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저궤도 기술시험용 소형위성 우리별3호 개발

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Engineering Test Satellite, KITSAT-3, Program

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Abstract

The SaTReC is to develop, deploy, and operate a low Earth orbiting small satellite system, KITSAT-3, carrying a remote sensing payload, a space science payload, and a data collection system. Through the development of KITSAT-3, the SaTReC is to demonstrate the small satellite system which provides highly accurate attitude control, high speed data transmission, and a unique spacecraft configuration and to provide educational opportunities to Korean space industries and research institutes. The KITSAT-3 is expected to be launched in the beginning of 1997 by Chinese Long March IV as a secondary payload into about 800 km's sunsynchronous orbit.

1. Introduction

Since 1990, the Satellite Technology Research Center (SaTReC) has developed two scientific and experimental micro-satellites, KITSAT-1 and 2, and has been currently operating. Through this first step into space, the SaTReC has trained many engineers in satellite engineering field and successfully acquired technology associated to micro-satellite systems. The SaTReC is now aiming to design its own satellite system to enhance the capability of itself.

For the primary objective, the SaTReC is to demonstrate the small satellite system which provides highly accurate attitude control, high speed data transmission, and a unique spacecraft configuration and to provide educational opportunities to Korean space industries and research institutes.

As the secondary mission objectives, the SaTReC is to develop, deploy, and operate a low Earth orbiting small satellite system carrying a remote sensing payload, a space science payload, and a data collection payload. The remote sensing payload will be able to monitor environmental disasters such as flood, volcanic eruption and earthquake mainly in Asia-Pacific Region. The space science payload will measure the distribution of high energy particles around mission orbit and monitor total dose on solid state memory devices. And the data collection payload will gather and store the information transmitted from buoys floating on ocean and dump the data stored at on-board memory with the identifications of corresponding buoys.

The total weight shall be less than 100 kg and the dimension approximately 45×45×60 cm. The power generated from GaAs solar cells is expected to be higher than 100 Watt during full illumination and not to be degraded by more than 30 % after 3 years mission life. The KITSAT-3 is expected to be launched in the beginning of 1997 by Chinese Long March IV into about 800 km's sunsynchronous orbit.

Until the end of 1995, the engineering model of KITSAT-3 will be manufactured and fully tested and in 1996, the flight model will be started to be assembled.

2. Mission

2.1 Mission Objectives

The mission objectives of KITSAT-3 system is development and in-orbit test of SaTReC's own small satellite BUS system with engineering tests of following technologies;

- 3-Axis Stabilized Attitude Control
- Common Bus Architecture
- Deployed Solar Panels
- High Speed Data Transmission

In addition to the technology development, the SaTReC would like to train engineers and transfer the experience gained from this project to Korean space industries.

2.2 Mission Payloads

The KITSAT-3 will carry three different payloads and they are Remote Sensing Payload, Space Science Payload, and Data Collection Payload.

The remote sensing payload performs a series of tests on key technologies required to manufacture a sophisticated remote sensing payload. It will also provide an opportunity to operate. The expected spatial resolution is about 15 m at the altitude of 800 km. Following technologies will be mainly tested: (1) high resolution and multi-spectral camera system, (2) on-board data processing and data compression, (3) multi-layer mass memory module, (4) high data rate transmission system, (5) data reception and processing, and (6) operation. The space science payload consists of High Energy Particle Telescope (HEPT) and Radiation Monitor (REME). The HEPT detects particles entering the telescope and distinguishes what kinds of particles they are and what energy levels they have. The REME measures total doses on micro-electronics such as RADFET and memory devices. The data collection payload collects data transmitted from buoys floating on ocean. The data may contain sea temperature, sea flow and so on. This payload and ground terminals will be jointly developed with Korea Ocean Research and Development Institute.

3. System Configurations

The overall configuration and the deployed view of KITSAT-3 satellite are shown in Fig. 1 and 2, respectively. One of main differences in external configuration to the KITSAT-1/2 system is the solar panels. While the KITSAT-1/2 have solar panels fixed their body, the KITSAT-3 has three panels and two of them are deployed in order to generate more power.

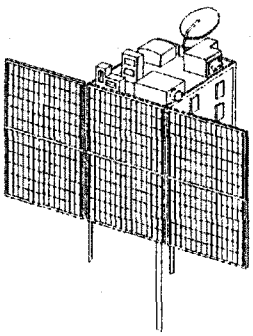

Fig. 1. KITSAT-3 Configuration

The attitude control is another main difference. The KITSAT-3 will be controlled in 3-axis stabilized using reaction wheels and enhanced magnetorquers. The architecture of the KITSAT-3 is based upon a modular structure. Fig. 2 shows that sensors, payloads, reaction control units, BUS, and adaptor are placed separately. As the payloads have their own space, this structure can be used for next missions without any further modification on structure.

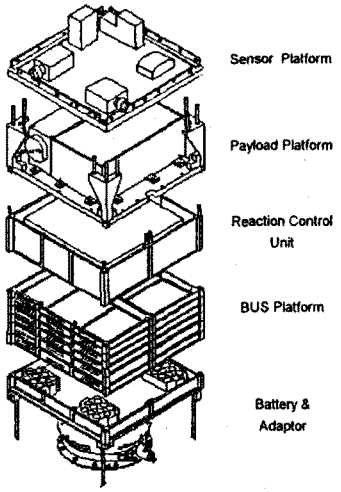

Fig. 2. Deployed View of KITSAT-3

Fig. 3 shows the KITSAT-3 system context with an internal configuration of satellite system as well as the interactions with ground terminals. All the bus systems are interconnected through common bus network which is a modified version from MIL-STD-1553 and is operating in lower speed.

