 15 lines $X^{15} + X^{13} + X^{10} + X^{1} + 1$ all “1” (reset at the beginning of minor frame sync code) EX-OR

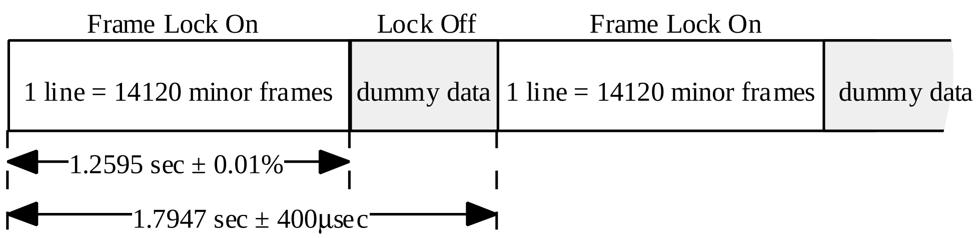


Fig. 3.2-1 GLI 250m Data Output Format

(3) 6km Data Format

GLI 6km coarse image data format includes following data:

- GLI 6km resolution image data (total 4channels)
- Calibration data (deep space, blackbody, and sunlight or internal lamp)
- PCD (Payload Correction Data)
- ID code of image correction data

The operation modes (Observation mode (day/night), Electrical calibration mode, Internal lamp calibration mode and Solar calibration mode) can be identified by 4bits flag and then the valid data can be distinguished in the data format.

Data format specification of GLI 6km data is as follows:

Table 3.2-2 GLI 6km Data Format Specification

ITEM	DESCRIPTION
Data Rate	23.5294 kbps
Data Format	13 bits / word 145 words / minor frame 19 minor frames / frame (line)
Sync Code Minor Frame Line	 1 word (1 1010 0100 0010) 1 word (1 0110 0101 0111)
Encoding Method Power Polynomial Preset Coding Theory	PN coding (except for minor / line sync codes) 11 lines $X^{11} + X^{10} + X^{3} + X^{2} + 1$ all “1” (reset at the beginning of minor frame sync code) EX-OR

4 Mission Data Processing Subsystem Interfaces

4.1 Data Recorder Performance

Table 4.1-1 MDR Performance

ITEM		DESCRIPTION
Data Rate	Recording	I ch: 3 Mbps
		Q ch: 3 Mbps
	Reproducing	I ch: 30 Mbps
		Q ch: 30 Mbps
Recording/Reproducing Time	Recording	longer than 200 min.
	Reproducing	longer than 20 min.
Recording Capacity		7.2 x 10^{10} bits (more than 9 GBytes)
BER		Less than 1 x 10^{-6} at EOL
Tape Speed	Recording	8.7 ips
	Reproducing	87.0 ips
Start/Stop Time	Start Time	6 sec (max.)
	Stop Time	6 sec (max.)
Input/Output Signal Type		NRZ-L
Tape Counter		0 (DEC) (BOT) to 255 (DEC) (EOT)

Table 4.1-2 ODR Performance

ITEM		DESCRIPTION	
Data Rate	Recording	6 Mbps	I ch: 3 Mbps
			Q ch: 3 Mbps
		60 Mbps	I ch: 30 Mbps
			Q ch: 30 Mbps
	Reproducing	I ch: 30 Mbps	
		Q ch: 30 Mbps	
Recording Capacity		3 GB (nominal)	
BER		Less than 1 x 10^{-8}	
Start/Stop Time	Spindle Run-up Time	4 min. to 4 min. 35 sec.	
	Spindle Run-down Time	4 min. to 4 min. 35 sec.	
Seek Time		Less than 1.5 sec. (seek from ready mode)	
Recording/Reproducing Start Time		Less than 100 msec. (recording/reproducing from still condition)	
Recording/Reproducing Address	Address Range	0000 (HEX) to 2ACD (HEX) (TBD)	
	Address Capacity	524.288 kBytes/address	

4.2 MDP Operation Modes

ADEOS-II can set the MDP operation modes as listed in Table 4.2-1. The typical operation scenario over a ground station refers to section 6.

Table 4.2-1 MDP Major Operation Modes (1/2)

	Operation Mode	IOCS				DT				MDR Recording	ODR Recording
		6Mbps Output	60Mbps Output			6Mbps Output	60Mbps Output				
		6Mbps Real	GLI 250m	MDR Reproducing	ODR Reproducing	6Mbps Real	GLI 250m	MDR Reproducing	ODR Reproducing		
Primary Mode (PR)	PR-1	O	O							O	
	PR-2	O	O			O				O	
	PR-3	O	O				O			O	
	PR-4	O	O			O	O			O	
	PR-5					O				O	
	PR-6						O			O	
	PR-7					O	O			O	
	PR-8	O		O						O	
	PR-9	O		O		O				O	
	PR-10	O		O			O			O	
	PR-11	O		O		O	O			O	
	PR-12									O	
Backup Mode (BK)	BK-1									O	(O)
	BK-2					O				O	(O)
	BK-3						O			O	(O)
	BK-4					O	O			O	(O)
	BK-5							O		O	(O)
	BK-6					O		O		O	(O)
Special Mode (SP)	SP-1	O	O							O	O
	SP-2	O	O			O				O	O
	SP-3	O	O				O			O	O
	SP-4	O	O			O	O			O	O
	SP-5	O			O					O	
	SP-6	O			O	O				O	
	SP-7					O				O	O
	SP-8									O	O

Table 4.2-1 MDP Major Operation Modes (2/2)

	Operation Mode	IOCS				DT				MDR Recording	ODR Recording
		6Mbps Output	60Mbps Output			6Mbps Output	60Mbps Output				
		6Mbps Real	GLI 250m	MDR Reproducing	ODR Reproducing	6Mbps Real	GLI 250m	MDR Reproducing	ODR Reproducing		
BER Measurement Mode (BE)	BE-1	6M PN code	60M PN code								
	BE-2						60M PN code				
	BE-3					6M PN code					
	BE-4										6M PN code
	BE-5										60M PN code
	BE-6	6M PN code			O						
Additional Mode	1	O	O			O		O		O	O
	2	O		O		O	O			O	O
	3	O			O	O		O		O	
	4	O		O		O			O	O	
	5	O			O	O	O			O	
	6	O	O			O			O	O	
	7	O	O			O		O			
	8	O		O		O	O				
	9	O			O	O		O			
	10	O		O		O			O		
	11	O			O	O	O				
	12	O	O			O			O		
	13	O	O			O		O		O	
	14	O		O		O	O			O	
	15	O	O			O		O			O
	16	O		O		O	O				O

5 Communication Subsystem Interfaces

5.1 Main Interface Function

Editing and recording of the ADEOS-II mission data except GLI 6km data are done at the MDP subsystem. The MDP subsystem transmits real time data or reproduced data through the IOCS subsystem or the DT subsystem. GLI 6km data is transmitted though the DTL subsystem.

The main interface functions of the MDP subsystem are as follows:

(1) Selecting and editing of the data to be transmitted by the automatic commands, stored commands or realtime commands.

(2) Selecting of the data transmission route based on the operation modes of each mission instrument, MDR and ODR.

(3) Supplying of the reference clock signal to POLDER and GLI-250m mode.

(4) Receiving the POLDER clock signal and POLDER mission data, and then formatting the mission data to E_PDU of CCSDS. For the PCM telemetry from CU, the same processing is done.

(5) For the ADEOS-II mission data except POLDER and GLI-250m mode, receiving the clock signal, the enable signal and the mission data by CCSDS ver. 1 packet format transmitted from each mission instrument, and then multiplexing their data with PCM telemetry and above (4) formatted data to PCA-PDU based on CCSDS at 6Mbps using the Reed Solomon Coding.

(6) Three MDRs are carried onboard and two of them can be operated simultaneously (two MDRs simultaneous recording or one MDR recording during one MDR reproducing).

(7) PN encoding of above (5) multiplexed data, and then transmitting them simultaneously or selectively to the IOCS subsystem, the DT subsystem, MDR, and ODR based on commands.

(8) Even though data output from a mission instrument is stopped, the data from other mission instrument can be transmitted.

(9) To measure BER, generating the known repeated PN code as a reference and outputting them to MDR, the IOCS subsystem, the DT subsystem and ODR to transmit to the ground stations.

(10) A differential coding is used when outputting to the IOCS subsystem and the DT subsystem. When outputting to the IOCS subsystem, UQPSK modulation is done after the differential coding.

(11) In a MDR reproducing operation, operating not to output non-modulation carrier by switching to BER measurement mode or GLI-250m mode taking account of tape start and stop times.

(12) The simultaneous operation of POLDER and ILAS-II is prohibited.

(13) The simultaneous operation among ILAS-II, TEDA and VMS is prohibited. Operation of ILAS-II has the first priority in the three instruments. So TEDA or VMS can be operated when ILAS-II is not operational.

5.2 Mission Data Link Conditions

5.2.1 X Band Mission Data Transfer Characteristic

Table 5.2-1 X Band Carrier Characteristic

ITEM		DESCRIPTION
Carrier Frequency		
	X1	8150.00 MHz
	X3	8250.00 MHz
Bandwidth (includes 99% of the energy)		
	X1	50.0 MHz
	X3	12.0 MHz
Transmission Filter		Fourth-pole Chebyshev Filter 60 MHz at –3 dB (SPEC.)
Frequency Stability of Carrier		
	Long-Term	Within $\pm 5\times10^{-6}$ /year
	Operating Temperature Range	Within $\pm 2\times10^{-6}$ (–10 to +40 °C)
	Short-Term	Within $\pm 5\times10^{-8}$ /sec
Phase Error		Within ±3°
Amplitude Error		Within ±0.6 dB
H/W Degradation		3.8 dB(design value from CDR)

Table 5.2-2 X Band Antenna Performance

ITEM			DESCRIPTION
Polarization			Right hand circular
Effective Isotropically Radiated Power (EIRP)			
	X1	Z axis = 0° (EL = 90°)	More than 4.6 dBW (worst case of ADEOS-II design value)
		Z axis = ±62.3° (EL = 5°)	More than 19.6 dBW (worst case of ADEOS-II design value)
	X3	Z axis = 0° (EL = 90°)	More than –3.9 dBW (worst case of ADEOS-II design value)
		Z axis = ±62.3° (EL = 5°)	More than 11.1 dBW (worst case of ADEOS-II design value)
Out of Band Spurious Emission			Less than –50dBc
Antenna Pattern			See Fig. 5.2-1 to 5.2-2

Table 5.2-3 X Band Modulation Parameters

ITEM		DESCRIPTION
Modulation Type		QPSK
Bit Rate		
	X1	60 Mbps
	X3	6 Mbps
Differential Encoding		See Fig. 5.2-3

