



REPORT

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# Defining and Advancing Rugged, Reliable Connectivity in Aerospace and Defense

APRIL 2025

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## INTRODUCTION: THE FUTURE OF AEROSPACE AND DEFENSE CONNECTIVITY

Modern aerospace and defense applications are constantly evolving, driving new demands for interconnect solutions. As these industries face increasingly complex hurdles, connectors have to do more than simply handle harsh conditions—they must maintain peak performance under relentless strain. In high-stakes situations, the right interconnect components must remain operational through vibration, shock, extreme temperatures and other environmental stressors while preserving overall system functionality. Zero failure is critical, particularly given that replacement of faulty parts in the field is almost always impossible.

How do we ensure these parts perform under pressure? This requires a shift to advanced connector design, going beyond basic durability to withstand the unique rigors of a given application.

Selecting connectors that meet military standards is critical for maintaining system integrity. These guidelines shouldn't be a goal for a design engineer but—instead—a baseline. Rigorous research, development and testing are required to create aerospace and defense connectors which will prevent failure caused by vibration, ingress and material fatigue, delivering operational continuity in high-stakes environments.



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## DEFINING RUGGEDNESS AND RELIABILITY ACCORDING TO ENGINEERING, NOT MARKETING

In aerospace and defense, the terms “rugged” and “reliable” are more than buzzwords—they represent engineering imperatives that help determine mission success. Ruggedness and reliability are not proven through vague marketing claims—they are measured by precise, tested performance metrics.



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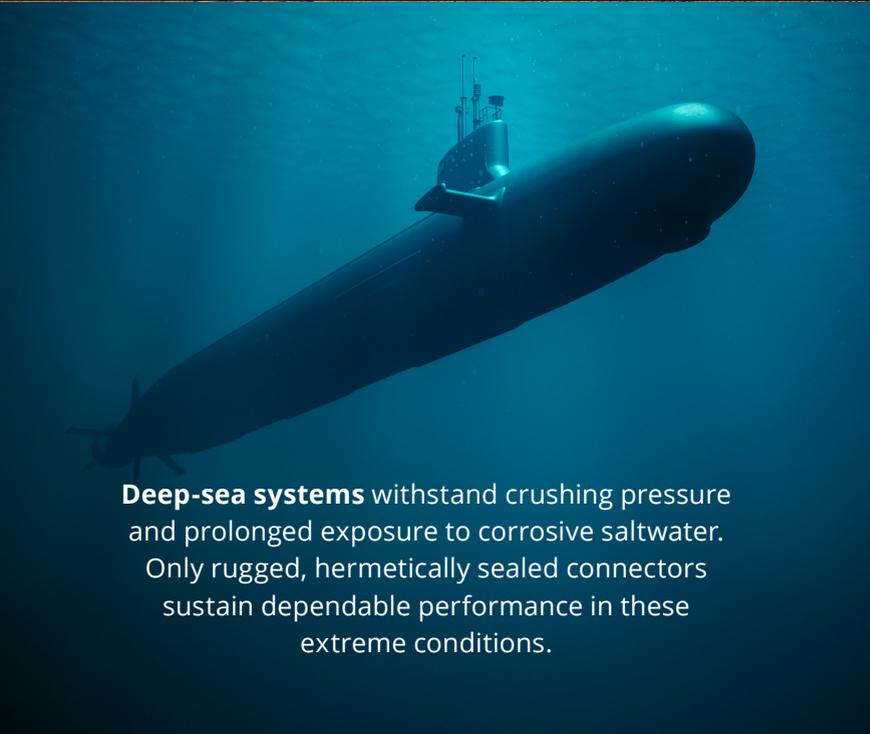
## RUGGEDNESS: ENGINEERING FOR EXTREME ENVIRONMENTS

What exactly defines ruggedness? It's the capacity to endure extreme mechanical, environmental and thermal stresses while maintaining functionality. In mission-critical applications, rugged connectors must not only survive these conditions but operate consistently despite them.





Rugged connectors in **land-based military systems** must handle severe vibration, thick dust accumulation and extreme heat—maintaining stable performance in battlefield environments.



**Deep-sea systems** withstand crushing pressure and prolonged exposure to corrosive saltwater. Only rugged, hermetically sealed connectors sustain dependable performance in these extreme conditions.



### Vibration Resistance

Connectors leveraged in aerospace and defense applications regularly face intense vibrations. For example, connectors in military vehicles or fighter jets are tested to resist forces up to 20G. They undergo vigorous testing in compliance with standards such as MIL-STD-202 and MIL-STD-810. These tests corroborate that connectors can operate reliably, even in environments where the mechanical forces from vibration are severe and ongoing.



### Shock Resistance

Tolerating shock is critical in many applications. Connectors experience high-impact forces during rapid acceleration or deceleration, requiring validation up to 50G for standard connectors and 100G for nano and micro designs. These benchmarks confirm that connectors remain intact and battle-ready in high-impact conditions, including missile launches or emergency landing scenarios. Shock testing commonly adheres to military standards such as MIL-STD-810 for operational shocks and MIL-STD-202 for component-level resilience, while specialized applications may require compliance with MIL-STD-883 for high-G environments or NASA-STD-7003 for pyroshock events.



Electronic systems in **space applications** face extreme temperature swings, vacuum exposure and intense mechanical stress during launch and reentry. Radiation-resistant, high-reliability connectors are essential for mission success.



Connectors in **aerospace systems** endure repeated takeoffs, landings and in-flight vibrations while maintaining secure, interference-free links that support ongoing operation.



