

# QwikConnect<sup>®</sup>

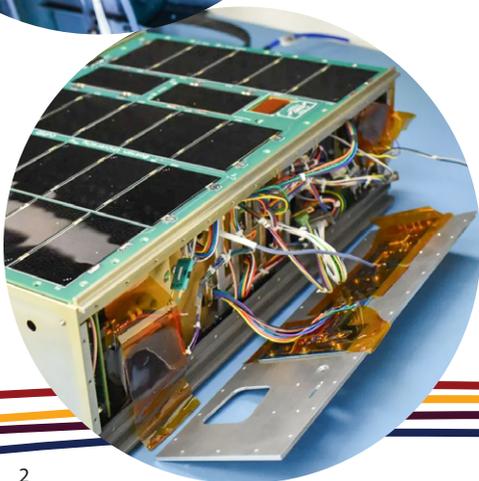
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**Glenair Aerospace-Grade  
Wire, Cable, and Assemblies:  
Signal • RF • High-Speed • Power**

# Glenair Aerospace-Grade Wire, Cable, and Assemblies: Signal · RF · High-Speed · Power

Modern aerospace systems require high-performance wire and cable



Electronic systems play a critical role in ensuring safety, reliability, and performance of aerospace vehicles. Integral to these systems, aerospace-grade wire and cable are unsung heroes, providing essential connectivity for instrumentation, power distribution, and communication.

From commercial airliners to sophisticated satellites, modern aerospace electronic systems require high-performance wire and cable. Yet, behind its seemingly simple architecture and function lies a world of engineering sophistication, where materials, design, and performance standards converge to meet the rigorous demands of extreme environments.

In this special edition of *QwikConnect*, we delve into the crucial role of aerospace-grade wire and cable, exploring the myriad challenges and considerations engineers and designers face in their quest to deliver wiring solutions that excel in the harshest environments. We'll examine a range of key issues, from the importance of performance standards to the critical factors influencing wire selection—all in the context of the aerospace-grade instrumentation, RF, high-speed, and power wire solutions available now from Glenair.

## Understanding aerospace wire and cable

Aerospace wire and cable can be selected based on various factors including its design, materials, and application. Common selection choices include:

### 1. Conductor Material:

- **Copper:** Most commonly used due to its high conductivity. Aerospace copper wire is coated with either tin, silver, or nickel.
- **Aluminum:** Used in applications where weight reduction is a primary concern, and in nondynamic applications.

### 2. Insulation Material:

- **Ethylene tetrafluoroethylene (ETFE):** Known for its excellent chemical resistance and high-temperature performance.
- **Cross-linked Ethylene tetrafluoroethylene (XL-ETFE):** Offers enhanced electrical, mechanical, and environmental properties including higher heat resistance and improved durability. Thin-wall XL-ETFE insulation saves weight without compromising performance.
- **Fluorinated Ethylene Propylene (FEP):** Offers similar properties to ETFE but with improved flexibility for high-speed data cabling.

### 3. Shielding Type:

- **Braided Shielding:** Provides excellent protection against electromagnetic interference (EMI), radio frequency interference (RFI), and crosstalk—particularly in differential data cabling.



- **Microfilament Braided Shielding:** Provides weight reduction, enhanced flexibility, and reduced windowing.
  - **Aluminum Mylar Shielding:** Offers a lightweight and effective tape-wrap shielding solution.
  - **Semi-Conductive Jacketing:** Used to maintain a constant voltage gradient and reduce corona discharge.
4. **Temperature Rating:**
- **Standard Temperature:** Suitable for normal operating conditions.
  - **High-Temperature:** Designed to withstand elevated temperatures encountered in aerospace applications.
  - **Low-Temperature:** Engineered for use in extreme cold or cryogenic environments.
5. **Voltage Rating:**
- **Low Voltage:** Typically used for signal and control applications.
  - **Medium Voltage:** Suitable for power distribution within aircraft systems.
  - **High Voltage:** Used for high-power applications such as electric motor propulsion systems.
6. **Application Specific:**
- **Communication Cables:** Designed for transmitting high-frequency RF and high-speed protocol (Ethernet) data within the aircraft.

**MIL★STAR**  
HIGH-PERFORMANCE HOOKUP WIRE AND CABLE

AEROSPACE-GRADE  
**SuperFlex**  
PCB/FLEX CIRCUIT ASSEMBLIES

BLUMARK **RF**  
COAX CABLES

**SpeedLine**  
High-Speed Protocol Cables

**turboflex**  
THE ULTRA FLEXIBLE RUGGED POWER CABLE

Glenair supplies high-availability (in-stock, no MOQ) wire and cable for rugged aerospace-grade applications. Our wire and cable brands include solutions for standard signal applications, RF, high-speed protocols, and power distribution. We also offer our SuperFlex series of flex and rigid-flex PCB products as a lightweight, high-flexibility alternative to conventional wire and cable.



Electrical wiring in the proximity of aircraft engines must be composed of insulation and conductor material that can maintain functionality in the extreme heat of this environment.

- **Power Cables:** Used for distributing electrical power throughout the aircraft.
- **Instrumentation Cables:** Employed for connecting sensors, gauges, and other devices.
- **Specialty Cables:** Tailored for specific functions or behaviors such as grounding, bonding, current return network, and so on.

## Wire and Cable Downselect

Selecting aerospace wire for a particular application involves considering various factors to ensure optimal performance and safety. By systematically considering these data points in the selection process, aerospace engineers can choose the most suitable wire for their application, balancing data loss performance, safety, regulatory compliance, and availability considerations. Here's a sequence or "down-select" of data points commonly used in the decision-making process:

1. Define the **general environmental requirements** of the application such as aircraft zone (pressurized versus non-pressurized), mechanical stress (inside-the-box versus exposed cable), chemical exposure (proximity to fuel), and so on.
2. Determine the **voltage and current requirements** of the application to select wires with appropriate size and insulation that can safely handle the expected electrical load. Higher current requirements typically necessitate larger AWG wire to minimize resistive losses.



## American Wire Gauge and Metric Equivalency Standards

3. Assess the **temperature range**. Consider both ambient temperature and temperature generated by electrical current. Choose wire with insulation and conductor materials that can withstand the expected temperature extremes without degradation.
4. Different grades of aerospace wire and cable comply with strict regulations regarding **low smoke and toxicity (LSZH)** in the event of fire. They are designed to minimize smoke generation and the release of toxic gases, enhancing safety for passengers and crew.
5. Different insulation and jacketing materials for aerospace wire and cable are engineered to better resist **exposure to chemicals, fluids, and environmental contaminants** commonly encountered in aerospace environments, including hydraulic fluids, lubricants, solvents, and cleaning agents.
6. Select core **conductor material** based on factors such as conductivity, weight, and environmental factors. Copper—with its various plating options—is the most common conductor material due to its high conductivity, but aluminum may be chosen for weight-sensitive applications.
7. Choose **insulation material** based on factors such as temperature resistance, chemical resistance, flexibility, and weight. Standard MS wire options include ETFE, XL-ETFE, and other compounds.
8. Determine if **shielding** is necessary to protect against electromagnetic interference (EMI/RFI). Select the appropriate grade of braided or tape wrapped shielding to meet application requirements.
9. Consider the **flexibility and durability** of the wire, especially if it will be subjected to bending or vibration during operation. Choose wire constructions that can withstand mechanical stresses without compromising performance or integrity.
10. Aerospace environments can subject wiring systems to **mechanical stress and abrasion** during operation. Dual-wall wire, incorporating two layers of insulation in contrasting colors, provides early visual detection of abrasion damage.
11. Evaluate the **weight constraints** of the air vehicle or satellite and select wire constructions that meet weight requirements without sacrificing performance or safety.
12. Compliance and certification ensure that the selected wire meets relevant industry standards and performance benchmarks for the application's regulatory environment: FAA (Federal Aviation Administration), EASA (European Aviation Safety Agency), MIL-STD (Military Standard), Def Stan (UK Defence Standard), and others.

American Wire Gauge (AWG) is a widely recognized and accepted standard for wire gauge measurement, even in countries that predominantly use the metric system. While the metric system typically uses millimeters (mm) to denote wire diameter, AWG is commonly used in industries worldwide due to its historical significance and widespread adoption.

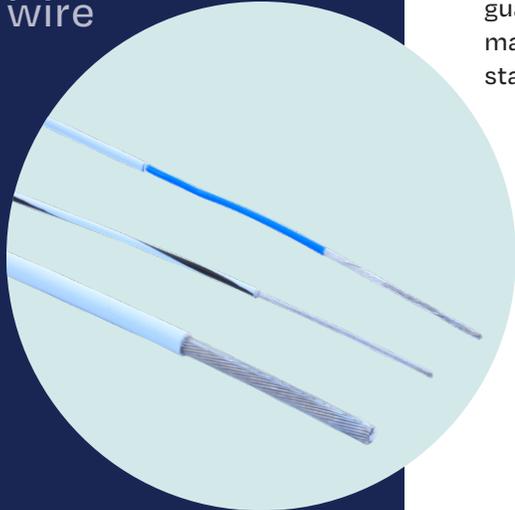
Converting between AWG and metric wire gauge (such as millimeters) is straightforward and can be done using conversion tables or formulas.

Although countries using the metric system may primarily use metric wire gauge measurements for certain applications, they often still reference AWG for compatibility with international standards, products, and specifications. Moreover, many technical documents, standards, and industry practices globally employ AWG as a standard unit of wire size measurement.



Manufacturing aerospace wire involves religious adherence to industry standards and requirements to ensure optimal performance and safety

Analog signal wires, coaxial wire for RF signals, and heavy-gauge power distribution wire



## Standards

Compliance with aerospace wire standards ensures that wire and cable meet the stringent performance, reliability, safety, and quality requirements demanded by the aerospace and aviation industries, and guarantees compatibility among components and systems from different makers. Some of the most important military and industry performance standards applied to aerospace-grade wire and cable include:

### 1. SAE AS50881

- This specification covers selection and installation of wiring used in aerospace vehicles

### 2. NEMA-WC27500

- Specifies the requirements for aerospace and defense multiconductor cables, including their construction, materials, performance, and testing criteria.

### 3. SAE AS22759

- Sets the performance requirements for high-temperature aerospace hookup wires, including their insulation and jacketing materials.

### 4. ASTM D3032 and SAE AS4373

- Key performance and test specifications that define standard test methods for hookup wire insulation, and test methods for insulated electrical wire respectively.

## Data Transmission Types

Aerospace-grade wire and cable are utilized to transmit various types of data and signals critical for the operation of flight systems. Specifically, these formats include:

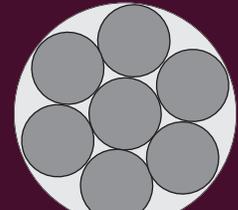
- Low voltage **analog signals** for various purposes such as sensor data, instrumentation signals, and analog communication systems.
- **High-speed signals** are commonly transmitted through controlled impedance wires for communication between onboard systems and control computers. This includes digital communication protocols such as Ethernet, USB, SATA, HDMI, DisplayPort, and others.
- **Power distribution** wires and cables are used for transmitting electrical power to various systems and components onboard the aircraft, satellite, or spacecraft. This includes power distribution for avionics, propulsion systems, lighting, and other electrical loads.
- **RF signals** are transmitted through specialized coaxial cables for applications such as radar, cockpit displays, surveillance cameras, payload imaging systems, and others.

These are just a few examples of the diverse range of data formats transmitted through aerospace-grade wire and cable. In addition to material considerations discussed above, selection of wire and cable type depends on factors such as data bandwidth, signal integrity requirements, environmental conditions, and other system parameters.

