The Redesign of a High Reliability Avionics Power Supply

Today's aviation electronics (avionics) designers voice common concerns. These are:

- Power Supply Weight Reduction
- Power Supply Efficiency Improvements
- Power Supply Reliability Improvements
- Power Supply Hot Swap-ability and Load Sharing

Power supply design for avionics has become an area of increased activity over the past few years.

New to the market are industrial quality, high current, lithium based battery systems. Available from a wide variety of vendors, these batteries are characterized by their low weight and high-energy availability. In avionics and terrestrial mobile applications, every pound saved counts. Typical older equipment provided portable power with heavy lead acid battery systems. Redesign of these older lead acid battery systems can result in a 50% or more weight reduction without sacrificing stored energy performance. Couple low-mass lithium batteries with reduced weight electronics design and a modern battery power supply can vastly improve the available energy to weight ratio of the entire power system.

Power supply efficiency improvements can be achieved through careful selection of the power supply topology for the required application. The power supply shown in the photograph below achieved 90% core efficiency. This high frequency forward converter design was optimized for a particular voltage current load curve. Core efficiency refers to the actual switcher design efficiency prior to application of additional features. Supervisory features such as over and under voltage lockout, current fold-back, over voltage detection, redundant controls, and power factor correction can rapidly eat away at a power supply's core efficiency number. Working closely with mechanical designers, a power supply can be crafted that is small in size, efficient, and easy to cool.

Power supply reliability and proven Mean Time Between Failures (MTBF) – in short design quality is of paramount importance in avionics. Power supply reliability can be greatly increased through conservative design techniques. This requires what we call, 'design discipline'. A high reliability (translate high quality) power supply design is one in which every component part has been analyzed. A component's normal operating range, de-rating curves, altitude effects, and known useful life characteristics must be considered by the conservative designer. Experience counts when making component selection. Often a thankless task, part selection is easily 75% of the challenge in high reliability design. Balancing circuit board physical area constraints, de-rating requirements and component cost is a delicate art. The best designs are achieved when component selection is not rushed

Power supply hot swap and load sharing features have become extremely popular. The ability to swap one power module for another results in greatly reduced overall system Mean Time To Repair. (MTTR) When aircraft service or terrestrial vehicle service must be performed quickly, low MTTR power supply sub-assembly designs really help. Use of low cost edge finger contacts, modular sub-system design, and the ability for sub-systems to load share makes hot swap possible. Ideal diode FET output stages can perform load sharing with great efficiency, low cost, low weight and low heat. Microcontroller supervision can add a layer of system level monitoring of power supply health. IPMI based power systems provide an industry standard method of performing power management. Alternately, custom communications can be implemented to supervise power management.

We at Orchid Technologies have successfully implemented the various techniques described within this article. We have designed high reliability power systems for the telecommunications, cable TV, military, and avionics marketplace. The design of custom electronics with demanding requirements and unforgiving schedules sets us apart.

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