### Temperature Extremes

Connectors in ground-based platforms operate in temperatures ranging from  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , while space systems require even broader ranges—from  $-65^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ . These environments expose materials to thermal cycling, where repeated temperature fluctuations cause expansion and contraction, potentially weakening materials and affecting conductivity. Differences in the coefficient of thermal expansion (CTE) between materials within a connector can also introduce mechanical stress at interfaces, potentially leading to misalignment or failure over time. Meeting these demanding requirements calls for not only specialized materials and manufacturing techniques but also adherence to military standards (MIL-STD-202, MIL-STD-810) for thermal resilience, while space systems adhere to international standards (NASA-STD-5019, ECSS-E-ST-10-03C) for thermal performance validation.



### Sealing and Ingress Protection

Protecting connectors exposed to moisture, dust and contaminants is vital for long-term operation. Aerospace and defense connectors, in such exposed environments, are designed to prevent ingress with customized sealing solutions—including O-rings, gaskets and grommets—to prevent ingress. These seals are scrutinized under exacting standards, such as those outlined in MIL-DTL-83513, verifying resilience in environments created in applications like tactical desert vehicles or submarines.



### Corrosion Resistance

Salt spray and oxidation exposure rapidly degrade connectors. To ensure environmental factors such as these do not reduce the performance level of connectors, it is critical that they undergo testing according to MIL-STD-202. This standard certifies their integrity in corrosive conditions found everywhere, from marine to desert environments.

## RELIABILITY: MEASURING PERFORMANCE THROUGHOUT COMPONENT LIFETIME

Beyond initial testing, long-term reliability means maintaining consistent performance despite repeated use, environmental exposure and mechanical stress.



### Mating Cycles

The ability to withstand repeated mating cycles is a key indicator of reliability, particularly for I/O connectors. Aerospace and defense connectors need to endure hundreds or even thousands of mating cycles without failure. To ensure consistent performance, manufacturers may adhere to quality management systems like AS9100 and test for mechanical durability per standards such as MIL-STD-1344.



### Oxidation and Fatigue

Oxidation and wear affect connector longevity. Corrosion on contact surfaces increases resistance, while repeated mating erodes plating and weakens base materials. Aerospace and defense connectors combat these failures with gold plating, which blocks oxidation, and nickel underplating, which adds durability against physical wear.

## NO UNIVERSAL STANDARD: APPLICATION-SPECIFIC DEFINITIONS OF RUGGEDNESS AND RELIABILITY

“Rugged” and “reliable” take on different meanings depending on the application. These terms must be defined in the context of specific mission environments—each with its own set of challenges. For example, connectors used in space applications face different conditions than those utilized in defense applications, requiring validation based on the specific mechanical, environmental and thermal conditions.

Engineers assess the exact stresses connectors face, from extreme temperatures to high-frequency vibrations to high-pressure environments like deep-sea exploration or space missions. As a result, ruggedness and reliability testing should exceed general commercial industry standards as well as ensure alignment with the unique needs of the mission.



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## CONNECTOR FEATURES: ENGINEERING FOR THE HARSHTEST ENVIRONMENTS

Rugged and reliable connectors are engineered to address key failure points. These connectors integrate multiple features that contribute to a cohesive system, balancing mechanical resilience, environmental adaptability and operational longevity. Each component—whether a latching mechanism, a sealing feature or EMI shielding—contributes to overall system integrity.

### A COHESIVE SYSTEM: FEATURE INTEGRATION MATTERS

Signal integrity, sealing and latching are not independent considerations—they function as a unified system to uphold reliability in extreme environments. Each element must be meticulously designed and validated to meet aerospace and defense requirements.

### Mating Cycles: Durability Over Time

A connector's longevity is not only about strength—it is also about endurance. Over their lifetime, connectors are exposed to repeated mating and de-mating. Aerospace and defense applications must undergo hundreds or thousands of mating cycles without failure.



- **Durable Contact Geometry**

The design of the contact surface is key to ensuring that connectors maintain low insertion force while forging lasting connections. Precision machining of contact geometries minimizes wear and tear on the connection.

- **Materials for Durability**

Repeated engagement over thousands of cycles requires connector contacts to retain both conductivity and structural integrity. To achieve this, contact surfaces are typically plated with 50  $\mu\text{m}$  or more of gold, which resists wear and oxidation, preserving signal integrity over repeated use.

## Engineering Features for Miniaturization

As connector footprints shrink, maintaining both durability and functionality becomes a challenge. Engineers must refine every design aspect to prevent compromises in structural integrity or performance. Optimized shielding and signal integrity strategies allow smaller connectors to withstand demanding environments without sacrificing reliability.

### Shielding and Signal Integrity

EMI shielding and signal integrity allow connectors to perform under conditions with high electrical noise, such as those found in military and aerospace systems.

- **Signal Routing**

Sophisticated routing strategies in miniature connectors focus on reducing crosstalk and signal degradation over long distances. These strategies are critical for high-speed applications like radar and communications systems, where even slight degradation can affect performance.

- **Advanced Shielding**

To maintain signal fidelity in aerospace and defense applications, rugged connectors use multiple layers of shielding. These shields are tested under MIL-STD-202 and MIL-STD-810 to verify their ability to suppress EMI in situations like aircraft in flight or satellite launch vibrations.





## **BALANCING RUGGEDIZATION AND FUNCTIONALITY: THE RIGHT TRADE-OFFS**

Rugged connectors combine several key features to achieve reliability in unforgiving environments. However, each added feature can introduce trade-offs. Modifying connector attributes affects other aspects of the connector's design, whether enhancing sealing, strengthening latching mechanisms or adding more shielding.

