Technical Article

4 Trends in Space-grade Power Management

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Power architecture designs for space applications have historically lagged behind the commercial world due to the complexity of designing radiation-hardened integrated circuits (ICs). Today, the situation is changing rapidly. Developments in 5G technology are fueling the need for more bandwidth and global Internet coverage, pushing many countries to launch higher volumes of satellites into space, while increased functionality and protection demands are driving the need for specialized space-grade power ICs that come in small packages and offer greater integration. As designers opt for more complex ICs for their space-grade power-management projects, here are four key trends to keep your eye on.

1. Higher power density in satellite payloads.

Modern satellites need to handle more onboard decision-making, requiring more bandwidth for data transfer and more secure data streams. As a result, satellite payload processing demands will continue to rise. This means that power requirements will continue to rise as well, as engineers expect higher power output capability from the same size board. The electronic components for space applications will get proportionally smaller, not only to support the high current requirements of the new generation of field-programmable gate arrays (FPGAs) that form the core of most satellite payloads, but also to meet the tight core voltage tolerance requirements of these FPGAs and to give designers more functionality in the same package size to achieve their design goals. TI's

TPS50601A-SP, the highest-power-density DC/DC converter IC in the market, is a 6-A, 7-V_{IN} buck converter that is 50% smaller than similar solutions.

2. Increased integration of space FETs and smaller ceramic packages.

Along with higher power density, engineers designing power supplies for space-grade applications will continue to look for smaller solution sizes. One way to decrease the existing solution size is to integrate some of the high quantities of discrete field-effect transistors (FETs) and passives into a monolithic IC. This trend will grow in 2020, with high demand for products in known-good-die form or with more integration if in a ceramic package. For example, the TPS7H2201-SP is an eFuse with integrated protection features that can replace discrete solutions for cold sparing, overcurrent and reverse-current protection, and programmable current limiting. You can also expect to see smaller ceramic packaging – to the point where new package development is die-size-limited – as IC manufacturers look for ways to further shrink the power-supply size.

3. More satellites with radiation-hardened power.

The growth of 5G networks is encouraging more countries to launch higher volumes of low-earth-orbit (LEO) satellites into space. These satellites are slated to be in space for less time than traditional satellites and therefore are exposed to less radiation. Thus, many satellite-makers are looking for a new class of products that offer some level of reliability and radiation performance at a lower price than traditional space-grade ICs. When designers try to achieve this by using a mix of radiation-hardened and commercial off-the-shelf products, they often realize the importance of the power-stage architecture in ensuring the success of the mission. Transients can damage downstream devices, and designers will increasingly look for failure propagation mitigation in the power solution. The TPS7H2201-SP and TPS50601A-SP are examples of products in the critical power path that can help protect downstream devices from overvoltage and overcurrent. Another option is to consider Space Enhanced Plastic (Space-EP) components, which are intended for short LEO missions, tested to a 30-krad total ionizing dose (TID), assured to 20-krad TID with radiation lot acceptance testing, and characterized to 43 MeV-cm^2/mg for single-event latch-up (SEL).

4. The growth of in-depth radiation effects analysis and collateral.

The growth of more complex, integrated power ICs makes radiation testing, modeling and reporting even more important, and requires detailed evidence of an IC's suitability for a space environment. Since the complexity of modern space-grade devices makes such analysis difficult, more designers will start to lean on suppliers for support, driving demand for detailed documentation for space-grade power-management devices, including radiation reports for TID, single-event effects (SEEs) and neutron displacement damage effects, as well as worst-case analysis (WCA) models. To answer this demand, more manufacturers will start providing full SEL, single-event upset (SEU), single-event transient (SET), single-event burnout (SEB) and single-event gate rupture (SEGR) characterization for devices, as well as worst-case analysis models, which include process-voltage-temperature variation, aging effects from life testing, TID effects, and support Monte Carlo analysis. WCA models are available today for the TPS7H1101A-SP low-dropout regulator (LDO), the TPS7A4501-SP LDO, and the TPS50601A-SP buck converter.

Conclusion

Engineers designing power supply for space-grade applications are demanding new, integrated technology that is in line with the commercial world but doesn't compromise reliability and capability. These four trends are among many driving the development of cutting-edge space-grade power-management products, as well as detailed radiation reports and Qualified Manufacturers List (QML) Class V radiation-hardness-assured qualification to support both high- and low-orbit projects.

Additional resources:

- To learn more about integrated ICs for space-grade power applications, read the technical article, "When failure isn't an option: power up your next satellite with integrated functionality and protection."
- To see how you can reduce the complexity of your radiation-hardened power supply, read the technical article, "Simplifying radiation-hardened power-supply design with eFuses."

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