IAF-90-130

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Kazuhiko Yoneyama, Director
Takeshi Masuda, Deputy Director
Norikazu Hara, Senior Engineer
Shigeru Usuki, Engineer
Earth Observation Satellite Group, NASDA
2-4-1 Hamamatsu-cho, Minato-ku, Tokyo 105, JAPAN
(Tel) 03-5470-4111, (Telex) J28424, (Fax) 03-432-3969

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ABSTRACT

ADEOS is a large earth observing satellite which carries two core sensors and six Announcement of Opportunity (AO) sensors. The objective of these sensors are global observation of land, ocean and atmosphere. ADEOS has another mission to develop some technology required for the future platform era. Inter Orbit Link (IOL) is one of them and will be established between ADEOS and ETS-VI for the first time in Japan, experimentally though. After launching of EDRTS, all of the observation data of ADEOS will be transmitted by the IOL as a real time basis, demonstrating that IOL is a key technology for future platform era. ADEOS accommodates conventional and reliable X band system also for the direct mission data transmission to the ground station. The science data from these sensors are properly multiplexed and recorded efficiently in the ADEOS to secure the global coverage. ADEOS is scheduled to be launched early 1995 by the H-II launch vehicle from Tanegashima Space Center. NASDA has just started the ADEOS phase C study.

1. INTRODUCTION

NASA Polar Orbiting Platform (NPOP) and ESA Polar Orbiting Platform (EPOP) are Planned in parallel with the Space Station program. In Japan, Japanese Polar Orbiting Platform (JPOP) is expected to be launched not far later than NPOP and EPOP. ADEOS is considered to be a stepping stone from MOS-1 & ERS-1 to JPOP. At first, it was planned to carry two NASDA sensors and one or two foreign sensor(s) with some technology demonstration required for platform type spacecraft. In addition, to share the launch cost of H-II, partner payload was assumed. ADEOS at first was a 2.5 ton satellite.

Having many proposal for sensors on board ADEOS from domestic and overseas organization, NASDA has selected six sensors in addition to two core sensors. Its weight and volume increased significantly and no more partner payload was allowed. ADEOS has changed its nature from technology development satellite to the quasi-operational earth observation satellite. Now people envisage the observation data set derived from ADEOS could be established for the worldwide scientists. ADEOS is now an international satellite by which Japan can contribute to the mission to planet earth or "Global Change" program.

2. MISSION OBJECTIVE

ADEOS mission objectives were summarized as follows at the first conceptual phase.

(1) To verify function and performance of two NASDA sensors.
(2) To provide the earth observation data following MOS-1 and ERS-1.
(3) To promote the international cooperation in the earth observation field by offering the opportunity of the other sensors on board ADEOS to foreign and domestic organizations not only offering earth observation data.
(4) To develop some technology required future platform era such as Inter Orbit Link (IOL).

Now ADEOS objectives can be simply specified as follows;

(1) To monitor the global change of the earth environment by operating eight sensors.
(2) To develop user equipment for IOL and some other technology required for future platform.

3. SENSORS ON BOARD

Followings are the brief description of all sensors on board ADEOS. Table 1 summarize the sensor requirements for system interface.

Ocean Color and Temperature Scanner (OCTS) scans earth's surface using a rotating scan mirror in the direction perpendicular to the satellite flight direction. In order to minimize sun glitter, the field of view must be pointable on command. OCTS has such tilting mechanism along track to either side of nadir. OCTS has 12 bands from visible to near infrared and 700 m resolution in 1400 Km swath width. OCTS is one of two core sensors NASDA is responsible to develop.

Advanced Visible and Near-Infrared Radiometer (AVNIR) is an electric scanning radiometer that observes solar light reflected by earth's surface. It is equipped with pointing mechanism that selects observing path arbitrarily in the cross track direction of ADEOS flight. AVNIR has a multiple band system and a panchromatic band system. Multiple band system has four band with 16 m resolution for 80 Km swath width. The panchromatic band system has 8 m resolution. These can be operated same time. AVNIR is another core sensor NASDA is developing.

NASA Scatterometer (NSCAT) is an active microwave radar(14 GHz) used to measure near surface wind speed and direction over the global ocean. Normalized radar cross-section is measured at 3 azimuth angles in each of two 600 Km wide swaths. At a spatial resolution of 50 Km, wind speed accuracy is (the greater of) 2 m/s or 10%, and direction accuracy is 20 deg. NSCAT is proposed by NASA-JPL.