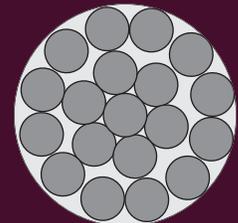
Strand count is an important consideration in wire selection, particularly in applications where flexibility, durability, and electrical performance are crucial. The strand count refers to the number of individual strands of wire twisted or braided together to form a single conductor within a wire. Here are some of the reasons strand count is an important consideration:

- 1. Flexibility:** Wires with a higher strand count tend to be more flexible than those with fewer strands. This increased flexibility is advantageous in applications where the wire needs to bend, twist, or flex frequently without risk of breakage or damage.
- 2. Resistance to Fatigue:** Wires with more strands are less prone to metal fatigue caused by repetitive bending or flexing. This resistance to fatigue ensures the longevity and reliability of the wire in dynamic applications, reducing the risk of premature failure.
- 3. Electrical Resistance:** In electrical applications, the resistance of the wire is inversely proportional to the cross-sectional area of the conductor. Increasing the strand count effectively increases the total cross-sectional area of the conductor, thereby reducing its electrical resistance and minimizing power loss.
- 4. Strand Diameter:** Wires with a higher strand count have thinner individual strands. This finer strand diameter allows for better surface contact between strands, improving the wire's conductivity and electrical performance.
- 5. Strand Movement:** In high-vibration environments, such as aerospace or land vehicle applications, wires with a low-to-moderate strand count offer better resistance to vibration, reducing the risk of internal abrasion, bird-caging, or wire breakage.
- 6. Termination and Crimping:** Wires with a higher strand count may require specialized termination techniques or crimping tools to ensure proper termination and secure connections. It's essential to consider these factors during wire installation and maintenance.
- 7. Current Carrying Capacity:** While increasing the strand count reduces the resistance of the wire, it also increases its overall diameter. Importantly, the current capacity for high strand count is improved for high-frequency AC applications.

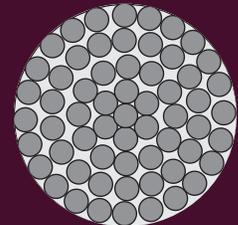
The appropriate choice of strand count depends on the specific requirements and constraints of the application, including environmental conditions, mechanical stress, electrical characteristics, and installation considerations.



7 strand wire



19 strand wire



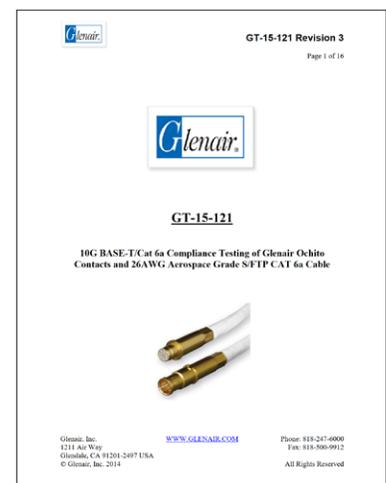
61 strand wire

## Performance Testing

Aerospace wire and cable undergo extensive qualification testing to ensure they meet stringent performance, reliability, and safety requirements defined in the standards. These tests cover a wide range of factors including environmental, mechanical, electrical, and chemical properties. Here are the common types of tests conducted during qualification testing:

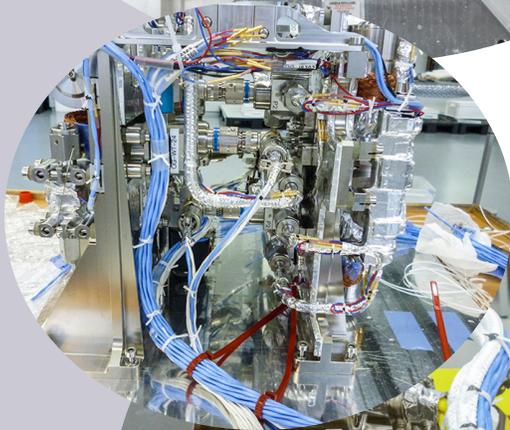
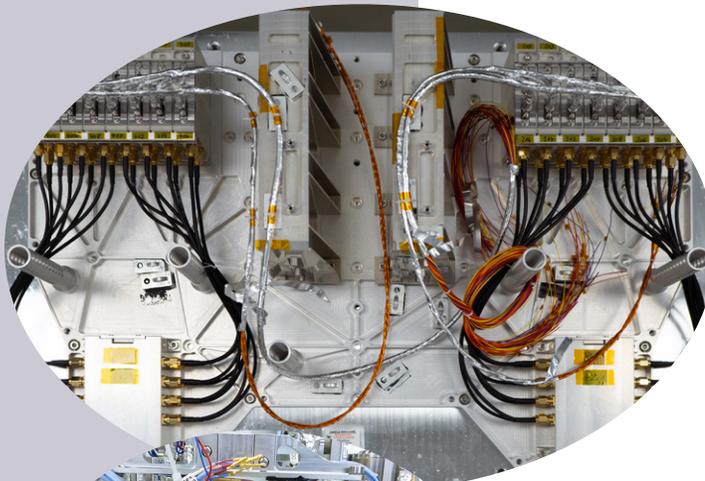
### 1. Environmental Testing:

- **Temperature Cycling:** Subjecting the wire or cable to alternating cycles of high and low temperatures to assess its ability to withstand thermal stress.
- **Humidity:** Exposing the wire or cable to high humidity levels to evaluate its resistance to moisture absorption and degradation.
- **Salt Spray:** Simulating corrosive environments by exposing the wire or cable to a mist or spray of saltwater to assess corrosion resistance.



Glenair wire and cable test reports available at [www.glenair.com/test-reports-and-technical-information](http://www.glenair.com/test-reports-and-technical-information)

Passing rigorous qualification tests is essential to ensure the performance, reliability, and safety of the wire and cable used in mission-critical aerospace applications



- **Thermal Shock:** Rapidly alternating between extreme temperature conditions to evaluate the wire or cable's resistance to thermal shock.

## 2. Mechanical Testing:

- **Tensile Strength:** Applying tension to the wire or cable to measure its maximum load-bearing capacity before breaking.
- **Flexibility:** Subjecting the wire or cable to bending, twisting, and flexing to assess its flexibility and resistance to mechanical stress.
- **Abrasion Resistance:** Controlled scratching or rubbing the wire or cable against abrasive surfaces to evaluate its resistance to wear and tear.
- **Impact:** Exposing the wire or cable to sudden impacts to assess its ability to withstand mechanical shocks.

## 3. Electrical Testing:

- **Conductor Resistance Measurement:** Measuring the electrical resistance of the wire and cable conductors to ensure they meet specified requirements.
- **Insulation Resistance:** Assessing the insulation material's ability to resist the flow of electrical current through it.
- **Dielectric Strength:** Applying a high voltage to the wire or cable to evaluate the insulation material's ability to withstand electrical stress without breaking down.
- **Voltage Withstand:** Applying a specified voltage to the wire or cable to ensure it can withstand the rated voltage without failure.

## 4. Chemical Testing:

- **Chemical Resistance:** Exposing the wire or cable to various chemicals and solvents to assess its resistance to chemical degradation.
  - **Flammability:** Evaluating insulation resistance to ignition and flame spread to ensure compliance with flammability standards.
  - **Outgassing:** Measuring the release of volatile compounds from wire and cable materials under vacuum conditions to assess their suitability for use in space or vacuum environments.

## 5. Other Tests:

- **Smoke Density:** Measuring the density of smoke emitted by wire and cable materials in the event of a fire to assess their safety in enclosed spaces in accordance with low-smoke zero-halogen requirements.

- **Corona Discharge:** Applying high voltage to wire and cable to detect and evaluate the occurrence of corona discharge, which can lead to electrical breakdown and failure.
- **Vibration:** Subjecting wire and cable to vibrations to simulate the conditions experienced during transportation or operation and assess reliability under vibration stress.



These tests are conducted according to industry standards and specifications such as those set forth by organizations like the Society of Automotive Engineers (SAE), the International Organization for Standardization (ISO), and various aerospace regulatory agencies like the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA). Passing these qualification tests is essential for aerospace wire and cable to gain certification and approval for use in aerospace applications. Glenair wire and cable test reports may be accessed on our website at [www.glenair.com/test-reports-and-technical-information](http://www.glenair.com/test-reports-and-technical-information)



Voltage and shock testing are just some of the qualification tests that wire must pass for use in aerospace applications.

## Red Plague

Glenair has been supplying its high-performance wire, cable, and harnesses for space and other harsh application environments for well over 50 years. Our MIL-STAR™ line of high-temperature hookup wire and cable may be supplied in special configurations to combat Red Plague corrosion.

Red Plague is the sacrificial corrosion of copper in a galvanic cell of silver (cathode) and copper (anode), which results in the formation of red cuprous oxide ( $\text{Cu}_2\text{O}$ ) and black cupric oxide ( $\text{CuO}$ ). In the presence of oxygen, this Red Plague corrosion can continue indefinitely, consuming conductor material and causing electrical system failures.

Mechanical damage during manufacturing, assembly, or packaging can result in exposure of the copper-silver interface resulting in Red Plague corrosion. High-humidity or high-temperature environments and chemical exposure are other contributing factors. Wire with inadequate silver plating thickness are more likely to develop Red Plague.

Our many years of experience in supplying aerospace-grade wire and cable make us uniquely able to combat this destructive environmental hazard, with mod codes 1304 or 1304 B for thick 80 microinch silver plating.



Images of Red Plague corrosion on wire conductor material and braided shielding courtesy NASA.

## CROSS-LINKED INSULATION

Cross-linked insulation (XL) and standard insulation are two types of dielectric materials used in wire and cable manufacturing. Each has its advantages and disadvantages, and the choice between them depends on the specific requirements of the application. Here are the advantages of using cross-linked ETFE insulation (XL-ETFE) over standard ETFE insulation in M22759 wiring:

### 1. Improved Thermal Stability:

- XL insulation offers superior thermal stability compared to standard insulation materials. It can withstand higher temperatures without softening or melting, making it suitable for applications where exposure to elevated temperatures is expected.

### 2. Enhanced Electrical Properties:

- Cross-linked insulation exhibits better electrical properties such as higher dielectric strength, reduced electrical losses, and improved resistance to electrical breakdown compared to standard insulation materials. This makes XL insulation ideal for applications requiring high electrical performance and reliability.

### 3. Resistance to Chemicals and Solvents:

- XL insulation is more resistant to chemicals, solvents, oils, and other environmental contaminants than standard insulation materials. This resistance helps maintain the integrity and performance of the wire or cable in harsh operating environments where exposure to chemicals is a concern.

### 4. Increased Mechanical Strength:

- Cross-linked insulation typically has higher mechanical strength and resistance to abrasion, cut-through, and physical damage compared to standard insulation materials. This improves the durability and longevity of wires and cables, especially in applications subject to severe mechanical stress or vibration.

### 5. Laser Markability:

- XL insulation accommodates laser marking. The direct imprinting of wires and cables with ultraviolet (UV) lasers is fully qualified and accepted within the aerospace industry for use on XL (cross-linked) ETFE insulation.

### 6. Longer Service Life:

- Due to its superior thermal, electrical, and mechanical properties, XL insulation generally offers a longer service life compared to standard insulation materials. This results in reduced maintenance requirements and lower lifecycle costs for wire and cable systems.

### 7. Compliance with Stringent Standards:

- Cross-linked insulation materials often meet stringent industry standards and regulatory requirements for performance, safety, and environmental sustainability. This ensures that wires and cables with XL insulation are suitable for use in critical aerospace, marine, downhole, and other industrial applications.

Overall, the advantages of using cross-linked insulation (XL) include superior thermal stability, enhanced electrical properties, resistance to chemicals and solvents, increased mechanical strength, laser-markability, longer service life, and compliance with standards. These benefits make XL insulation an attractive choice for a wide range of demanding wire and cable applications.



GS22759-33 XL-ETFE open-loom wire assembly for a mission-critical satellite application

## WIRE CORE PLATING OPTIONS EXPLAINED

The plating types used in M22759 hook-up wire—silver-coated copper, tin-coated copper, and nickel-coated copper, applied to both standard copper and high-strength copper alloy—offer a range of different benefits:

### 1. Silver-Coated Copper:

- **Conductivity:** Silver is an excellent conductor of electricity, making it suitable for applications where low resistance and high performance are critical.
- **Corrosion Resistance:** Silver is highly resistant to corrosion, which can improve the longevity and reliability of the wire in environments such as space.
- **Solderability:** Silver-coated copper wire typically has good solderability, facilitating the soldering process if used during assembly.

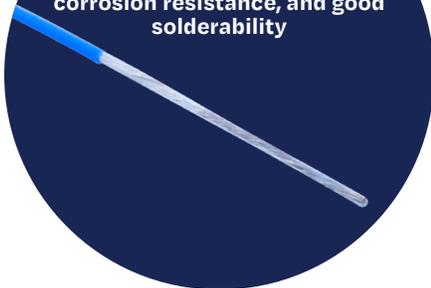
### 2. Tin-Coated Copper:

- **Cost-Effectiveness:** Tin is generally less expensive than silver, so tin-coated copper wire can be a more cost-effective option while still providing adequate performance for many applications.
- **Solderability:** Tin coating enhances solderability, making it easier to solder connections during assembly.
- **Corrosion Resistance:** Tin provides a good degree of corrosion resistance, though not as high as silver. It still offers protection against oxidation and corrosion.