### **LATCHING MECHANISMS**

Latching mechanisms prevent accidental disengagement due to shock or vibration. Engineers must balance secure engagement with accessibility, ensuring connectors remain compact while maintaining mechanical integrity.

- **MIL-STD-202 Compliance**

Connectors for aerospace and defense must meet MIL-STD-202, which includes rigorous vibration and shock testing protocols. These tests ensure that the latching mechanisms maintain secure engagement even under extreme stress. For example, connectors used in missile guidance systems may need to tolerate shock loads up to 50G to maintain performance during launch.

- **Adaptive Latching Systems**

Some rugged connectors use low-profile latching systems, which offer stability and secure mating while reducing the overall connector size. Spring-loaded locks or push-to-lock mechanisms, for instance, allow connectors to be both mechanically stable and easy to use under battlefield conditions.



## Sealing and Ingress Protection

Protecting connectors from external contaminants is essential for their long-term functionality. Without proper sealing, even small amounts of external contaminants can compromise the connector's performance and lead to failure.

- **O-rings, Gaskets and Grommets**

Customized O-rings and gaskets made from materials like fluorocarbon rubber (FKM) and silicone provide sealing and strain relief. These components help protect connectors from moisture, dust and aggressive chemicals, while also absorbing mechanical stress.

- **Environmental Sealing**

Sealing requirements vary widely depending on the platform and intended use. Ground-based systems may require a rating of IP67, offering full protection from dust and immersion in water. On the other hand, aerospace and space connectors demand custom sealing solutions to prevent pressure loss in high-altitude applications. These connectors adhere to MIL-DTL-83513 guidelines.

## FEATURE INTEGRATION IS KEY TO RELIABILITY

Designing rugged connectors for aerospace and defense is a precise balancing act, requiring the combination of multiple features to deliver continuous performance under extreme conditions. Every factor and fine detail, from mating cycles to shielding and sealing, is part of a holistic connector ecosystem.

## CONTACT SYSTEMS: THE CORE OF RELIABILITY

Extreme vibration, shock and environmental stress put aerospace and defense connectors to the test. While robust housings and environmental sealing provide external protection, the true reliability test happens at the point of contact. Even the most durable connector housing won't prevent failure if a connection is unstable.

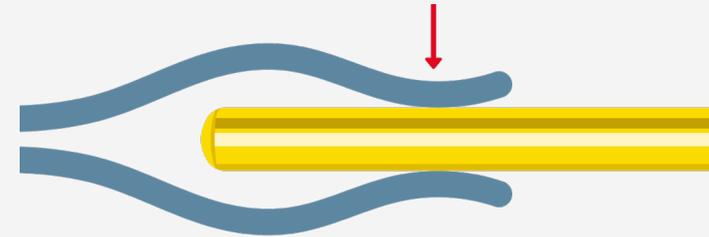


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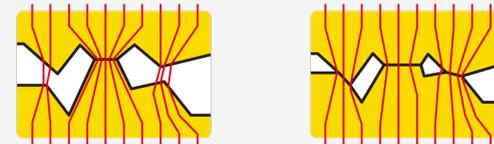


The contact system needs to sustain a stable electrical connection, limit resistance, prevent corrosion and resist mechanical fatigue. Engagement length, normal force, plating thickness and manufacturing precision all influence a connector's long-term reliability. But when properly calibrated, these factors help sustain electrical performance through thousands of mating cycles.

A system is only as strong as its weakest link. In high-stakes aerospace and defense applications, electrical inconsistencies can disrupt mission-critical operations. The contact system isn't just another design consideration—it provides the foundation for long-term reliability.



Sustaining normal force is critical for reliability. A high-performance spring material maintains contact pressure and durability.



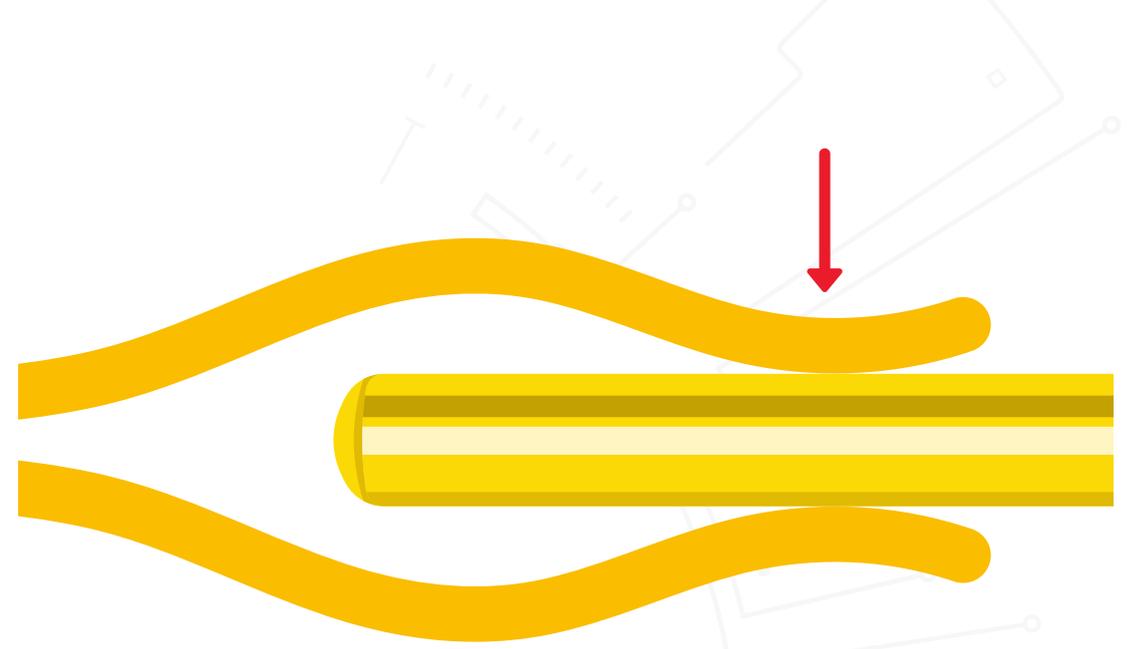
Stronger contact force reduces air gaps, lowering resistance and improving signal integrity. Optimized geometry distributes pressure for stable conductivity.