Total Ozone Mapping Spectrometer (TOMS) is a mapping ultraviolet polychromator which measures atmospheric albedo at six wavelengths absorbed by ozone and sulfur dioxide, and reflected by clouds and the underlying surface. The albedo is

Table 1 Description of Sensor Characteristics

Item \ Sensor	AVNIR	OCTS	NSCAT	TOMS	POLDER	IMG	ILAS	RIS
Observation Wave Length (μm)	multi 0.40-0.50 0.52-0.62 0.62-0.72 0.82-0.92 pancro. 0.52-0.72	0.412 0.440 0.490 0.520 0.565 0.665 0.765 0.865 3.70 8.50 11.0 12.0	13.995 (GHz)	0.3040 0.3125 0.3250 0.3175 0.3326 0.3600	0.443 * 0.490 0.520 0.565 0.670 * 0.765 0.880 * 0.950 * mark: Polalization	4-15 sweep	Ch.1 6.0-6.8 7.3-11.8 Ch.2 0.753- 0.784	0.3-14
IFOV (μrad) (m)	20 10 16 x168x 8	850 700x700	25 x 25 (Km)	3 deg.	0.37 deg. 5x 5 [Km]	0.60 deg. 8 x 8 (Km)	Alti. Resol. 2 (Km)	N/A
Scan Method	Electronic	Rotating Mirror	Electronic	Rotating Mirror	Electronic	Linear Motio Mirror	Electronic	N/A
Other Functions	Pointing Mechanism	Tilting Mechanism	---	---	---	Image Mot. Compens.	2 Axis Gimb. Mirror	---
Detector	Silicon CCD Array	Silicon,InSb, HgCdTe	---	Photo-multiplier	Silicon CCD Area Array	InSb, HgCdTe	Pyroelectric PD Array	---
Pixels	5000 10000	10	---	---	550x288	---	44	---
Weight (Kg)	250	320	237	20	33	115	118	50
Power (W)	230	315	275	22	40	150	90	0
Data Rate (Kbps)	60,000 x 2	3,000	3.178	0.5	900	600	500	0
Dimention (m)	2.15x1.x1. 0.9x1.2x.25	2.x1.25x1.1 2.0x0.8x0.8	.97x.7x.25 .65x.47x.25 .33x.31x.25 3.17x.16x.15(x6)	.21x.24 x.51 .15x.20x .36	.45x.45x.34	1.0x.8x .50	.56x.78x.54 (x 2) .22x.22x.25	.62x.90 x1.37
Field of View - Obs. (deg)	90 x 6	140 x 60	100 x 6 [x 2 x 6]	3 x 112	110 x 110	10 x 5	30 x 20 (x 2)	30 Cone
Field of View - Cali. (deg)	Sun 13 Cone	Sun, Space 25 x 30	----	Sun 0 - 25	----	Space 2 Cone	----	----
Field of View - Heat dessip.	Yes	Yes	Yes	----	----	Yes	Yes	----
Operational Time	Day	Day/Night	Day/Night 24 Hours	Day/Night 24 Hours	Day/Night	Continuous 3 D/13 D	Dawn /Sunset	Day/Night
Observation Object	Land	Ocean	Ocean Atmosphere	Atmosphere	Ocean Atmosphere	Atmosphere	Atmosphere	Atmosphere
Development Organization	NASDA	NASDA	NASA	NASA	CNES	MITI	EA	EA

converted to total ozone and column sulfur dioxide amounts by algorithm developed at GSFC. TOMS is proposed by NASA GSFC.

Polarization and Directionality of the Earth's Reflectances (POLDER) observes bidirectionality and polarization of the solar radiation reflected by the atmosphere. POLDER consists of a telecentric lens, a rotating wheel with filters and polarizers, a matrix Charge Coupled Device (CCD) detector, and electronics for image digital processing and motor. Polder recognizes eight spectral bands, three of which are scrutinized on the polarization. POLDER is proposed by CNES-LERTS (Toulouse Space Center).

Interferometric Monitor for Greenhouse Gases (IMG) observes carbon dioxide, methane, nitrogen dioxide and other greenhouse effect gases in the air. IMG is a Michelson interferometer which scans the mirror in the direction of light axis at the speed of 1 mm/s. In addition, IMG has Image Motion Correction (IMC) mirror which has two axis gimbals for the targetting same point during the mirror scan. IMG is proposed by the Ministry of International Trade and Industry (MITI) of Japanese government.

Improved Limb Atmospheric Spectrometer (ILAS) observes the limb atmospheric micro-ingredient over high latitude area. ILAS consists of two sets of sensor unit and one electronics unit. One sensor unit is used for sunrise, another for sunset. Each Sensor unit has two telescopes. 12 cm diameter one has 44 elements multi pyro electric array sensors for two infrared bands. 3 cm diameter one has photo diode array sensitive to another infrared band. This sensor is proposed by the Environment Agency (EA) of Japanese government.

Retroreflector In Space (RIS) reflects laser beam transmitted from a ground station to measure ozone, fluorocarbon, carbon dioxide, etc. by laser beam absorption technique. RIS is a Coner Cube Reflector (CCR) of which effective diameter is 50 cm. It will be equipped with debris shield in front of flight direction. RIS is proposed by also EA.

In addition to eight sensors above, ADEOS carries Technical Engineering Data Acquisition equipment (TEDA) to monitor space environment. TEDA is a set of several small scale monitors such as Single Event Upset Monitor (SUM), Heavy Ion Telescope (HIT), Dose Monitor (DOM) and so on. Data Transmission for Local users (DTL) is a UHF transmitter to send the thinned out OCTS data in real time for the local users like fishing boats.

4. PLATFORM BUS TECHNOLOGY

Inter Orbit Link

It may be the most urgent and important issue for Japan who has no foreign stations over the world to establish Inter Orbit Link (IOL) system. Inter orbit link consists of S band and Ka band system. Ka band is also used for the feeder link which is the link between a data relay satellite and a ground station. The frequency has been chosen based on the recommendation by the Space Network Interoperability Panel (SNIP) for the future cooperation in this field.