### 3. Nickel-Coated Copper:

- **High-Temperature Resistance:** Nickel coatings can withstand higher temperatures compared to tin and silver, advantageous in high-temperature applications such as in proximity to aircraft engines
- **Corrosion Resistance:** Nickel offers excellent corrosion resistance, making it suitable for applications where exposure to corrosive environments is a concern.
- **Wear Resistance:** Nickel coatings can also provide enhanced wear resistance, offering durability in demanding conditions.

Glenair MIL-STAR  
 GS22759-43-22-9 wire  
 with silver-coated copper  
 core for highest conductivity,  
 corrosion resistance, and good  
 solderability



Glenair MIL-STAR  
 GS22759-16-8-9 wire  
 with tin-coated copper core  
 for enhanced solderability  
 and reliable, cost-effective  
 performance

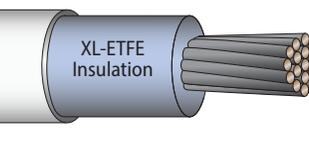
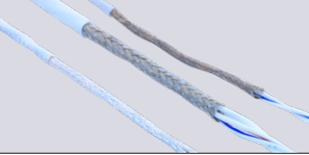
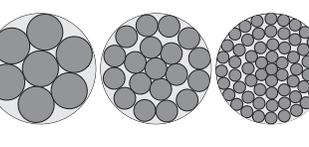
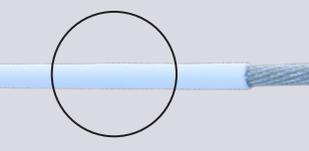
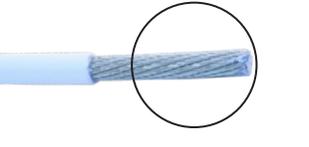
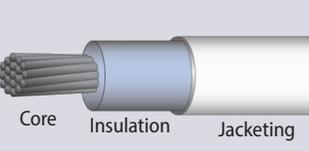
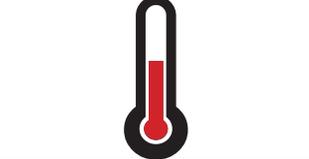


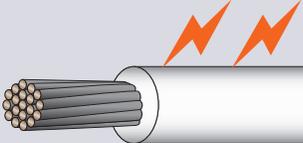
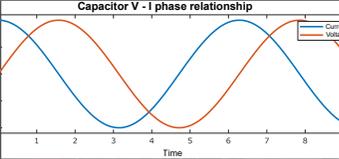
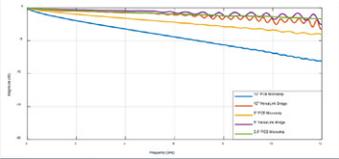
Glenair MIL-STAR  
 GS22759-92-20-9 wire  
 with nickel-coated copper core  
 for durable corrosion resistance  
 and high-temperature  
 performance



# Wire and Cable Glossary

Here's a short glossary of key terms related to aerospace wire and cable:

	<p><b>American Wire Gauge (AWG)</b></p>	<p>A standardized wire gauge system used to denote the diameter or thickness of wire. Lower AWG numbers represent thicker wires.</p>
	<p><b>Cross-Linked Insulation (XL)</b></p>	<p>Insulation material that has been chemically cross-linked to improve its thermal stability, electrical properties, and resistance to environmental factors.</p>
	<p><b>Shielding</b></p>	<p>A layer of material, typically metallic, surrounding a wire or cable to protect against electromagnetic interference (EMI), radio frequency interference (RFI), and crosstalk.</p>
	<p><b>Strand Count</b></p>	<p>The number of individual strands of wire twisted or braided together to form a single conductor within a wire or cable.</p>
	<p><b>Insulation Material</b></p>	<p>The material surrounding the conductor(s) of a wire or cable, providing electrical insulation and protection against environmental factors.</p>
	<p><b>Conductor</b></p>	<p>The metal wire or cable core that carries electrical current within a wire or cable.</p>
	<p><b>Jacketing</b></p>	<p>An outer layer of alternate-color material in dual-wall construction wire and cable, providing additional mechanical protection, insulation, and environmental resistance.</p>
	<p><b>Thermal Stability</b></p>	<p>The ability of wire and cable materials to maintain their properties and performance under high temperatures encountered in aerospace environments.</p>
	<p><b>Electrical Performance</b></p>	<p>The overall electrical characteristics of wire and cable, including conductivity, resistance, capacitance, and inductance.</p>
	<p><b>Flexibility</b></p>	<p>The ability of wire and cable to bend, twist, and flex without breaking or causing damage to the insulation or conductor.</p>

	<p><b>Water Absorption</b></p>	<p>The tendency of wire and cable materials to absorb moisture from the environment, which can affect insulation properties and electrical performance.</p>
	<p><b>Low Smoke and Toxicity (LSOH)</b></p>	<p>Wire and cable materials designed to minimize smoke emission and the release of toxic gases in the event of fire, enhancing safety in enclosed spaces.</p>
	<p><b>Dielectric Strength</b></p>	<p>The ability of insulation materials to withstand high voltage without breaking down or allowing electrical current (partial discharge) to flow through.</p>
	<p><b>Environmental Testing</b></p>	<p>Testing procedures conducted to evaluate the performance of wire and cable under various environmental conditions, including temperature extremes, moisture, vibration, and chemical exposure.</p>
	<p><b>Compliance and Certification</b></p>	<p>Adherence to industry standards and regulatory requirements governing the design, manufacture, and use of aerospace wire and cable, often validated through certification processes.</p>
	<p><b>Impedance</b></p>	<p>Refers to the opposition that an electrical circuit presents to the flow of alternating current A/C. In transmission lines, impedance (measured in Ohms) crucial for efficient power transfer and signal integrity.</p>
	<p><b>VSWR</b></p>	<p>Voltage Standing Wave Ratio is a measure of how well a transmission line is matched to the impedance of the connected load, indicating signal reflection and loss.</p>
	<p><b>Insertion Loss</b></p>	<p>A measure of how much signal power is lost when a component or device, such as a connector or splice, is inserted in a transmission line or circuit.</p>
	<p><b>Red Plague Corrosion</b></p>	<p>A unique type of surface oxidation that can occur in silver-plated cables, characterized by a red or pinkish-colored corrosion product on the surface of the wire.</p>
	<p><b>Partial Discharge</b></p>	<p>Partial discharge (PD) is an electrical discharge that occurs across a localized area of a dielectric, caused by discontinuities or imperfections in the insulation.</p>

# MIL-STAR™

## GS22759 AEROSPACE-GRADE WIRE



**MIL-STAR High-Performance Hookup Wire and Cable** Glenair has branded its GS22759 high-temperature aerospace-grade wire, and GS27500 multi-conductor cables for aerospace applications, under the MIL-STAR brand. These discrete wires and cables are built in accordance with SAE specifications with a "GS" leadoff in place of both the base specification and the part number for individual slash sheets.

MIL-STAR is a high-performance, better-than-QPL discrete wire and cable specification unique to Glenair. The brand covers both protected (inside-the-box) hookup wire, high-durability open-loom wiring, and multi-conductor shielded and jacketed M27500-type cable.

M22759 single-ended hook-up wires are the industry standard for inside-the-box mil-aero environments and are optimized for size, weight, high-temperature resistance, and low flame propagation. The hundred-plus variants of AS22759 are organized by conductor material and plating, insulation type, wire gage, and single- or dual-wall.

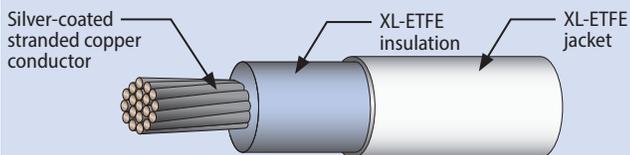
### MIL-STAR™ 22759 OPEN WIRE LOOM AND (PROTECTED) HOOKUP WIRES

AS22759 high-temp single-conductor 600V military and aerospace-grade wire, standard and crosslinked, lightweight single-wall and rugged dual-wall configurations.

#### Crosslinked (XL) ETFE samples

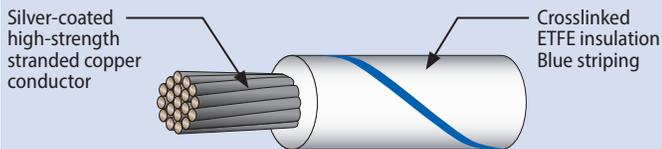
##### GS22759-43-22-9

- Silver-coated copper core, std. weight dual wall XL-ETFE insulation/jacket. High-temp, radiation- and fire-resistant.



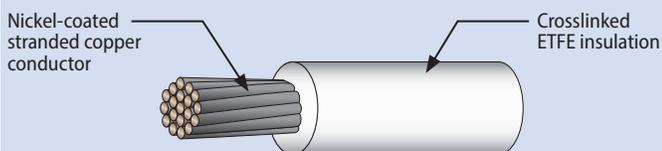
##### GS22759-33-24-96

- Silver-coated copper core with XL-ETFE insulation (blue striping). High-temp, low flammability.



##### GS22759-45-12-9 (Light weight)

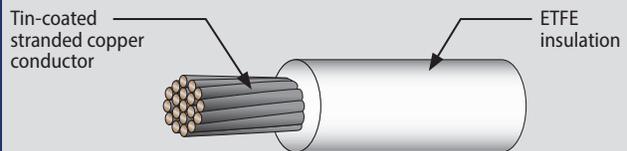
- Nickel coated copper core with XL-ETFE insulation. High-temp (200°C), fire and chemical resistant.



#### Conventional Fluoropolymer samples (ETFE, PTFE)

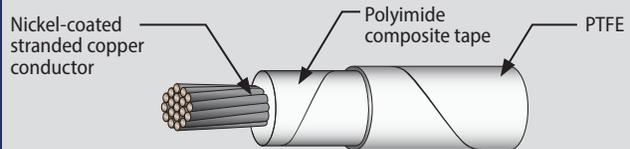
##### GS22759-16-8-9

- Tin-coated copper core with extruded ETFE insulation. Radiation-resistant and temperature tolerant to 150°C.



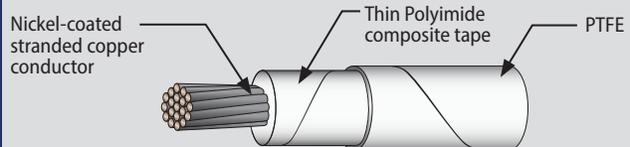
##### GS22759-87-20-9 (Standard weight)

- Nickel-coated copper, PTFE/Polyimide tape-wrapped. High-temp (260°C), fire and chemical-resistant, low smoke.



##### GS22759-92-20-9 (Light weight)

- Nickel-coated copper, PTFE/thin-wall Polyimide tape-wrapped. High-temp (260°C), fire and chemical-resistant, low smoke.



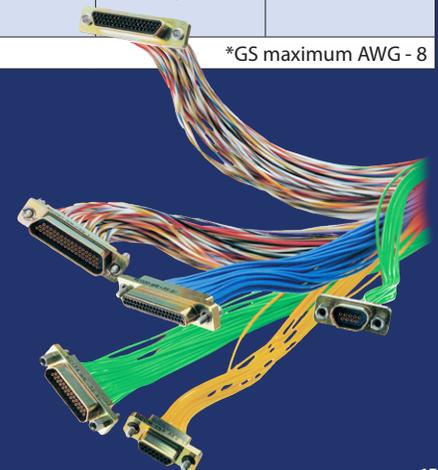
**How-to-Order GS22759 Wire:** MIL-STAR part numbers are easy to understand. Glenair part number structure simply replaces the MS with GS and uses a dash separator instead of a slash. The dash number (-33 for example) provides the basis for the construction including insulation type, conductor coating, voltage rating, temperature rating, and insulation thickness. Variables in the part number cover wire size, jacket color, and optional striping.

