Space Fan: A Mechanical De-Orbiting Device System for Satellites

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First Iteration
First Iteration

First Iteration performance Values
Area : 0,345 m²
Satellite lifetime 560 days

New Design
Area : 0,6285 m²
Satellite Lifetime : 504 days
Advantage : more solar panels
Deployment Mechanism

- Interface PCB
- Opening Control Switch
- Multiple springs
- 10 ohm, 5 V for 30 seconds, less than 50mW, 75 Joule
Opening Sequence
Opening Sequence
Opening Sequence
Folding of Sail

- Thickness of the kapton is 0.125 mm *
- Folding like hand fans

<table>
<thead>
<tr>
<th>Radius</th>
<th>Circumference</th>
<th>Height of Folding</th>
<th>Folding Number</th>
<th>Total Folding Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>94,25</td>
<td>1,8</td>
<td>47,12</td>
<td>0,58</td>
</tr>
</tbody>
</table>

Mechanical Properties
Mechanical Properties

- 12 grams for opening rots
- 10 grams for springs
- 8 grams Resistor + Kapton + Melting Wire

- Total Mass = 60 gr
- Cost 500 – 1000 $
Mechanical Properties

- 98.4 mm Structure
- 5.6 mm Panel + Opening Mechanism
  Thickness (one side)

- Allowable space is 9.5 mm from structure to outwards
ISIPOD CubeSat Deployer

The Maximum Advised Available Clearance for CubeSat Antenna’s and/or Baffles, etc is: 9.0 [mm]
(on all: Y+, Y-, X+, X- sides)

The Total Maximum Advised Available Volume is:
L x W x H = 340.5 x 88.0 x 9.0 [mm]

Pusher Plate has access volume available for CubeSats;
(Maximum) Dimensions: 174.8 [mm], depth 46.0 [mm]

The ISPOD inner walls are flat, this applies to all four walls.
They do not contain any obstructions/edges/etc. and can be
safely used to hold deployables.
(In this specific case one car exceed the above mentioned
maximum advised available clearances, up to the total 10.0 [mm])

The need switches activation magnets are positioned below
the pusher plate.

POM Interface to CubeSat feet
☐ 10x10 [mm]

The Guide Rolls are Hard Anodized Aluminum components.
Outer dimensions are ☐ 15x15 [mm] with a cut out of ☐ 5x5 [mm]
Rolls Width = 1.5 [mm]

Guide Rolls to Launch Vehicle
(2x Y- Side)

Guide Rolls
(2x Y+ Side)
Analysis Configurations

Case A

Case C

Case D
## Analysis Results

<table>
<thead>
<tr>
<th></th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
<th>Case D</th>
<th>Case E</th>
</tr>
</thead>
<tbody>
<tr>
<td>CubeSat Mass [kg]</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Drag Area [m$^2$]</td>
<td>0.01</td>
<td>0.03</td>
<td>0.0633</td>
<td>0.6285</td>
<td>0.5627</td>
</tr>
<tr>
<td>Altitude [km]</td>
<td>552</td>
<td>552</td>
<td>552</td>
<td>552</td>
<td>552</td>
</tr>
<tr>
<td>Attitude Control</td>
<td>3 axis</td>
<td>Random</td>
<td>3 axis</td>
<td>3 axis</td>
<td>Pas. Aero. Stab.</td>
</tr>
<tr>
<td>De-orbit Date</td>
<td>3 Agu 2023</td>
<td>27 Jul 2021</td>
<td>7 Mar 2020</td>
<td>16 Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Flight Time</td>
<td>+30 years</td>
<td>1748</td>
<td>1011</td>
<td>504</td>
<td>513</td>
</tr>
</tbody>
</table>
Passive Aerodynamic Stabilization

Design helps passive aerodynamic stabilization. It's possible to stabilize the satellite with about 15 degree pointing error at each axis with passive aerodynamic stabilization.*

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*An Attitude Control System for ZA-AeroSat subject to significant Aerodynamics Disturbances Willem H. Steyn, Mike Alec Kearney
Advantages

• Simplicity
• Cheap
• Not wasting space
• Applicable with COTS launch pods
Disadvantages

• Deployment mechanism spring*
• Solar panel deployment mechanism is needed $$$

*%2 change in modules loss for each 55 degree change

Space Vehicle Mechanisms: Elements of Successful Design
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Thank You For Your Attention