Advancing technology enlists new MIL-COTS power solutions

By **KEITH NARDONE**

The Pentagon is challenging industry to reduce development time and cost. To meet delivery and budget goals, there are fewer opportunities for new development items. The shift is toward field-proven commercial off-the-shelf (COTS) components with configuration flexibility. This keeps cost down while meeting delivery expectations and with the lowest possible risk.

To look at one area, the need for tactical intelligence has had a place in warfare for as long as wars have been fought, but asymmetric warfare—with the bad guys intermingling with the populace—intensifies that need. Commanders in the field have always tried to optimize their situational awareness but they had precious little ability to do much about it.

Now, the relentless advancement of technology has provided some ability for commanders to gain real-time insights 24/7. Such tools as unmanned aerial vehicles (UAVs) are gathering surveillance imagery that helps to find and neutralize insurgents and, perhaps equally important, identify those who legitimately live and work there. But technology brings more than the UAV itself, which might be carrying video cameras or other electronics for communication, navigation, and weapon control. There are more compute-intensive electronics on the ground, including ruggedized monitors, computers, and communications equipment.

Although the requirements of each electronic device or system are different—fast delivery, light weight, unique packaging, heat and noise management, low voltages, high currents, fast transient response, high efficiency—they all need MIL-COTS power.

UAVs, which have been characterized as the biggest change on the battlefield since the introduction of gunpowder, can weigh a pound or so and be held in a hand or have a wingspan of about 50 feet. They are designed to fly at altitudes of 2,000 feet or as high as 50,000 or even higher; some can remain in the air for days. They may be fixed-wing or helicopters, yet most important from a power point of view is the payloads they carry.

In the air, the power solutions are dictated by the requirements of the onboard electronics, which could include an onboard computer for image processing, autopilot, data acquisition/analysis, control actuation; sensors like GPS receiver, gyroscopes, accelerometers; transceivers; and cameras like infrared, thermal imagers, low-light TV cameras, and video cameras. Power requirements likely include MIL-COTS 28-volt DC input (MIL-STD-704) with output of perhaps plus-or-minus 5 volts for inertial sensors, 3.3-volt DC for computers and GPS); and 12-volt for transmitters. Power could be in the range of tens to hundreds of watts.

In general, whether a MIL-COTS system is in the air or on the ground, reduced size, weight, and power (SWaP) is the order of the day. With smaller UAVs, small and lightweight are more than the order of the day; they're crucial. MIL applications, of course, have to be rugged and able to withstand severe environments, including shock and vibration and very high and low temperatures. In Afghanistan temperatures, for example, can range from about -50 to 110 degrees Fahrenheit.

Proximity of the power train to the load can be a significant issue. Several electronic systems likely to be collocated on a UAV suggest the need for filtering to manage the conducted noise and radiated noise. Shielding is a consideration when electronics are in close proximity to one another. With several devices on a UAV, for example, busing might be needed. With 28 volts to be distributed the current can be high. That means larger traces or system distribution losses could become significant. Using small, power-dense devices to perform the voltage transformation and current multiplication at the point of load mitigates this issue.

On the ground, the parameters driving the power requirements shift to high-performance, compute-intensive imaging and analysis capabilities. The ground control station, which might incorporate a virtual cockpit and even be remotely located in the United States; certainly includes computers, displays, and communications.

Although ruggedness and small size remain desirable, the power solution now must provide such capabilities as high power density and fast transient response. While new multi-core technologies not only offer increasing computer power and produce more work per watt, the power needs of a ground control station are substantial.

Just introduced early this year to great fanfare in the MIL-COTS community, the Intel Core i7 processor is already being used in many MIL-COTS applications for image processing. Each time a new processor architecture or technology is introduced, it typically requires different conditions than prior processors. In this case, power supplies must meet the requirements of the VR12 design guidelines, a standard that dictates response time, trim range, the amount of droop that can occur, and many other parameters. The Core i7 processor will go into a sleep mode when there's no processing needed, and when it instantaneously wakes up, power must be there ready to go. Clearly, with such a processor, fast transient response from the power supply is absolutely essential.