## CONTACT ENGAGEMENT AND NORMAL FORCE

A well-engineered contact system balances engagement length and normal force to prevent weak connections, excessive wear and mechanical stress that could cause component performance-loss. If contact force is too low, electrical resistance increases, leading to signal instability. Conversely, too much force accelerates plating wear and premature fatigue in the contact structure. Maximizing these forces is the key to a contact system's long-term durability and functionality.



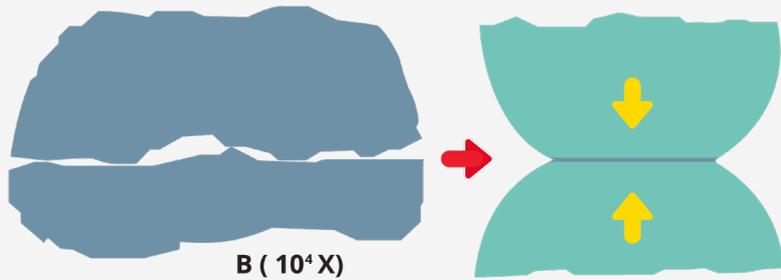
Single or dual-point contacts risk failure under high vibration and G-forces. Multi-point designs improve stability and signal integrity.



Contact engagement is the axial overlap between pin and socket, balancing force, continuity and mechanical stability.

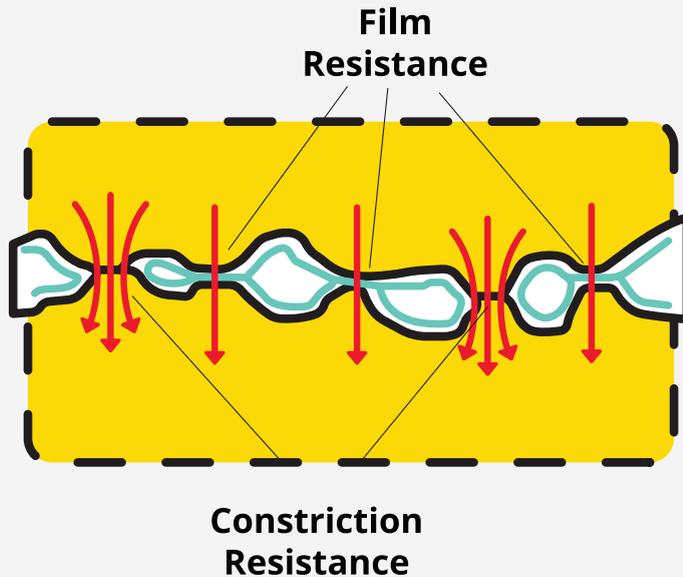
## Multiple Points of Contact

Ruggedized connectors incorporate multi-point contact systems—unlike commercial connectors' one or two points—to distribute mechanical loads during vibration/shock. These contact systems prevent arcing or signal loss from micro-movements and establish redundant contact paths for critical systems. This multi-point design promotes uninterrupted performance in extreme high-G and high-vibration environments where single-contact systems risk intermittent connectivity.



B ( 10<sup>4</sup> X)

Electrical contact occurs at microscopic asperities.  
Higher force flattens them, improving conduction and reducing resistance.



Constriction resistance limits current flow through asperities.  
Film resistance from oxides increases resistivity.

## Optimized Contact Engagement Length

Precision contact design enhances stability under high mechanical stress, helping connectors maintain a firm electrical interface.

- **Reducing Intermittent Signals**

Proper contact engagement length helps to prevent vibration-induced disconnects. These design considerations are necessary to avoid signal transmission failures that could disrupt essential systems.

- **Minimizing Resistance Fluctuations**

Contact surfaces are engineered to maximize physical contact across the entire surface area, reducing resistance fluctuations. This is especially important in high-frequency applications, where impedance stability affects data integrity in systems like radar, avionics and secure communications equipment. Impedance mismatches throughout an interconnect component can degrade performance, resulting in signal reflection, power loss and signal distortion.

## Contact Wipe

Contact wipe is the sliding motion that occurs when the spring member moves across the non-spring member as the pin and socket fully mate.

This movement removes surface contaminants like oxidation and debris, ensuring a stable electrical connection. A well-designed contact wipe maintains conductivity over thousands of mating cycles.

### **Balanced Normal Force**

Contact force is critical to wear resistance, vibration tolerance and long-term conductivity. Engineers fine-tune normal force to match the demands of each application—whether for high-speed data transfer, extreme vibration conditions or frequent mating cycles.

### **Tuning Contact Force for Longevity**

Properly calibrated contact force supports both signal integrity and connector lifespan. For harsh environments, contact forces must be aligned to their specific operational stresses, factoring in vibration resistance, mating cycle requirements and signal frequency. By mastering these factors, engineers can achieve an optimal balance of signal integrity, mechanical durability and long-term reliability.