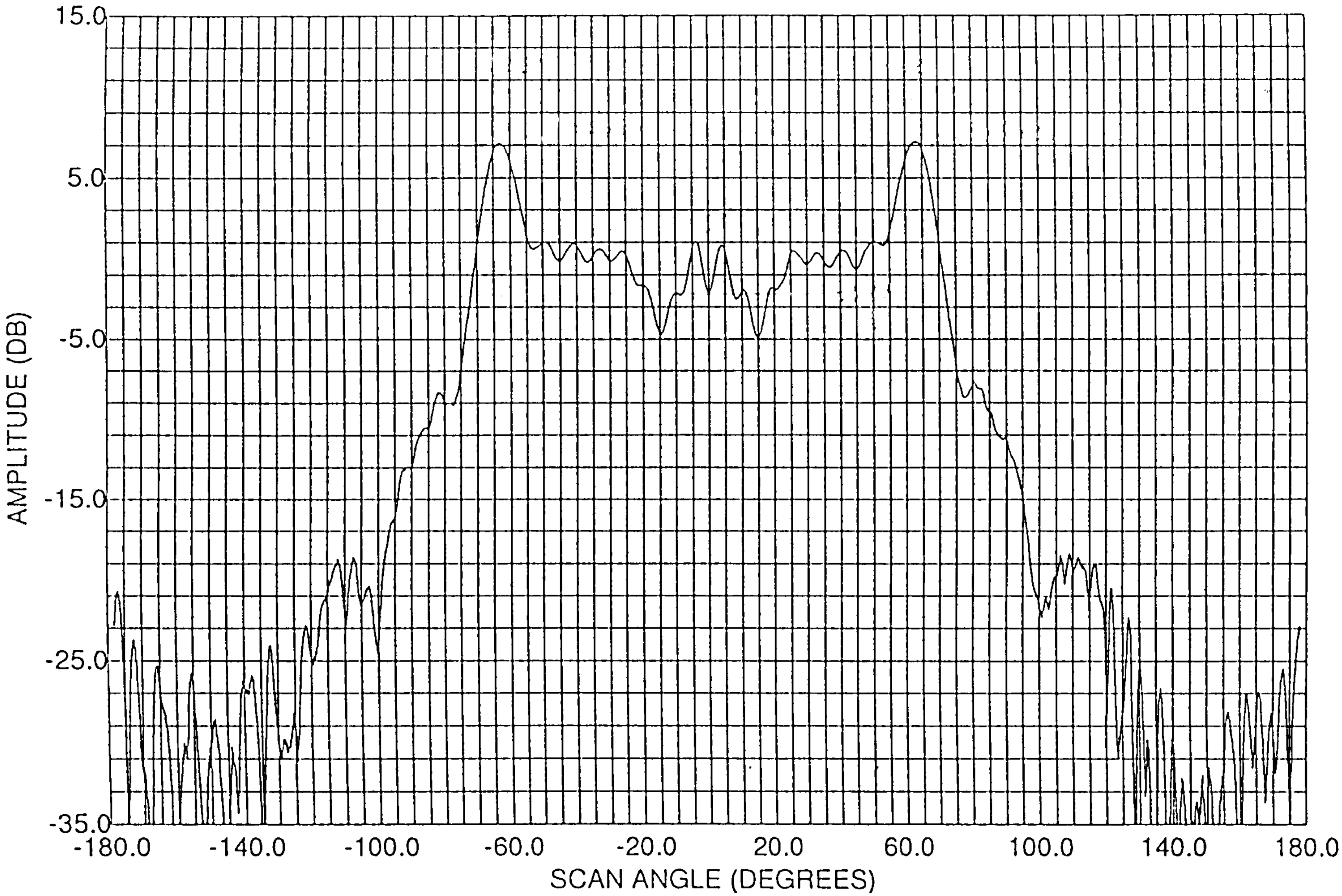


Fig. 5.2-1(a) X Band Antenna Pattern (8.15GHz, X1ch, f=90°)

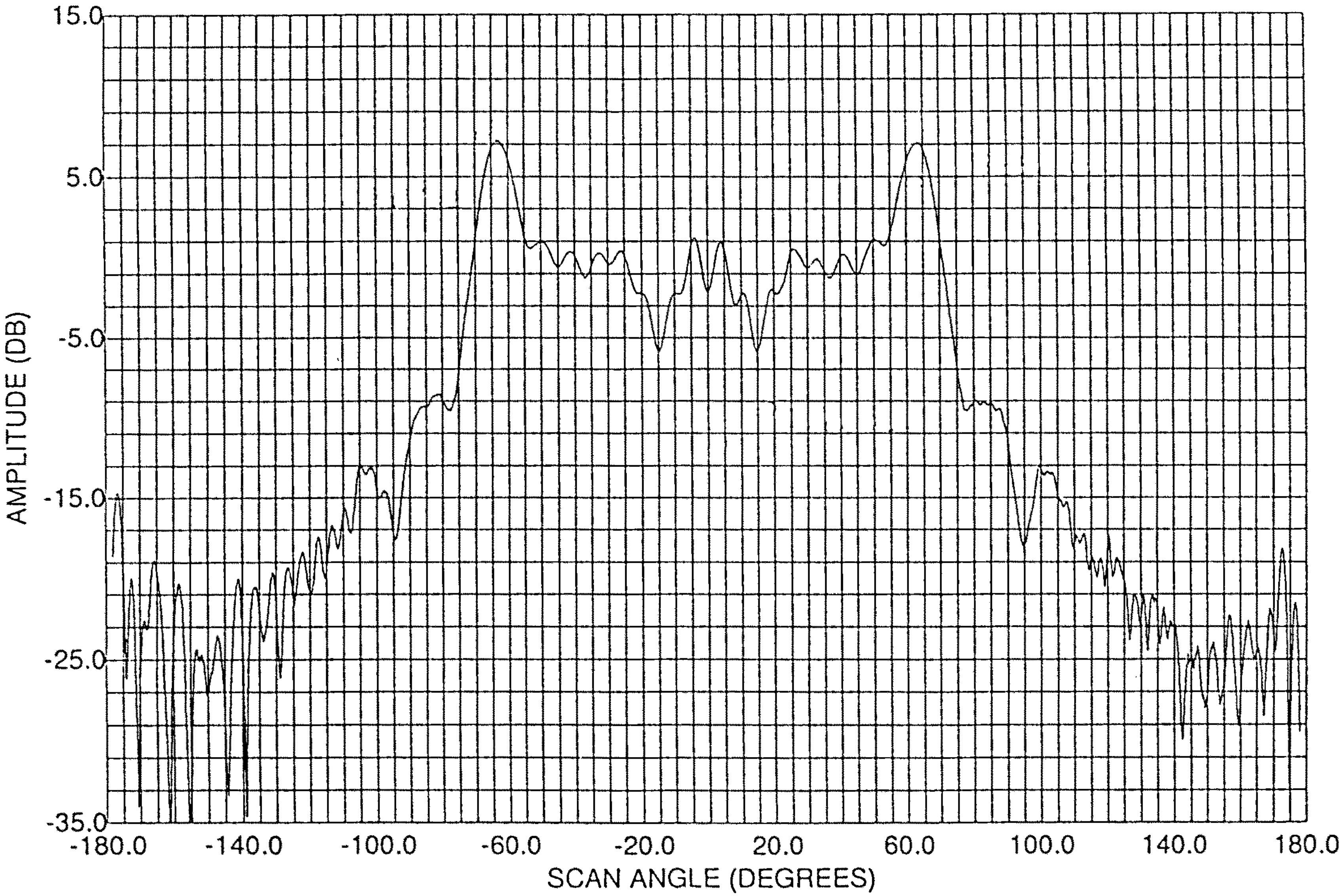


Fig. 5.2-1(b) X Band Antenna Pattern (8.15GHz, X1ch, f=±180°)

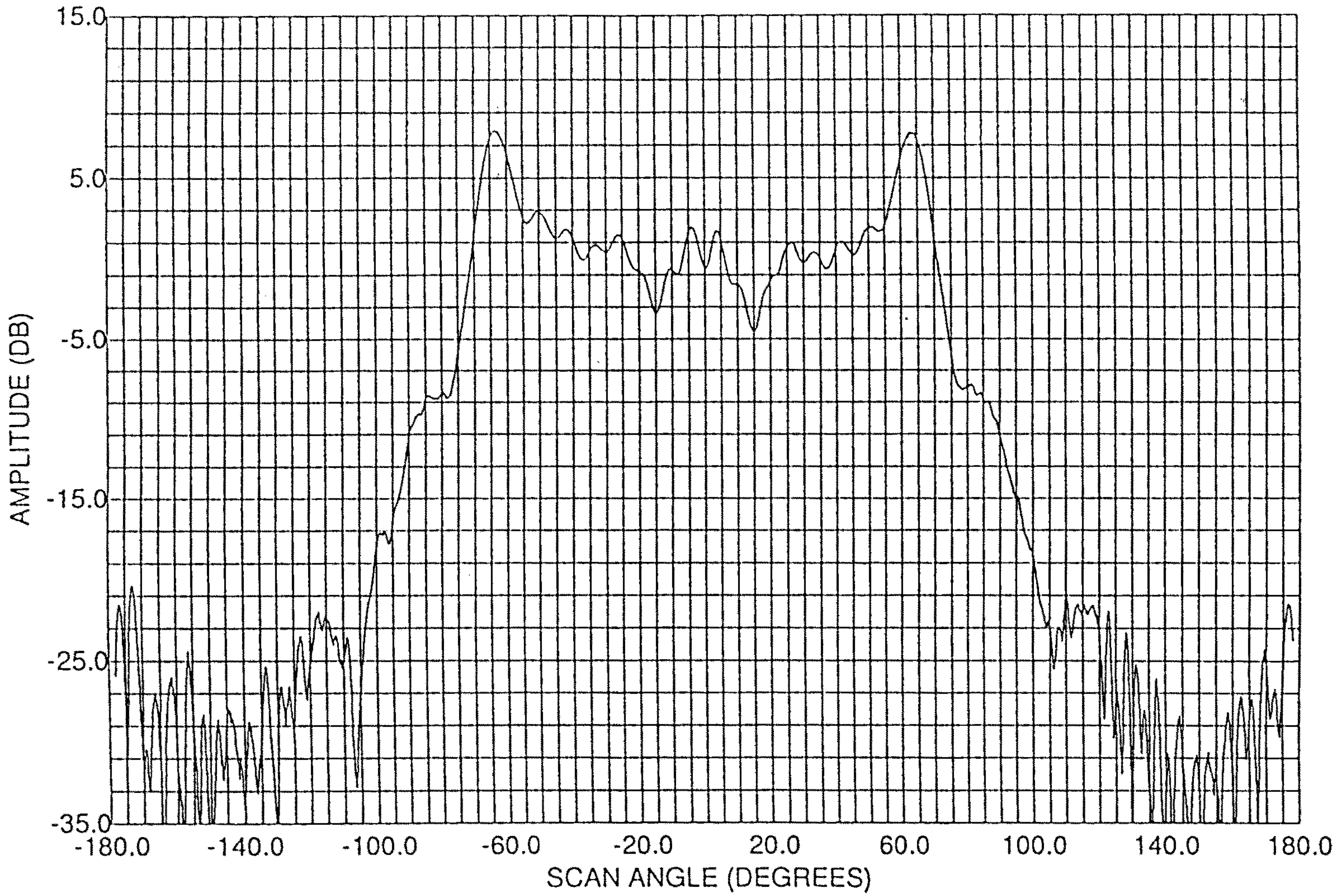


Fig. 5.2-2(a) X Band Antenna Pattern (8.25GHz, X3ch, f=90°)