An input voltage of one volt or so for the processor core is still demanding. If, however, the power supply must be a distance away from the processor, overcoming the inductance becomes challenging at the levels of current involved. Again, having current multiplication/voltage transformation at the processor relieves these issues.

New MIL-COTS power solutions are available to support such advanced technologies as those represented by UAVs and their ground systems, and they are small, light weight, rugged, low noise, highly efficient, and provide fast dynamic response. Specifically, for example, power solutions based on V-I Chips can more easily be designed because they are small (1/16 and 1/32 brick footprints), light weight (0.5 ounce), rugged (encapsulated), 95 percent efficient, and operate in temperatures from

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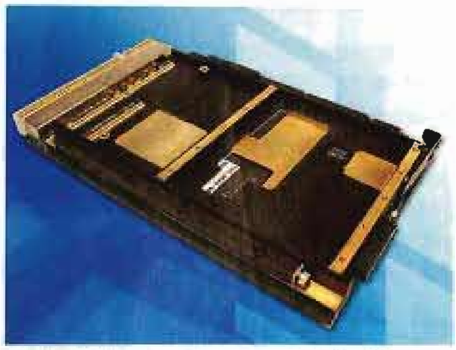
the next-generation technology beyond 90 nanometer would be radiation hardened by design at the 45 nanometer process node."

"Radiation-hardening of DC-DC converters consists of a combination of component selection, circuit worst case analysis, and radiation testing at both the component and converter level to verify the required performance when exposed to the space environmental conditions," VPT's Sable says. "A strict, well-defined test plan is paramount to the success of the product development plan.

"The radiation hardness verification consists of determining parameter degradations through piece part radiation testing and applying them to the circuit analysis," Sable says. "The final converter design is then radiation tested to ensure that the converter parameter degradations can be explained by the component level degradations. For example, the impact of the shift in input offset voltage and current of an operational amplifier used in the current limit circuit should show up as a predictable shift in output current limit in the converter over radiation. It is also important that measurements are made at several radiation levels during the component level and converter level tests because some parameter degradations are not monotonic and therefore may not be worst case at the design radiation level.



The S950-02 from Aitech has a total ionizing dose resistance greater than 15 kilorads.

"The design of enhanced low dose rate sensitivity (ELDRS) free converters can require long test cycles due to the fact that the time to reach the test dose level can be several months," Sable notes. "This has increased both cost and schedule for product development for space products, however its value to the long term reliability of the mission is critical."

Development times are longer not only because of the radiation-hardening aspect especially with FPGAs, Patterson says. "The development time is actually taking longer because of the additional features that now must be built in the FPGA design as the development of the FPGA code is becoming more complicated. This is due in part to having more FPGA gates and more features which are being added. Many times, deliveries can be shortened as Aitech has refined its manufacturing process and tailored it to respond to small and large quantity orders simultaneously."

Enhanced low dose rate sensitivity

"A major industry concern the past few years has been enhanced low dose rate sensitivity (ELDRS)," says Leonard Leslie, manager, space programs at VPT. Designs must not show ELDRS, which is "caused by components degrading earlier when exposed to a dose rate closer to that seen in the application, as opposed to high dose rates traditionally used for design qualification," he adds.

The high dose rates of greater than 50 rads per second "used for testing rad-hard devices historically may be a flawed method for many of the user's applications," Leslie notes. "A low dose rate of less than 10 megarads per second may provide a more reliable predictor of actual tolerance in many applications.

"Some extreme reliability applications VPT supports, such as the GPS III program, also need custom designs that have enhanced requirements in addition to total ionizing dose and single event upset tolerance, he says. "These requirements include increased component screening and hardening for special environments that may be far in excess of even the typical stringent space component levels.

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-55 to 125 degrees Celsius, and have 1-microsecond transient response.

Another advantage that these devices bring to military applications is the robustness of the design. They withstand enormous amounts of shock. The interconnect systems are very rugged. Because the regulation and isolation are split into two devices, they can be physically located in different sections of the end use, distributing the thermal load more efficiently and allowing for weight distribution.

Nevertheless, design engineers will continue to pack more electronics into smaller places. This will continue to challenge the power industry to reduce size and weight while increasing power density and efficiency.

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