IOL communication will be conducted between ADEOS and Engineering Test Satellite - VI (ETS-VI) for the first time in JAPAN. Because of small antenna of ETS-VI, it is limited to the low rate data transmission. After launching of Experimental Data Relay Satellite (EDRTS), which is expected to be one or two years after ADEOS launching, ADEOS will be able to send most of

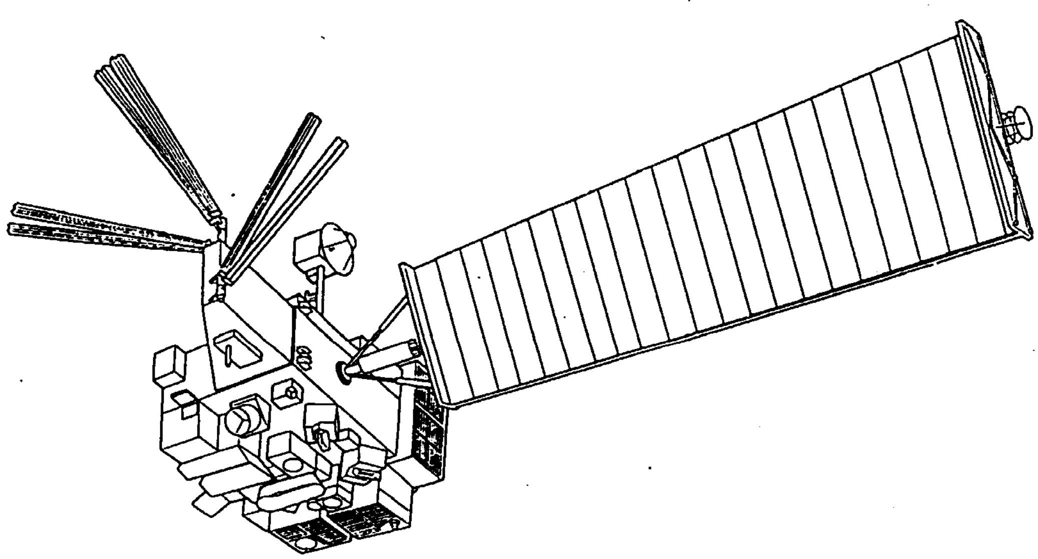

Fig.1 ADEOS Artist's view

mission data in real time covering almost 66 % of time.

ADEOS is to be installed an omni antenna also to its DRTS antenna mast. It is used for the backup measure to establish IOL. The pointing by narrow beam made by parabola antenna is considered difficult. As installing the both antenna for IOL makes the ADEOS system somewhat complicated, the necessity of the omni antenna should be discussed more.

Module & Unit Concept

ADEOS consists of Mission Module and Bus Module. All of the mission sensors are installed in the mission module. Bus module carries bus units. In principle, sub-system components are installed in one unit box. Most of sensors are also composed of one or two unit box(es) to have the clear interface with ADEOS system. Each unit box should have the independent heat control system so as to give the free hand to the ADEOS system design and integration. In the future, platforms are serviced in orbit. That is, repair, exchange, refuel, inspection, etc. are done in space. Each components or sub-system must be designed so as to be serviced easily in space, as this was proved by Solar Maximum Mission (SMM). ADEOS's unit boxes are, however, not serviced in space. Therefore, these are bolted to the module structure forever, but with minimum number of interface bolts and with minimum number of connectors. Thanking this concept, every unit can be removed for special inspection or testing, for example, even in the launch site.

ADEOS module structure utilizes many vibration suppression materials to reduce vibration response. We hope sensors on board ADEOS will enncounter less severe environmental condition than usual in spite of its large structure. In the future we may not be able to test the very large platform with its whole configuration. It would become difficult to simulate environmental condition. The testing cost will be raised exponentially versus its scale. Someday we have to decide to launch without whole scale test to reduce launch cost and development schedule. Although the system test cannot be eliminated on the ADEOS, we believe ADEOS's unit & module concept will be useful for this purpose in the near future.

Autonomous Operation

The more mission sensors are installed, the more complicated operational work is necessary. To relieve this situation, platform should be operated automatically as far as our technology allows. It is desirable for every mission unit to operate by itself with minimum control signal.

ADEOS bus provides every sensor all of the necessary utility with good field of view and moderate vibration condition during launch phase, like a very comfortable condominium. Disposal of heat is not included in case of ADEOS, though. The utility means providing power, data transmission to the ground, transferring control signal and keeping orbit and attitude within the allowance. In addition, ADEOS bus provides the Payload Correction Data (PCD) through Remote Interface Unit (RIU) to every sensor. PCD consists of the data such as time, orbit, attitude, attitude rate, equator crossing mark. Each sensor should include PCD in its mission data if it is necessary for mission data analysis.

Future platform must have on board orbit determination system. In other word, she must be able to know by herself where she is. ADEOS, however, has no fancy instrument for this purpose. Instead the orbit element is determined by ground based tracking system as it is and transmitted to the ADEOS once per every a few days or whenever its current orbit is calculated.

