MITA : IN ORBIT RESULTS OF THE ITALIAN SMALL PLATFORM AND THE FIRST EARTH OBSERVATION MISSION, HYPSEO

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ABSTRACT

On July 15th 2000 the first MITA (Italian Advanced Technology Minisatellite) was launched from Plesetsk (Russia) by a Cosmos rocket as a secondary payload with the CHAMP satellite. The main purpose of the first MITA mission is its in-flight validation, since MITA is going to be used as standard platform for small missions. Furthermore the scientific payload NINA-2 of INFN (Istituto Nazionale di Fisica Nucleare) and the technological payload MTS-AOMS (Micro Tech Sensor for Attitude and Orbit Measurement System) were embarked. The NINA-2 goal is the survey of galactic and solar cosmic rays at 450 km altitude. MTS is an ESA multi-tasking autonomous sensor based on Active Pixel Sensor (star and horizon sensor), Angular Rate Sensor and Magnetic Field Sensor. In this paper the main MITA bus characteristics are reported, together with the description of the launch and the commissioning phase. The first mission nominal orbit is circular, with a 450 Km altitude and a 87.3° inclination. The satellite attitude is nadir pointing, 3 axes stabilised. Spacecraft mass is 169.9 Kg. Two fixed solar panels provide an average power of 85 W EOL. The configuration of the satellite main body is based on a cubic shape module, made of Aluminium beams and honeycomb panels.

This paper will start with a brief description of the MITA standard bus, followed by the presentation of its in-orbit results and performances, while a second part of the text will introduce the two new implementative missions of the bus i.e., AGILE, a Gamma Ray astronomical observatory and HypSEO, an Earth Observation demonstrating mission supporting an Hyperspectral Camera.

EXTENDED ABSTRACT

The MITA Bus

MITA (Italian Advanced Technology Minisatellite) is an Italian Space Agency (ASI) programme for the development of a standard, low cost and multi-purpose platform for small missions in LEO and GTO orbits.

Successfully launched and operating since July 15th 2000, MITA was developed on behalf of ASI by Carlo Gavazzi Space as Prime Contractor, with the co-operation of a large number of Italian enterprises, especially small and medium size companies.

The MITA bus in its standard version is a 3-axis stabilised platform for mini-satellites. With a design lifetime of 5 years, it is able to support a wide range of payloads for: Two-way communications, Earth observation, Radio-localisation, Astronomy and Scientific research. This flexibility is achieved thanks to a modular design in the main platform subsystems: data handling, telemetry and telecommand, attitude control and power distribution.

The satellite core is the multi-tasking On Board Data Handling subsystem which is in charge of managing all the control and operative functions of the bus; in particular, the implemented software (bus controller), controls the internal and external (TM/TC) communications, the attitude control law and its implementation, the power management, and the housekeeping activities. In addition, and in order to allow the Payload Team to concentrate on the development of the instrument itself and not on the supporting functions, the MITA bus provides a second computer entirely dedicated to the payload, able to manage the payload itself and to perform a pre-processing on the scientific data thanks to a (from ground) up-loadable program.

The Attitude Control Systems controls the pointing along the three axis with a precision from 0,1 to 1 degree depending on the chosen sensors/actuators set. The Communication link is in S-band with CCSDS compatible TM/TC protocol. Thermal Control is passive and Mass Memory allows for 64 MBytes data storage. Both Data Handling and Communication subsystems are redundant, ensuring the satellite operations after a failure, even if with reduced performances.

The first satellite using the MITA bus has been launched on July 15th 2000 by a Cosmos rocket from the Plesetsk Cosmodrome. The MITA satellite has been correctly released on a nearly circular and polar orbit at an altitude of 450 Km.

This first MITA mission is the “in orbit validation of the platform” which is obviously extremely important in order to verify its functionality and to qualify the bus for future low Earth orbit missions.

Furthermore this first mission also provides significant scientific and technological returns, having two payloads on board :

- the NINA instrument from INFN (Istituto Nazionale Fisica Nucleare - Rome) is a silicon spectrometer for charged particles.

- The MTS-AOMS payload by the ESA Technology Flight Opportunity Program (TFO) is a combined sensor for attitude and orbit measurements, consisting of three sub-units: an APS-Camera with beamsplitter-optic, a Magnetic Field Sensor and an Angular Rate Sensor.

