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DESCRIPTION OF THE ATTITUDE DETERMINATION AND CONTROL SUBSYSTEM OF CONASAT PROJECT– INPE/CRN

CONASAT

The CONASAT project, constellation of environmental nanosatellites, has the objectives to increase the availability and quantity of the environmental data collected besides update the space segment of the Brazilian Environmental Data Collection System. It is a low-cost initiative and for this reason was chosen the CubeSat technology which consists of physical blocks that have cubic format with sides of 10 centimeters and comport all the electronic elements need.

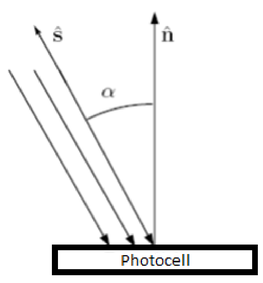
Attitude Determination and Control Subsystem

The Attitude Determination and Control Subsystem (ADCS) is crucial to any space mission that requires pointing to achieve the mission goals. The purpose of this subsystem is to estimate the actual orientation of the nanosatellite on space, i.e. its attitude, and to change it, if necessary. In order to perform these functions the nanosatellite needs a hardware which have sensors and actuators.

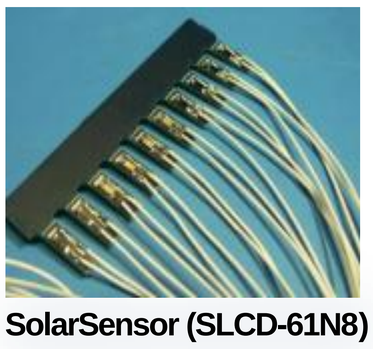
ADCS's Hardware (Sensors)

In order to determine the satellite's orientation on space, sensors are required. They are used on the attitude estimation process providing information about satellite's location in a body frame perspective.
The CONASAT project has two types of sensors: solar sensors and magnetometers. The first one is used to determine the Sun's direction and the magnetometer is used to measure the magnetic field's orientation around the satellite.

The solar sensor is used when the satellite is in the illuminated part of the orbit to measure the angle formed between the vector normal, $\hat{n}$, to the sensor and the vector of incidence of sunlight, $\hat{s}$.



The CONASAT project uses low cost components. For example, the solar sensors are six planar photodiodes, each one on a side of the nanosatellite and connected to an interface board., named CubeControl. This photodiodes are the SLCD-61N8, which generated a short-circuit current proportional to the light incident on each of them. The current depends on the cosine of the angle between the direction of the Sun and the direction of the perpendicular line to the sensor. With respect to the magnetometer, the project uses the HCM1053, which is a magnetometer of three axis that measure, in the body reference frame, the direction and magnitude of the Earth magnetic field around the satellite.

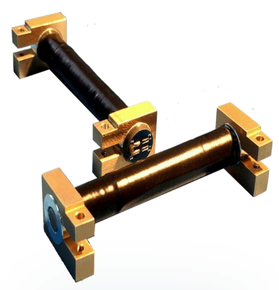

SolarSensor (SLCD-61N8)


Magnetometer (HCM1053)

ADCS's Hardware (Actuators)

The CONASAT project has two possible actuators: torque coils and reaction wheels. The CONASAT first version will use only the torque coils.

Torque Coils

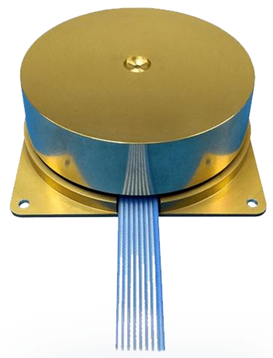

CubeTorquer

- Has two ferromagnetic core torque coils that are put on the axis X-Y of the interface board, named CubeTorquer;


CubeCoil

- Has one coil with air core on the Z-axis, named CubeCoil;
- Is used to control the satellite in three axis, because the magnetic field generated interacts with the Earth magnetic field trying to aligned.

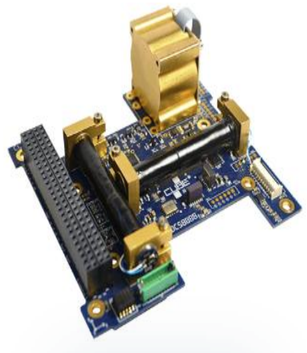
Reaction Wheel


CubeWheel LM

The CONASAT's laboratory also has another actuator, the CubeWheel LM, which is a reaction wheel. This actuator is a rotor that keeps the satellite stable, reducing the effects of external disturbances, and acts on the conservation of angular momentum.

ADCS's Hardware (Interface Board)

The CONASAT's interface board is the CubeControl, which is an interface between board computer, actuators and sensors.


CubeControl

- Its main application is to manage the attitude control.
- This board can be configured to include any combination of actuators and sensors, depending on the mission goals.

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