HYPERSONIC MISSILE DURABILITY SOLUTIONS

While hypersonic missiles provide superior speed and maneuverability, these strengths present unique component design challenges.

NAVIGATING DURABILITY CHALLENGES FOR HYPERSONIC MISSILE COMPONENTS

Hypersonic missiles are a relatively new class of missiles, capable of reaching speeds greater than Mach 5 or even Mach 10. Active guidance systems pair this speed with extreme maneuverability, allowing hypersonic missiles to fly much lower than conventional missiles while maintaining an unpredictable ballistic trajectory. This makes it difficult to anticipate the missile's flight path and intercept it.

With its superior speed and maneuverability, more defense programs are investing in hypersonic technology. However, the hypersonic missile's strengths also bring complex component engineering challenges. To achieve optimal performance, all components must be built to withstand and function flawlessly in extremely harsh conditions.

THE CHALLENGE OF ENGINEERING RESILIENCE INTO HYPERSONIC MISSILE MATERIALS

The durability of component materials can make or break a mission when relying on hypersonic weapon systems. These materials need to enable connectivity components to maintain structural integrity under high loads and to withstand extreme heat for sustained periods of flight, all while operating with reduced size, weight, and power (SWaP) consumption. After the challenge of selecting appropriate materials, each component — from sensors and circuitry to relays and harness to connectors and cabling — must undergo rigorous nondestructive testing to enhance its reliability.

Managing Extreme Temperatures and Thermal Shock Resistance

Due to their high speed, hypersonic missiles operate in sustained temperatures as high as 3000°F (1648°C) or more. Many common metals used in connectivity products begin to melt at much lower temperatures, and components made of other materials, like plastics and finishes, are also at high risk of degradation.

Even more pressing, sensitive sub-systems for launch, navigation, and flight control, as well as seeker sensors and guidance processor units, must be able to operate reliably in these harsh conditions. Hypersonic missile materials and designs need to withstand thermal shock, thermal expansion, contraction, condensing humidity, and radiation.

LEARN MORE ABOUT THE EVOLVING TECHNOLOGY WITHIN HYPERSONIC MISSILE SUB-SYSTEMS. ▶

IMPROVING STRUCTURAL INTEGRITY IN HYPERSONIC MISSILES

Material degradation at high speeds and fluctuating temperatures is a common concern. As temperatures and aerodynamic loads increase, the fatigue life of hypersonic materials is impacted, threatening the structural integrity of the missile. Components on hypersonic missiles must find a balance between optimizing performance and prioritizing survivability. To do this, connectors and other electronic components must either be constructed with more durable and high-temperature materials or protected from intense heat and corrosive environments. The latter can be done using techniques like thermal barrier coatings and plating schemes designed for extreme temperatures during flight as well as in storage.

REDUCING SIZE, WEIGHT, AND POWER (SWAP)

Miniaturizing the many components within a missile, and therefore lessening size, weight, and power consumption, can lead to greater performance in the field. Reducing SWaP is crucial, but designing components that are smaller and lighter while still handling complex connectivity requirements adds to the challenge. Effective solutions for lightweight yet rugged sub-systems include using lighter superalloys in spring and pin mechanisms that can withstand high heat without sacrificing electrical conductivity.

YOUR ENGINEERING PARTNER FOR HYPERSONIC CONNECTIVITY

TE Connectivity (TE) has decades of experience in extreme environment applications such as space and aviation, as well as defense. This gives TE the unmatched ability to ruggedize and custom design components for hypersonic weapon systems. To engineer missile-ready connectivity solutions in this unique and evolving application, TE puts its components through extensive research and development to understand design and material needs based on factors like temperature and vibration limits. Components also undergo hypersonic testing and simulation methods, including exposure to extreme temperatures, to evaluate performance in the different scenarios they will meet on the modern battlefield.

KEY TAKEAWAYS

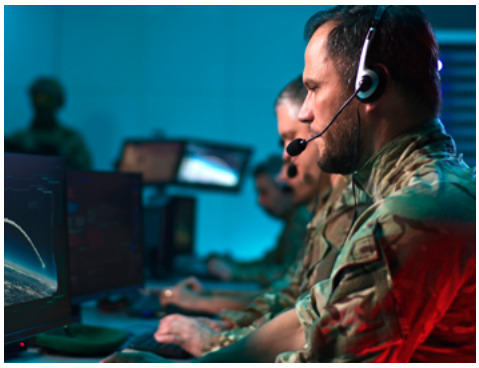
- Hypersonic missiles operate with superior speed and maneuverability, but their components need to withstand the structural integrity issues of harsh environments.
- Hypersonic weapon systems must be engineered to operate in temperatures of 3000°F or more, while pushing through thermal shock and radiation challenges.
- Materials used in hypersonic weapon systems depend on a high fatigue life to prevent degradation. This can be achieved through either high-temperature materials or thermal shields.
- Balancing complex connectivity requirements while reducing SWaP with miniaturized components can be a challenge.
- All ruggedized components must undergo intensive testing to ensure reliability under extreme scenarios.

HYPERSONIC MISSILES

TE Connectivity is your trusted partner in advancing faster, heat-resistant technology. From custom assemblies to a comprehensive range of components, including cables, connectors, and engineered polymer solutions, we simplify connecting critical components in tight form factors. For seekers, our sensors, lightweight VPX connectors, and mil-spec wire and cable streamline prototyping.

INTEGRATED AIR AND MISSILE DEFENSE SYSTEMS FOR HARSH ENVIRONMENTS

Mission-critical detection, launch, flight and precision targeting demand smaller, lighter, faster, reliable interconnects and systems



TYPES OF MISSILE DEFENSE SYSTEMS

Selecting the right type of missile defense system – and the customized components within it – can be a game-changing decision in modern military strategy.

PARIS AIR SHOW TRENDS FROM | TE CONNECTIVITY

TE analyzes seven key trends that dominated the 2023 Paris Air Show experience, including decarbonization, hybrid aircraft, eVTOL, emerging markets, and more.

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