After the separation from the launcher, MITA autonomously started the damping phase of the angular rates and the sun acquisition manoeuvre. The operations have been successfully completed and the satellite attitude was stable after 33 minutes from the separation.

The first ground station contact with the MITA satellite has been nominally established after about 5 hours. Following the first contact, the two ground stations located in Cordoba (Argentina) and Malindi (Kenya) regularly contacted the satellite, sending the commands for optimal satellite maintenance and downloading the stored payloads and housekeeping data.

During the first two weeks of the mission all the operations to verify the correct behaviour of the Bus subsystems have been conducted. The two payloads were switched on to check their correct functionality and to acquire the first scientific/technological data.

On July 31st 2000, once the on-board test was successfully concluded, the MITA satellite was commanded to start the manoeuvres to reach the nominal earth pointing attitude. In about 20 minutes a coarse earth pointing attitude was reached, and after about 12 hours the required attitude precision of ± 1° was achieved.

During the following months, several successful manoeuvres from earth pointing to sun pointing attitude have been performed and the ACS on board models have been validated.

The NINA payload operated during the strongest solar flares storms of the present solar cycle, acquiring unique information on the particles fluxes. The test campaign of the MTS-AOMS payload has been successfully performed following the planned mission plan. Since the beginning of the mission the on-board SW has been running without any interruption due to reset or latch up events.

All these excellent in-orbit results of the MITA bus, opened thus the way for the practical implementation of the platform to scientific and application missions.

First Scientific Mission : AGILE

AGILE, which stands for *Astro rivelatore Gamma ad Immagini Leggero* (Gamma-ray Astronomical Low-Mass Detector) is the first implementative mission of the MITA bus, selected by ASI as the first mission of its Small Scientific Missions Programme.

The scientific goal of AGILE is to provide the Scientific community with an astronomical observatory for Sky Mapping in the high energy spectra, thanks to a solid state low-mass silicon Gamma Ray detector. The mission is predicted for launch at the end of year 2002 for a 2 years mission lifetime, however being out of the scope of the workshop, it will only be briefly described hereafter.

AGILE's Gamma Ray detector will explore the sky in the [30 MeV – 50 GeV] energy range, its main requirement on the mission is the necessity to orbit in an equatorial plane with the instrument watching the sky along a direction perpendicular to the Sun direction. The selected orbit is then an equatorial LEO of 550 Km and the spacecraft attitude is inertially Sun-pointed, with possibility of rotating the instrument boresight along the Sun axis.

The customised MITA platform meets the observation requirement by means of a 3-axis stabilised control system which makes use of one momentum/reaction wheel and magnetic coils as actuators and a set of Sun Sensors, two Star Trackers and a GPS sensor for location. Most of the subsystems

require minor changes or not at all with respect to the first MITA design, the most noticeable differences being surely the manoeuvring capability, the bigger payload power request and hence the deployable solar arrays.

First Earth Observation Mission: HypSEO

Since December 2000, Carlo Gavazzi Space is involved in the B phase of an Italian Earth Observation satellite with Hyperspectral capability: HypSEO (HyperSpectral Earth Observer).

For this mission supported by ASI, Carlo Gavazzi Space has been selected as Responsible for the design of the satellite bus which, thanks to the now demonstrated capabilities, will base its design on the standard MITA platform with the obvious reductions in cost and development time. The industrial part is also composed by Officine Galileo, Prime Contractor and Responsible for the payload, and Telespazio, Responsible for the Ground Segment. The complete year 2001 will be devoted to the Phase B , for a predicted flight mid 2003.

Great emphasis is put within the Italian Space Agency's Strategic Plan for the Earth Observation, on future satellites with hyperspectral capabilities. In the framework of COSMO/SkyMed program, ASI intends, with the HypSEO project, to build up a rapid and low-cost demonstrative mission.

HypSEO's mission objective is twofold:

1. Validate the Italian technology for Hyperspectral Imagers.
2. Verify the enormous potential of hyperspectral data for the improvement of Remote Sensing applications and products

The very demanding characteristics of the Hyperspectral camera, like Swath width of 20 Km., Spatial resolution of 20m., Spectral resolution of 10 nm over a spectral range from 0.4 to 2.5 μm, 12 bit data, data fusion capability with a panchromatic image of 5 m spatial resolution, etc., require innovative solutions for the MITA Bus.
The paper will deeply describe the satellite technical characteristics for the HypSEO demo mission as they emanate from the Phase A study and the current Phase B.