COMPASS-1

Picosatellite Project

Aachen University of Applied Sciences

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DLR

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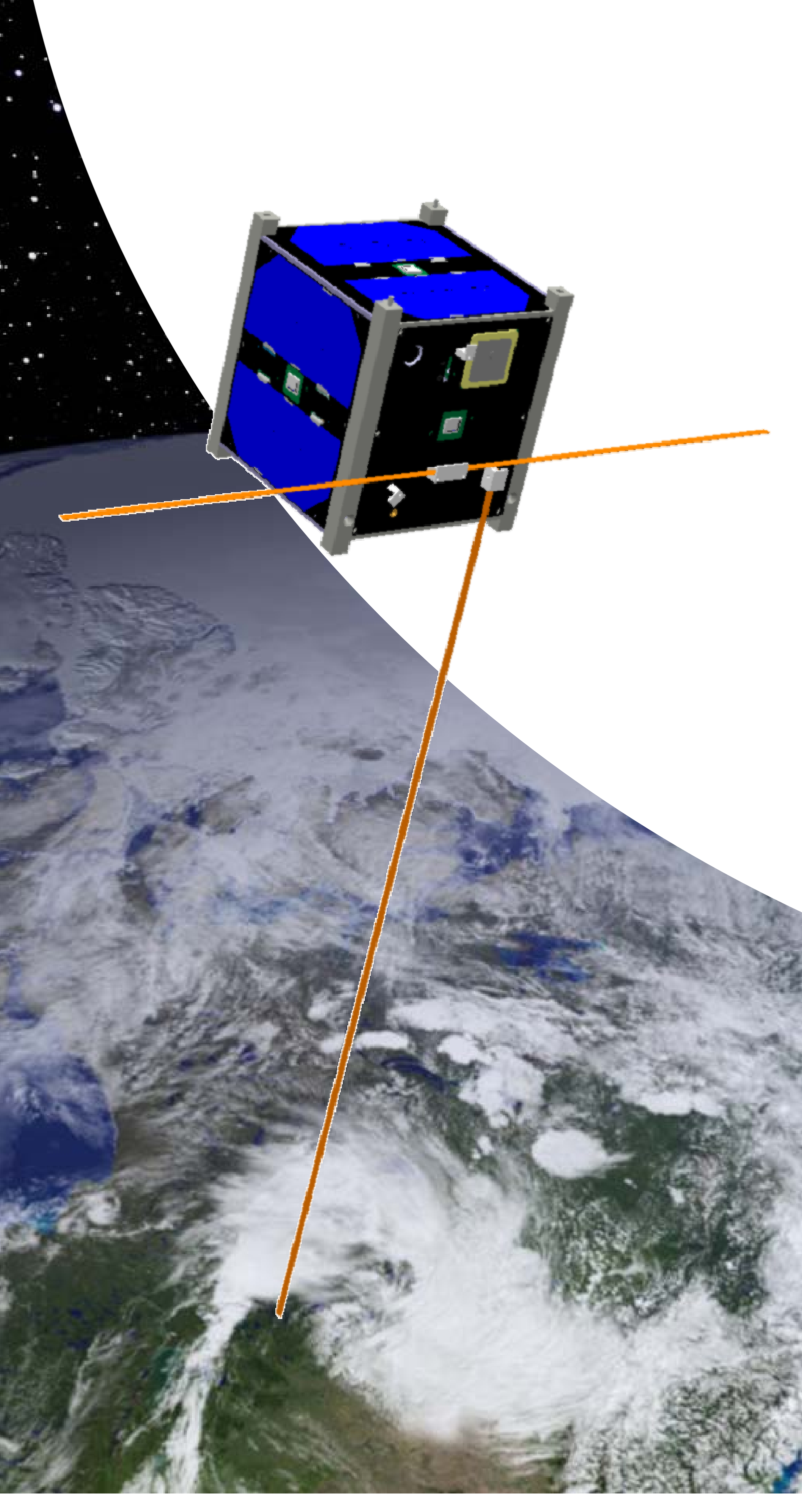
A remote sensing satellite in pocket size format

COMPASS-1 is the first picosatellite developed at the Aachen University of Applied Sciences in Germany. Its mission is to capture images from the earth and to validate the newly developed miniaturized spacecraft bus.



The COMPASS-1 project was initiated in end of 2003 by a team of eight students from the astronautical engineering course. The basic motivation for the involved students was (and still is) to gain experience in the process of spacecraft system engineering, i.e. to put the lectures into real-world practice. And with the novel approaches that were taken for virtually all of the spacecrafts' systems, this work will serve as an national encounter with the anticipated boom in low-cost picosatellites for various mission scenarios.

The satellite itself is not much bigger than a cup of tea, though the involved project aspects (from project management to system engineering and qualification testing) resemble very much any other satellite mission, however on a lower scale.

Through the combination of bright, novel ideas of young engineers-to-be and the use of commercial off-the-self components, the realization of cheap and fast responsive pico- and nanosatellite missions become not only feasible, but also worthwhile!