### **Spring Force and Fatigue Resistance**

Aerospace and defense connectors often integrate spring elements to retain consistent contact force over time. Spring-loaded contacts compensate for slight variations in contact alignment while ensuring reliable conductivity across repeated mating cycles. To prevent relaxation or material fatigue, springs are designed with specific

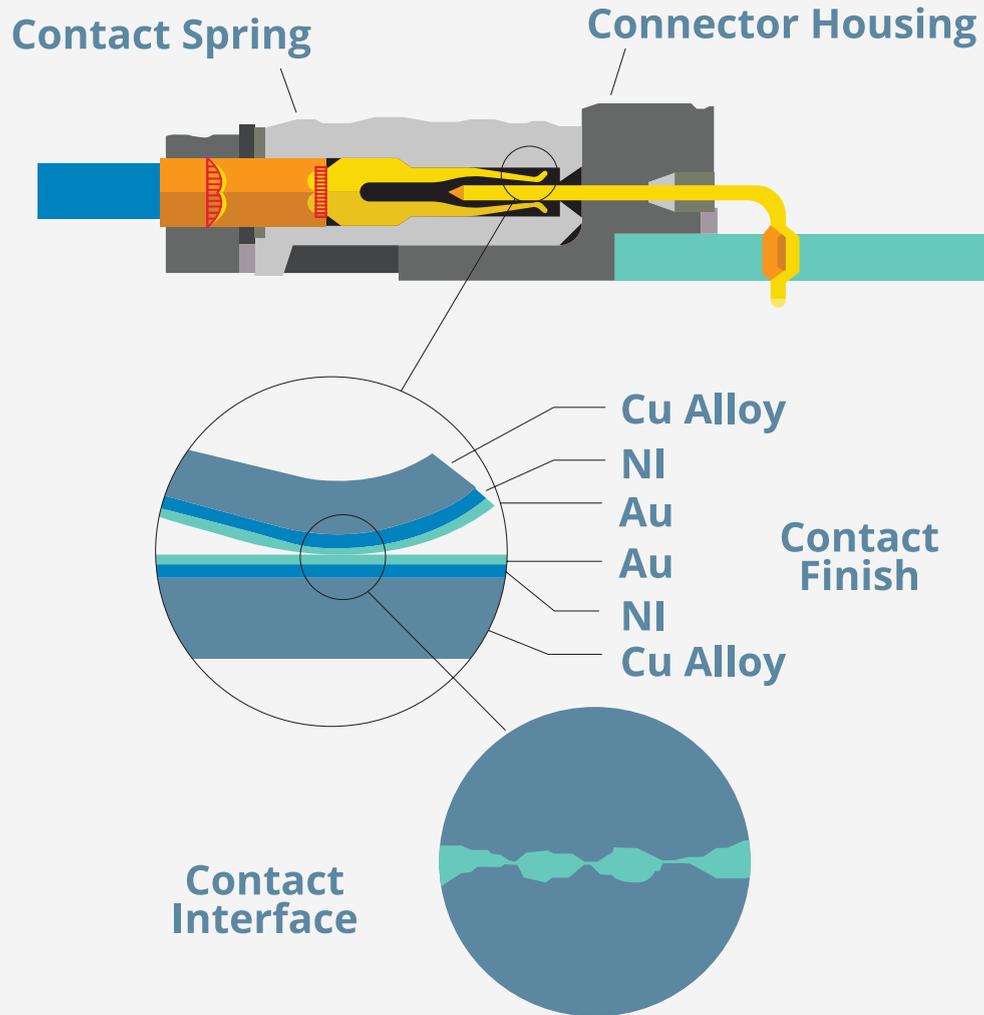


deflection tolerances. These tolerances are not arbitrary but are calculated based on the spring material properties (elastic modulus, yield strength, fatigue strength), spring geometry (wire diameter, coil diameter, number of coils) and application requirements (contact force, mating cycles, operating temperature).

### **Staying in Contact**

No single component dictates a connector's longevity; rather, it's the system-level design that allows all parts to work harmoniously under extreme conditions. Every design choice ripples through the system, affecting long-term performance. Each variable needs to be optimized for an application's specific electrical, mechanical and environmental demands.

The bottom line? Reliability begins at the contact level and extends throughout the entire connector ecosystem.



Contact materials determine spring elasticity, force retention and fatigue resistance while affecting electrical conductivity, thermal dissipation and corrosion resistance.

## BUILT FOR THE LONG HAUL: MATERIAL SELECTION FOR PERFORMANCE AND DURABILITY

A connector's durability is defined by its materials. The metals and polymers used for contacts, plating and housings must weather significant mechanical stress, corrosion and electrical demands. In aerospace, defense and space applications, material selection determines whether a connector operates reliably for decades or if it degrades prematurely under harsh elemental conditions.

