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Powering Hypersonic Missile Interception

How Custom Magnetics Help Enable Next-Generation Interceptor Missiles to Hit Hypersonic Targets.





When an Interceptor Missile Has to Hit a Hypersonic Target

Today's modern military defense systems must do what seems impossible: like intercept and stop an incoming hypersonic weapon moving at five to 10 times (or more) the speed of sound! Every second, the danger comes hurtling at speeds as high as 12,246 kilometers per hour (7,610 miles per hour).

To counter the incoming hypersonic missile, a next generation interceptor must identify, track, and properly react to it. To do this, the interceptor must contain the most advanced technology in sensors, processing, and software. Without all these state-of-the-art systems, this critical task would fail.

The interceptor needs to move and maneuver with precise and hypersonic speed, unencumbered by even the slightest excess in size or weight. The interceptor systems must be free from excess heat and high frequency eddy effects that could disrupt system operations. And all the system components have to be supplied the operating power necessary at the optimal voltages for everything to work.

This analytical breakdown of a Hypersonic Missile Interceptor points to the one basic part that enables all of these critical systems to function: power transformers. Without properly provided and regulated power, the individual systems and, therefore, the Interceptor's ultimate objective, will fail. Therefore, optimized (and often customized) power transformers play a critical role in making sure the threatening hypersonic missile is intercepted.

Minimal Space for Indispensable Control: A Case Study

A missile's overall architecture puts extreme restrictions on the systems and components it can contain. One example missile design included a PC board requiring a transformer exceeding a standard part of a power supply. This transformer had to control voltage and provide signal isolation while managing environmental challenges. Input voltages could range from about 16 volts to 32 volts, while the output was 18 volts. Because the switching frequency the transformer had to support was so high, it required the use of a high-performance planar ferrite core (intended for medium- to high-frequency transformers) that could optimize performance between 500 KHz to 3 MHz.

The core would require custom machining to fit the form factor with a planar configuration rather than a wirewound, which couldn't have achieved the physical compression. A flyback converter was also under consideration, but the required gap would have introduced eddy currents rather than a taller construction that could have kept conductors out of the windings to avoid transients on the output. Managing parasitic signals with multiple layers was critical for input and output stability.

The unit had to operate under significant shock, vibration, and heat conditions of MIL-PRF-27. The geography was the most obviously striking — it had to fit into a slot only a quarter inch tall so the board could stack with others in its allotted space.

The space requirement alone was daunting, but the bigger challenge was how to properly balance between maximizing safety and electrical isolation on one hand and optimizing thermal and magnetic performances on the other. It is a perfect example of Indispensable control in a minimal space.



Working with the Right Vendor

Most manufacturers were unwilling to take on the project cited above. Common magnetics manufacturer business models ultimately aim to mass produce anything they design to address the off the-shelf market.

The approach is certainly not without warrant. The military — and so many other industries — would prefer to work with off-the-shelf products whenever possible. Volume for a large market can drive down costs. But there are trade-offs, and ultimately the size, weight, topology, performance, capacity, and electrical characteristics must be general enough to satisfy the crowd, not the disciplined, focused, life-and-death requirements that must have ultimate reliability and optimization.

For a project like the next-generation interceptor missile example above, compromise was not an option. The transformer, among other aspects of the project, needed custom design and contractual obligation for long-term manufacturing and support. That also meant a product compliant with the International Traffic in Arms Regulations, or ITAR. Such a product cannot be released into commercial use. There is no larger market to justify designing such a device.

The work is demanding. When using multiple layers in a transformer, with gapped magnetic designs, the tolerances and specifications are complex. Winding layers must be the correct thickness for a given frequency. Even then, simulations are necessary to ensure the design properly shares current without localized hotspots, all while maintaining compliance with the appropriate mil standards.

For critical situations demanding nonstandard and innovative, cutting-edge magnetics designs, working with experienced solutions providers like Standex Edge can make the difference in attaining timely success.



A Standex **Electronics** Business

The new brand name for the Standex Electronics Magnetics division exemplifies the position occupied by Standex Magnetics engineers in relation to magnetic component innovation.

Standex Edge expertise spans transformers, inductors, current sensors, chokes and other advanced magnetic components used across multiple industries.

Combining decades of engineering innovation with global manufacturing capabilities, Standex Magnetics Engineers are leaders in component miniaturization, thermal management, robust design, and efficient production. They have firmly established their position at the **Edge** of innovation, where energy meets possibility.

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