AS22759 Slash Sheet	Glenair Commercial Part No.	Temperature Rating	Conductor	Plating	Conductor Code	Weight	Conductor AWG Range
<b>SAE AS22759/16-19, ETFE</b>							
M22759/16	GS22759-16*	150°C	Copper	Tin	TCC	Medium	24-00
M22759/17	GS22759-17	150°C	High-Strength Copper Alloy	Silver	SCA	Medium	26-20
M22759/18	GS22759-18	150°C	Copper	Tin	TCC	Light	26-10
M22759/19	GS22759-19	150°C	High-Strength Copper Alloy	Silver	SCA	Light	26-20
<b>SAE AS22759/32-35, XL-ETFE</b>							
M22759/32	GS22759-32	150°C	Copper	Tin	TCC	Light	30-12
M22759/33	GS22759-33	200°C	High-Strength Copper Alloy	Silver	SCA	Light	30-20
M22759/34	GS22759-34*	150°C	Copper	Tin	TCC	Normal (Dual Wall)	24-00
M22759/35	GS22759-35	200°C	High-Strength Copper Alloy	Silver	SCA	Normal (Dual Wall)	26-20
<b>SAE AS22759/41-46, XL-ETFE</b>							
M22759/41	GS22759-41*	200°C	Copper	Nickel	NCC	Normal (Dual Wall)	26-00
M22759/42	GS22759-42	200°C	High-Strength Copper Alloy	Nickel	NCA	Normal (Dual Wall)	26-20
M22759/43	GS22759-43*	200°C	Copper	Silver	SCC	Normal (Dual Wall)	26-00
M22759/44	GS22759-44	200°C	Copper	Silver	SCC	Light	26-12
M22759/45	GS22759-45	200°C	Copper	Nickel	NCC	Light	28-12
M22759/46	GS22759-46	200°C	High-Strength Copper Alloy	Nickel	NCA	Light	28-20

\*GS maximum AWG - 8

**Interconnect Wire Assemblies:** Glenair utilizes massive quantities of our own GS22759 and GS27500 wire and cable in point-to-point and complex cable assemblies. MIL-STAR wire and cable is part of a complete ecosystem of EWIS offerings from Glenair, ranging from bulk wire and cable to terminated, shielded, and overmolded assemblies built with Glenair signature connectors and accessories

From our signature 'Better-than-QPL' SuperNine series to Micro-Ds, Mighty Mouse, HiPer-D, Series 79 and others—MIL-STAR wire and cable is employed by Glenair in the delivery of value-added aerospace-grade interconnect assemblies with industry-leading speed-of-delivery.

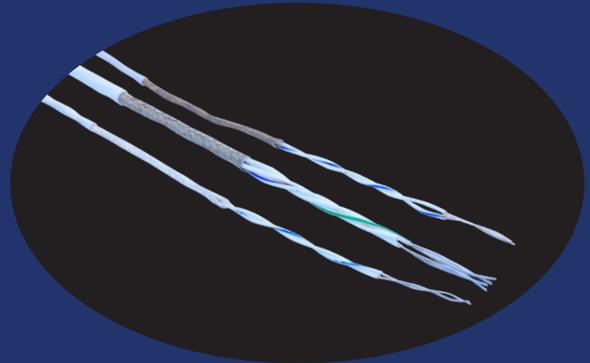


# MIL-STAR™

## GS27500 MULTI-CONDUCTOR CABLE

**Glenair MIL-STAR multi-conductor 27500 type cables** are built from in-house manufactured GS22759 hookup wire, available with industry qualification as well as Glenair GS signature part numbering. GS27500 constructions for shielded and unshielded cable are:

<b>Made and tested IAW ANSI/NEMA WC 27500</b>
<b>1-15 22759 primary hook-up wires</b>
<b>Insulation types including crosslinked ETFE</b>
<b>Industry-standard and Glenair signature shielding materials</b>
<b>Standard and signature jacket compounds</b>

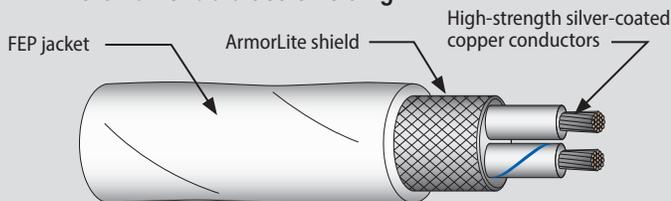


### MIL-STAR™ 27500 MULTI-CONDUCTOR CABLES

ANSI/NEMA WC 27500 and Glenair signature multi-conductor cables. Each series supports M22759-16 thru -46 wire types with wire count, gauge, shield, and jacket options as allowed.

#### 968-001-24SC2AR09

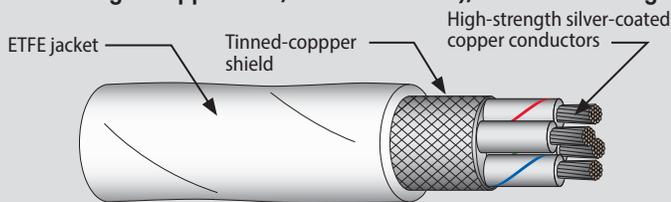
- 27500 type with ArmorLite or AmberStrand lightweight microfilament braided shielding



MIL-STAR GS27500 cables may be specified with signature braided shielding including ArmorLite, ArmorLite CF, and AmberStrand. The ability to supply 27500 type cable in accordance with the ANSI/NEMA standard but optimized for SWaP with lighter weight ArmorLite and AmberStrand shielding is a unique Glenair-only capability.

#### GS27500-22TF4T14

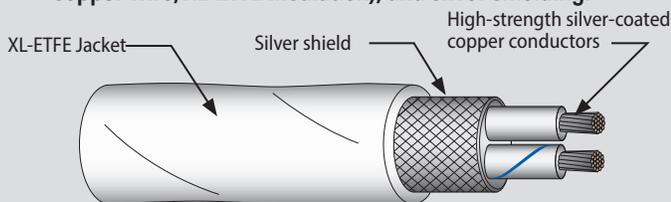
- 27500 type with GS22759-17 wire (silver-plated high-strength copper wire, ETFE insulation), and TC shielding.



This configuration of multi-conductor GS27500 cable is built with GS22759 dash 17 inner wires: silver-plated high-strength copper wire with ETFE insulation. The cable is equipped with an overall tinned-copper EMI/RFI shield and standard fluoropolymer ETFE outer jacket. The superior mechanical properties of high-strength conductors contribute to the overall safety, reliability, and mechanical strength of the cable.

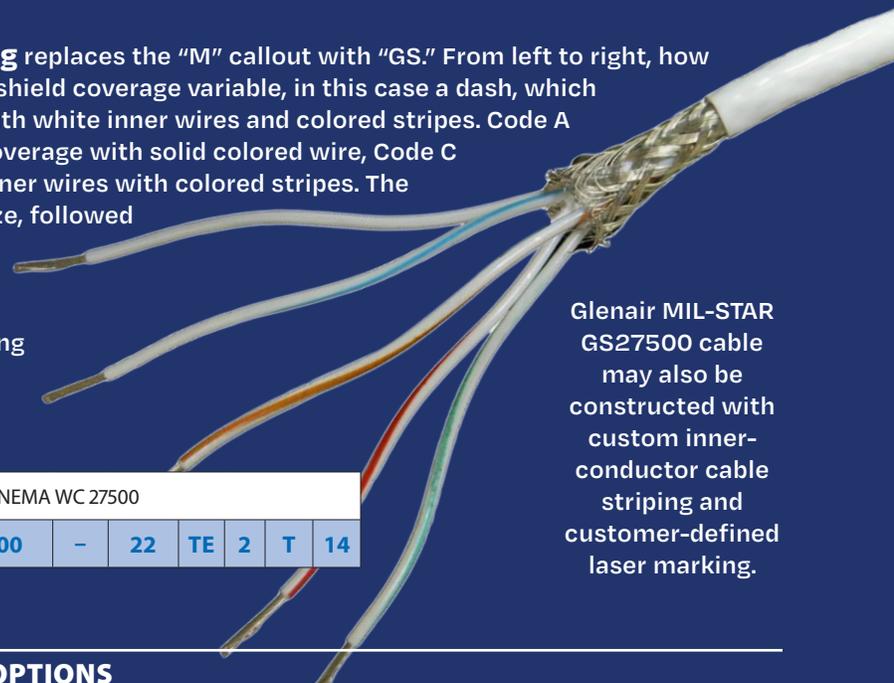
#### GS27500-24SC2S23

- 27500 type with GS22759-33 wire (silver-plated high-strength copper wire, XL-ETFE insulation), and silver shielding.



This cross-linked configuration of multi-conductor GS27500 cable is built with GS22759 type dash 33 inner wires: silver-plated high-strength copper wire with cross-linked XL-ETFE insulation. Cable is equipped with an overall silver-plated EMI/RFI shield and cross-linked XL-ETFE outer jacket. This multi-conductor 27500 type cable delivers far superior thermal stability, enhanced chemical resistance, mechanical strength, and electrical properties compared to non-crosslinked versions.

**MIL-STAR GS27500 cable part numbering** replaces the “M” callout with “GS.” From left to right, how to order variables begin with the color code and shield coverage variable, in this case a dash, which indicates default 85% overall shield coverage, with white inner wires and colored stripes. Code A used in this position would denote 85% shield coverage with solid colored wire, Code C would denote 90% shield coverage with white inner wires with colored stripes. The next variable, 22 in our example, is conductor size, followed by the base wire specification (TE) indicating GS22759-16 wire is to be used in this cable buildup. Final variables include the number of inner wire conductors (2), type of overall shielding (T, for Tinned Copper), and finally jacketing material (14, indicating extruded ETFE in white).



Glenair MIL-STAR GS27500 cable may also be constructed with custom inner-conductor cable striping and customer-defined laser marking.

Multi-conductor M27500 type IAW ANSI/NEMA WC 27500

<b>MIL-STAR Cable Sample Part Number</b>	<b>GS27500</b>	<b>-</b>	<b>22</b>	<b>TE</b>	<b>2</b>	<b>T</b>	<b>14</b>
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### BETTER-THAN-QPL MIL-STAR SHIELDING OPTIONS

Glenair signature braided cable shield solutions include single and double layers of metal-clad composite microfilament AmberStrand®, microfilament nickel-clad stainless steel ArmorLite™, and ArmorLite™ CF corrosion-resistant.

MIL-STAR GS27500 Shielding Options

Single Shield Code	Double Shield Code	Shield Description
<b>AM</b>	<b>AS</b>	AmberStrand®, Round
<b>AR</b>	<b>AL</b>	ArmorLite™, Round
<b>AC</b>	<b>AF</b>	ArmorLite™ CF, Round
<b>U</b>	<b>U</b>	Unshielded



# Car 54 Where Are You?

Our automotive editor has mislabeled these famous rides from old TV shows and movies.



