

Projects Catalogue for AAU satellite /DRAFT

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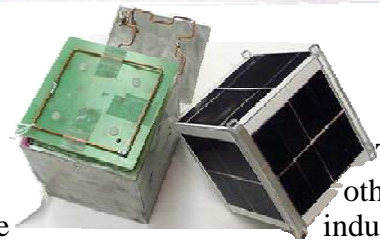
Description of the AAU satellite Project

During the autumn and the spring semesters of 2001/2002 the students of Aalborg University will build and launch the first AAU spacecraft. The spacecraft project is a joint venture of the Institute of Electronic Systems, Institute of Mechanical Engineering, Institute of Computer Science, and Institute of Energy Technology giving the students a unique chance to experience a real engineering project with real engineering problems.

CubeSat Concept

A CubeSat concept developed by Stanford University has been chosen for the first AAU satellite. The reasons are a fast development phase (within one year) and inexpensive launch possibility, which fits ideally to project based education form used at Aalborg University.

The CubeSat is a standardized platform for small orbital experiments. The entire satellite weight is less than one kilogram. 10-centimeter cubes are designed to house small experiments that would be cost-prohibitive to flight validate. Universities, alongside industrial interests, are able to place their own CubeSats into orbit using a standardized deployment system developed by California Polytechnic State University (CalPoly). The deployment system is known as P-POD (Poly Pico-satellite Orbital Deployer). It mounts to various launch vehicles. In this way a particular CubeSat team are not concerned by the issues related to the launch. Stanford University in collaboration with a firm One Stop Satellite Solution (OSSS) plans to launch the first 18 CubeSats with Dnepr-rocket from Baikonur Kosmodrom in Kazakhstan November 15th 2001.



Financing

Private foundations and the Aalborg University will finance the AAU satellite project. Furthermore, the project has already established contacts with firms who are willing to support the spacecraft, e.g. Danionics (batteries) and Terma (electronic components).

Organization

All the subsystems on-board will be designed and manufactured by the students. The each project student-group will be responsible for a particular subsystem. The stress will be not only on the design, but also on the documentation and engineering communication with other groups working for the AAU satellite project. As usual there will be assigned a project supervisor, but there will be a free access to other supervisors in the AAU satellite project. Current status of the projects and taken decisions will be

presented in weekly project meetings. There will be established a common strategy for the choice of components and materials, due to requirements on the level of withstood radiation, shock, vibration, and temperature gradient. To make the project startup phase smooth Prof. Robert Twiggs responsible for CubeSat project will visit Aalborg University. A number of talks about the aerospace will be organized. The general topics such as the space environment, radiation, orbit modeling, launchers, ground stations will be given. The lecturers will be primarily industrial engineers with experience in the satellite design and manufacturing.

Work Packages

The CubeSat project is divided into the following Work Packages (WPs): the System, the Platform, and the Payload. The System comprises the overall system structure, interfaces on the subsystem level and interfaces with the P-POD. The Platform encompasses mechanical structure, harness, electrical power subsystem, command and data handling subsystem, communication subsystem, and attitude control subsystem. The Payload comprises of all the tasks connected with the design, and mechanical/electrical interfaces between the spacecraft and the payload.

System Work Packages

WP1. Mission analysis

- Support of the payload design,
- Establishing and maintaining Mission Requirement Specification,
- Establishing and maintenances of Missions Operations Requirements.

WP2. Launch Vehicle and CubeSat Coordination and Contact

- Negotiate a launch contact on P-POD with One Stop Satellite Solution,
- Handle all interfaces to P-POD with respect to schedule, prepare documentation on tests and requirements,
- Define interfaces to P-POD,
- Establish separation mechanism requirements for P-POD.

WP3. On-Board System Engineering

- Develop and maintain project documentations,
- Define satellite electrical configuration,
- Develop and maintain structural and thermal test configurations,
- Generate tele-commands and telemetry lists,
- Maintain mass, power and magnetic budgets,
- Perform technical co-ordination of interfaces on the sub-systems level and payload,
- Develop and maintain power consumption profile,
- Define overall timing concept,
- Define the on-board storage and processing requirements.

WP4. Ground Segment

- Adapt the old Ørsted ground station at Aalborg University to the needs of CubSat.

Platform

WP5. Spacecraft Structure

- Structure modeling, design and manufacturing,
- Spacecraft mechanisms – deployable antenna, solar arrays,
- Thermal, vibration, shock test.
- Harness design manufacturing and test.

WP6. Electrical Power Subsystem

- Battery unit,
- Solar panels,
- Power control unit,
- Power distribution unit.

WP7. Command and Data Handling Subsystem (CDH)

- On-board software development and test,
- CDH hardware.

WP8 Communication Subsystem

- Communication unit,
- Communication antennas.

