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solar array panels: more than 150 identical panels have been produced over the last 5 years.

Now, to satisfy growing market demands, a new-generation design has been developed to provide more than 15 kW power EOL in a 7-panel version. In addition, a new Lightweight Panel Structure (LPS) has been introduced to increase the solar array W/kg and thus maintain the competitiveness of Spacebus in the commercial market.

2004 was a particularly bad year in the telecommunications market; half of the insurance payouts stemmed from solar array problems in space (from other suppliers!). This confirmed that products as critical as solar arrays must be robustly developed to ensure high reliability. Robust and exhaustive development is mandatory but not compatible with flight schedules. In fact, as the market becomes more aggressive, the manufacturing cycles are being more tightly squeezed. The conclusion is that development must be done outside of flight programmes. This requires ‘generic’ development to ensure the product is ready for the market before the first missions requires it.

Meeting Power Growth Needs

Usually, power growth is achieved by increasing the efficiency of the solar cells. This is how the 15% efficiency of standard silicon cells has grown to today’s 28% for triple-junction gallium arsenide (GaAs) cells. More than 30% efficiency is expected in the near future for GaAs.

However, improving the power-to-mass ratio also calls for redesigning the mechanical and electrical architectures. The mechanical improvement is inline with the logic of 1998: a standard modular panel multiplied to provide the desired area. The new array has seven panels per wing as the baseline, but offers a growth potential to a 10-panel version. Thanks to the novel way the array is stowed, non-structural ultrathin lateral panels can be used. No other solar array does this.

Different cell technologies will cope with the power demand:

- for the near-term 15 kW EOL, thin high-efficiency silicon cells will be used for the first missions;
- GaAs cells will be called on in a second step if more power is needed;
- design novelties already under development will make the design more attractive.

Development Based on Design Heritage

The overall goal of this huge development effort is that the optimised mechanical structure will support continuous improvements in the electrical architecture over the next 10 years. After this robust generic development, prototype flight qualification will be provided by the first flight project.

Design targets

The new design is based on the fact that, during the three major life phases of a solar array (launch, deployment and orbital life), the structural needs of the central panels are more important than for the lateral panels. The novelty of the LPS design rests on this difference, allowing the lateral panels to be half as thick as the central panels.

A central mast has a yoke plus two, three or four central panels. When more power is needed, lateral panels are added. The stowed configuration is the key to this innovative design. The panels are stacked at launch so that the ultrathin lateral panels are protected between two ‘structural’ central panels. Shims keep the launch loads away from the lateral panels. This approach allows several configurations, with two or three panels in line and zero to six lateral panels.

Step-by-Step validation

Qualification was achieved using a step-by-step approach that limited the risk during the programme. The first test campaign characterised the shims’ dynamic behaviour during launch. A second test validated the load path through the shims, tuned the shims and validated the model’s stiffness linearity. Thanks to these two main tests at the start of the development process, it was possible to model the shim characteristics and to build a global mathematical model that represents the entire solar wing. Using this model, a detailed analysis was performed to size the new substrates and the mechanical architecture of the 4-10 panel wing configurations.

Additional intermediate tests were performed on half-scale panels to verify early on the integrity of the solar cells after the vibration tests.

In addition, new manufacturing processes were developed for the lightweight panels, together with a robust database for mechanical and thermal design. Compatibility with all cell and bonding processes were verified via lifecycle testing. Finally, full-scale panels equipped with GaAs, silicon cells and representative cell dummies were subjected to thermal vacuum cycling. In addition, the full Assembly, Integration and Test sequence was validated.

Conclusion

The first two steps of this development programme are completed. Three commercial flight projects are already running using silicon high-efficiency cells for 15 kW EOL power. The use of GaAs cells is then foreseen to provide more power or reduce the number of panels. GaAs cells will allow the LPS architecture to satisfy future market needs easily. It will be possible to reach 23–29 kW BOL in a 7-panel configuration; more can be achieved because the LPS design offers 10 panels per wing.
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