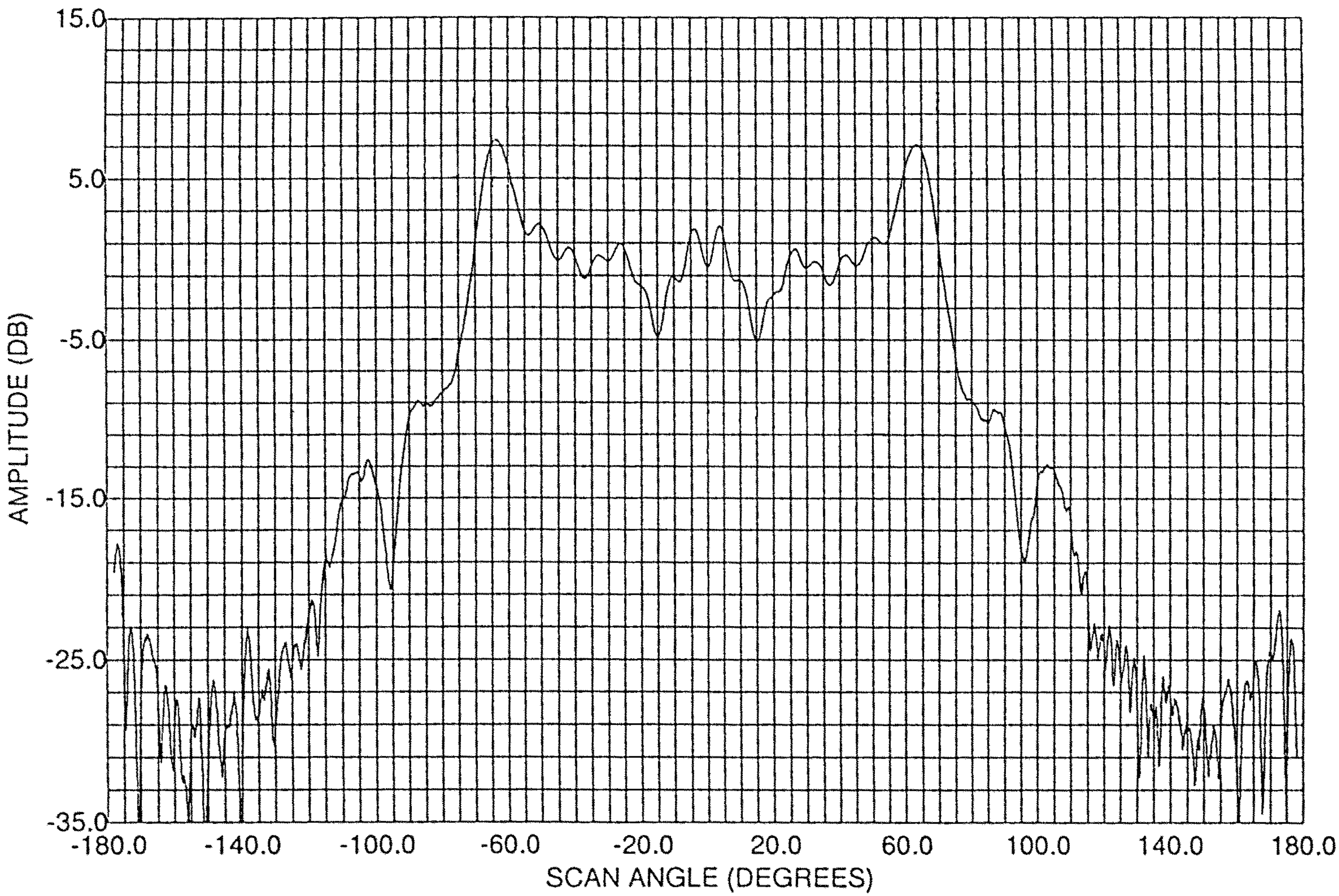


Fig. 5.2-2(b) X Band Antenna Pattern (8.25GHz, X3ch, f=±180°)

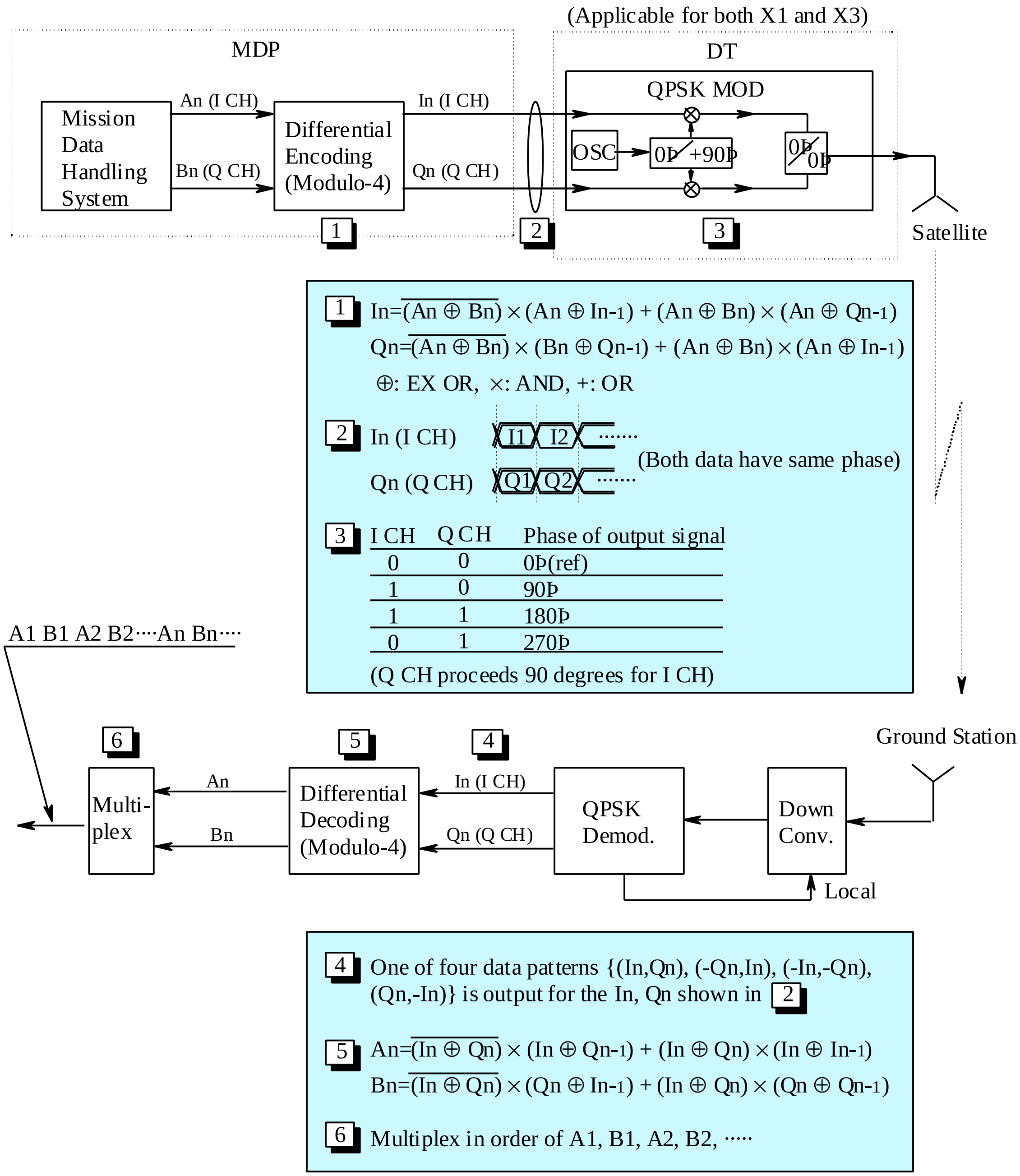


Fig. 5.2-3 ADEOS-II Encoding / Decoding Scheme

The bit order of data stream transmitted from ADEOS-II are shown in Table 5.2-4.

All bits of GLI-250m data output are based on negative logic, so the data are replaced “1” with “0” (“0” with “1”). In order to get the original GLI-250m data without bit inversion, it is necessary to replace the bits at a ground system.

MDR reproduced data consists of frames with every bit in reverse order as show in Fig. 5.2-4.

Table 5.2-4 Order of Data Stream from ADEOS-II

Data Source	Output Data
ODR reproduced data	Time-forward (GLI-250m data : based on negative logic.)
GLI-250m realtime data	Time-forward, negative logic
MDR reproduced data	Time-reverse
Others	Time-forward

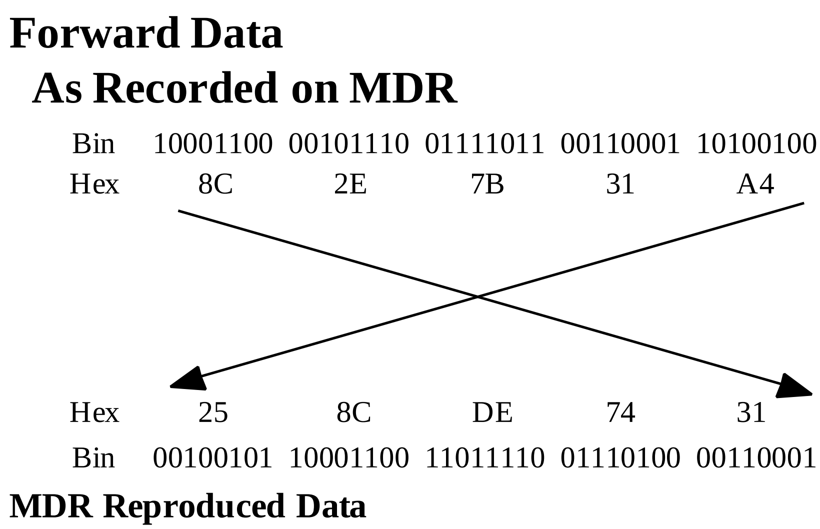


Fig. 5.2-4 Order of MDR Reproduced Data (Example)

5.2.2 Link Budget Analysis

Table 5.2-5 Link Calculation for X Band Downlink

No.	Item	Unit	X1		X3		Note
1	Frequency	MHz	8150.0		8250.0		
2	El Angle	deg	5.0	90.0	5.0	90.0	
3	X-ANT Positioning Angle	deg	62.3	0.0	62.3	0.0	
4	Transmit Path	km	2832.1	802.9	2832.1	802.9	
5	Transmitter Power	dBW	15.3		8.5		
6	Transmit Line Loss	dB	–1.5		–3.2		
7	Antenna Gain	dBi	5.8	–9.2	5.8	–9.2	
8	EIRP	dBW	19.6	4.6	11.1	–3.9	
9	Free Space Loss	dB	–179.7	–168.8	–179.8	–168.9	
10	Atmosphere Loss	dB	–0.3	–0.1	–0.3	–0.1	
11	Rain Loss	dB	–1.5	–0.1	–1.6	–0.1	
12	Ground Receiving Power	dBW	–161.9	–164.4	–170.6	–173.0	
13	Pointing Loss	dB	–0.2	–0.2	–0.2	–0.2	
14	Antenna Gain	dBi	55.5		55.5		
15	System Noise Temp.	dBK	22.1	22.1	22.1	22.1	Availability 99%
16	Ground Antenna G/T	dB/K	33.4	33.4	33.4	33.4	Antenna: 10.0m ϕ
17	C/No	dB•Hz	99.9	97.4	91.2	88.8	
18	Required C/No (encoding gain)	dB•Hz	88.1		78.1		
19	Required C/No (no encoding gain)	dB•Hz	92.4		–		GLI-250m
20	Margin (encoding gain)	dB	11.8	9.4	13.1	10.8	
21	Margin (no encoding gain)	dB	7.5	5.1	–	–	GLI-250m
22	Transmit Data		High-bit rate data		Mid-bit rate data		
23	Modulation	–	QPSK		QPSK		
24	Required Eb/No	dB	10.8		10.8		BER: 1.00E-6
25	Encoding Gain	dB	4.3		4.3		
26	H/W Degradation	dB	3.8		3.8		
27	Bit Rate	dB•Hz	77.8		67.8		
		Mbps	60		6		
28	Required C/No (encoding gain)	dB•Hz	88.1		78.1		
29	Required C/No (no encoding gain)	dB•Hz	92.4		–		GLI-250m

6 Operation Conditions

The typical data acquisition modes over the ground stations are summarize in Table 6-1.