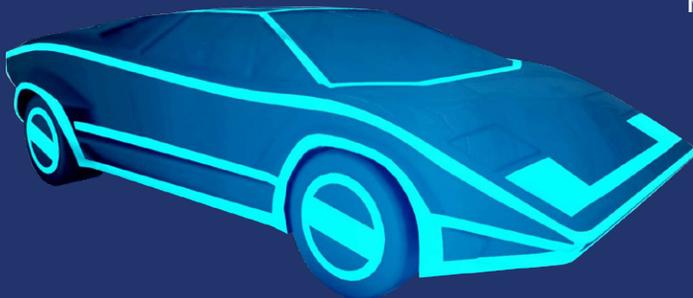
B.J. and the Bear  
Kenworth Semi Truck



Coyote X, Hardcastle and  
McCormick



Miami Vice Ferrari Testarossa



Alfa Romeo Duetto Spider, The Graduate



Car 54



James Bond's Aston Martin



The A-Team Van



Bluesmobile,  
The Blues Brothers



Mad Max V8 Pursuit Special  
AKA the Interceptor



DeLorean Time Machine, Back to the Future



The Dukes of Hazzard  
"General Lee"



Autocar, Automan



The Batmobile



Ecto-1 Ectomobile,  
Ghostbusters



Herbie the Love Bug



KITT from Knight Rider



Magnum P.I. Ferrari 308 GTS



I, Robot Audi RSQ



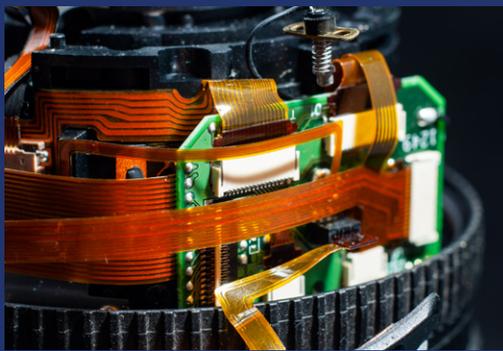
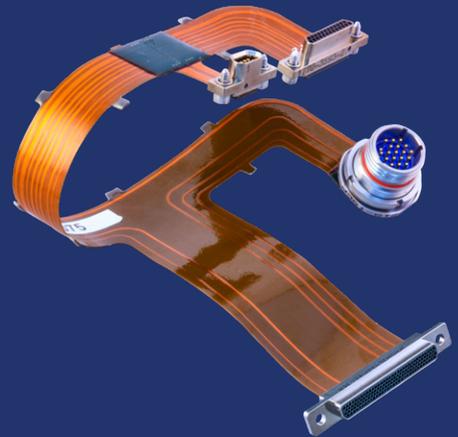
Columbo's Peugeot 403

AEROSPACE-GRADE

# SuperFlex™

PCB/FLEX CIRCUIT ASSEMBLIES

Turnkey connectorized flex, rigid flex, and rigid PCB assemblies incorporating Glenair's broad range of innovative small form-factor circular and rectangular PC-tail connector solutions for optimized ease-of-assembly and SWaP



Flex circuits—metallic layers of traces, usually copper, bonded to a dielectric layer, like polyimide—are used to interconnect embedded electronic packages, displays, backplanes, and other PCB components. Flex and rigid-flex circuits are frequently superior to conventional wiring as they can be easily routed in three dimensions, are lighter and smaller than discrete wires, and

offer virtually unlimited flex cycles in articulated applications. Flex and rigid-flex circuits are commonly deployed within avionic LRUs and other complex electronic systems, as well as between articulating components, such as disk drive, robotic arms, and other electro-mechanical devices.

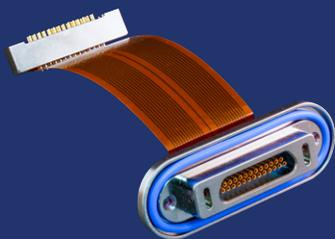
Compared with conventional wiring, compact flexible printed circuit assemblies reduce system complexity and assembly time as well as enhance reliability. Due to their low mass and high circuit density, flex circuit assemblies are less susceptible to impact and vibration damage than conventional wire harness assemblies, making them an ideal choice in satellite applications such as articulated solar arrays, sensors, and antenna.



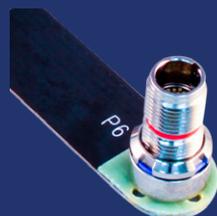
IPC 6012/6013 Class I, II, III,  
Types 1–4 Certified Production

Glenair recommends commercial customers specify IPC-6012/6013 standards of workmanship, which are fully supported by Glenair. Military customers may alternatively cite specifications IAW MIL-PRF-31032.

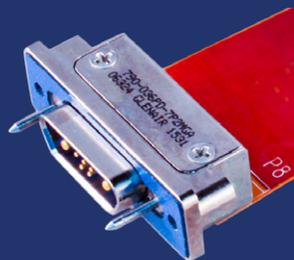
## GLENAIR SIGNATURE PC-TAIL CONNECTOR TYPES AVAILABLE IN TURNKEY FLEX ASSEMBLIES



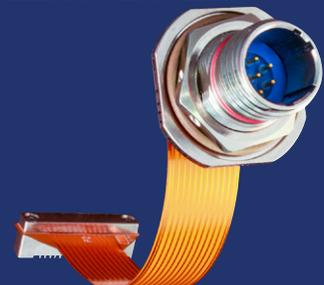
Series MWD Micro-D and spring-contact AlphaLink



Series 88 SuperFly

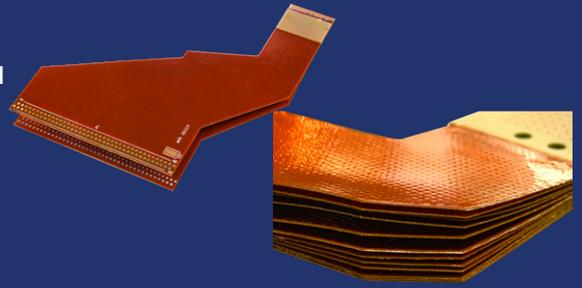


Series 79 Micro-Crimp

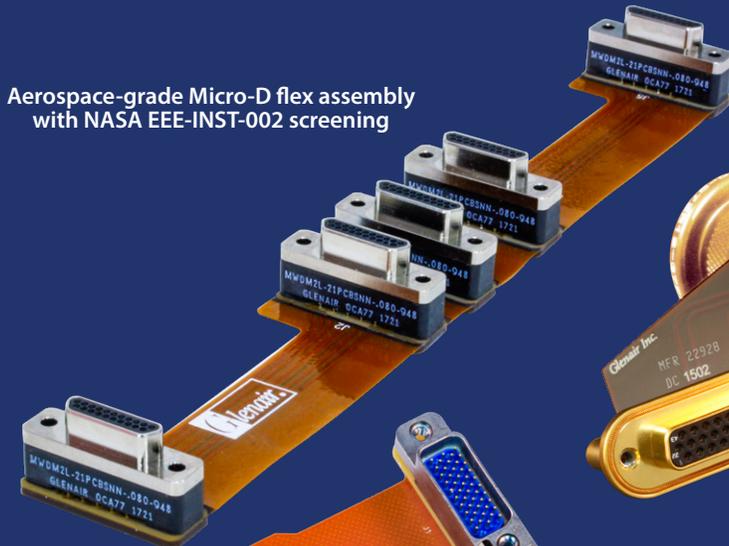


SuperNine MIL-DTL-38999 type flexi with board connector

**Glenair SuperFlex** turnkey connectorized flex, rigid flex, and rigid PCB assemblies begin with our signature flex circuit fabrication and innovation. All SuperFlex assemblies are optimized with ground planes and shields, strain relief features, mounting points for improved resistance to vibration and shock, and are available in multi-layer and double-sided configurations. All terminations backpotted for compliance with conformal coating processes. Optical and electrical solutions available. Special long-length assemblies up to 12 feet.



**MULTIBRANCH SUPERFLEX ASSEMBLIES WITH GLENAIR SIGNATURE CONNECTORS**



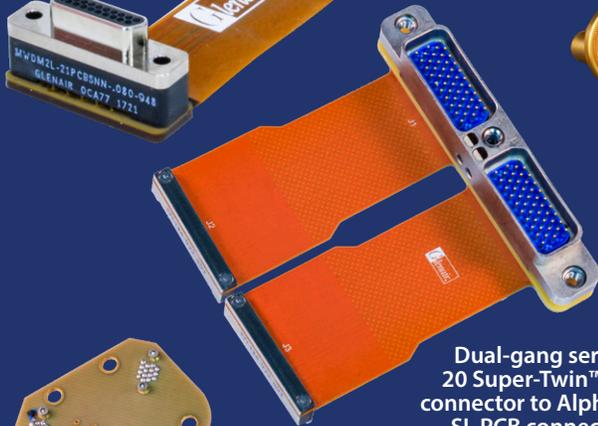
Aerospace-grade Micro-D flex assembly with NASA EEE-INST-002 screening



High-shock matched-impedance Mighty Mouse assembly with flex circuit



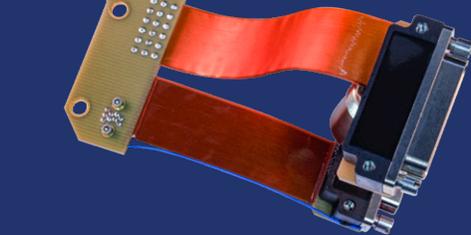
Aerospace-grade Series 28 HiPer-D to Series 80 Mighty Mouse I/O jumper: a tight space-constrained rectangular-to-circular solution



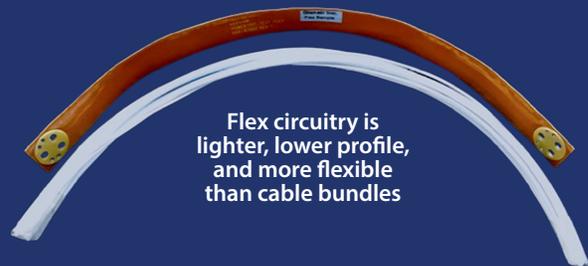
Dual-gang series 20 Super-Twin™ I/O connector to AlphaLink SL PCB connector



Hybrid flex/rigid flex multibranch Micro-D and Series 23 SuperNine flex assembly with discrete RF circuits



Stacked Micro-D I/O connectors with flex jumper to rigid PCB assembly

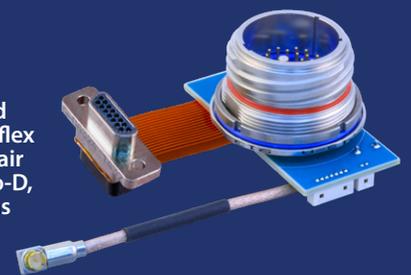


Flex circuitry is lighter, lower profile, and more flexible than cable bundles



Special long-length HiPer-D assembly with clock-spring design element

High vibration and shock resistant rigid flex assembly with Glenair Mighty Mouse, Micro-D, and RF connections



AEROSPACE-GRADE

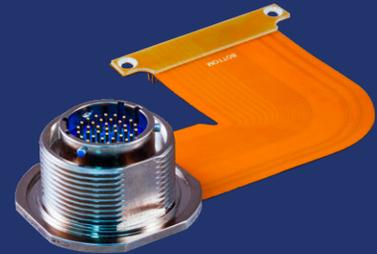
# SuperFlex™

PCB/FLEX CIRCUIT ASSEMBLIES



IPC 6012/6013  
Class I, II, III, types 1-4  
ISO 9001, AS9100  
Certified

Glenair Integrated PCB/Flex assembly production facilities are operated in accordance with commercial and military standards. Staff includes 200+ PCB and cable assemblers with J-STD-001 Space certification for special processes and ESD management.



- High-availability catalog components as well as custom design and manufacture
- No minimums
- We never obsolete parts



ASC Autoclave  
enabling continuous  
lamination up to 96  
inches

Oversized flex  
fixturing tables



Limata laser direct  
imaging system for  
extended length flex  
circuits

### SUPERFLEX SPECIFICATIONS AND FORMATS

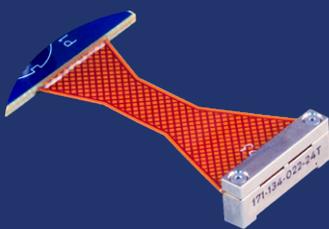
<b>Design Formats</b>	PADS • PADS PRO • Pro E / Creo • SolidWorks • Autodesk Inventor • CAM 350 • Altium • Valor • POLAR • XPedition
<b>Manufacturing Formats</b>	DXF • Gerber • ODB++ • IPC 2581
<b>Layer Count</b>	Max typ. up to 8
<b>Termination</b>	Thru hole • ZIF • Surface-mount • Straddle-mount
<b>Conductor Width/Space</b>	Lines: .003" • Spacing: .003" (dependent on copper weight)
<b>Bend Radius (military)</b>	Single Metal Layer: 4–6X overall flex thickness • Double Metal Layers: 6–10X overall flex thickness • Multi Layer Metal: 12–15X overall flex thickness
<b>Materials / Tg</b>	Substrate: DuPont™ Kapton® adhesive and adhesiveless -60°C to 125°C, Panasonic Felios Cover layer: DuPont™ Kapton®, Panasonic Felios Stiffener: FR4 or DuPont™ Kapton® (metal stiffeners available upon request) Conductor: Copper, Constantan High-temperature materials and more available <i>DuPont™ and Kapton® are trademarks or registered trademarks of E.I. du Pont de Nemours and Company.</i>
<b>Surface Finish</b>	ENIG • HASL • Immersion Tin and Silver • Soft and Hard Gold
<b>Specs and Quality Management</b>	IPC-6013 Class I, II, III, types 1-3 • ISO 9001, AS 9100J-STD-001 Space

### SUPERFLEX RIGID-FLEX SPECIFICATIONS AND FORMATS

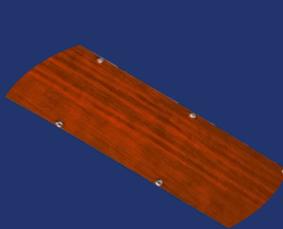
<b>Design Formats</b>	PADS • PADS PRO • Pro E / Creo • SolidWorks • Autodesk Inventor • CAM 350 • Altium • Valor • POLAR • XPedition
<b>Manufacturing Formats</b>	DXF • Gerber • ODB++ • IPC 2581
<b>Max Panel Thickness</b>	Range of thicknesses from .010" to as thick as .250"
<b>Layer Count</b>	27 +
<b>Via Technology</b>	Blind, buried • Thru hole • Filled (conductive and non-conductive)
<b>Conductor Width/Space</b>	Lines: .003" • Spacing: .003" (dependent on copper weight)
<b>Materials / Tg</b>	Substrate: Nelco 4000, Rogers, Megtron, Polyimide, and more
<b>Surface Finish</b>	ENIG • HASL • Immersion Tin and Silver • Soft and Hard Gold
<b>Specs and Quality Management</b>	IPC-6013 Class I, II, III, type 4 • ISO 9001, AS 9100, J-STD-001 Space

### SUPERFLEX SHIELDING AND STRAIN RELIEF DESIGN OPTIONS

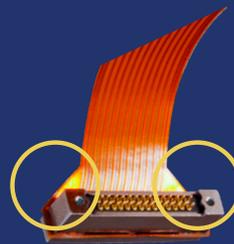
Managing EMI emissions, signal line impedance, and mechanical strain relief are critical aspects of flex circuit design. Effective use of ground planes, reinforcing polyimide, and potting ensures life-of-system durability.