ADEOS operational plan should utilize its orbit speciality, that is sun synchronous recurrence. The orbit number is defined as the revolving number of the earth counting up by one when ADEOS cross the ascending node. Although the orbit number does not appear consecutively in the World Reference System (WRS), it can be found by simple algorithm. The relation between path number and orbit number is clear and fixed once ADEOS is launched. Each round takes around 6055 sec. If we reset the timer zero every time she crosses the equator from south to north, combination of the timer value and the orbit number equals to the absolute time once ADEOS is launched. This combination gives us easily rough idea where ADEOS is. Therefore, the sensor operation will be easily planned based on this combination eliminating a possibility of human error. ADEOS can store the seven days of sensor operational plan in the Random Access Memory (RAM) of On Board Computer (OBC), which supplement the capability of Central Unit(CU) explained later.

Automatically keeping the orbit within tolerance is planed at first to reduce operational work at ground station. This capability is eliminated to reduce development cost for ADEOS, because of the necessity of keeping orbit is not so often through the experience of MOS-1. The most of all users of each sensors are scientist. We found that they like to know the exact orbit element during sensor operation rather than to be assured that the orbit is always within some limit. As a consequence, the orbit of ADEOS will be maintained within ± 5 Km of the WRS by command from Tracking And Control Center (TACC).

Flexible Solar Paddle

Solar paddle (PDL) is a critical part giving single point failure for ADEOS and yet adopting very challenging technology, flexible paddle, GaAs solar cell and deployment mechanism. The flexible paddle will be extensively used for the platform in the future, because of its high efficiency, compactness and retractability. The efficiency is not necessarily better than light rigid type paddle for the relatively moderate power of 4.5 KW required for ADEOS. GaAs solar cells are to be used for expanding its future possibility. Newly developed HIMAST and Hingeless Mast are the competitive candidates for deployment mechanism of ADEOS PDL. The dimension of ADEOS PDL is around 15 m long and 3 m width.

5. ORBIT

The ADEOS orbit shown in Table 2 was chosen convenient for the observation by two core sensors during conceptual phase and frozen when NASDA issued the Announcement of Opportunity for sensors on board ADEOS.

Table 2 Typical orbital parameters

Type	Sun-Synchronous Sub-recurrent
Altitude	796.75 Km
Inclination	98.59 deg.
Period	100.92 min.
Recurrent Period	41 days (or 585 revolution)
Local Time	10:30 ± 15 min. AM (at descending node)

6. ADEOS SYSTEM

SPECIFICATION

Table 3 shows main specification of ADEOS. Total sensors weight reaches 1.2 ton.

Table 3 Main Specification of ADEOS

Weight	3.5 ton
Power	4.5 KW (EOL)
Life	3 years
Attitude Control	Three-axis stabilized zero momentum strap-down
Data Transmission	Direct transmission and Inter Orbit Communication
Launch Vehicle	H-II (5m ϕ fairing)
Launch Site	Tanegashima Space Center
Launch Date	Early 1995

System Block Diagram

Fig. 2 shows very simplified ADEOS System Block Diagram and Fig. 1 in the previous page shows artist's view of ADEOS in Orbit.

Communication & Data Handling (C&DH) system is composed of the Unified S Band (USB) system and satellite data bus system. As these are critical