### BASE MATERIALS: DETERMINING THE RIGHT ALLOY FOR THE JOB

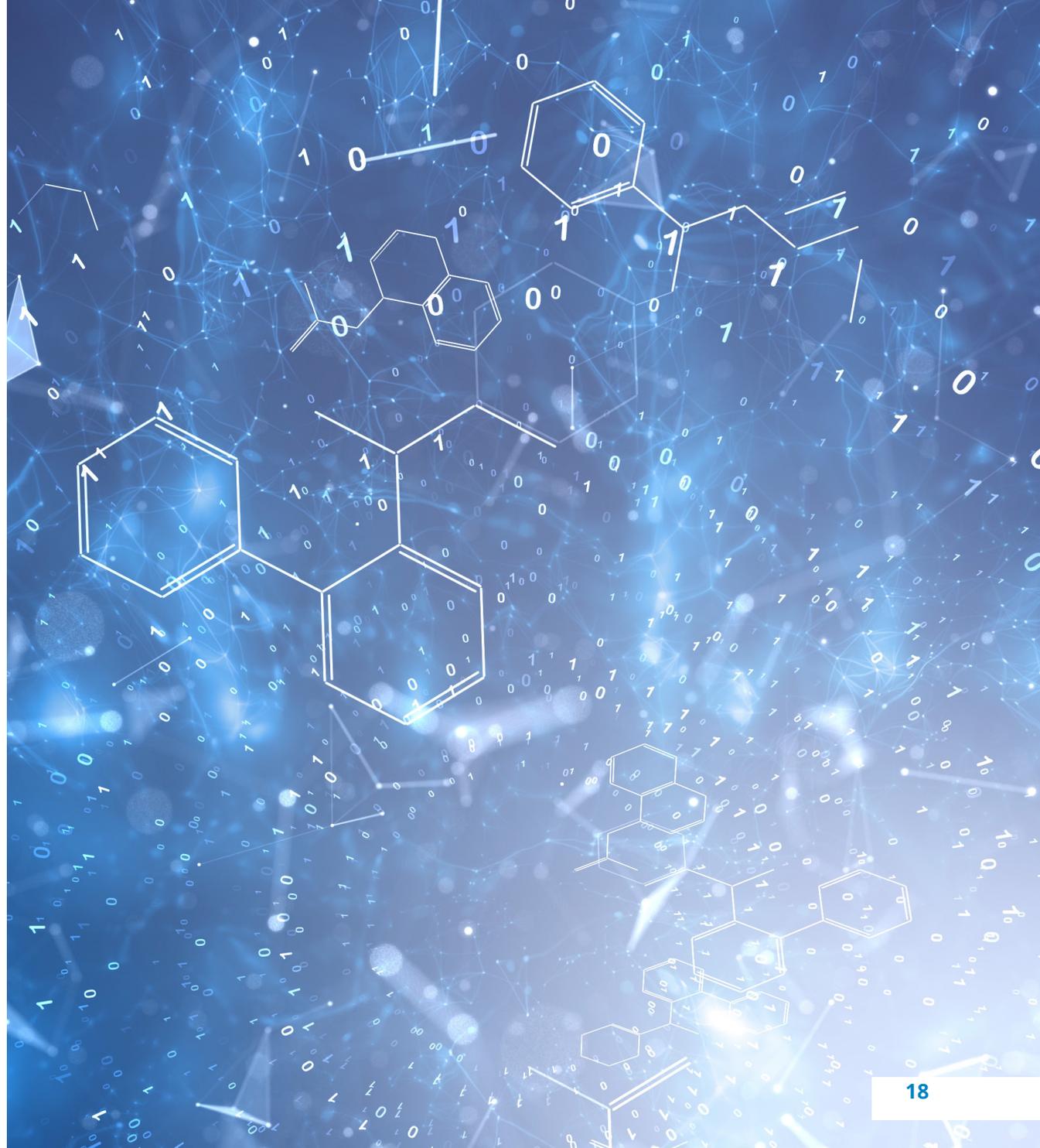
The choice of base materials directly impacts a connector's mechanical strength, conductivity and longevity. Engineers must select materials that resist fatigue, oxidation and degradation over time while balancing electrical performance with durability.

### **Beryllium Copper (BeCu)**

BeCu is widely used in aerospace and defense connectors for its excellent strength-to-weight ratio and exceptional fatigue resistance. It is particularly well-suited for spring member contacts, where elasticity and long-term resilience under stress are essential. While high-strength BeCu, often in half-hard or full-hard temper, possesses one of the highest tensile strengths among available copper-based alloys, its conductivity (15-30% IACS) is much lower than pure copper (100%). This trade-off makes it ideal for applications where mechanical endurance takes priority over maximum conductivity.

### **Phosphor Bronze and Brass**

Commonly used for non-spring contacts, phosphor bronze strikes a balance between strength and conductivity. Known for its corrosion resistance and moderate spring properties, phosphor bronze is frequently used for compact connectors and fine pitch connectors that require moderate elasticity but aren't subjected to continuous flexing. Brass, with its higher conductivity (28% IACS) compared to phosphor bronze (15% IACS), is often used in static sockets and fixed sockets, where movement is minimal but conductivity is a priority. Its excellent machinability also makes brass a practical choice for complex connector geometries.



## PLATING MATERIALS: SURFACE PROTECTION FOR ELECTRICAL STABILITY

While base materials provide structural strength, plating materials protect against wear, environmental degradation and fretting corrosion. The right plating strategy minimizes signal loss, prevents oxidation, resists mechanical wear in high-cycle applications and discourages fretting corrosion at contact interfaces.

**Gold plating** is the industry standard for aerospace and defense connectors, preventing corrosion and encouraging consistent electrical performance over time. In high-reliability applications, 50  $\mu\text{in}$  gold plating is preferred, significantly exceeding the 10–30  $\mu\text{in}$  found in commercial-grade connectors. This thicker plating resists wear-through, delivering continued signal integrity in connectors subjected to frequent mating in harsh environmental conditions.

**Nickel underplating** forms a foundation layer beneath gold plating, providing additional durability and acting as a diffusion barrier. Typically applied at thicknesses between 50 and 150  $\mu\text{in}$ , nickel underplating improves plating adhesion and further enhances corrosion resistance. The combination of gold plating and nickel underplating is key for long-term reliability in aerospace, defense and space applications.