In the Mode 1, ground stations will acquire:
(a) GLI 250m data via the X1 band;
(b) MRT data via the X3 band.

In the Mode 2, ground stations will acquire:
(a) MDR data, GLI 250m data and/or ODR data via the X1 band;
(b) MRT data via the X3 band.

Table 6-1 Typical Data Acquisition Modes

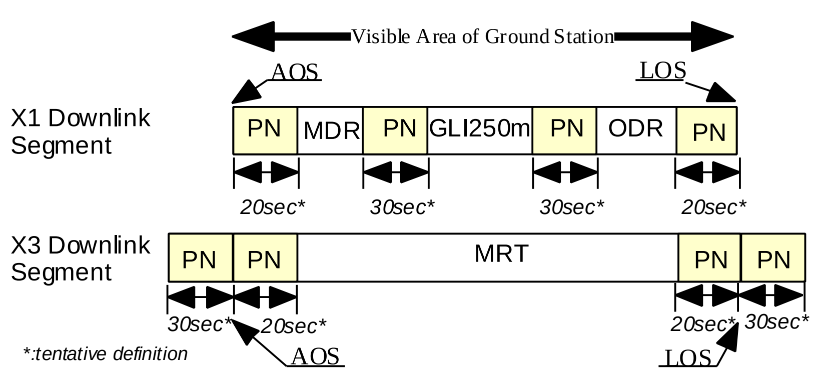
Mode	Transmission	Data
Mode 1	X1 (60Mbps)	GLI 250m data
	X3 (6Mbps)	MRT
Mode 2	X1 (60Mbps)	MDR data
		GLI 250m data
		ODR data
	X3 (6Mbps)	MRT

The operation scenario of the X band is illustrated in Fig. 6-1.

PN code data is always transmitted to ground stations between different data sources, before true data (around AOS), and after true data (around LOS) on each data transmission over each ground station on X1 downlink.

On X3 downlink, PN data is basically transmitted before and after MRT data.

The duration of the PN code is treated as a variable parameter by NASDA/MMO, tentatively defined as shown in Fig. 6-1. The order of true data within one X1 downlink segment is case by case and the kind is also not fixed. The start time of each true data transmission is informed from NASDA/MMO to each ground station.



Note 1: In the Mode 1, only GLI 250m data will be basically dumped via X1 band.
Note 2: In the Mode 2, maximum three types of mission data (MDR, GLI 250m, ODR) will be dumped in a downlink pass via X1 band.
Note 3: In X1 band data, the ordering of transmission is case by case.

Fig. 6-1 Operation Scenario of X Band Downlink

Appendix A ADEOS-II Mission Data CCSDS Format

Except for GLI-250m source data, all instrument and housekeeping data packets are forwarded to the Spacecraft Transfer Frame Generator (TFG) within the Multiplexing data unit (M_PDU) for processing. Reed-Solomon encoding occurs in the Virtual channel data unit (VCDU) and headers are applied in the transfer frame data unit (PCA_PDU), according to CCSDS standards.

Packets of each different source type are assigned to individual transfer frames.

The transfer frame is forwarded at 6Mbps data rate to the X-band/DT transmitter and Ka-band/IOCS transmitter for real time transmission, and is also recorded on the Mission Data Recorder (MDR).

The following two types of service are applied to ADEOS-II/CCSDS packets:

(1) Path service
Data source: AMSR, GLI-1km, SeaWinds, ILAS-II, DCS, TEDA, VMS and DMS - use CCSDS path protocol data specification: Version-1 CCSDS packet (CP_PDU).

(2) Encapsulation service
Data source: Housekeeping telemetry and POLDER - use CCSDS encapsulation protocol data specification: Version-1 CCSDS packet (E_PDU).

The entire format of ADEOS-II CCSDS data is shown in Fig. A-1.
The structure of Channel Access Data Unit (CADU) is shown in Fig. A-2.
The structure of Virtual Channel Data Unit (VCDU) is shown in Fig. A-3.
The structure of Multiplexing Protocol Data Unit (M_PDU) is shown in Fig. A-4.
The first header pointer is shown in Fig. A-5.
The structure of CCSDS Packet and Encapsulation Protocol Data Unit (EPDU) is shown in Fig. A-6.

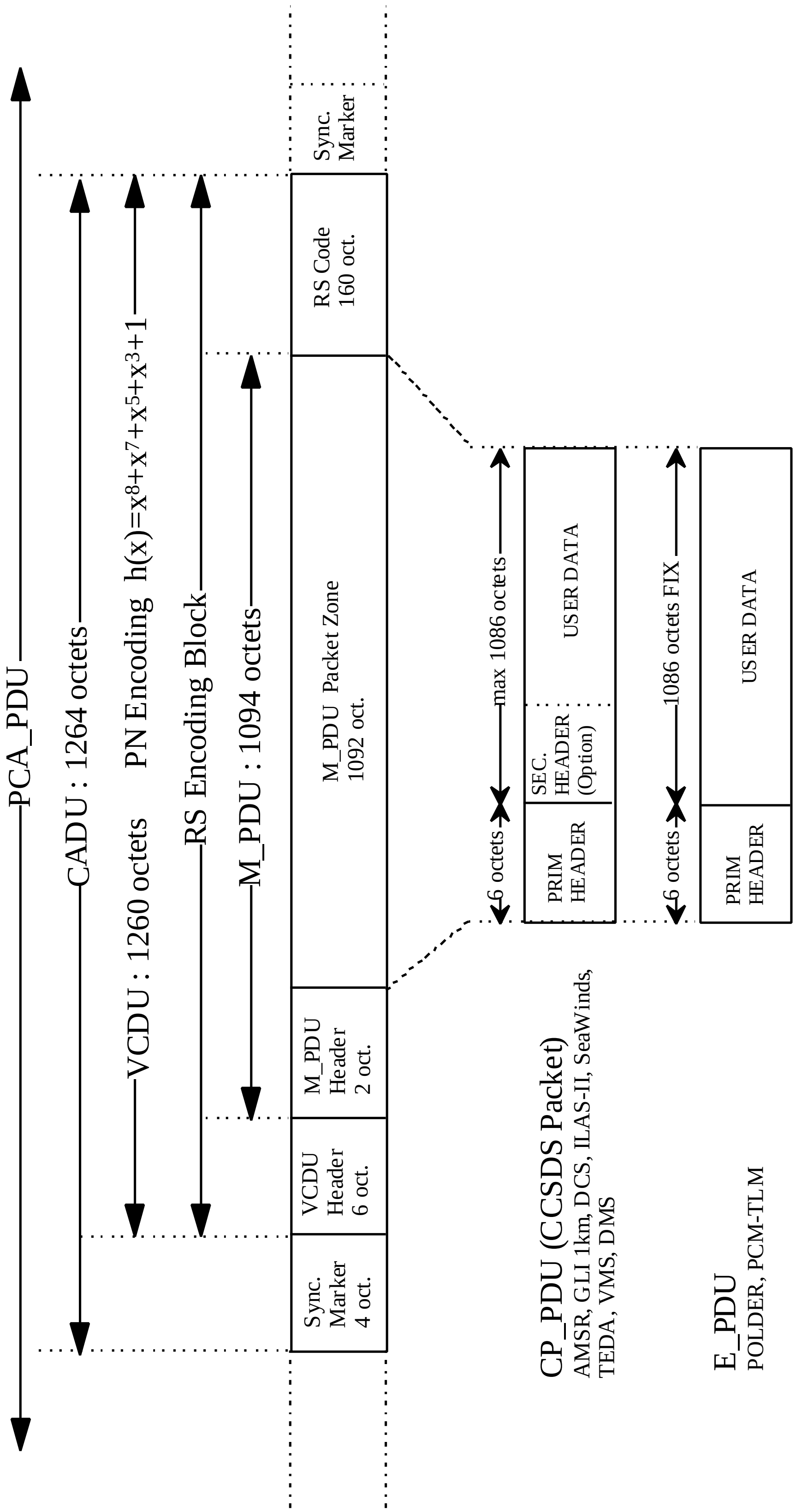


Fig. A-1   Entire Format of ADEOS-II CCSDS Data

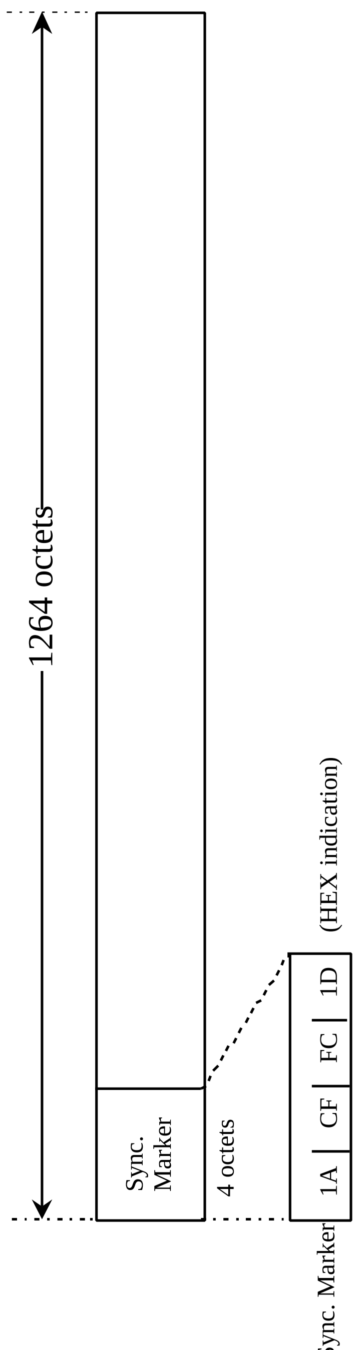
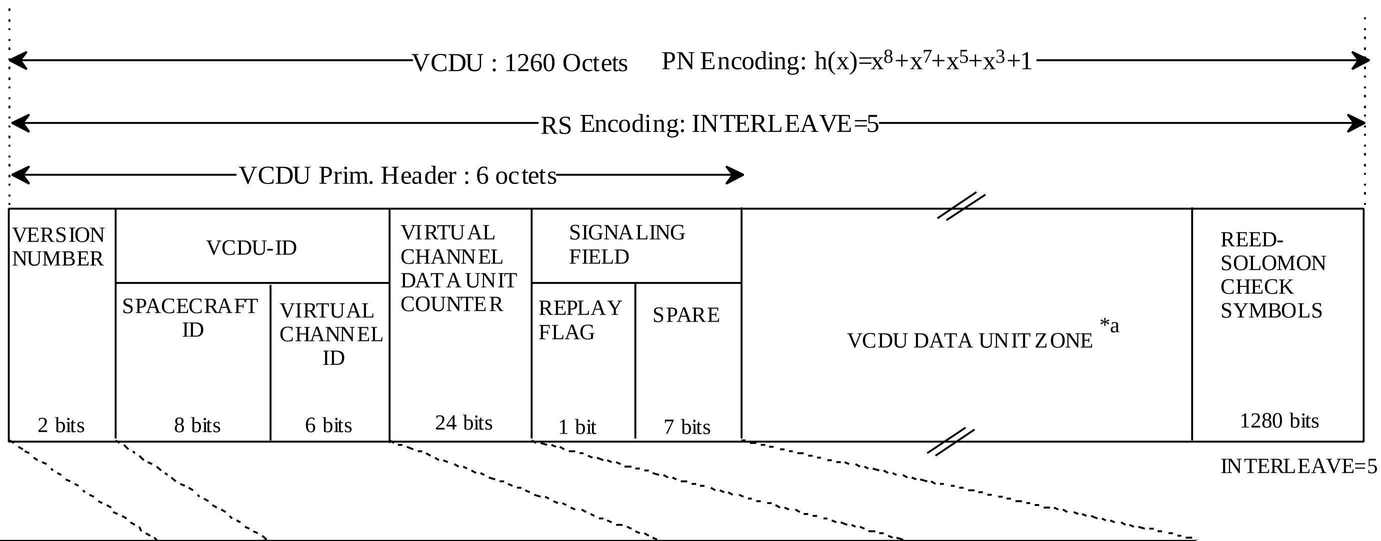