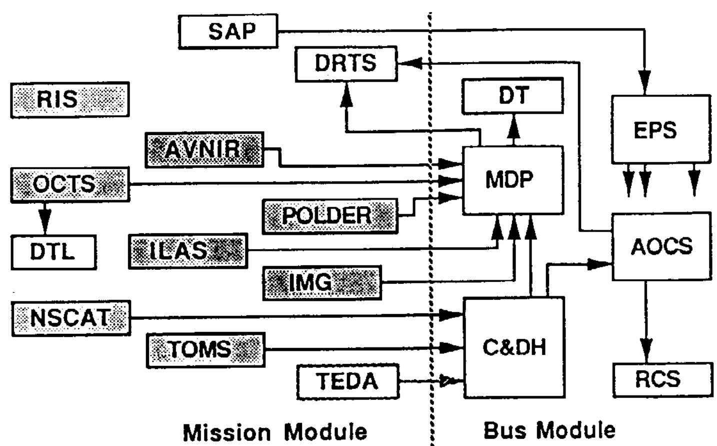

Fig.2 ADEOS System Block Diagram

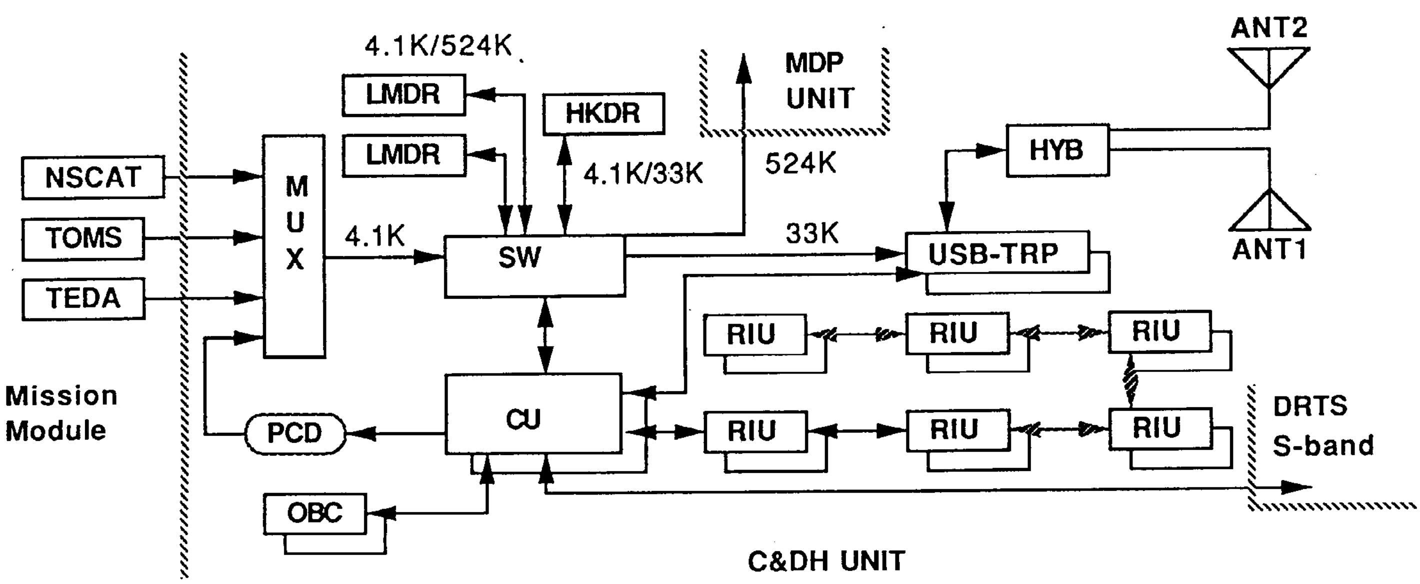

Fig. 3 C&DH Unit Block Diagram

systems for ADEOS itself, C&DH is a full redundant system.

ADEOS is controlled from ground mainly by the USB system. The command bit rate is 500 bps and real time House Keeping (HK) telemetry bit rate is 4096 bps. Although the band width allowed for the downlink is not so wide, 32 Kbps of playback HK telemetry data is also carried on the one of two sub-carriers in the same time sending real time HK telemetry data and ranging tone. Instead of sending playback HK telemetry it may be switched over the combination of real time low speed mission data, that is, NSCAT, TOMS and TEDA.

Satellite data bus system consists of Central Unit (CU) and 16 pairs of Remote Interface Units (RIUs). The CU distributes the command to mission unit or subsystem through RIU. Commands are received by the USB transponder or generated by the On Board Computer (OBC). CU can also edit the House Keeping (HK) telemetry data gathered through RIUs and output it to the USB transponder.

For the automatic operation of the mission sensors, OBC will assist the CU. Typical pattern of seven days operation program will be stored in the memory of OBC. This program will be executed as the time goes by. OBC will output the Payload Correction Data (PCD) mentioned before. Fig. 3 shows the block diagram of C&DH unit.

AOCS

The attitude control system of ADEOS is called Attitude and Orbit Control System (AOCS). This is a zero momentum strap-down three axis attitude control system. Its basic design comes from the ETS-VI rather than ERS-1. The Attitude and Orbit Control Electronics contains redundant CMOS gate-array Main Processing Unit (MPU) which is equivalent to i8086 16 bits CPU. This rad-hard gate-array has been developed for ETS-VI. The attitude control accuracy and stability are less than 0.3 deg. and 0.003 deg/sec respectively for each axis. Other main components are Reaction Wheel (RW), Inertia Reference Unit (IRU), Magnetic Torquer (MTQ). The feed forward control technique is to be incorporated for the DRTS antenna gimbaling to attain sufficient stability. Fig. 4 shows the AOCS unit block diagram.

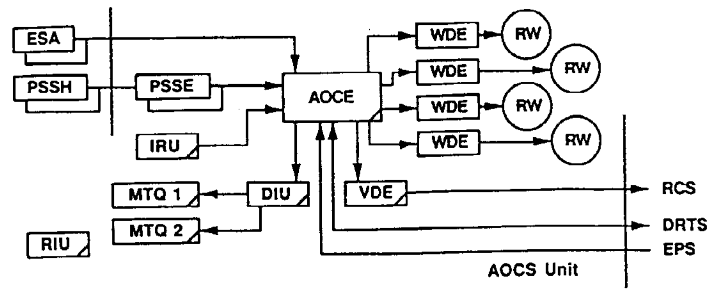

Fig. 4 AOCS Unit Block Diagram

EPS

ADEOS has enough power so as to operate most of sensors on board without restriction by power. Single floating bus is selected for ADEOS.