## HOUSING MATERIALS: STRUCTURAL INTEGRITY AND ENVIRONMENTAL RESISTANCE

Connector housings do more than encase internal electrical contacts—they protect them from mechanical stress, extreme temperatures, corrosive elements and moisture ingress while maintaining an optimal balance between durability and weight. While these material choices are common, the best selection depends on specific application requirements, environmental conditions and performance needs. Engineers should conduct detailed trade-off analyses for each unique application.

### High-Performance Polymers and Composite Materials

For weight-sensitive applications, thermoplastic polymers such as poly-ether-ether-ketone (PEEK), poly-phenylene sulfide (PPS) and polyetherimide (PEI) offer excellent mechanical strength, thermal resistance and chemical stability. These materials effectively absorb vibration and shock without adding extra weight, making them ideal for avionics, unmanned systems and compact electronic assemblies.

Composite materials, including fiberglass-reinforced polymers and carbon fiber composites, provide excellent strength-to-weight advantages. They can be engineered to maximize specific properties such as tensile strength, impact resistance or thermal stability, offering versatile performance in high-stress applications. Even in these applications, the composite housings are generally

used in embedded systems. Metal enclosures are typically preferred for applications involving direct environmental exposure.

### **Metal Enclosures**

Stainless steel and aluminum alloys are preferred materials for connector housings in the high-shock, high-vibration and high-EMI environments typical in aerospace and defense applications.

**Stainless steel** connector housings offer exceptional corrosion resistance and mechanical strength, making them ideal for marine, industrial and aerospace applications where exposure to moisture, chemicals or salt spray presents a significant challenge. In high-corrosion environments, stainless steel housings may receive additional coatings to further protect against oxidation and degradation.

**Aluminum alloys** provide a balance of strong EMI shielding, low weight and excellent machinability. These properties make aluminum alloys the material of choice for connector housings in military vehicles, avionics and space-based applications where weight reduction is crucial but electrical performance cannot be compromised. Aluminum's natural oxide layer offers inherent corrosion resistance, which can be further improved through anodizing treatments.

## **PROHIBITED MATERIALS: ELIMINATING KNOWN RELIABILITY RISKS**

Material selection is not only about choosing the right alloys and coatings—it also requires avoiding materials that can compromise long-term reliability. Aerospace, defense and space applications impose restrictions on materials to prevent failures due to environmental or operational stressors.

### **Pure Tin**

Pure tin is prohibited in many applications due to the risk of tin whisker growth. These whiskers can cause electrical shorts and lead to system failures. Tin-lead alloys, permitted with an industry-standard  $\geq 3\%$  lead composition are used instead to mitigate whisker formation.

### **Cadmium and Zinc**

These materials are completely restricted in space applications (NASA-STD-6012) due to outgassing, galvanic corrosion and health concerns. While not officially restricted in aerospace and defense, the materials are being actively phased out in favor of more stable alternatives.



### Radiation-Hardened (“Rad-Hard”) Polymers

Radiation-hardened polymers, commonly referred to as “Rad-Hard” materials, are specifically engineered to withstand prolonged exposure to ionizing radiation with minimal degradation in mechanical strength, electrical properties or chemical structure. Certain polymers (like PVC and LCP) degrade under extreme thermal cycling or prolonged radiation exposure in space and high-altitude applications. In these environments, degradation can release volatile organic compounds (VOCs), posing a health risk to astronauts and pilots in enclosed spaces. Instead, engineers favor rad-hard alternatives (including PEEK and PEI) that meet NASA ASTM-E595 outgassing standards.

Avoiding high-risk materials is more than a precaution—it is a necessity for long-term system integrity and personnel health. Specifically, during manufacturing and assembly, technicians handling these materials may be exposed to dust or fumes generated during cutting or machining. By eliminating failure-prone substances and adhering to strict standards, engineers can extend connector longevity and protect device operators from potential hazards.

### MATERIAL SELECTION DRIVES RELIABILITY

Material selection is fundamental to rugged connector design. Every choice—from the base alloys to plating thickness to housing material—affects mechanical strength, electrical performance and long-term durability. Resilient materials go beyond merely improving a connector’s effectiveness; they help define reliability.



**Resilient materials go beyond merely improving a connector’s effectiveness; they help define reliability.**





## RADIATION-RESISTANT CONNECTORS FOR SPACE APPLICATIONS

Connectors used in satellites, deep-space probes and high-altitude aerospace systems face constant exposure to ionizing radiation, which can degrade materials, interfere with electrical performance and weaken structural integrity. In space environments, connectors must be built to resist radiation-induced embrittlement, conductivity loss and atomic oxygen erosion while maintaining reliability in vacuum environments.

### KEY MATERIAL CONSIDERATIONS FOR RADIATION RESISTANCE:

- **Rad-Hard Polymers:** High-performance thermoplastics such as PEEK and PPS provide superior radiation resistance while maintaining low outgassing properties, ideal for satellite payloads and space avionics.
- **Metal Shielding for EMI and Radiation Hardening:** Aerospace-grade aluminum alloys with electroless nickel finish offer structural durability while shielding against radiation effects and atomic oxygen exposure, particularly in low-Earth orbit (LEO) and deep-space applications.
- **Gold Plating for Electrical Stability:** Gold plating forms a protective barrier against radiation damage, preserving electrical integrity and contact reliability in extended space missions.



