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HONING THE EDGE OF THE SWORD

Hypersonic & Other Advanced Missile Development

Standex Electronics

Creating A Next-Generation Missile Means Addressing Next-Generation Design Issues

Figure 1: Next-gen weapon systems like hypersonic missiles present advanced design challenges.

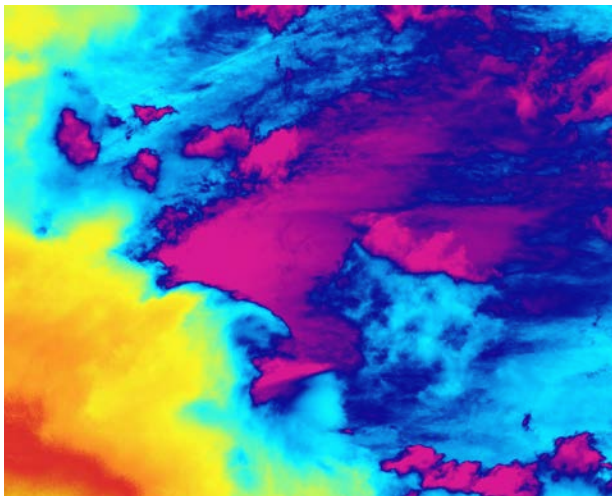
There has been a great deal of attention paid to the latest news about hypersonic missiles being tested by potential adversaries, putting pressure on the design and development of such advanced missile systems. **The creation of such weaponry requires advanced solutions to address the many complex issues involved and their challenges**, which range from thermal management to shock and vibration mitigation (Figure 1).