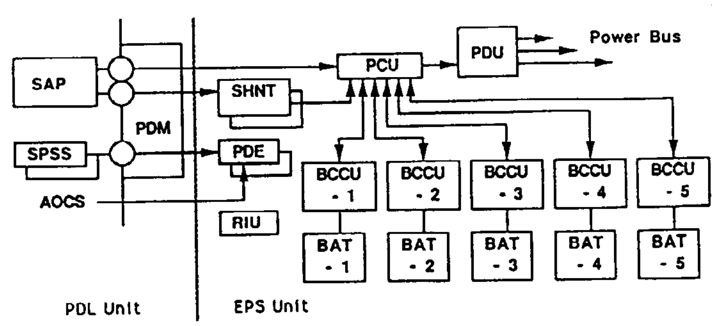

Fig. 5 EPS Unit Block Diagram

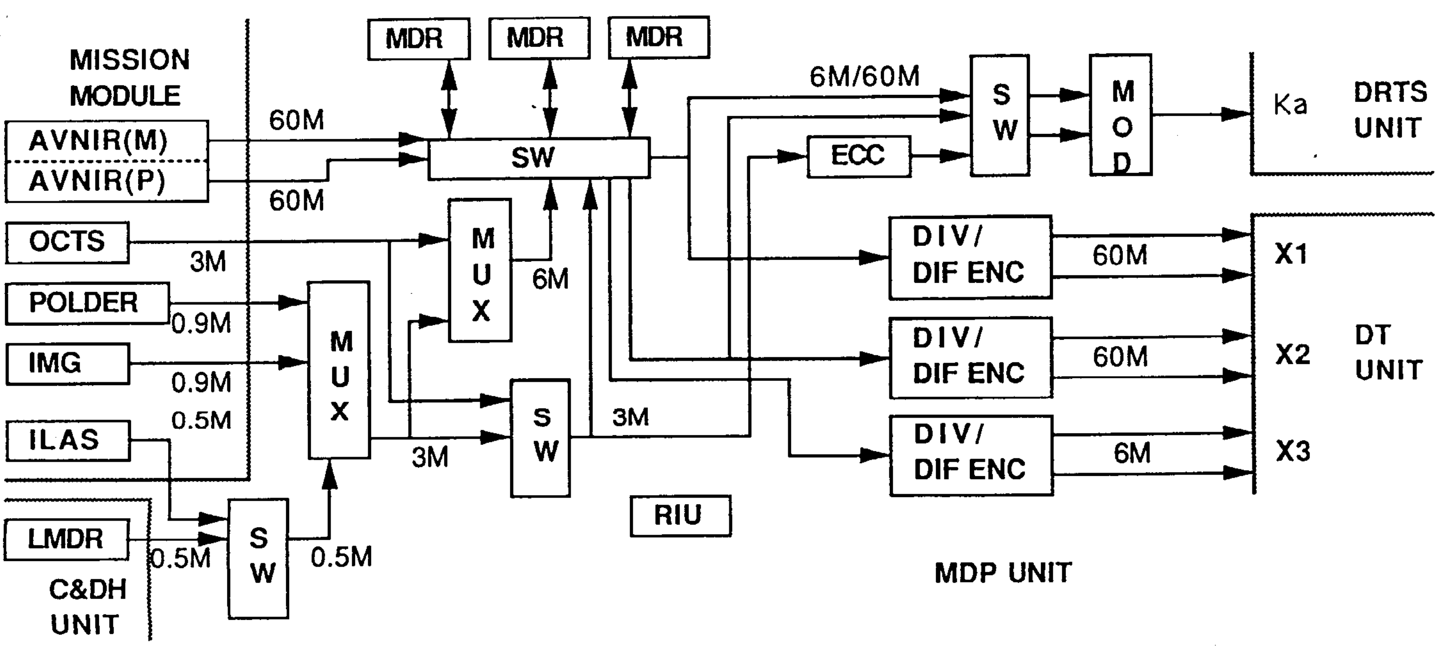

Fig.6 MDP Unit Block Diagram

Therefore every unit must have own DC/DC converter or regulator. The voltage is around 50 volt. Five sets of 35 Ah NiCd battery cell is installed. The Depth Of Discharge (DOD) is kept within 20 % level for three years of mission life. Fig. 5 shows EPS unit block diagram.

Mission Data Processor & Communication (MDP&C) is responsible for the transmission of the all of the observation data to the ground station. MDP&C consists of Mission Data Processor(MDP), Direct Transmission (DT) and Data Relay and Tracking Satellite equipment (DRTS).

As shown in the Table 1 Description of Sensors, eight sensors are operated on the different place at different time. The data rate generated by these sensors spans from very low rate of TOMS to very high rate of AVNIR. It is convenient to group these mission data into high, middle and low rate one. The high rate group consists of channel 1 (multi band) and channel 2 (panchromatic band) of AVNIR. These can be operated in the same time. The middle rate group consists of OCTS, POLDER, IMG and ILAS. The low rate group consists of NSCAT, TOMS and TEDA.

Mission Data Processor (MDP) has multiplexers (MUXs) and Mission Data Recorders (MDRs) for compiling several kinds of mission data and storing before sending them to ground station. MDRs have three recording speed, 3, 6 and 60 Mbps for efficient collecting Observation data. On the contrary, the playback speed is only one, 60 Mbps. MDRs play an important role for collecting global data of middle rate group taking advantage of the capability of dumping function not only storing data, because visible time from ground station is very limited. From Hatoyama Earth Observation Center we can contact ADEOS around four times of ten minutes period per day by direct transmission link.
The data of low rate group are firstly compiled and then recorded by the Low speed Mission Data Recorders (LMDRs) installed in the C&DH unit box. LMDRs are exceptionally installed in the C&DH unit box. This is because MDP unit box is full and LMDRs and HKDR are same hardware and can backup each other. The low rate group data stored in the LMDR is played back at 128 times of recording speed of 4096 bps. The output data rate is compatible with the data rate of ILAS. As ILAS observes only dawn and sunset, this data stream channel can give away to the playback of LMDR. Fig. 6 shows the MDP unit block diagram.

