

INTISARI

Deployable Solar Panel (DSP) merupakan salah satu sub-sistem penting pada CubeSat 6U untuk memenuhi kebutuhan daya listrik, namun keberadaannya sebagai struktur tambahan menyebabkan DSP rentan terhadap masalah dinamika struktur, khususnya terkait pemenuhan persyaratan frekuensi alami minimum saat peluncuran. Indian Space Research Organisation (ISRO) mensyaratkan frekuensi alami struktur satelit yang diluncurkan menggunakan Polar Satellite Launch Vehicle (PSLV) harus lebih dari 90 Hz. Penelitian ini bertujuan untuk menganalisis pengaruh konfigurasi pin penumpu dan *hold-down and release mechanism* (HDRM) terhadap frekuensi alami DSP CubeSat 6U serta memperoleh desain optimal DSP dengan struktur penguat aluminium yang memenuhi persyaratan PSLV.

Metode penelitian dilakukan melalui perancangan konseptual, desain analitis, dan *computational modal analysis* (CMA) menggunakan metode elemen hingga. Variasi konfigurasi kondisi batas berupa posisi HDRM dan pin penumpu dianalisis untuk menentukan konfigurasi optimal. Selanjutnya dilakukan optimasi desain struktur penguat menggunakan geometri berperforasi guna menurunkan massa DSP.

Hasil penelitian menunjukkan bahwa penambahan pin penumpu meningkatkan kekakuan global struktur sehingga frekuensi alami pertama DSP meningkat secara signifikan. Struktur penguat dengan geometri *orthogrid* terbukti memiliki rasio penurunan massa per penurunan frekuensi alami paling efektif, serta paling mudah untuk dimanufaktur. Desain akhir DSP memiliki massa total sebesar $478,9 \pm 47,9$ gram dan memenuhi persyaratan frekuensi alami minimum PSLV dengan margin desain 10%.

Kata kunci: *Deployable Solar Panel*, CubeSat 6U, Frekuensi Alami, Pin Penumpu, *Computational Modal Analysis*.

ABSTRACT

Deployable Solar Panels (DSPs) are one of the critical subsystems in CubeSat 6U missions to meet electrical power requirements. However, as additional structural components, DSPs are susceptible to structural dynamic issues, particularly in meeting the minimum natural frequency requirements during launch. The Indian Space Research Organisation (ISRO) requires satellite structures launched using the Polar Satellite Launch Vehicle (PSLV) to have a natural frequency higher than 90 Hz. This study aims to analyze the influence of support pin and hold-down and release mechanism (HDRM) configurations on the natural frequency of a CubeSat 6U DSP and to obtain an optimal DSP design with an aluminum stiffening structure that satisfies PSLV requirements.

The research methodology includes conceptual design, analytical design, and computational modal analysis (CMA) using the finite element method. Various boundary condition configurations, defined by the positions of the HDRM and support pins, are evaluated to determine the optimal configuration. Furthermore, the stiffening structure design is optimized using perforated geometries to reduce the DSP mass.

The results show that the addition of support pins increases the global stiffness of the structure, leading to a significant increase in the first natural frequency of the DSP. The orthogrid reinforcement geometry is proven to be the most effective in reducing mass, with minimal reduction in natural frequency, while also being the easiest to manufacture. The final DSP design has a total mass of 478.9 ± 47.9 grams and meets the minimum natural frequency requirement of PSLV with a design margin of 10%.

Keywords: Deployable Solar Panel, CubeSat 6U, Natural Frequency, Support Pin, Computational Modal Analysis.