Fig. A-2 Structure of Channel Access Data Unit (CADU)

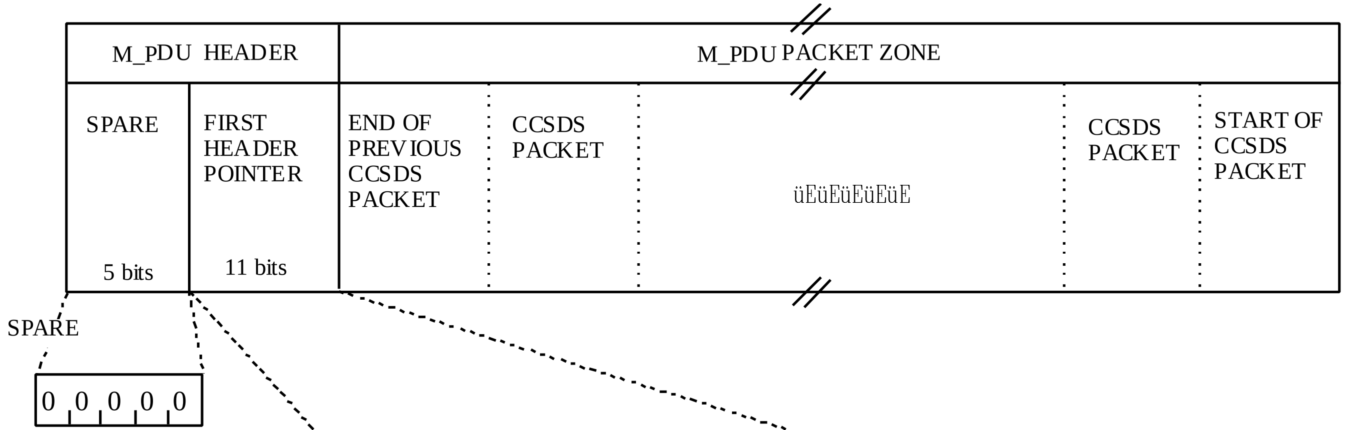


	Version Number	VCDU-ID		Virtual Channel Data Unit Counter *b	Signal Field	
		Spacecraft ID	Virtual Channel ID		Replay Flag	Spare
Number of bits	2 bits	8 bits	6 bits	24 bits	1 bit	7 bits
PCM TLM	0 1	1 0 1 0 0 0 1 0	0 0 0 0 0 0	all 0 - all 1	0	0 0 0 0 0 0 0
POLDER			0 0 0 0 0 1	all 0 - all 1		
GLI 1km			0 0 0 0 1 0	all 0 - all 1		
DMS			0 0 0 0 1 1	all 0 - all 1		
AMSR			0 0 0 1 0 0	all 0 - all 1		
SeaWinds			0 0 0 1 0 1	all 0 - all 1		
DCS			0 0 0 1 1 0	all 0 - all 1		
ILAS-II/TEDA/VMS			0 0 0 1 1 1	all 0 - all 1		
Fill VCDU			1 1 1 1 1 1	all 0 - all 1		

*a: In the VCDU DATA UNIT ZONE of Fill VCDU data field, indefinite data is inserted.

*b: The counter starts at "1" when power is turned on, after that it repeats all 0 to all 1.

Fig. A-3 Structure of Virtual Channel Data Unit (VCDU)



FIRST HEADER POINTER

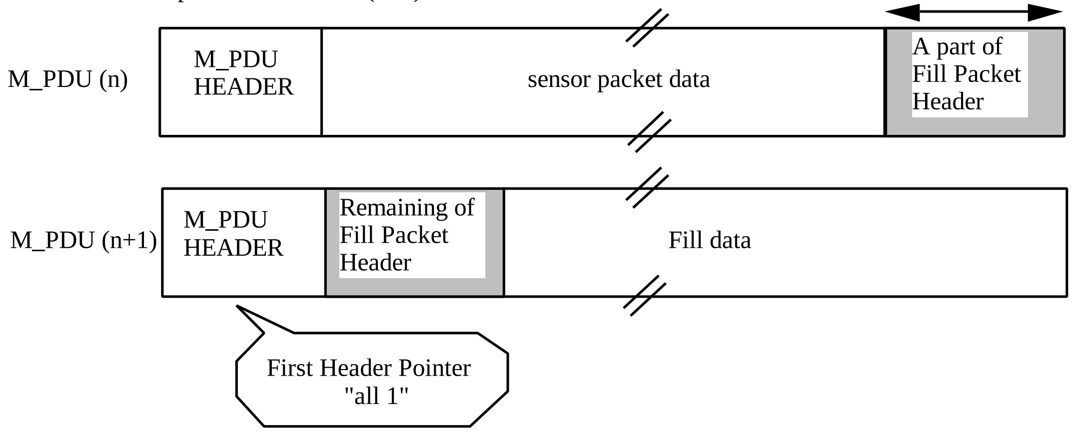
Case	MSB										LSB	Corresponding CCSDS 701.0-B-2 Number
Nominal	Octets No. of the first CCSDS packet header – 1 (Binary)											5.3.8.2.2.2. c
No packet header in the M_PDU packet zone	1	1	1	1	1	1	1	1	1	1	1	5.3.8.2.2.2. d Refer to Fig. A-5
A first packet header is divided in two M_PDU packet zones.	[Front M_PDU] Position of the first packet header of this M_PDU Octets No. of the first CCSDS packet header – 1 (Binary) [next M_PDU] Position of the next new packet header of the M_PDU, not divided header Octets No. of the first CCSDS packet header – 1 (Binary)											5.3.8.2.2.2. f 5.3.8.2.2.2. g 5.3.3.2.2.2. h

First Header Pointer provides the octet number of the first CCSDS packet in M_PDU packet zone.
Where, the octet number is counted at the first bit in a M_PDU packet zone as "octet 1".

Fig. A-4 Structure of Multiplexing Protocol Data Unit (M_PDU)

[case 1]

Case of the remaining M_PDU PACKET ZONE is less than 6 octets.
The first header pointer in M_PDU(n+1) becomes all 1.



[case 2]

Case of the remaining M_PDU PACKET ZONE is 6 octets.
The first header pointer in M_PDU(n+1) becomes all 1.

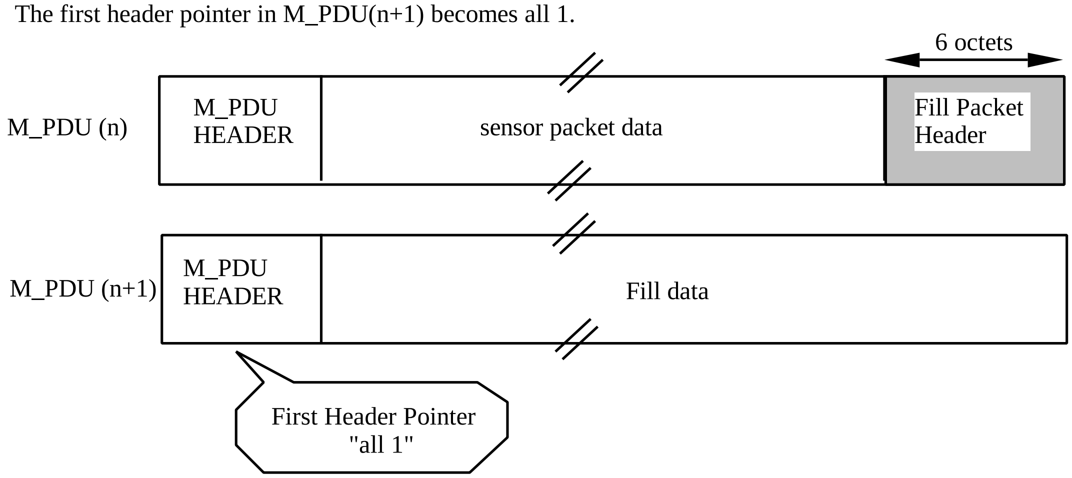


Fig. A-5 First Header Pointer (Special Cases)

PRIMARY HEADER : 6 octets | max 1086 octets

PACKET IDENTIFICATION				PACKET SEQUENCE CONTROL				
VERSION No.	TYPE	SEC. HDR. FLAG.	APPLIC. PROCESS ID	SEQUENCE FLAGS	PACKET SEQUENCE COUNT	PACKET LENGTH	SECONDARY HEADER (OPTIONAL)	USER DATA
3 bits	1 bit	1 bit	11 bits	2 bits	14 bits	16 bits		

	PACKET IDENTIFICATION				PACKET SEQUENCE CONTROL		
	VER. No.	TYPE	SEC. HDR. FLAG	APPLIC. PROCESS ID	SEQUENCE FLAGS	PACKET SEQUENCE COUNT	PACKET LENGTH
Number of bits	3 bits	1 bit	1 bit	11 bits	2 bits	14 bits	16 bits
PCM TLM	0 0 0	0	0	0 0 0 0 0 0 0 0 0 0 0	1 1	all 0 - all 1 *e	1085 DEC
POLDER			0	0 0 0 0 0 0 1 0 0 0 0	1 1	all 0 - all 1 *e	1085 DEC
GLI			0	0 0 0 0 0 1 0 0 0 0 0	*a	all 0 - all 1	*b
ILAS-II			0	0 0 0 0 0 1 1 0 0 0 0	*a	all 0 - all 1	*b
AMSR			1	0 0 0 0 1 0 0 0 0 0 0	*a	all 0 - all 1	*b
SeaWinds			1	0 0 0 0 1 0 1 0 1 0 1	*a	all 0 - all 1	*b
DCS			0	0 0 0 0 1 1 0 0 0 0 0	*a	all 0 - all 1	*b
TEDA			0	0 0 0 0 1 1 1 0 0 0 0	*a	all 0 - all 1	*b
VMS			0	0 0 0 0 1 1 1 0 1 0 1	*a	all 0 - all 1	*b
DMS-1 *d			0	0 0 0 0 1 1 1 1 0 1 0	1 1	all 0 - all 1	*b
DMS-2 *d			0	0 0 0 0 1 1 1 1 1 1 1	1 1	all 0 - all 1	*b
Fill Packet			0	1 1 1 1 1 1 1 1 1 1 1	1 1	all 0	*b, *c

*a: Segmented case — 0 1 (first packet)
— 0 0 (intermediate packet)
— 1 0 (last packet)
Non-segmented case — 1 1

*b: User data length (octets) including Secondary Header – 1, (binary)
*c: In user data area of Fill Packet, indefinite data is inserted.
*d: DMS-1: Accelerometer data, DMS-2: Star Tracker data
*e: The counter starts at "1" when power is turned on, after that it repeats all 0 to all 1.