Cross-hatch mesh shield



Stitched via



Reinforcing "wings"



Molded epoxy encapsulant

# BLUMARK COAX CABLES



**BluMark RF Low-Loss 50 Ohm Coax Cables** are available in size categories including 047, 086, 160, 200, 235, 300, and 450 and are suitable for both flight- and test-grade equipment. Vibration-stable, hand-formable designs are intended for non-environmental applications.

047	 26.5 GHz Vibration-Stable Silver-Plated Copper Braid .047 (1.2) Diameter	 70 GHz FEP Jacket Silver-Plated Copper Braid .047 (1.2) Diameter
	 40 GHz FEP Jacket Tape + Braid Shield .104 (2.6) Diameter	 40 GHz ETFE Jacket Tape + Braid Shield .097 (2.5) Diameter
086	 40 GHz FEP Jacket Triple Shield .161 (4.1) Diameter	 18 GHz FEP Jacket Tape + Braid Shield .163 (4.1) Diameter
	 18 GHz ETFE Jacket Tape + Braid Shield .163 (4.1) Diameter	 18 GHz ETFE Jacket Triple Shield .145 (3.7) Diameter
160	 40 GHz Low Phase Change FEP Jacket .157 (4.0) Diameter	 40 GHz Low Phase Change ETFE Jacket .157 (4.0) Diameter
	 26.5 GHz FEP Jacket Triple Shield .204 (5.2) Diameter	 26.5 GHz ETFE Jacket Triple Shield .187 (4.7) Diameter
200	 18 GHz FEP Jacket Triple Shield .235 (6.0) Diameter	 18 GHz ETFE Jacket Triple Shield .205 (5.2) Diameter
235	 18 GHz FEP Jacket Triple Shield .310 (7.9) Diameter	 10 GHz FEP Jacket Triple Shield .448 (6.0) Diameter
300		
450		

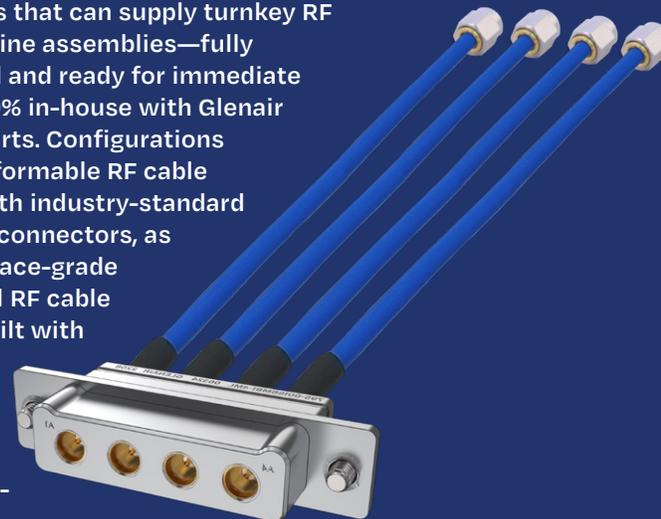
## BluMark RF high-frequency, low-loss cables

are suitable for aerospace applications and test equipment. Jacket options include FEP and radiation-resistant space-grade ETFE. Triple-shielded high-performance cables have expanded PTFE dielectric core for low loss up to 40 GHz. Application selection is based on attenuation (loss budget), and compatibility with a particular RF / microwave connector type and size, as well as flexibility, EMI screening, weight considerations, temperature tolerance, and altitude.

Temperature changes can cause phase shift in coax cables with PTFE dielectric cores. Low Phase Change Fluoropolymer (LPCF) cables are available from Glenair that replace the PTFE core with a fluoropolymer material yielding improved phase stability over a wide temperature range. Consult factory.

## RF Cable Assemblies

Glenair is one of just a few interconnect manufacturers that can supply turnkey RF transmission line assemblies—fully connectorized and ready for immediate use—built 100% in-house with Glenair component parts. Configurations include hand-formable RF cable assemblies with industry-standard single-line RF connectors, as well as aerospace-grade environmental RF cable assemblies built with BluMark RF low-loss cable, and Glenair signature high-frequency connectors for rugged multi-port shell configurations.



## GLENAIR BLUMARK RF™ COAX ECOSYSTEM OF LOW-LOSS CABLES, COMPATIBLE CONNECTORS, AND SIGNATURE SERIES MULTI-PIN HOUSINGS

Glenair high-frequency RF technologies—low-loss cables, shielded contacts, and signature connector housings—are typically used in line replaceable units and chassis that are part of an RF communications chain. Examples of common application environments include fighter jet radar, RF/microwave signal processing, various forms of GPS navigation, jamming systems, and more. Glenair turnkey RF assemblies for space applications—again, built from our complete ecosystem of low-loss RF interconnect cables, contacts, and connectors—are optimized for compatibility with size #8, #12, and #16 drop-in contacts for use in environmentally sealed and shielded circular and rectangular connector housings.

Accurate specification of RF assemblies depends on a thorough understanding of these key variables:

- Operating environment (temp, moisture, etc.)
- Operational frequency range
- Insertion Loss budget
- VSWR requirement

**962-025-086**



- 50 ohm size 086 (.104" diameter)  
40 GHz max. frequency low-attenuation cable
- -65 to +165 °C rated operating temperature
- FEP jacket, PFA dielectric, solid SPC center conductor
- Double-shielded: Tape/braid shield layers

**962-025-047**



- 50 ohm size 047 (.056" diameter)  
70 GHz max. frequency low-attenuation cable
- -65 to +165 °C rated operating temperature
- FEP jacket, PFA dielectric, solid SPC center conductor
- Double-shielded: Tape/braid shield layers



Size 8 for use with  
-086 cable  
18 GHz BMB interface  
50 Ohm  
Solder termination

Snap-in, rear release  
pin and socket coax  
contacts, spring-loaded.



Size 12 for use with  
-086 cable  
40 GHz SMPM interface  
50 Ohm  
Solder termination

Snap-in, rear release  
pin and socket coax  
contacts, spring-loaded.



Size 12 for use with  
-047 cable  
40 GHz SMPM interface  
50 Ohm  
Solder termination

Snap-in, rear release  
pin and socket coax  
contacts, spring-loaded.



Size 16 for use with  
-047 cable  
65 GHz SMPS interface  
50 Ohm  
Solder termination

Snap-in, rear release  
pin and socket coax  
contacts, spring-loaded.



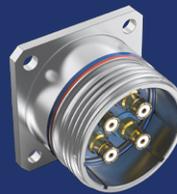
**SuperNine®**

Series 23 SuperNine  
"better-than-QPL"  
MIL-DTL-38999 Series III  
type connector



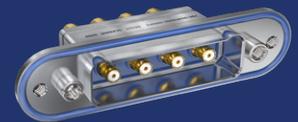
**MIGHTY  
MOUSE**

Series 80 Mighty Mouse  
reduced size and weight  
aerospace-grade  
connector



**SERIES  
806 RF  
MIL-AERO**

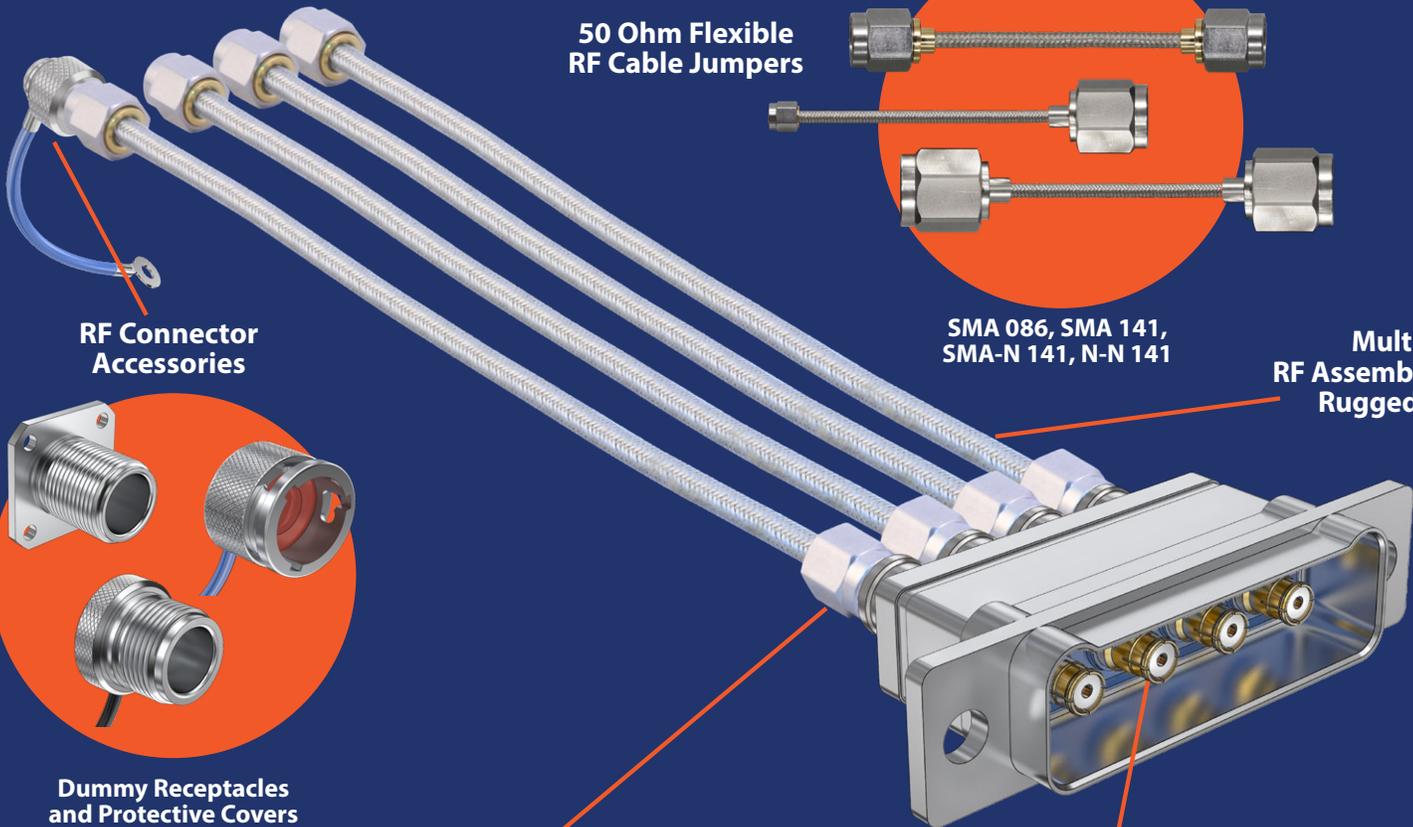
Series 806 Mil-Aero  
micro miniature circular  
with performance  
IAW D38999