Direct Transmission (DT) is a redundant X band system for mission data transmission. X1 and X2 bands can carry 60 Mbps each by 40 W output power of Solid State Power Amplifier (SSPA) while X3 carries 6 Mbps by 5W SSPA. X3 is single but systematically backked up by X1 and X2.

NSCAT and TOMS data are required the near real time data acquisition. It means that foreign ground stations are necessary before the EDRTS is launched. If NASA's or NOAA's station are available for ADEOS, LMDR will be played back over these stations. These data is transmitted using the X3 band. Fig. 7 shows the DT unit block diagram.

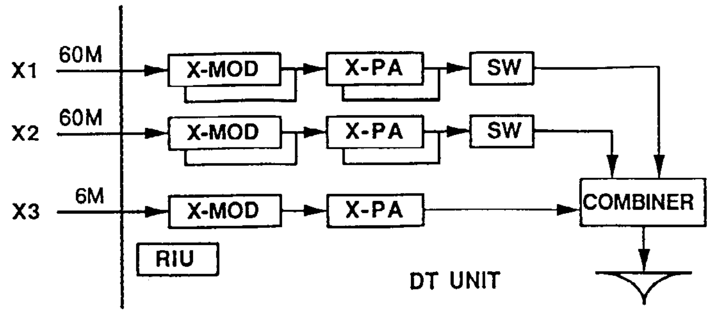

Fig. 7 DT Unit Block Diagram

Data Relay and Tracking Satellite (DRTS) sub-system is the most important experimental equipment on the ADEOS. This is the user system for Ka band and S band Inter Orbit Link which communicate with ETS-VI and EDRTS. Ka band TWTs have 20 W of output power. Around 1.3 m ϕ parabola antenna is equipped with ADEOS. DRTS is an experimental system and has no redundant except TWTs. Fig. 8 shows DRTS unit block diagram.

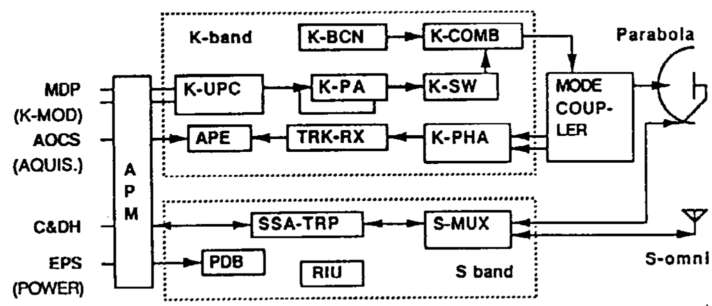

Fig. 8 DRTS Unit Block Diagram

Fig.9 shows the block diagram of the ADEOS Reaction Control System (RCS). This is a conventional full redundant system equipped with 1 N thrusters, 20 N thrusters and relatively abundant fuel stored in the three of 550 mm ϕ spherical tanks. RCS is installed afterward of flight direction ADEOS as a unit of bus module.

7. FREQUENCY USED

Table 4 shows the all radio frequency ADEOS uses. In principle all of the mission data are transmitted using X-band. The Unified S Band (USB)

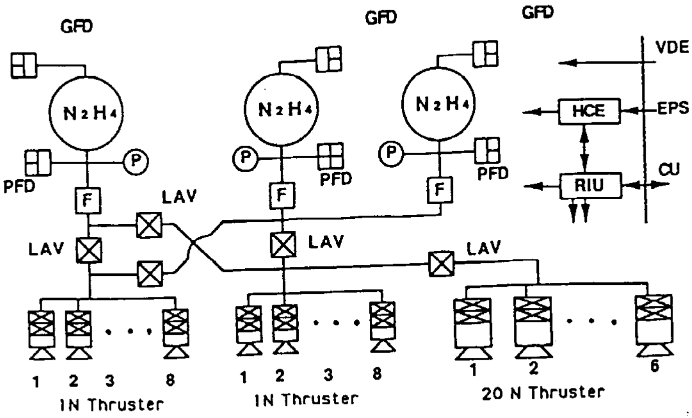

Fig. 9 RCS Unit Block Diagram

is used for the ADEOS control, that is, Telemetry, Tracking and Control (TT&C). Ka band and S band are used for Inter Orbit Link. Ka band can carry massive data and will be able to supersede the X band system. It is much easier to establish IOL for parabola antenna to point each other satellite by S band than Ka band. Therefore, S band IOL can supersede the USB. In case of ADEOS, IOL system will be operated only for experimental purpose. Especially, the data transmission via the IOL between ETS-VI and ADEOS is extremely limited due to the small antenna of ETS-VI. EDRTS will be launched one or two year after ADEOS launching. If EDRTS antenna does not have the diameter of 5m ϕ, the data transmission of 120 Mbps will be difficult. In case of 3.5 mϕ antenna for EDRTS, 66 Mbps is possible for ADEOS mission data transmission. The design of EDRTS is affected by the recommendation of Space Network Interoperability Panel (SNIP). In case of ADEOS, the data transmission by S band command is restricted to the very low level in account of the omni antenna. We are not sure now the necessity of this omni antenna for the future platform. If we need not use the omni antenna, S