## AIRBORN'S SPACE-RATED SOLUTIONS

Space-rated interconnects from AirBorn, a Molex company, comply with NASA's outgassing specifications (ASTM-E595) and meet NASA's EEE-INST-002 standards, verifying their suitability for space applications.

- **NASA 8739.4 Certified Manufacturing Operators**  
Trained to meet mission-critical spaceflight standards.
- **Validated Connector Families**  
AirBorn's W-Series, R-Series, M-Series and N-Series have been successfully deployed in space missions.
- **Application-Specific Testing**  
AirBorn conducts acceptance testing for spaceflight, including thermal vacuum and radiation exposure assessments.

By leveraging radiation-resistant materials and rigorous spaceflight qualification testing, AirBorn connectors provide consistently high performance in satellites, deep-space exploration and high-radiation environments.



## MANUFACTURED FOR MISSION-CRITICAL STANDARDS

High-reliability connectors for the aerospace, defense and space industries must meet exacting quality standards. AirBorn manufactures every connector to meet IPC-620 Class 3, the highest workmanship benchmark for mission-critical electronics where reliability is non-negotiable. This level of precision helps maintain electrical integrity and mechanical strength in demanding environments.

Beyond industry compliance, AirBorn takes extra steps to reduce the risk of defects before deployment. Each product undergoes 100% dielectric withstanding voltage (DWV) and insulation resistance (IR) testing. Multi-piece contacts, including cables and welded terminations, receive additional continuity and contact resistance evaluations to verify performance under real-world conditions.

For customers with specialized and stringent aerospace, defense and space requirements, AirBorn provides acceptance testing, material traceability and application-specific qualification programs. Through meticulous manufacturing and extensive validation, AirBorn delivers connectors engineered for unwavering reliability.

# ANSWERING THE NEED: AIRBORN SINERGY MODULAR HIGH-SPEED HYBRID CONNECTORS

## Modularity Meets High-Speed Performance in Rugged Environments

Aerospace and defense systems require more than durability—they demand high-speed, high-density interconnects capable of sustaining top performance in extreme conditions. AirBorn's Sinergy family of connectors meet this requirement by combining modular flexibility with proven ruggedness, delivering a connector system that adapts to evolving mission needs.

Built to MIL-DTL-83513 standards, this mini-modular hybrid connector integrates signal, RF and Twinax modules into a single interface. Built for demanding conditions, Sinergy balances high-speed data transmission with adaptability in mission-critical applications across avionics, space systems, radar and military applications.

## HIGH-SPEED CONNECTIVITY FOR DEMANDING APPLICATIONS

- Supports up to 25Gbps per lane or 75Gbps aggregate BiDi bandwidth
- Compatible with XAUI, USB 3.0, PCIe Gen 3/4, SAS-3/4 and Ethernet (10G/25G per lane)



- Four points of contact to stabilize signal transmission under vibration and mechanical stress
- Designed for radar systems, military drones, avionics and satellite communications

## MODULAR ARCHITECTURE FOR VERSATILE DESIGNS

- Configurable in 1 to 5 bays with interchangeable signal, RF and Twinax modules
- Offers vertical board-mount, right-angle board-mount, cable I/O and flex circuit mounting options
- Swappable locking, jacking and guide hardware for flexible configurations
- Multi-bay configurations simplify development and integration



## RELIABLE CONTACT SYSTEM FOR HARSH ENVIRONMENTS

- Single-piece contacts with four engagement points reinforce electrical connections
- 50 µin gold-plated contacts resist corrosion and wear over repeated use
- SMT signal termination meets IPC-A-610 Class 3 requirements

## RUGGED CONSTRUCTION FOR MISSION-CRITICAL USE

- Die-cast metal housings provide structural integrity and EMI shielding
- Validated to MIL-DTL-83513 standards to meet aerospace and defense requirements
- Compact form factor serves as a high-performance alternative to traditional Micro-D and Nano-D connectors

## WHY SINERGY?

SInergy merges speed, durability and adaptability into a high-density interconnect system. Its modular design gives engineers the flexibility to configure connectors based on specific performance and environmental requirements, whether for high-vibration military vehicles, thermally demanding avionics or high-radiation space applications. With high-speed capabilities, ruggedized construction and a scalable architecture, SInergy extends the themes of this report—demonstrating that connectors not only focus on durability but also on delivering uncompromising performance where it matters most.



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## ADVANCING AEROSPACE AND DEFENSE WITH HIGH-RELIABILITY CONNECTORS

The future of aerospace, defense and space industry innovation depends on interconnect solutions that deliver durability, signal integrity and long-term performance. As mission requirements evolve, connectors must be built to handle extreme environments without compromising electrical function.

AirBorn, a Molex company, has built a reputation for engineering high-performance connectors that excel in demanding environments. From resilient contact systems designed for high-vibration environments to modular solutions like SIenergy, AirBorn continues to expand what is possible in rugged connectivity. Its integrated approach—combining connectors, assemblies and embedded systems—provides a streamlined path for engineers developing next-generation aerospace and defense systems.

As a global leader in electronic solutions, Molex brings extensive aerospace and defense expertise, offering lightweight, high-reliability connectors. With a strong commitment to innovation and compliance with AS9100 and MIL-SPEC standards, Molex delivers mission-critical solutions that enhance performance and reliability across the industry.

Pushing boundaries in lightweight compact designs and radiation-hardened space applications while ensuring reliability, Molex and AirBorn are now combining their decades of collective expertise to create something even more powerful. In this pursuit, reliability and ruggedness are not merely buzzwords; they are meticulously engineered into every connection.