Fig. A-6 Structure of CCSDS Packet and Encapsulation Protocol Data Unit (EPDU)

Appendix B GLI Mission Data Format

This appendix provides the detailed formats of GLI 1km data that NASA/NOAA processes to higher level products.

B.1 Overview

The number of packets on the 1km data format is synchronous with the scanning cycle of the GLI scanning mirror. Packet spacing (d') of the 1km data format depends on a deviation of the revolution cycle of the scanning mirror (1.7947sec ± 400μsec).

The CCSDS source packet format concept of the GLI data is shown in Fig. B.1. The packet composition for one scanning cycle is shown in Fig. B.2.

<--Primary Header-->

	Packet ID				Packet Sequence Control		Packet Length	User Data
	Version No.	Type	Sec. Header Flag	Applic. Process ID	Sequence Flags	Packet Sequence		
Bit No.	0 to 2	3	4	5 to 15	16 to 17	18 to 31	32 to 47	48 to 7535
Number of bits	3	1				14	16	7488
	16 bits				16 bits		16 bits	
	7536 bits							

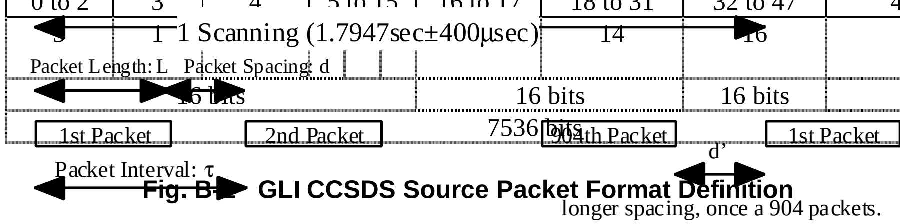


Fig. B-1 GLI CCSDS Source Packet Format Definition

Packet Length	L		Number of Bytes	Number of bits
		Header	6	48
		Data	936	7488
		Enable		2
		Total	942	7538
Packet Spacing =50.874μsec	d	64 μsec (4MHz Clock * 256bits)		
Packet Interval	τ	1.9485 msec (4MHz Clock * (256+7538)bits)		
Average Data Rate	L/τ	3.8687Mbps		

Fig. B-2 Packet Composition for One Scanning Cycle

B.2 Primary Herder Composition

Table B-1 Definition of Primary Header for GLI Data

Item	Bit No.	bits	Condition	Data
Version No.	0 to 2	3 bits	common to all instruments	000
Type	3	1 bit	common to all instruments	0
Sec. Flag	4	1 bit	disuse	0
Applic. Process ID	5 to 7	3 bits	common to all instruments	000
	8 to 11	4 bits	GLI assigned code	0010
	12 to 15	4 bits	optional	0000
Sequence Flags	16 to 17	2 bits	first packet	01
			intermediate packet	00
			last packet	10
Packet Sequence Count	18 to 31	14 bits	14 bits full count, count reset is done only at power on.	00 0000 0000 0000 to (0 dec) 11 1111 1111 1111 (16383 dec)
Packet Length	32 to 47	16 bits	(User Data Length/8)–1	0000 0011 1010 0111 (935 dec)

B.3 User Data Composition

The user data of GLI 1km data format is composed of following data fields:

- PCD (Payload Correction Data)
- GLI Operation Modes
- GLI 1km VNIR/SWIR Data
- GLI 250m VNIR/SWIR Data (2km sampling data)
- Image Correction Data

The GLI 1km user data format is illustrated in Fig. B-3.

B.3.1 Payload Correction Data (PCD)

The user data format for PCD is shown in Fig. B-4.

B.3.2 GLI Operation Modes

The user data format for GLI operation modes is shown in Fig. B-4.

The logical rule for GLI operation modes is shown in Table B-2.

Table B-2 Logical Rule for GLI Operation Modes

	GLI Operation Mode	Rule
BIT 3	Daytime/Nighttime Observation Modes	“1”: Daytime Observation, “0”: Nighttime Observation
BIT 2	Electrical Cal Mode	“1”: ON, “0”: OFF
BIT 1	Internal Lamp Cal Mode	“1”: ON, “0”: OFF
BIT 0	Solar Cal Mode	“1”: ON, “0”: OFF

B.3.3 GLI 1km VNIR/SWIR Data

The user data format for GLI 1km VNIR and SWIR data is shown in Fig. B-5.

Table B-3 Channel List for Resolutions

12BIT Resolution*	13BIT Resolution
CH01, CH02, CH03, CH06, CH09, CH10, CH11, CH12, CH13, CH14, CH15, CH16, CH17, CH18, CH19, CH24, CH25, CH26, CH27	CH04, CH05, CH07, CH08

* For 12BIT resolution data, the dummy bit is added to BIT12.

Table B-4 Channel List for Element Orders

Element 12 to Element 1	Element 1 to Element 12
CH01, CH02, CH03, CH06, CH09, CH10, CH13, CH15, CH17, CH19, CH25, CH27	CH04, CH05, CH07, CH08, CH11, CH12, CH14, CH16, CH18, CH24, CH26,

Table B-5 Valid Data Field (GLI 1km VNIR/SWIR)

Data	Valid Data Field
Image Data or Electrical Cal Data	SAMPLE 0001 to SAMPLE 1276
Deep Space Data	SAMPLE 0005 to SAMPLE 0024
Internal Lamp Cal Data or Solar Cal Data	SAMPLE 0001 to SAMPLE 0016

B.3.4 GLI 1km MTIR Data

The user data format for GLI 1km MTIR data is shown in Fig. B-6.

Table B-6 Valid Data Field (GLI 1km MTIR)

Data	Valid Data Field
Image Data or Electrical Cal Data	SAMPLE 0001 to SAMPLE 1276
Wallclump Data	SAMPLE 0006 to SAMPLE 0010
Deep Space Data	SAMPLE 0005 to SAMPLE 0020
Blackbody Data	SAMPLE 0001 to SAMPLE 0028

B.3.5 GLI 250m VNIR/SWIR Data (2km sampling data)

The user data format for 2km sampling data from GLI 250m VNIR and SWIR data is shown in Fig. B-7.

Table B-7 Valid Data Field (GLI 250m VNIR/SWIR)

Data	Valid Data Field
Image Data or Electrical Cal Data	SAMPLE 0001 to SAMPLE 5097
Deep Space Data	SAMPLE 0017 to SAMPLE 0089
Internal Lamp Cal Data or Solar Cal Data	SAMPLE 0017 to SAMPLE 0057

B.3.6 Image Correction Data

The user data format for image correction data is shown in Fig. B-8.