Table 4 Frequency Plan for ADEOS

Link	Frequency		Data Rate	Modulation
ADEOS → Ground	USB	2220 MHz	4.1 Kbps 33 Kbps	PCM(Biø-L)-PSK-PM PCM(Biø-L)-PSK-PM
	X	8150 MHz 8250 MHz 8350 MHz	60 Mbps 3 Mbps 60 Mbps	QPSK QPSK QPSK
	UHF	465.00 MHz	20 Kbps	PCM(Biø-L)-PM
Ground → ADEOS	USB	2044.25 MHz	500 bps	PCM(NRZ-L)-PSK-PM
ADEOS → ETS-VI	S	2287.5 MHz	4.1 Kbps	SQPN
	Ka	25.8505 GHz	3 Mbps	BPSK
		25.298 GHz	(beacon)	—
ETS-VI → ADEOS	S	2106.4 MHz	125 bps	UQPSK
	Ka	23.3875 GHz	(beacon)	—
ADEOS → EDRTS	S	2287.5 MHz	37 Kbps	SQPN
	Ka	25.8505 GHz	120 Mbps	QPSK
		23.3875 GHz	(beacon)	—
EDRTS → ADEOS	S	2106.4 MHz	125 bps	UQPSK
	Ka	23.3875 GHz	(beacon)	—

Table 5 Operational Mode for Middle & High Rate Sensors and MDR

DATA Source	AVNIR-M	60	O	**O**	--	**O**	O	--	O	--	O	O	O	--	--	--	--	--	--
	AVNIR-P	60	O	**O**	--	**O**	O	--	O	--	O	O	O	--	--	--	--	--	--
	OCTS	3	**O**	**O**	**O**	--	--	--	**O**	**O**	**O**	--	--	--	**O**	**O**	--	--	--
	POLDER	0.9	**O**	**O**	**O**	--	--	--	**O**	**O**	--	**O**	--	--	**O**	--	**O**	O	--
	IMG	0.9	**O**	**O**	**O**	--	--	--	**O**	**O**	--	**O**	--	--	**O**	--	**O**	O	--
	ILAS /LMDR	0.5	**O**	**O**	**O**	--	--	--	**O**	**O**	--	**O**	--	--	**O**	--	**O**	--	**O**
	MDR1	60	O	--	**O**	--	O	**O**	--	O	--	--	--	O	--	--	--	--	--
	MDR2	60	O	--	**O**	--	O	**O**	--	O	--	--	--	O	--	--	--	--	--
	Total Data Rate	M bps	126	126	126	120	120	120	66	66	63	63	60	60	6	3	3	0.9	0.5
Processing	EOC Visible	X band 1~3	G1	G2	G3	G4	G5	G6	G7	G8	--	--	G11	G12	G13	--	--	--	--
	ETS-VI Visible	Ka band	--	--	--	--	--	--	--	--	--	--	--	--	--	E14	E15	E16	E17
	EDRTS Visible	Ka band	--	--	--	D4	D5	D6	D7	D8	--	--	D11	D12	D13	--	--	--	--
	Unvisible Record	MDR	--	--	--	R4	--	--	R7	--	R9	R10	R11	--	R13	R14	R15	--	--

O : Operation O : Either one operation -- : Cease band IOL is also useful for replacing USB. We have confirmed all of these link except a few experimental one has appropriate link margin in consideration of the data transmission and the Power Flux Density (PFD) limitation.

8. OPERATIONAL MODE

The ADEOS operational mode is recognized by the combination of sensor operation and the data processing. In other word, the combination of operating sensors and data processing method defines the operational mode. The data source are sensors and playback operation of data recorders. The media of data processing are to transmit them to the ground station directly or via IOL, and to record by data recorders. Table 5 shows the operational mode for middle and high rate sensors and MDRs. The low rate group sensors can be operable any time and be recorded by LMDR. G2, G3, R7 are considered typical operational modes. From E14 to E17 and from D4 to D6 are experimental mode. ADEOS has not enough link margin for these mode. G13 mode is effective to the near real time data acquisition for the NASA sensors if foreign ground stations are available. G13 mode means OCTS, POLDER, IMG and playback of LMDR are transmitted by the X3 band. G3 mode requires the highest power because two set of MDR are in playback operation and X1, X2 and X3 are active, AVNIR is at stand-by though.

9. DEVELOPMENT SCHEDULE

Table 6 shows the ADEOS development Schedule. This is very tight schedule to keep the launch date of early 1995, because of several long lead time components. Not only the flight model but also the development models must be delivered to NASDA in time.

10. CONCLUSION

ADEOS system described here can satisfy all of the mission requirement. Many sensor data are multiplexed and compressed using tape recorder before transmitted by the X band system. The ADEOS phase C study has just begun for shaping up its configuration. Science teams corresponding to the each sensor on board ADEOS are being organized now for the analysis and evaluation of the data.

REFERENCES

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Table 6 ADEOS Development Schedule