A new and cheaper approach to space access

COMPASS-1 wants to emphasize the universities' vital role in space business, by providing modern, innovative and cost-effective solutions for scientific and commercial missions within an educational framework.

As with all engineering courses, the learning of hands-on experiences is of great importance. Within the COMPASS-1 project, the major involvement of students did not only stimulate the design concepts with fresh ideas but in turn also provides them with the essential skills requested from industry and research institutes alike.

For the purchase of special hardware (such as the solar cells and the GPS receiver) and to conduct testing campaigns, the students did establish contacts to professionals in national industry and european space centers. In most cases the industry supported with free donations of hardware and offered knowledge support.

Moreover, a strong collabortaion with local and national radio amateurs has been very important for the project, regarding all aspects of the communication architecture.

The earths' images that will be captured and transmitted by the satellite will serve as measurement data to validate the chain from payload data generation, processing and storage all through to its transmission to ground. And with the pictures being published in the internet, it will also be a great promotion of space technology in Germany!

Mission Characteristics

Launch Date	TBD
Launch Site	TBD
Launcher	TBD
Orbit	Sun-Synchronous
Altitude	500-600km
Inclination	~98°
Dimensions	10 x 10 x 10 cm^3
Satellite Mass	1 kg
Power Generation	2 Watt
Power Consumption	1 Watt (average)
Mission Operations	FH Aachen
Access time per day	35min (about 7 min each single access)
Mission Lifetime	6 months

Payload Characteristics

GPS Receiver	DLR Phoenix
Power	800 mW
Mass	22 g
Optical Sensor	CMOS VGA Camera
Resolution	640 x 480 x 8 bit
Coverage	416 x 380 km^2
FOV	53° diagonal

Technology demonstration for picosatellite systems

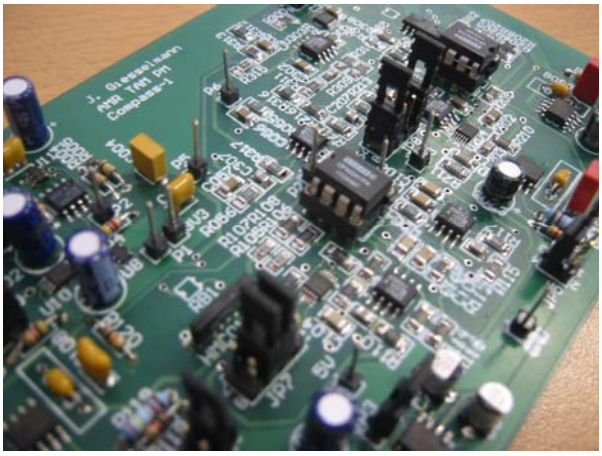
COMPASS-1 is being built according to the CubeSat standard, which specifies a cubical shape with given dimensions and mass properties and is classified as a picosatellite. Due to the lack of available spacecraft systems that correspond to the strigent mass, power and volume limits, nearly all subsystems and units had been designed from the scratch.

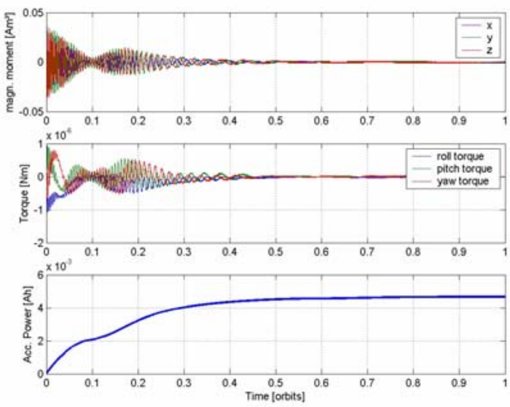
Purposely the objective was set to remote sensing because such missions oppose stringent requiremnts on the key systems for picosatellite technology: attitude control, communications and power supply.

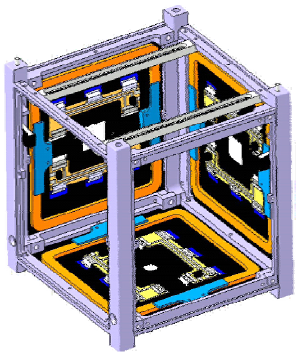
Attitude Determination and Control:
The spacecraft's attitude is derived from measurements of the suns' position and the instantaneous geomagnetic flux density. The attitude information is then fed into a regulator which drives a set of three mutually perpendicular electromagnetic coils. These magnetorquers generate a magnetic dipole which interacts with the geomagnetic field to produce the control torque necessary to maintain the satellite's nominal nadir alignment.