**SERIES™  
795  
RF**

Series 795 RF  
precision-machined  
aerospace-grade  
coax connector

# BLUMARK COAX CABLES



50 Ohm Flexible  
RF Cable Jumpers

SMA 086, SMA 141,  
SMA-N 141, N-N 141

Multi-Port  
RF Assemblies: Ha  
Rugged Enviro

RF Connector  
Accessories



Dummy Receptacles  
and Protective Covers

Precision-Grade  
RF Connector Adapters



TNC-SMA, N-SMA, SMA-SMA,  
SMP-SMA, 2.92-SMA,  
BNC-SMA

Single-Channel RF Connectors for  
Multi-Port Shell Configurations  
sizes #8, #12, #16



G-Link<sup>RF</sup>

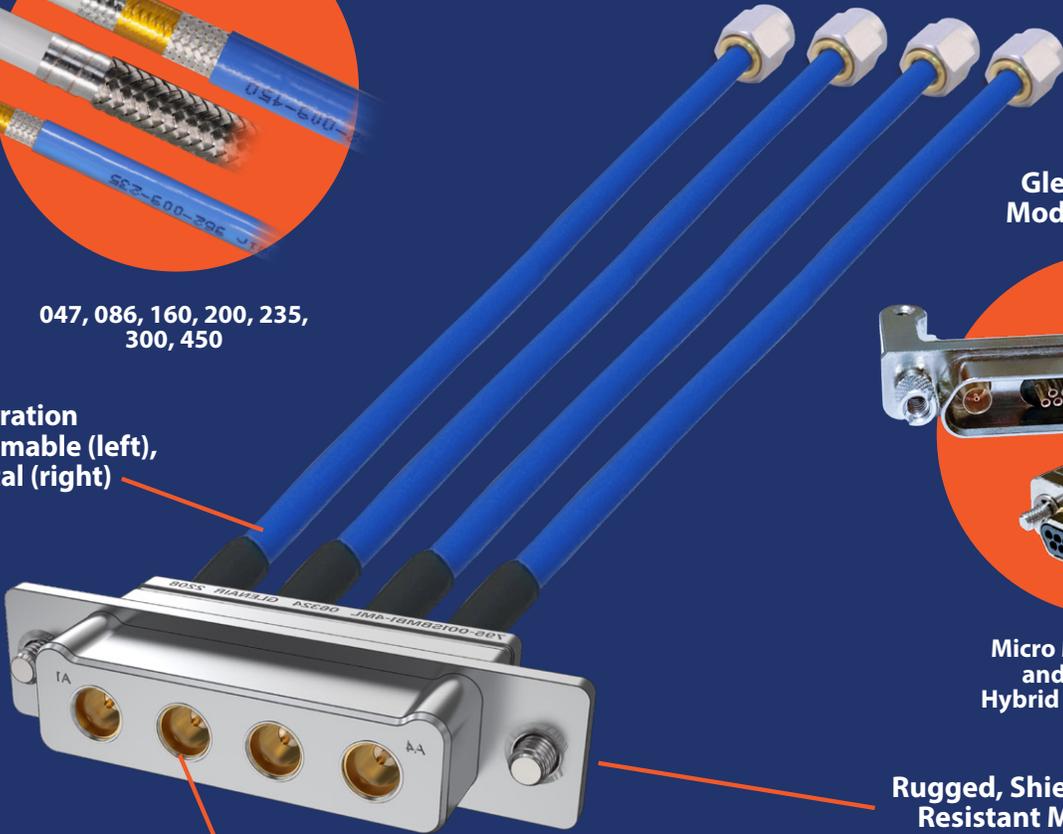
G-Link<sup>RF</sup>: 18 GHz RF  
BMB-to-SMA contact adapters

**BluMark RF Mil/Aero-Grade Flexible Cables**



047, 086, 160, 200, 235, 300, 450

Configuration and-Formable (left), Formable (right)



**Glenair GMMD Modular Micro-D**



**GM MD**

Micro Miniature Board and I/O-to-Board Hybrid Coax Connectors

Rugged, Shielded, Vibration-Resistant Mil-Aero Grade Multi-Port RF Shells

Single-Channel RF Connectors for Multi-Port Shell Configurations sizes #8, #12, #16



**G-LinkRF**

G-LinkRF: 18 GHz RF BMB-to-SMA contact adapters



SuperNine, Mighty Mouse, Series 806 RF, and Series 795 RF Multi-Port RF Connector Shells

# SpeedLine™

## High-Speed Protocol Cables

Glenair supplies a wide range of high-speed shielded twisted pair cabling for use with El Ochito®, VersaLink™, SpeedMaster™, and other of our shielded high-speed connector and contact technologies. High flexibility and high-density reduced-weight cable designs are a specialty. Glenair offers turnkey Cat 8 Ethernet, SuperSpeed USB 3.0, HDMI, SATA, and other solutions for today's most mission-critical application platforms.

Glenair SpeedLine cables are optimized for signal integrity, weight savings, flexibility, and durability. In addition, these aerospace and space-grade cables have been optimized for ease of termination and across-the-board compatibility with our broad range of high-speed contact modules and connectors.



SpeedLine™ high-speed cable assemblies such as this VersaLink cordset for DisplayPort 2.0 and USB 4 are supplied as turnkey tested solutions, ready for immediate use

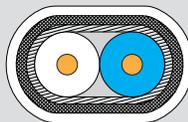
- Cat 8 Ethernet, SuperSpeed USB 3.0, HDMI, SATA, and other solutions for mission-critical applications
- Individual foil shielding around each data pair for reduced crosstalk and attenuation
- Up to 200°C high-temperature-rated cable
- Skydrol resistant, RoHS compliant versions
- Ethernet versions meet ANSI/TIA 568-C.2 Category 6A requirement up to 262 feet/80 meters
- Low-skew SuperSpeed USB data pairs have individual braided shields
- LSZH jacketing options including Duraelectric Light and polyurethane



SpeedLine™ high-speed protocol cables: shielded differential data-pair cables for high-datarate Ethernet, USB, SATA, PCIe, DisplayPort, and HDMI protocols

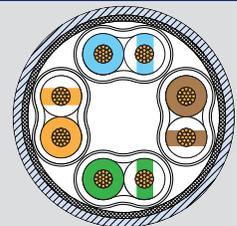
### 963-069-26

- 100 Ohm #26 AWG flat pair shielded cable for use with VersaLink™ connectors
- Performance up to 18 GHz
- -65 to +200 °C rated operating temperature
- FEP jacket, FEP insulation
- Dual shields: Aluminized Kapton tape and #44 AWG silver-plated copper



### 963-066-24

- 100 Ohm #24 AWG 4-pair shielded cable for use with El Ochito contacts
- Performance up to 10 Gigabit Ethernet
- -65 to +200 °C rated operating temperature
- FEP jacket, FEP insulation with PTFE tape wrap
- Outer shield: #40 AWG silver-plated copper



Glenair signature SpeedLine high-speed protocol cables are designed for direct application and use with VersaLink™, SpeedMaster™, El Ochito®, and other of our lightweight, small form-factor high-speed protocol connectors.

# Glenair Signature SpeedLine™ Cables, Shielded Contacts, and Connectors: a complete ecosystem of interconnect technologies for high-speed protocol applications in rugged aerospace-grade systems

Glenair supplies a complete ecosystem of military/aerospace-grade interconnect technology in support of every popular high-speed protocol. Downselect typically begins with protocol identification in accordance with application data rate requirements and standards. For each high-speed protocol, Glenair can supply an exactly-designed, tested, and qualified SpeedLine™ differential data cable, shielded high-speed contact insert, and a signature range of ruggedized, environmentally-sealed connector housings.

## SPEEDLINE HIGH-SPEED PROTOCOL CABLE ASSEMBLIES



Glenair SpeedLine high-speed cable assemblies for VersaLink™ include factory-terminated pigtails and double-ended jumpers as well as turnkey Series 806 Mil-Aero and Series 794 Micro-Crimp high-density solutions



Glenair SpeedLine high-speed cable assemblies for El Ochito® include single- and double-ended jumpers, commercial protocol connector jumpers, and integrated Series 806 Mil-Aero, SuperNine®, and Series 792 Micro-Crimp

## SPEEDLINE-COMPATIBLE HIGH-SPEED DIFFERENTIAL-PAIR SHIELDED CONTACTS



Size #8 differential twinax contacts

Size #8 quadrax contacts

Size #8 El Ochito octaxial

Size #8 SpeedMaster octaxial

VersaLink differential twinax

## SPEEDLINE COMPATIBLE GLENAIR SIGNATURE HIGH-SPEED CONNECTORS



Series 806 Mil-Aero high-speed El Ochito micro miniature

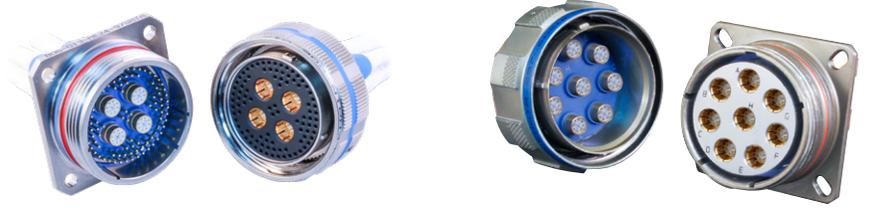
SuperNine MIL-DTL-38999 "Better than QPL" high-speed El Ochito

Speed-Master™ modular 10G+ Ethernet (shown in SuperNine® packaging)

Series 792 Micro-Crimp precision-machined high-speed El Ochito

# SpeedLine™

High-Speed Protocol Cables



Signature Connector Series	Series 806 Mil-Aero / Mighty Mouse				SuperNine® D38999 Type	
Protocol	816 El Ochito	806 El Ochito	806 VersaLink	824 SpeedMaster	233 El Ochito	233 SpeedMaster
Ethernet up to 10GBase-T Cat 6A	 10-1 - El Ochito White	 10-1 - El Ochito White	 11-4V	 824-010	 9G5 - El Ochito White	 11-1
SpeedLine Cables	963-066-26 963-066-24	963-066-26 963-066-24	963-068-26 twisted 963-069-26 flat	963-066-26 963-066-24	963-066-26 963-066-24	963-066-26 963-066-24
Ethernet up to 40GBase-T Cat 8	 10-1 - El Ochito White	 10-1 - El Ochito White	 11-4V	N/A	 9G5 - El Ochito White	N/A
SpeedLine Cables	963-066-26 963-066-24	963-066-26 963-066-24	963-068-26 twisted 963-069-26 flat		963-066-26 963-066-24	
SpaceWire	 10-1 - El Ochito White	 10-1 - El Ochito White	 11-4V	 824-010	 9G5 - El Ochito White	 11-1
SpeedLine Cables	963-089-26 963-089-24	963-089-26 963-089-24	963-068-26 twisted 963-069-26 flat	963-089-26 963-089-24	963-089-26 963-089-24	963-089-26 963-089-24
USB 3.2 Gen 1x1 * USB 3.2 Gen 2x1 Type A, B, uB	 10-1-El Ochito Blue	 10-1-El Ochito Blue	 11-2V9*	N/A	 9G5-El Ochito Blue	N/A
SpeedLine Cables	963-077-26	963-077-26	963-068-26 twisted 963-069-26 flat		963-077-26	
USB 3.2 Gen 2x1 USB 3.2 Gen 2x1 USB 3.2 Gen 2x2 USB4 Gen 2x2 USB4 Gen 3x2 Type C	N/A	N/A	 14-4V15	N/A	N/A	N/A
SpeedLine Cables			963-068-26 twisted 963-069-26 flat			



Series 79™ Micro-Crimp		Micro-D			SuperFly® Datalink	HiPer-D®
792 El Ocho	794 VersaLink	GHSM Micro-D	GHS4-M VersaLink	GMMD	882 SuperFly DataLink	280 SpeedMaster™
 A-1W1 - El Ocho White	 F-4V or P-4V	 15E	 4-0 (Shell Size 25)	 4T (Shell Size 15)	 882-001/002 White	 2 or 4 modules
<b>963-066-26</b> <b>963-066-24</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-065-30</b>	<b>963-066-26</b> <b>963-066-24</b>	<b>963-066-26</b> <b>963-066-24</b>
 A-1W1 - El Ocho White	 F-4V or P-4V	 15E	 4-0 (Shell Size 25)	 4T (Shell Size 15)	 882-001/002 White	N/A
<b>963-066-26</b> <b>963-066-24</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-065-30</b>	<b>963-066-26</b> <b>963-066-24</b>	
 A-1W1 - El Ocho White	 F-4V or P-4V	 9	 4-0 (Shell Size 25)	 4T (Shell Size 15)	 882-001/002 White	 2 or 4 modules
<b>963-089-26</b> <b>963-089-24</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-065-30</b>	<b>963-089-26</b> <b>963-089-24</b>	<b>963-089-26</b> <b>963-089-24</b>
 A-1W1-El Ocho Blue	 D-2V4*	 15U*	 2-9* (Shell Size 25)	 2T9* (Shell Size 21)	 882-009/010 Blue	N/A
<b>963-077-26</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>	<b>963-065-30</b>	<b>963-077-26</b>	
N/A	 G-4V12	N/A	 4-15 (Shell Size 51-2)	N/A	N/A	N/A
	<b>963-068-26 twisted</b> <b>963-069-26 flat</b>		<b>963-068-26 twisted</b> <b>963-069-26 flat</b>			

