Electronic board: State of the art

The ADCS electronic board is composed of two parts: the hardware and the software. The hardware of the ADCS is a critical subsystem of the CubeSat. It has to combine the entire sensor system that the CubeSat needs in order to determine the satellite's attitude. It will run attitude determination and control algorithms.

a) Hardware

ADCS hardware has to:

- Get the sensor data.
- Process the data.
- Sample/correct them (for example Kalman filter).
- Determine the current attitude
- Determine the target attitude
- Control the magnetorquers to reach the target attitude.
- Handle the tether

There are different hardware method to achieve the ADCS CTRL function.

- By using a FPGA card
- By using a PIC-Controller

The FPGA card is more developed because it can calculate faster than a PIC and also it can handle a multiple signal treating. In a small satellite, as a CubeSat, the ADCS hardware can also be combined with the OBC. Usually even if the ADCS is on the OBC there is an actuator board to make the link between the ADCS and the OBC. One card is shown on the next figure.

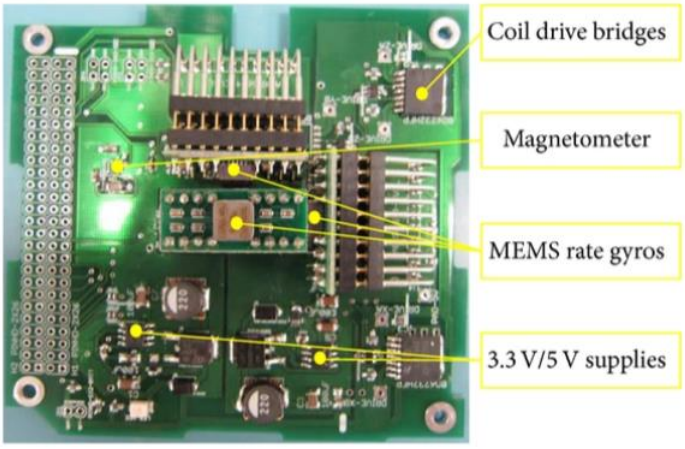

Figure 1 : example of ADCS board

b) Hardware constraint

Space is a harsh environment, that is why the hardware has to be designed to withstand many constraints:

- It has to resist the temperature differences. In space, the temperature can fluctuate between -40 and 60 degree on the side panels and the temperature is around 10 to 40 degree inside of the satellite[1].
- The vacuum in space causes some materials destruction (especially plastic). If air bubbles are trapped in a component, it can create some cracks and in the worst case explode or damage components.
- The components are also exposed to radiations which can decrease the performance. And they are also exposed to ultraviolet radiations which can create some hardware failures.
- The hardware has to withstand high accelerations.
- Stay well oriented in order to let the tether deorbit our CubeSat.
- It also has to stay well oriented for the solar panels.

[1] Data recorded in January 9th 2010 on the Ørsted satellite. Source: ADCS for AAUSAT3.

c) Software approach

The software will handle the same functions that we enumerated for the hardware because both are very close. So obviously, the software will be designed to realize the same functions:

- Get the sensors' data
- Process, sample and correct the data (Kalman Filter)
- Determine the target attitude with ADCS CTRL Algorithm
- Calculate the rotations to reach the target attitude
- Control the actuators to modify the attitude accordingly

The CubeSat will be able to adapt in each situation thanks to an algorithm processing different states.

State	Sensor sampling	Attitude estimation	Control
OFF	NO	NO	NO
SLEEP	NO	NO	NO
STANBY	YES	YES	NO
Tether ON	YES	YES	ADVANCED
DETUMBLE	YES	NO	ADVANCED
Pointing	YES	YES	YES