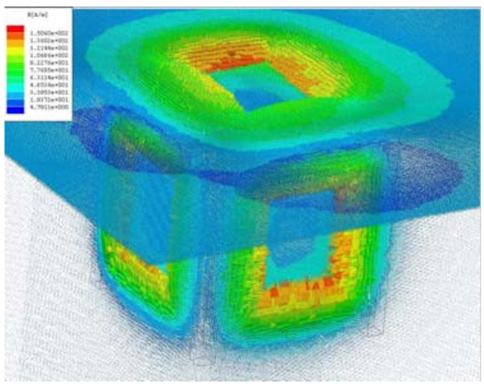
Key System Characteristics

Attitude Control	3-axis stabilized via magnetic torquers
Attitude Determination	Sun Sensors and Magnetometer
Data Downlink	1k2 – 9k6 bps FSK
Command Uplink	DTMF pulse tones
Onboard Storage	32 Mbyte Flash
Number of Processors	4 (distributed computing)
Solar Cells	GaAs Triple-Junction
Energy Storage	2,4 Ah Lithium-Polymer





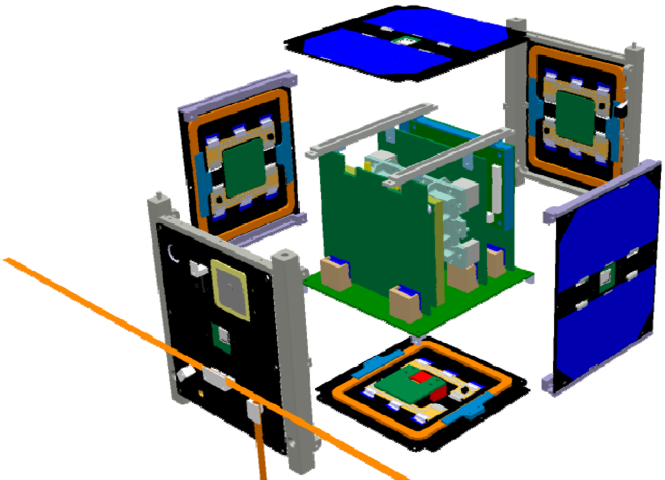




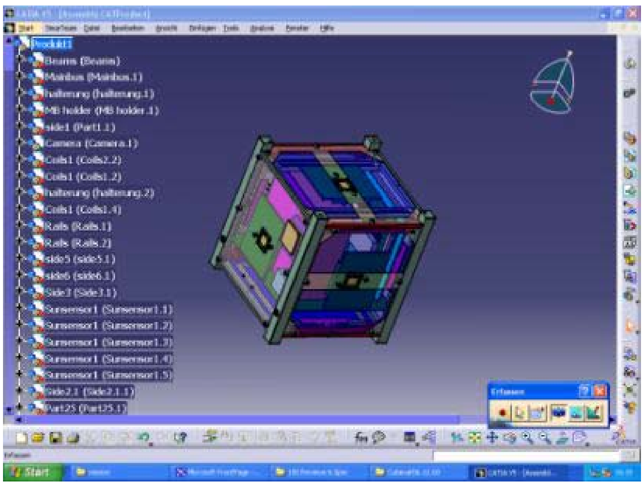
Communication System:
The satellite can be controlled from a UHF/VHF groundstation through commands, which are sent in reliable DTMF pulse tones. Data packets containing images and housekeeping information are then downlinked from the satellite using the AX.25 protocol. The system periodically emits a beacon signal with the satellite signature and basic system information data.

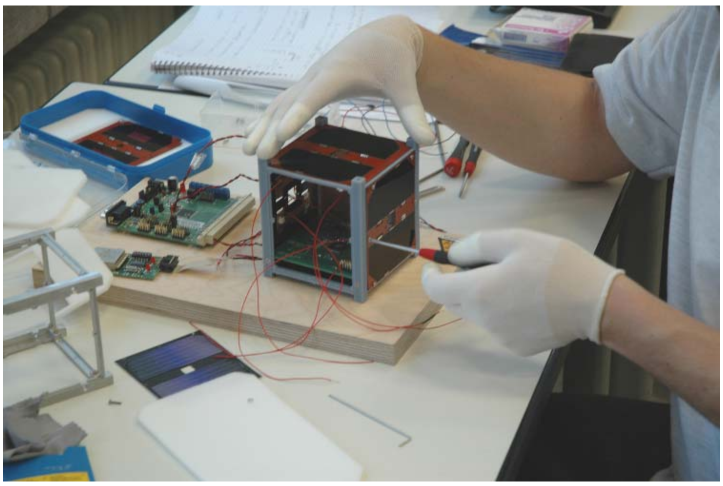
Command and Data Handling System:
The commands that are sent to the satellite are processed and executed by the microcontroller of the CDHS and the data amounts are stored in the non-volatile memory. The data is composed of the images captured by the camera module that is connected and controlled by this system and from the housekeeping data which are requested from the other subsystems.

Electrical Power System:
The Triple-Junction solar cells are the power source of the satellite. Lithium-Polymer cells are used to store excessive energy during sunlight and to supply the system loads while the satellite is in eclipse. The EPS carries out power management to secure batteries at good capacity and detects and correct failures caused by Single-Event Effects. Active thermal control is realized with a heater placed at the batteries.



Structure and Mechanisms:
To protect the electronics and other parts of the satellite against the launch loads and to allow thermal control of the inner components, a rigid structure with special surface properties is used. The structure is highly modular for easy assembly. The mechanisms to deploy the UHF/VHF antennas and to close the power circuit of the satellite are highly critical and important.





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