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Acta Astronautica 56 (2005) 133–138
ACTA ASTRONAUTICA
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Development of engineering model of medium-sized aperture camera system

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Abstract

SaTReC*i* and ATSB are developing medium-sized aperture camera (MAC) system for earth observation. Following the first model, the development of the engineering model (EM) was completed. The optical subsystem incorporates a conventional approach of using low-expansion optical and structural materials. It is a 300-mm on-axis system with two aspheric mirrors and two field correction lenses. It has five linear detectors aligned on its focal plane together with proximity electronics. The electronics subsystem consists of five modules; two for management and control in cold redundancy, two for image data storage and one for power supply. EM was developed to have a storage capacity of 16 Gbits, which can be easily increased to 32 Gbits by adding memory packs for following models. EM weighs about 41.9 kg and consumes about 45.4 W of peak power.

1. Introduction

SaTReC*i* and ATSB have been developing an imaging system, the medium-sized aperture camera (MAC), as an international collaborative program since April 2000. Development of four models is planned for risk minimization, system verification and technology absorption.

In November 2001, the development program of its satellite bus system, MACSAT program, was kicked off between two organizations. The launch of MACSAT was planned in early 2004 into a circular near-equatorial low-earth orbit (NEqO) with an inclination between 7.5 and 9° and a nominal altitude of 685 km.

Following the successful development of the first model, test model (TM) [1], the engineering model (EM) was developed and tested. MAC EM was integrated with MACSAT electrical test bed (ETB) and structural model (STM) and various tests were

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doi:10.1016/j.actaastro.2004.09.002

performed. The features of MAC EM and its test results are presented. Future plan is also briefly described.

2. System overview

2.1. MAC system

MAC is a typical pushbroom imaging system with five linear detectors aligned in parallel on its focal plane. Its ground sample distances are 2.5 and 5.0 m in panchromatic and multi-spectral bands, respectively at the nominal altitude. Its swath width is greater than 20 km at this altitude.

A simplified functional block diagram of MAC is shown in Fig. 1. MAC consists of two configurable subsystems: electro-optical subsystem (EOS) and payload management subsystem (PMS). EOS includes telescope, focal plane assembly (FPA) and processing unit. PMS performs system control and management and image data storage and maintenance. Key performance features of MAC are summarized in Table 1.

2.2. MACSAT system

MACSAT is a three-axis stabilized small satellite that has a hexagonal shape. It weighs about 200 kg including MAC and provides more than 330 W at the end of life from three deployable solar panels.

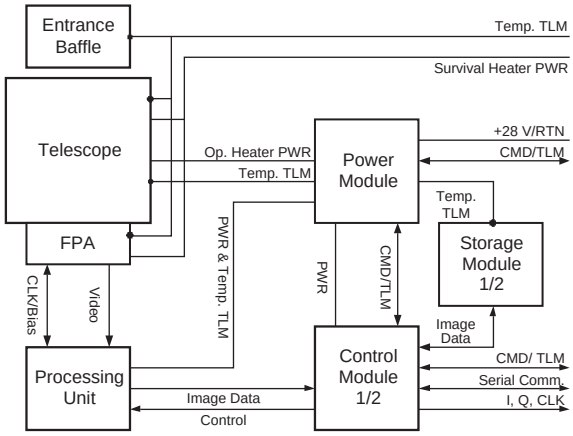

Fig. 1. MAC functional block diagram.

Table 1
Key features of MAC system

Imaging channels	1 panchromatic (PAN)	
	4 multi-spectral (MS)	
Spectral bands (μm)	PAN	0.51–0.73
	MS	0.45–0.89
GSD (m)	PAN	2.5
	MS	5.0
Swath width	⩾20 km	
MTF (%)	PAN	⩾8
	MS	⩾15
SNR	⩾70	
Signal quantization	8 bits	
Signal gain	Programmable	
Data storage capacity	32 Gbits (16 for EM)	
Data transmission	30 Mbps QPSK	
Mass	⩽50 kg	
Peak power consumption	⩽50 W	

Table 2
MACSAT system features and mission characteristics

Orbit	Circular NEqO
Nominal altitude	685 km
Inclination	7.5∼9°
Mass	⩽200 kg
Envelope	ϕ1200 mm×1200 mm
Power generation	⩾330 W at EOL
Battery	NiCd, ⩾ 6Ah×3
Attitude control accuracy	0.2°
Off-axis imaging	Up to ±30°
Communication	1.2, 9.6 & 38.4 kbps (S-band)
Image Data D/L	30 Mbps (X-band)
Mission lifetime	⩾ 3 years

MACSAT mission objectives are as follows:

- medium/high-resolution earth observation,
- generation of stereo image product,
- image map generation of 1:25,000 scale,
- off-axis imaging up to ±30°.

Some of the MACSAT system features and mission characteristics are summarized in Table 2.

Fig. 2 shows a solid model of MACSAT without external and solar panels. MAC is mounted to MACSAT frame structure using external flexures along one axis.