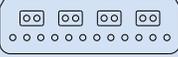
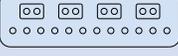
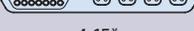
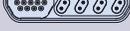
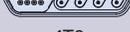
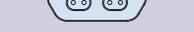
# SpeedLine™

High-Speed Protocol Cables



Signature Connector Series	Series 806 Mil-Aero / Mighty Mouse				SuperNine® D38999 Type	
Protocol	816 El Ochito	806 El Ochito	806 VersaLink	824 SpeedMaster	233 El Ochito	233 SpeedMaster
<b>HDMI</b> up to 2.0 * up to HDMI 2.1	 14-20A - El Ochito Red	 14-20A - El Ochito Red	 14-4V15*	N/A	 13-14 - El Ochito Red	N/A
<b>SpeedLine Cables</b>	963-127-3	963-127-3	963-068-26 twisted 963-069-26 flat		963-127-3	
<b>DisplayPort</b> up to 1.4 * up to DisplayPort 2.0	 14-20A - El Ochito Red	 14-20A - El Ochito Red	 14-4V15*	N/A	 13-14 - El Ochito Red	N/A
<b>SpeedLine Cables</b>	963-127-3	963-127-3	963-068-26 twisted 963-069-26 flat		963-127-3	
<b>DVI Single</b>	 14-20A - El Ochito Red	 14-20A - El Ochito Red	 14-4V15	N/A	 13-14 - El Ochito Red	N/A
<b>SpeedLine Cables</b>	963-127-3	963-127-3	963-068-26 twisted 963-069-26 flat		963-127-3	
<b>DVI Dual</b>	 16-22 - El Ochito Red (2)	 16-22 - El Ochito Red (2)	 18-8V31	N/A	 19-17 - El Ochito Red (2)	N/A
<b>SpeedLine Cables</b>	963-127-3	963-127-3	963-068-26 twisted 963-069-26 flat		963-127-3	
<b>eSATA</b> SATA 3.0	 10-1 - El Ochito Red	 10-1 - El Ochito Red	 9-2V	N/A	 9G5 - El Ochito Red	N/A
<b>SpeedLine Cables</b>	963-072-24	963-072-24	963-068-26 twisted 963-069-26 flat		963-072-24	



Series 79™ Micro-Crimp		Micro-D			SuperFly® Datalink	HiPer-D®
792 El Ocho	794 VersaLink	GHSM Micro-D	GHS4-M VersaLink	GMMD	882 SuperFly DataLink	280 SpeedMaster™
 B-23W1 - El Ocho Red	 G-4V12*	 21*	 4-15* (Shell Size 51-2)	 4T9 (Shell Size 31)	 882-019/020 Red	N/A
<b>963-127-3</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-065-30</b>	<b>963-127-3</b>	
 B-23W1 - El Ocho Red	 G-4V12*	 21	 4-15* (Shell Size 51-2)	 4T9 (Shell Size 31)	 882-019/020 Red	N/A
<b>963-127-3</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-065-30</b>	<b>963-066-26 963-066-24</b>	
 B-23W1 - El Ocho Red	 G-4V12	 21	 3-9 (Shell Size 37)	 4T9 (Shell Size 31)	 882-019/020 Red	N/A
<b>963-127-3</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-065-30</b>	<b>963-066-26 963-066-24</b>	
 C-24W2 with El Ocho Red (2)	 H-6V16	 25	 8-9 (Shell Size 67)	 8T15 (Shell Size 51-2)	N/A	N/A
<b>963-127-3</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-065-30</b>		
 A-1W1 - El Ocho Red	 B-2V	 9	 2-0 (Shell Size 15)	 2T (Shell Size 9)	 882-023/024 Red	N/A
<b>963-072-24</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-057-28</b>	<b>963-068-26 twisted 963-069-26 flat</b>	<b>963-065-30</b>	<b>963-072-24</b>	

# turboflex

THE ULTRA FLEXIBLE RUGGED POWER CABLE



TURNKEY  
**turboflex**  
Flexible Cable Assemblies

TurboFlex is an ultra flexible and rugged power cable solution ideal for high-power electrical distribution and propulsion applications such as battery-plant-to-inverter-to-electric-motor cables for eVTOL aircraft. Constructed from rope-lay configuration copper or aluminum wire and jacketed with Glenair signature Duraelectric insulation, TurboFlex cables are optimized for use in an ecosystem of Glenair signature contact and connector technologies. Turnkey connectorized or lugged cable assemblies—fully tested and ready for immediate use—provide reliable high-temperature tolerant performance up to 4500 VAC.



## STANDARD TURBOFLEX R VS. TURBOFLEX M



TurboFlex M with M22759 cable construction



TurboFlex R with rope-lay cable construction



◀ Duraelectric™ is the high-performance TurboFlex® jacketing material. Different compounding formulas are optimized for weight savings, radiation resistance, ultra low temperatures, conductivity, and immersion in chemical or caustic fuels. Available in a broad range of colors including safety orange.

All TurboFlex cables are jacketed with Duraelectric insulation, which contributes significantly to the flexibility of the product. Available wire cores include rope-lay cable (TurboFlex R) and M22759 cable (TurboFlex M). TurboFlex R provides maximum flexibility. TurboFlex M has a slightly larger bend radius but far superior flexibility compared to standard M22759 cable.

## THE TURBOFLEX ECOSYSTEM: CABLES, CONTACTS, CONNECTORS, AND ACCESSORIES

A broad range of TurboFlex cable constructions are available for different application requirements. At the most basic level, we offer two major categories, copper core and aluminum core, both of which have similar electrical performance with significant weight reduction with the aluminum core product. The use of single and dual-wall insulation (Duraelectric or Duraelectric Light) plus available shielding optimizes cable construction for different voltage, power, and environmental requirements. Standard constructions are available for 2-pole DC power, added abrasion protection, 3-phase power plus ground, and VFD 3-phase power requirements for contact gauges #8, #4, #2, #0, #00, and #0000.

### TURBOFLEX-COMPATIBLE HIGH-TEMPERATURE TOLERANT CROWN RING CONTACTS



#### Glenair Signature Crown Ring high temperature tolerant contacts

provide reduced contact resistance, superior conductivity, and higher temperature tolerance than conventional AS39029 contacts and specialized high-power contacts from other manufacturers. Safe-touch configurations available.

- Maximum operating temperature 260°C
- Superior conductivity performance compared to beryllium copper contacts, across full temperature range
- Up to 60% lower contact resistance than equivalent AS39029 contacts (normalized, less wire)
- Contact bodies made from high conductivity copper alloy (approximately 95% IACS)
- Stainless steel Crown Ring
  - Provides socket forces without stress relaxation at high temperatures
  - Moves socket spring function from socket body to ring, allowing use of high-conductivity copper
- Gold over nickel plating
  - Thicker plating than industry standards for reduced contact fretting and higher temperature endurance
  - Gold over nickel is “gold standard” for high-reliability aerospace contacts

### THE TURBOFLEX ECOSYSTEM: COMPATIBLE CONNECTOR DESIGNS WITH OPTIMIZED ELECTRICAL AND ENVIRONMENTAL PERFORMANCE

Raised “Safe-Touch” Socket towers for improved creep path performance

Crown Ring Socket contacts for higher temperature/higher power performance

Integrated EMI spring for improved shell to shell grounding

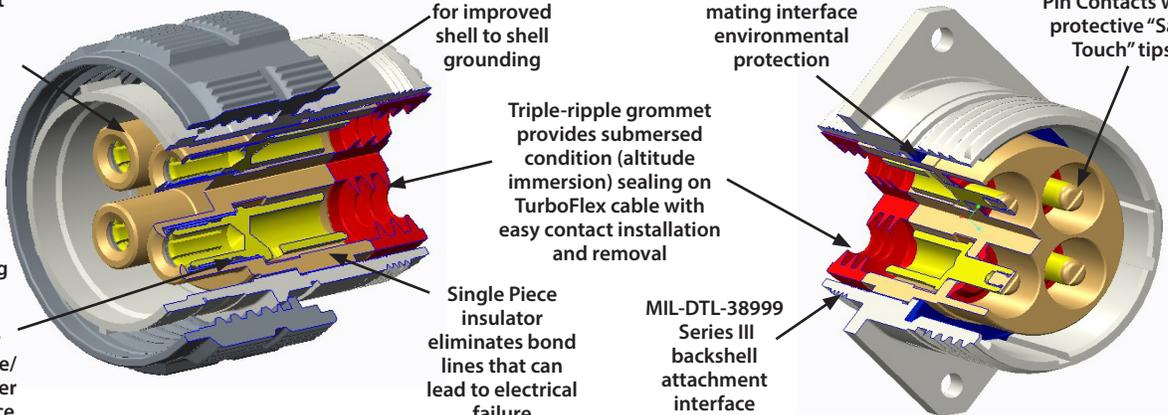
Triple-ripple grommet provides submersed condition (altitude immersion) sealing on TurboFlex cable with easy contact installation and removal

Single Piece insulator eliminates bond lines that can lead to electrical failure

Peripheral Seal for mating interface environmental protection

MIL-DTL-38999 Series III backshell attachment interface

Pin Contacts with protective “Safe Touch” tips



### TURBOFLEX-COMPATIBLE POWERPLAY SIGNATURE HIGH-POWER CONNECTOR FAMILY



SuperNine Series III PowerPlay Triple-Start



SuperNine Series I PowerPlay Bayonet



Series 806 Mil-Aero PowerPlay High Density



Micro-Crimp PowerPlay Rectangular

# Outlook

## Who Are You Going to Believe?

I was recently emailed a link to video of a public figure I admire, side by side with someone I believe to be a perfect scoundrel. They were laughing and cavorting like good old friends. The implication of the mail was that “my guy” was clearly a bad fellow—just look at the company he keeps. And I must admit, I was totally taken in. Everything looked and sounded “real,” at least as far as I could tell. So disappointing.

Now happily I have developed the habit of reading the comments on YouTube posts and elsewhere, as they often reveal the true story behind what passes for news nowadays. And sure enough, the comments exposed that the video I had been sent was fake. A creation of artificial intelligence (AI) – from the picture-perfect image to the convincing tone of voice. All fake. Again, so disappointing.

Because if they can AI a scene like the one I saw, what can’t they do? I understand now that the chat versions of AI can answer any question in a convincing written form without any grammatical errors or tell-tale awkwardness. That movie makers can replace an actor’s voice with that of another—speaking a totally different language to boot—and no native speaker can tell the difference. That they can in fact turn a frog into a prince would not surprise me.

Once upon a time there was a popular expression, *who are you going to believe, me or your own two eyes?* I believe it was first voiced by one of the Marx Brothers. Back then of course it was a gag line. Nowadays it would be more of a philosophical riddle since we apparently can no longer trust our eyes and ears to tell us the truth.

And of course, it isn’t just the media who have turned to AI to trick and cheat our senses. The latest “Nigerian Prince” scam email I received was written in flawless English. So even those rascals have gotten on board with AI.

All of which is to say, that in these changing times it is necessary to be a little less trusting, a little more careful, a little more suspect of the things we see and hear. Does “Made in America” mean what you think it means? Does Amazon really have a refund check for you and is it in fact just one click away? Is that nice man on the phone really from Microsoft and does he have your best interests in mind?

Our subsea connector group here at Glenair always starts big meetings and presentations with a “safety moment,” a brief practical reminder on workplace safety. Taking a page from their book, may I remind everyone in our Glenair world to practice safety and caution when it comes to the things we see *with our own two eyes?*

*Chris Toomey*

# QwikConnect

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