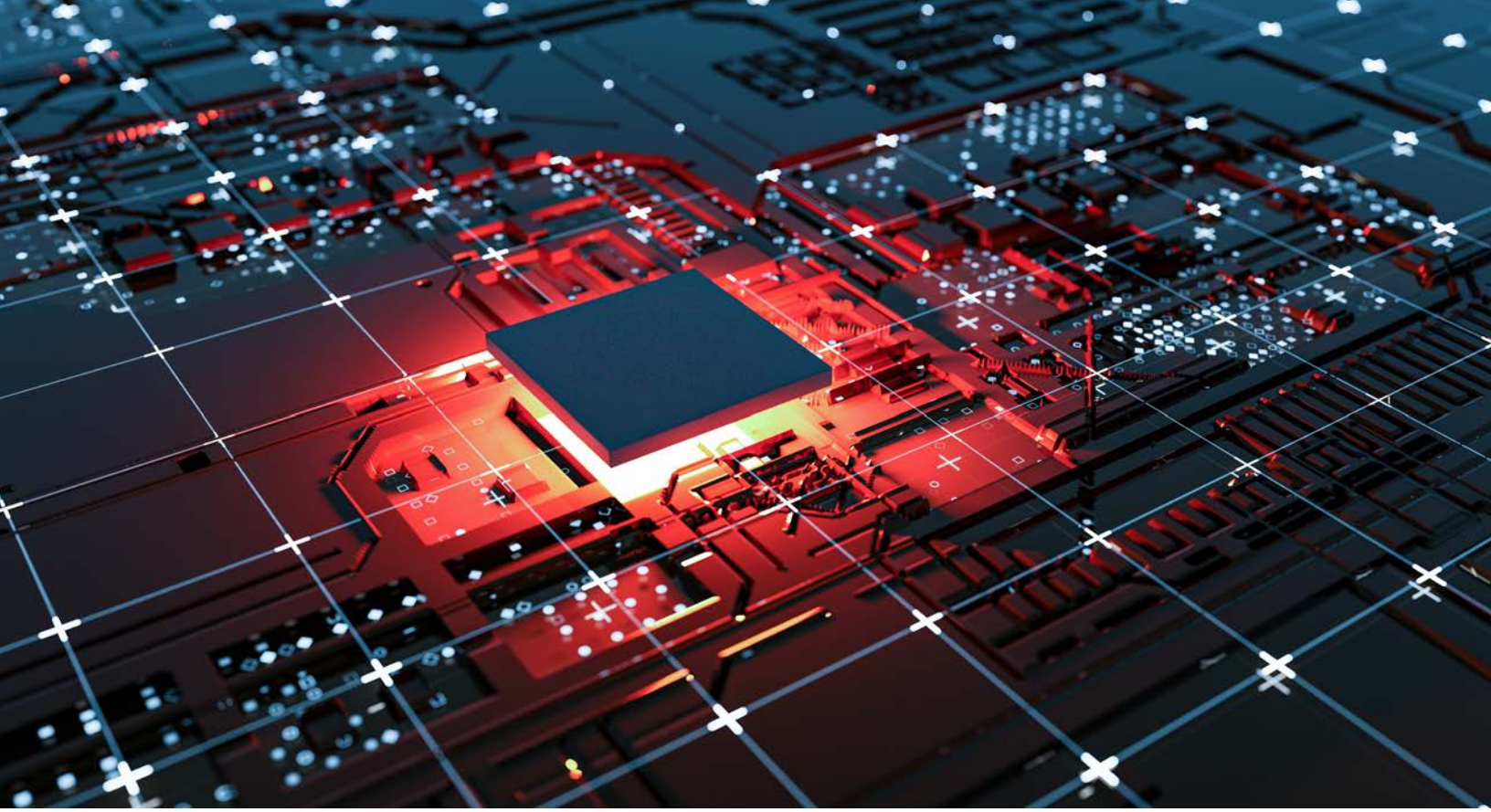
A Hot Issue

Thermal management is one of the most critical aspects of any electronic system. Not only can heat damage components and materials, it can also cause the degradation of performance in circuitry, especially in power conversion and management systems (derating). In most cases thermal mitigation is directly related to power control and the energy budget of the missile's electronics.

There are two sides to the thermal source coin: heat generated by the system, and heat entering the system. Luckily there are multiple ways to address each source, and many leverage one another as well as other system protection methodologies. Thermally encapsulated potting for heat transfer can also perform well for shock and vibration mitigation, for example. Conversely, insulation intended to protect the missile from friction heat can negatively impact the ability of the power electronics within to discard heat.

Generated heat comes mostly from electronic system waste energy, and presented heat can





range from direct sunlight to the air-friction thermal impact blasting through the sky at over five to seven times the speed of sound. Temperatures on hypersonic vehicles can reach over 2,000°C (4,000°F), a temperature over the melting point of most metals. Advanced composite materials can address some of this, but the need for the power electronics to be as efficient as possible to reduce thermal waste is critical.

The recent availability of wide-bandgap semiconductors in production quantities has presented one portion of the solution. **Devices made using these materials, Gallium Nitride (GaN) and Silicon Carbide (SiC), can deliver operational performance over three times that of those based on Silicon**. In real-world terms this means power solutions up to two-thirds smaller than legacy products, or more than twice the power in the same physical space.

The advanced power circuit topologies being created using these new semiconductor capabilities are another important part of the power efficiency solution. This includes the sophisticated technologies needed to develop them, from advanced simulation software to custom transformers and inductors, as well as the myriad other magnetics in a smart weapons system. These range from the magnetic components in motors and actuators to those in sensors and displays. A custom magnetic solution can always optimize efficiency, as well as functionality and precision.

Communication is Important

The functionality of a smart weapons system like a hypersonic missile is only as good as its ability to communicate to send data and receive instructions. These instructions can be something as basic as target data, or as critical as being able to abort or redirect a strike. RF systems in missiles of any kind have space and power issues, and communication at hypersonic speeds puts another layer of difficulty into an already challenging design situation.

Hypersonic and related systems that create a potential RF barrier present a special problem to wireless communications, compounding the traditional issues of power and frequency management significantly. Hypersonic speeds create a high level of surface heating, energizing the air around the missile to such an extent that the air itself is ionized into plasma, which can block communications signals. This is above the thermal, shock, and vibration issues presented in extreme flight profiles at speeds previously in the realm of science fiction.

Here again, **the only way to create an optimum solution is to use customized magnetics to increase efficiency and precision in both the power conversion and RF management systems**, as they address performance, thermal management, and sensor accuracy issues, among others. In the environments encountered and challenges presented, only an optimized system using custom magnetics and other components can perform at the level required.

Moving and Jinking

Hypersonic weapons deploying conventional warheads, or using kinetic-force penetrators to destroy a target, must be much more precise than those that are nuclear-tipped. Being able to use hypersonic weapons conventionally will be a significant factor in force projection in the next-generation battlefield, so precision guidance mechanisms are an important part of missile design. Here again **the precision of the circuits involved will directly impact the performance of the solution design**.

While the speed itself is not a novel challenge - spacecraft and ballistic missiles travel far faster - the mission profile of a hypersonic missile requires it to be able to maneuver enroute to make tracking and interception difficult. This presents high structural and aerodynamic loads to the missile, and all of its systems must be able to handle these loads to ensure that control surfaces can create the necessary forces. **This requires actuators and/or motors of the highest possible performance, only possible using the best materials in a bespoke design tailored for the application space**.

Onward and Upward

Advanced weapons platforms demand the very best solutions from the available technologies. Implementing and integrating these technologies into components and subsystems requires **custom magnetics** and component solutions in order to deliver optimum performance. **Experienced solution providers like Standex Electronics can address the needs of mil/aero systems** with a diverse range of space-saving planar transformers and power magnetics for Military and Aerospace applications.

The company has expertise in mechanical package design and how to have it perform reliably in harsh Military environments. Standex custom power conversion magnetic designs can also withstand thermal vibration and other military performance specifications, as well as providing high reliability and durability.

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