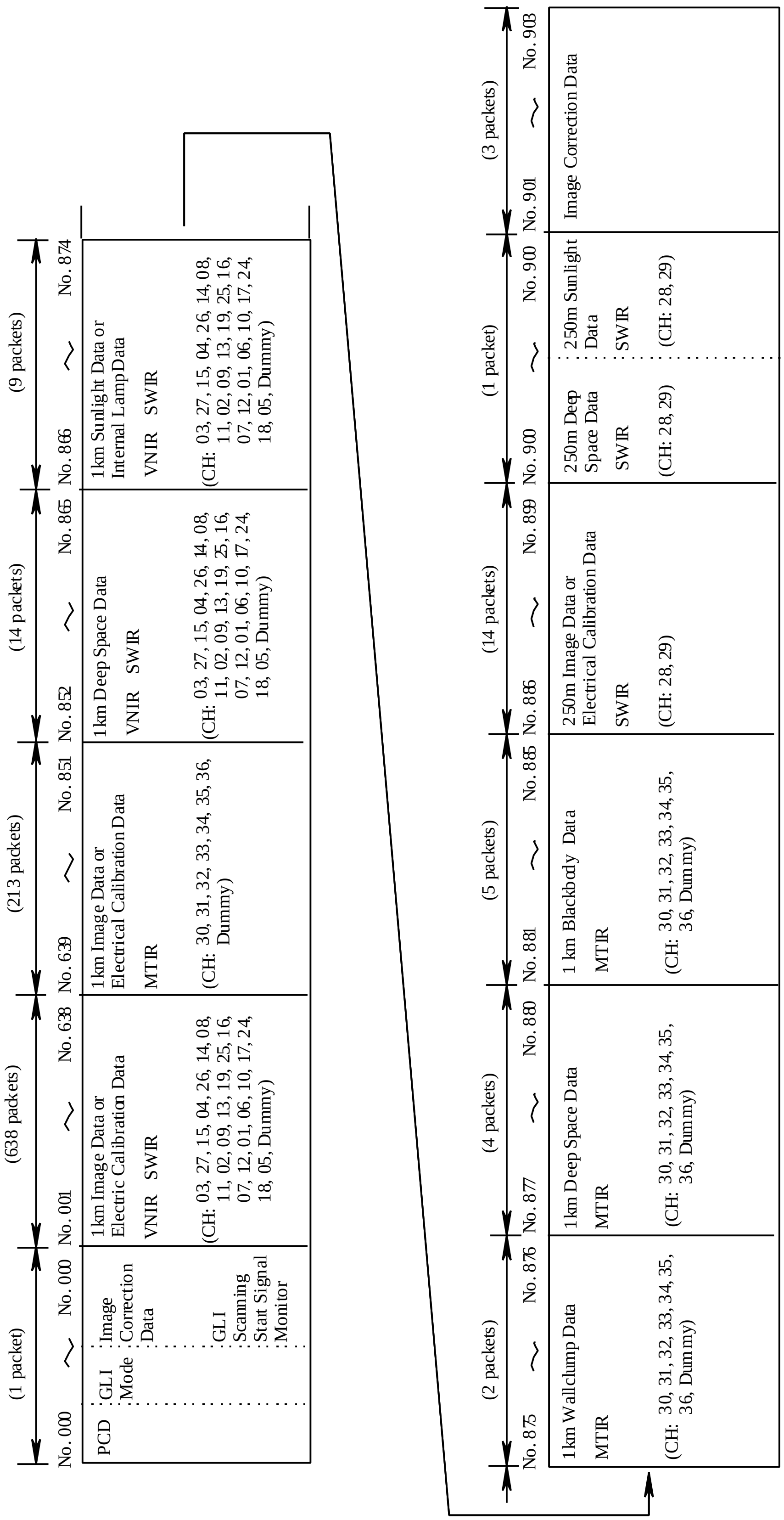


Fig. B-3 GLI 1km User Data Format

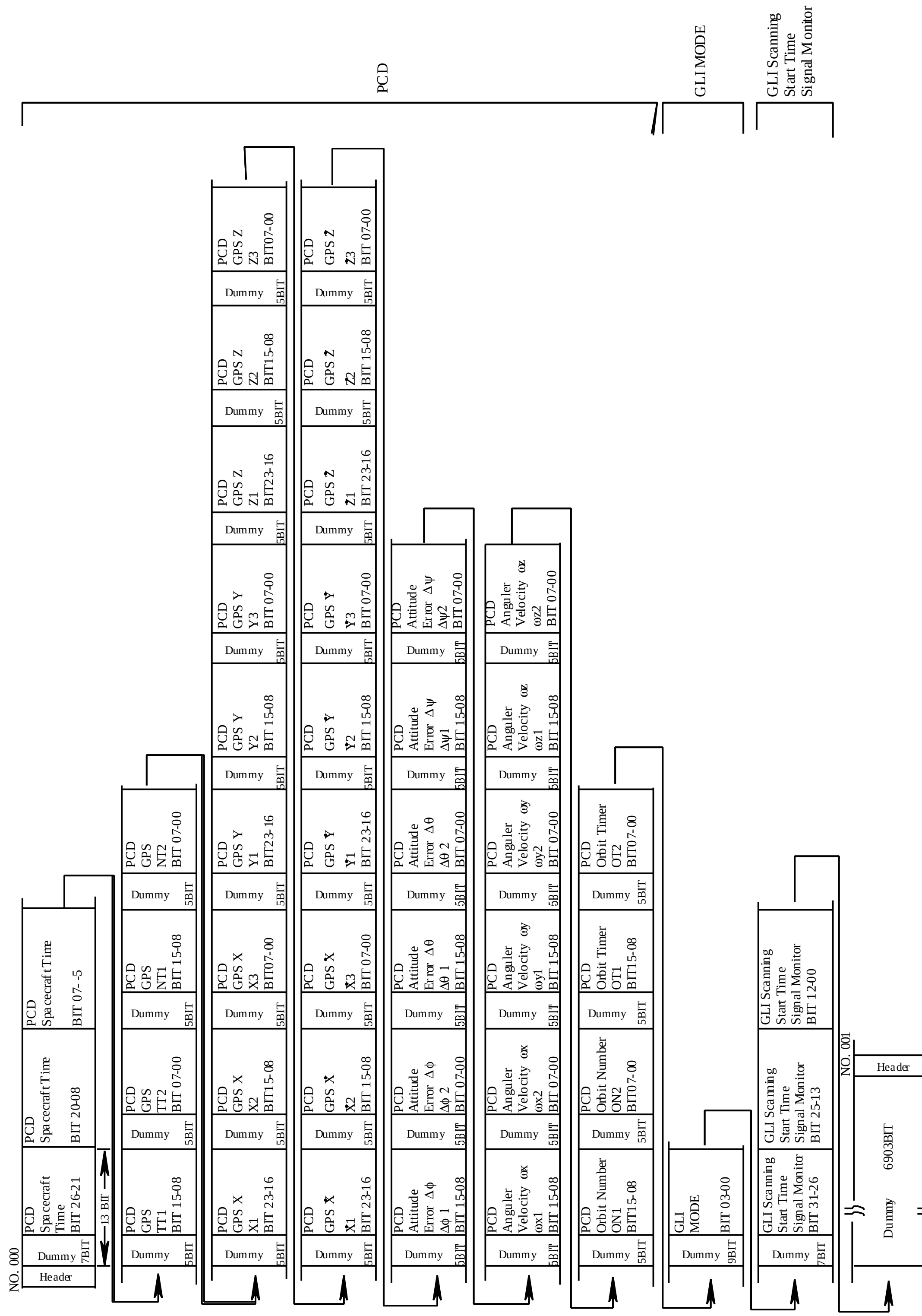


Fig. B-4 PCD / GLI Modes / Image Correction Data Formats

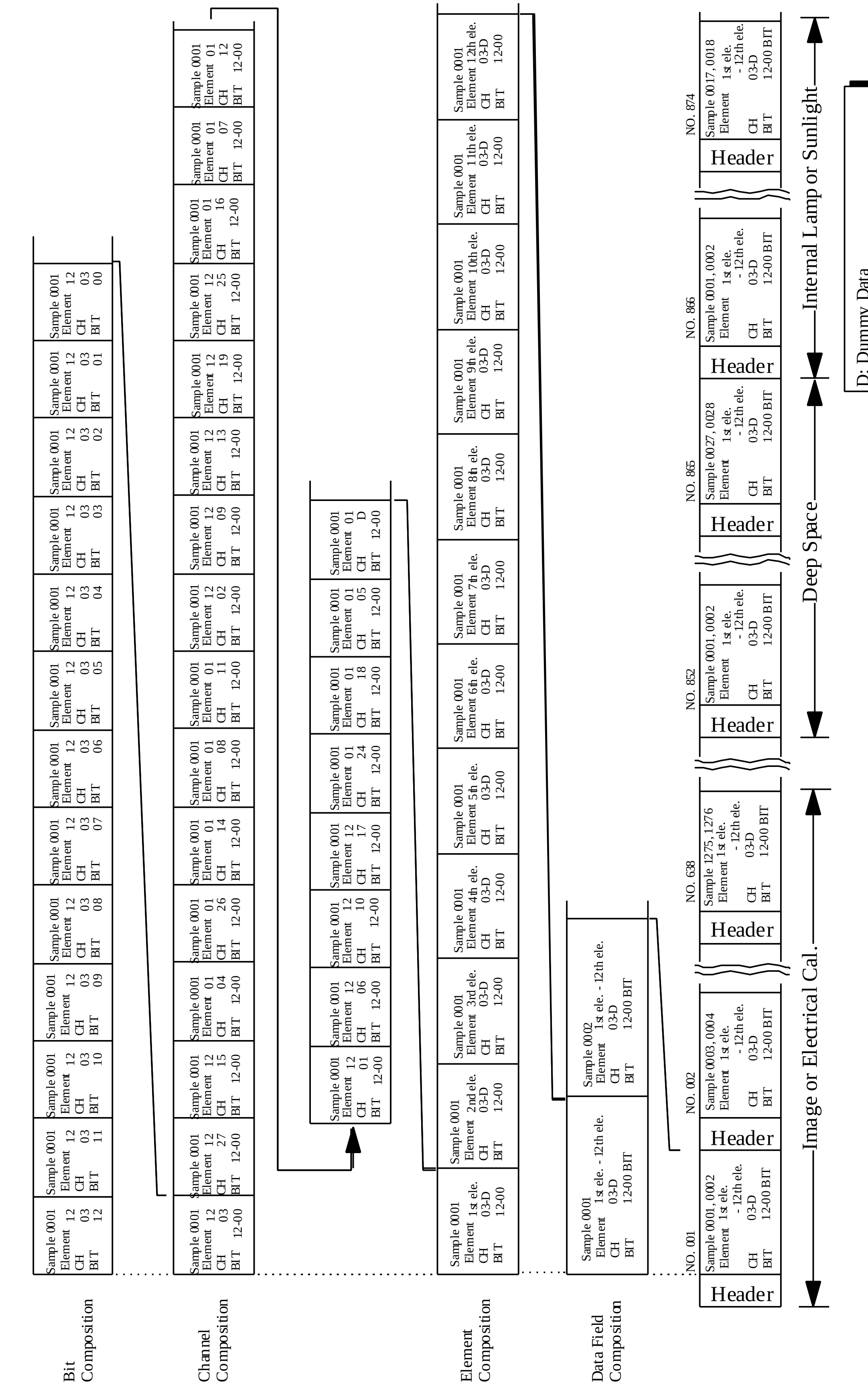


Fig. B-5 GLI 1km VNIR/SWIR Data Format

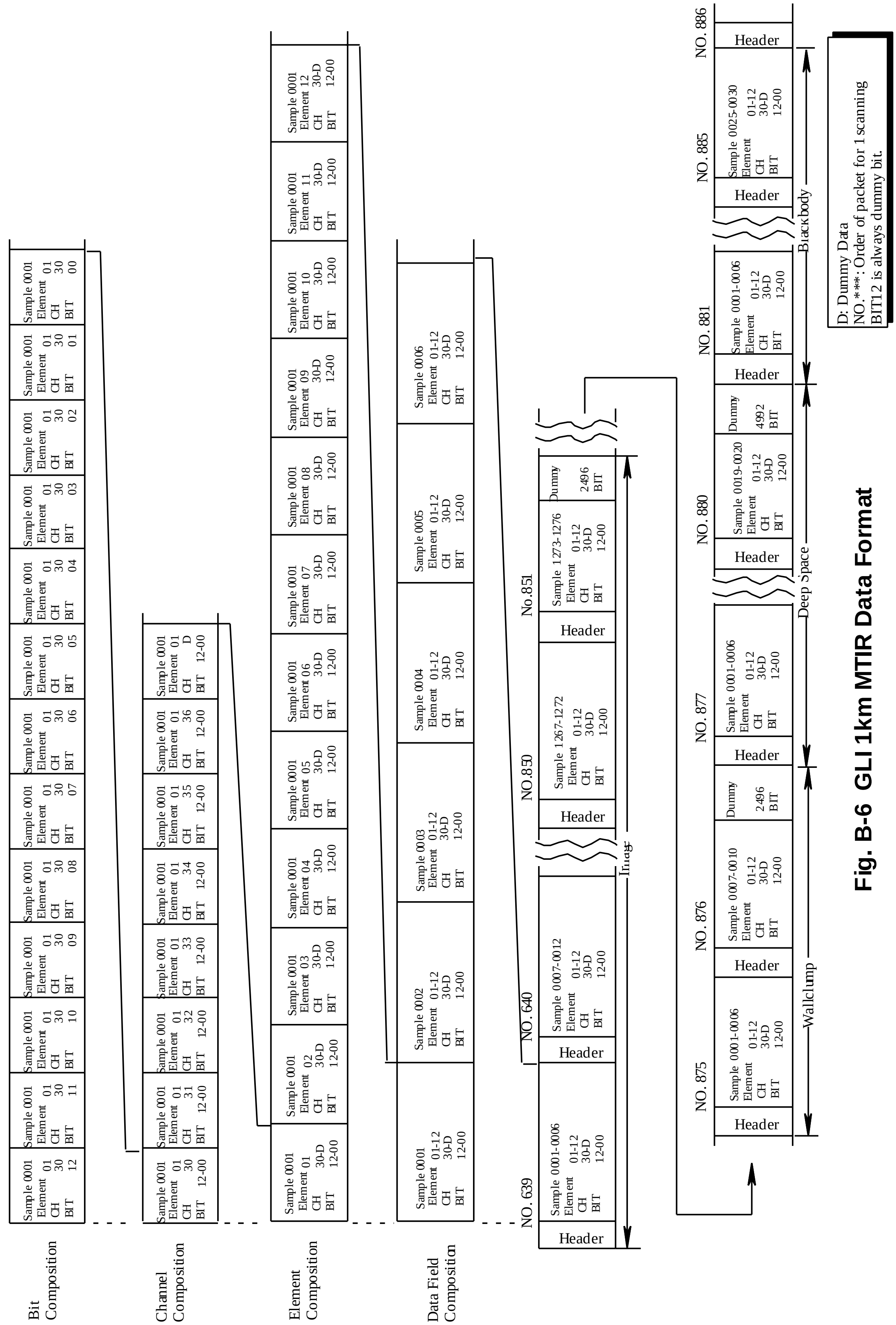


Fig. B-6 GLI 1km MTIR Data Format

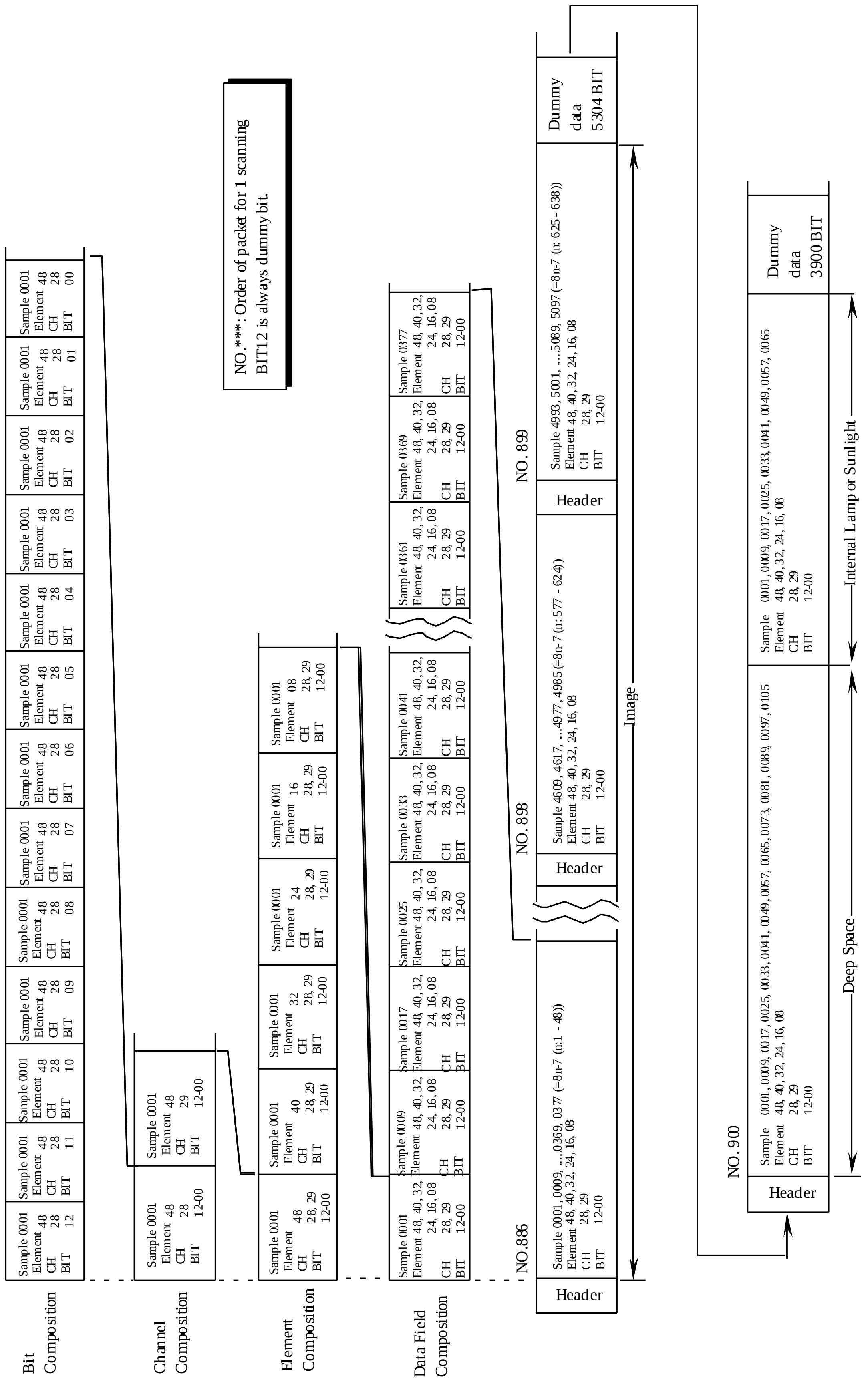


Fig. B-7 GLI 250m VNIR/SWIR Data Format (2km sampling data)

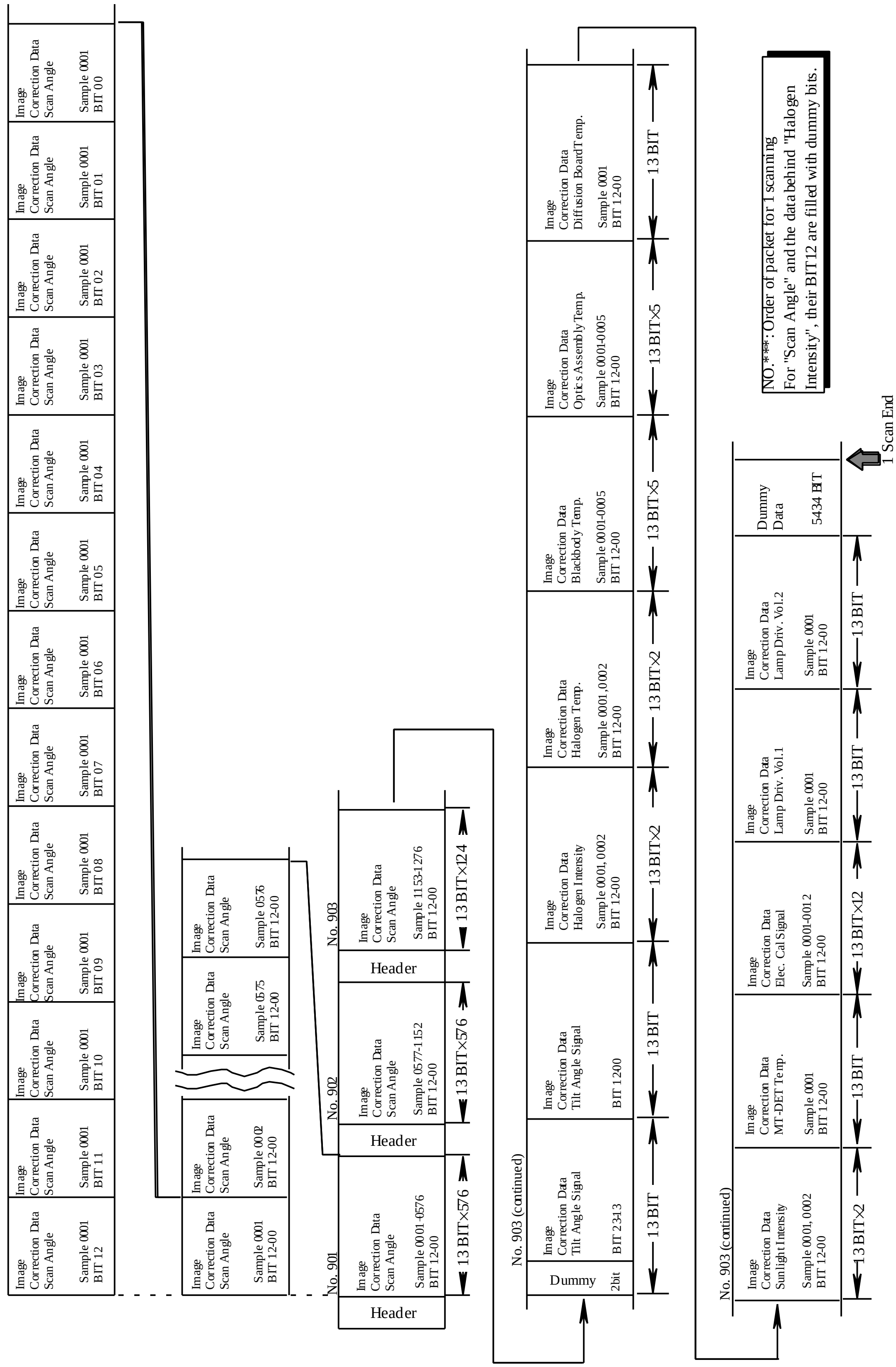


Fig. B-8 GLI Image Correction Data Format

Appendix C Acronyms and Abbreviations

ADEOS-II	:	Advanced Earth Observing Satellite-II
AGSID	:	ADEOS-II to Ground Stations Interface Document
AMSR	:	Advanced Microwave Scanning Radiometer
ANT	:	Antenna
AOCE	:	Attitude and Orbit Control Electronics
AOCS	:	Attitude and Orbit Control Subsystem
AOS	:	Acquisition of Signal
APE	:	Antenna Pointing Electronics
APID	:	Application Process Identifier
APM	:	Antenna Pointing Mechanism
ASF	:	Alaska SAR Facility (University of Alaska)
BAT	:	Battery
BCCU	:	Battery Charge Control Unit
C&DH	:	Communication and Data Handling Subsystem
CADU	:	Channel Access Data Unit
CCITT	:	International Telegraph and Telephone Consultative Committee
CCSDS	:	Consultative Committee for Space Data Systems
COMB	:	Combiner
CP_PDU	:	CCSDS Path Protocol Data Unit
CU	:	Central Unit
DCS	:	Data Collection System
DIP	:	Diplexer
DMS	:	Dynamics Monitoring System
DRTS	:	Data Relay and Tracking Satellite
DT	:	Direct Transmission (Subsystem)
DTL	:	Direct Transmission subsystem for Local Users
Eb/No	:	Information Bit Energy to Noise Ratio
EOC	:	Earth Observation Center (NASDA)
EPS	:	Electrical Power Subsystem
E_PDU	:	Encapsulation Protocol Data Unit
ESA	:	Earth Sensor Assembly
FSSE	:	Fine Sun Sensor Electronics
FSSH	:	Fine Sun Sensor Head
GLI	:	Global Imager