WP9 Attitude Control Subsystem (ACS)

- Control System design,
- Sensors and actuators,
- Implementation and test,

WP10 Ground Station

- System for ground data processing,
- Web-base user interface.

Payload

Projects

Based on the work packages described in the last section the following student-projects are identified: Mechanical Structure and Harness for AAU Satellite, Electrical Power Subsystem for AAU Satellite, Communication Subsystem for AAU Satellite, and Data Handling Subsystem for AAU Satellite, On-board Computer for AAU Satellite, Thermal Design for AAU Satellite, Attitude Control Subsystem for AAU Satellite, Payload Design for AAU Satellite, Ground Station Software for AAU Satellite.

Mechanical Structure and Harness for AAU Satellite

The objectives of this project are:

- To perform detailed analysis of the structural behavior of the satellite,
- To define mass and inertia characteristics,
- To perform design of the mechanical interface with P-POD,
- To design structural model,
- To perform mass properties analysis of the individual satellite elements for MoI and CoG,
- To complete flight parts and material list,
- To perform the design of the cable harness,
- To perform design of the antenna deployment mechanism,
- To establish Mechanical Ground Support Equipment,
- To perform thermal, vibration, vacuum, shock tests,
- Prepare progress reports.

Electrical Power Subsystem for AAU Satellite

The objectives of this project are:

- To perform the design of the battery unit,
- To perform the design of the solar panels or adopt the existing CubSat solar arrays,
- To perform the design of the Power Control Unit,
- To perform the design of the Power Distribution Unit,
- To complete flight parts and material list,
- To provide input for power budget,
- To prepare progress reports.

Communication

The objectives of this project are:

- To perform the design of the communication unit,
- To perform the design of the communication antennas,
- To perform antenna pattern and mock-up and testing,
- To complete flight parts and material list,
- To prepare progress reports.

Data Handling Subsystem for AAU Satellite

The objectives of this project are:

- To design and implement boot software,
- To establish data exchange protocols
- To design and implement on-board data handling software,
- To design and implement software for handling telemetry, tele-commands and system diagnostics,
- To design and implement or decide on an existing real-time kernel for attitude control,
- To design and implement software for a system monitor,
- To test the software,
- To prepare progress reports.

On-board Computer for AAU Satellite

The objectives of this project are:

- To establish microprocessor requirements,
- To perform the design of the onboard computer,
- Design low-level drives,
- To perform the design of driver electronics for on-board actuators and sensors (magnetorquers, a sun sensor, a magnetometer),
- To design and manufacture magnetorquers,
- To establish electrical ground support equipment,
- To complete flight parts and material list,
- To prepare progress reports.

Thermal Design for AAU Satellite

The objectives of this project are:

- To develop a thermal model of the spacecraft,
- To perform a detailed thermal analysis of the satellite and suggest configuration,
- To define thermal paint and areas to paint,
- To prepare progress reports.

Attitude Control Subsystem for AAU Satellite

This subsystem is designed in two projects running in parallel:

1. Attitude Control Algorithms and ACS Software for AAU Satellite
 - To define requirements for attitude control system,
 - To design attitude control algorithms,
 - To validate attitude control design,
 - To define requirements for magnetorquers,
 - To define requirements for a magnetometer,
 - To define requirements for sun sensor,
 - To implement attitude control algorithms,
 - To design software objects for attitude control system,
 - To test the implement,
 - To prepare progress reports,
2. Attitude Determination and Fault Detection for AAU Satellite
 - To define requirements for attitude determination,
 - To design attitude determination,
 - To validate attitude determination,
 - To define requirements for fault detection,
 - To design fault detection,
 - To define requirements for ACS Supervisor,
 - To establish design for ACS supervisor,
 - To validate ACS supervisor,
 - To prepare progress reports.

Payload Design for AAU Satellite,

Web-Based Ground Station Software for AAU Satellite

The objectives of this project are:

- To adopt existing Ørsted ground station for the AAU satellite,
- To design and implement software for receiving, extracting and presentation of the telemetry form the satellite,
- To design and implement SW for compressing, and sending tele-commands to the satellite,
- To design and implement mechanism for security check,
- To design and implement web-based user interface,
- To prepare progress reports.

Time Schedule

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| 1. Presentation of the projects, student team is established. | June 2001 |
| 2. Final definition of the projects | End of August 2001 |
| 3. Workshop with Robert Twiggs from Stanford University (responsible for CubeSat) in Denmark | Beginning of September 2001 |
| 4. Start of the student-projects | September 2001 |
| 5. Preliminary design review | December 2001 |
| 6. Critical design review | February 2002 |
| 7. Engineering model is finished | April 2002 |
| 8. Flight model is finished | May 2002 |
| 9. Opsendelse | June 2002 |