INTRODUCTION
The SPORT Cubesat (6U form factor) mission aims to improve the knowledge about several phenomena related to space weather:
- IVM (Ion Velocity Meter),
- GOE (GPS Occultation Experiment),
- FME (precise Fluxgate Magnetometer Experiment),
- SLP (Sweeping Langmuir Probe),
- EFP (Electric Field Probe),
- SIP (Sweeping Impedance Probe).

The main requirements for the ADCS are:
- The nominal attitude should be Earth pointed, with an error less than 0.1° (3σ).
- The attitude shall be determined on board with an error less than 0.02°.

The ADCS shall be composed by:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Qty</th>
<th>Type</th>
<th>Technology</th>
<th>Accuracy</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star sensor</td>
<td>1</td>
<td>3 axis</td>
<td>CCD</td>
<td>0,01-0,1°</td>
<td>20°</td>
</tr>
<tr>
<td>Magnetometer</td>
<td>1</td>
<td>3 axis</td>
<td>Mag resistive</td>
<td>0,2 μT</td>
<td>100 μT</td>
</tr>
<tr>
<td>Sun sensor</td>
<td>1</td>
<td>2 axis</td>
<td>Photodiode</td>
<td>0,5°</td>
<td>± 60°</td>
</tr>
<tr>
<td>Gyroscopes</td>
<td>1</td>
<td>3 axis</td>
<td>MEMS</td>
<td>15 hr</td>
<td>± 225°</td>
</tr>
<tr>
<td>Reaction wheel</td>
<td>3/4</td>
<td>1 axis</td>
<td>BLDC</td>
<td>5 rpm</td>
<td>± 0.01 Nm</td>
</tr>
<tr>
<td>Magnetic torquers</td>
<td>1</td>
<td>1 axis</td>
<td>Air core</td>
<td>-</td>
<td>± 0,13 Ams</td>
</tr>
<tr>
<td>Computer</td>
<td>1</td>
<td>12 bit</td>
<td>AVR</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The ADCS operating modes are:

- Detumbling
- Attitude Acquisition
- Ground command
- Calibration
- Error detection
- Nominal

SENSOR AND ACTUATOR MODELS
Star sensor (SS): detection of Earth in the sensor’s FOV, detection of Sun in the baffle’s excluding zone, axis dependent gaussian noise.
Magnetometer (MAG): bias, bias instability and random walk, based on sensor’s Allan Variance
Digital Sun sensor (DSS): detection of the Sun in the sensor FOV and direction dependent gaussian noise.
Gyroscopes (GYR): bias, bias instability and angle random walk, based on sensor’s Allan Variance curve.
Reaction Wheel (RW): maximum torque, maximum angular rate, zero speed dead band, angular rate measurement noise and speed control loop.
Magnetic torquers (MT): magnetic moment and maximum PWM duty cycle.

ATTITUDE DETERMINATION

- Gyro measurements
- Magnetometer and sun sensor readings
- Valid sun sensor?
- Track only, Magnetometer and sun sensor readings
- Compute attitude
- Compute SS angular rate
- Compute gyro bias
- SS measurements
- high accuracy
- mean accuracy
- Gyro integrated attitude
- Compute attitude 2 vectors (TRIAD or QUEST)
- Valid SS?
- Compute attitude
- Compute SS angular rate
- Compute gyro bias
- SS measurement

ATTITUDE CONTROL SIMULATION

Detumbling mode (DM): B-dot control

- Satellite kinetic energy - B-dot control

Nominal Mode (NM): PD control and RW unloading by MT

Nominal Mode (NM): PD control with high gains

Sensor inside the SS exclusion cone

Magnetometer Instrument Calibration Mode (MICM): autonomous attitude manoeuvres, angular velocity vector control.
Rotating axis: Roll, Pitch and Yaw.
Sub-maneuver 0: Nominal attitude
Sub-maneuver 1: Pointing the rotation axis
Sub-maneuver 2: Accelerate to the angular rate
Sub-maneuver 3: Keeping an inertial rotating axis
Sub-maneuver 4: Decelerating
Sub-maneuver 5: Pointing to nominal attitude

Pitch maneuver:

Magnetometer readouts

BIBLIOGRAPHY