GPS	:	Global Positioning Satellite
HYB	:	Hybrid Circuit
ILAS-II	:	Improved Limb Atmospheric Spectrometer-II
INT	:	Integration Hardware Subsystem
IOCS	:	Inter-Orbit Communication Subsystem
LAV	:	Latch Valve
LOS	:	Loss of Signal
MDP	:	Mission Data Processing Subsystem
MDR	:	Mission Data Recorder

MMO : Mission operation Management Organization
MOD : Modulator
M_PDU : Multiplexing Protocol Data Unit
MRT : Mission Real Time
MTQ : Magnetic Torquer

NASA : National Aeronautics and Space Administration
NASDA : National Space Development Agency of Japan
NESDIS : National Environmental Satellite Data and Information Service
NOAA : National Oceanic and Atmospheric Administration
NTSK : NASDA Transportable Station-Kiruna

OCL : Operations Coordination Letter
ODC : Ordnance Controller

PCA_PDU : Physical Channel Access Protocol Data Unit
PCD : Payload Correction Data
PCM : Pulse Coded Modulation
PCU : Power Control Unit
PDL : Solar Array Paddle Subsystem
PDM : Paddle Drive Mechanism
POLDER : Polarization and Directionality of the Earth's Reflectances

RCS : Reaction Control Subsystem
RIU : Remote Interface Unit
R-S : Reed-Solomon
RW : Reaction Wheel
RX : Receiver

SHNT : Shunt
SPSS : Solar Paddle Sun Sensor
SSA : S-band Single Access
STR : Structure Subsystem
SW : Switch Circuit

TACC : Tracking And Control Center (NASDA)
TACS : Tracking And Control Station (NASDA)
TBD : To Be Determined
TCS : Thermal Control Subsystem
TEDA : Technical Data Acquisition Equipment
TFG : Transfer Frame Generator
THR : Thruster
TKSC : Tsukuba Space Center (NASDA)

UHF : Ultra High Frequency
UPC : Up Converter
USB : Unified S-Band

VMPDE : Valve, Magnetic Torguer and Paddle Drive Electronics
VMS : Visual Monitoring System

WDE : Wheel Drive Electronics
WFF : Wallops Flight Facility

XPDR : Transponder