The spacecraft can be expanded easily for future missions requiring more enhanced operations and system complexity by modifying the subsystem or adding other components.

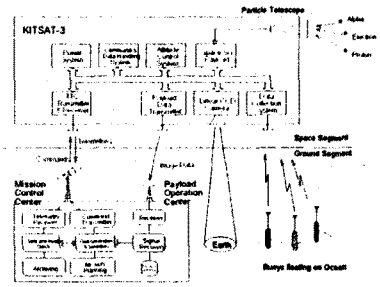

Fig. 3. System Context

4. System Specifications

The system specifications are not freezed yet, however they can be summarized in Table 1 and are compared with three of other satellites.

	KITSAT-1/2	KITSAT-3	POT-3
Weight	50 kg	< 100 kg	1830 kg
Power	30 Watt	100 Watt	1 kWatt
Solar Panels	Body Fixed	2 Deployable 1 Fixed	15.6 m of Span
Data Transmission	UHF 9.6 kbps	X-Band < 10 Mbps	X-Band 50 Mbps
Attitude Control	Gravity Gradient	3-Axis Stabilized	3-Axis Stabilized
Control Accuracy	< 5 Deg	< 1.0 Deg	< 0.1 Deg
Attitude Control Actuator	G.G. Boom Magnetorquers	Momentum Wheels Magnetorquers	Momentum Wheels Magnetorquers Thrusters
Remote Sensing Payload	Area CCD B/W & Color	Linear CCD Multi-Spectral	Linear CCD Multi-Spectral
Spatial Resolution	400/200 m	15 m	10/20 m

Table 1. KITSAT-3 System Specifications

5. Operation Modes

During the normal operation, the attitude of the KITSAT-3 is controlled to generate the maximum power from the solar panels. During eclipse period, the satellite is maneuvered to keep contact with ground control.

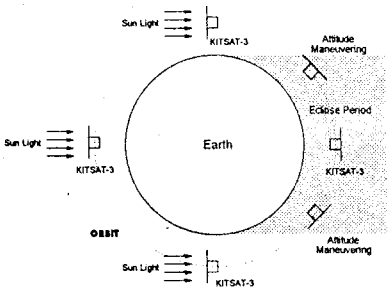

Fig. 4. Attitude Control for Normal Operation

For the operation of camera system, the attitude maneuvering is performed to let the camera point the desired area prior to initiate a series of actions.

The other attitude control mode for payload operation is a pitch angle rotation mode for the space science payload. This mode is only used after solar flare precaution for about 48 hours. During this mode, the high energy particle telescope distinguishes particle types and their energy levels and measures the directivity as well.

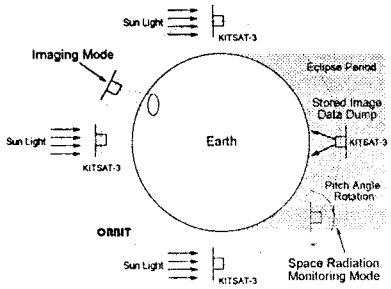

Fig. 5. Attitude Control for Payloads Operations

6. Development Schedule

The KITSAT-3 is expected to be launched in the beginning of 1997 and the flight schedule is under negotiation with launcher companies. Until the end of 1995, the KITSAT-3 engineering model will be completely manufactured and tested. It also includes a qualification test for the launcher. In 1996, the flight model will be assembled and tested and the KITSAT-3 system will be ready to launch at the end of the year. The detailed timelines are shown in Fig. 6.

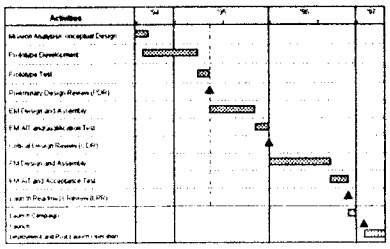

Fig. 6. KITSAT-3 Mission Timelines

7. Future Planned Missions at SaTReC

7.1 KITSAT-4 Mission

The mission objectives if the KITSAT-4 mission are as follows: (1) development of a 300 kg class small satellite system based on KITSAT-3 architecture, (2) development of 5 m resolution Linear CCD camera system, and (3) demonstration of SAR technology on board small satellite.

7.2 Specifications

The KITSAT-4 is just under planning stage. The specifications conceptually designed are as follow:

Weight :	200 to 300 kg
Power (EOL) :	> 200 Watt
Attitude Control :	3-Axis Stabilized
Attitude Accuracy :	< 0.2 Deg (Yaw Axis)

8. Conclusion

The KITSAT-3 satellite system will provide design, manufacturing, and operation capabilities of sophisticated small satellite systems. Through the experiences from developing the KITSAT-3 engineering test satellite, the SaTReC will expand its capability to design a next generation small satellite, KITSAT-4, carrying a high resolution CCD camera and a SAR demonstrator until the end of 1999.

The KITSAT-3 system will demonstrate some state-of-art features of small satellite with low cost but competitive quality, compared with those of commercial remote sensing satellites or highly expensive scientific satellites. The spacecraft system for the KITSAT-3 system will be a back-bone architecture for SaTReC's future space science missions.

9. References

[1]. **"Operations Concept Document for KITSAT-3"**, *SaTReC Doc.*, 1995.

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