QwikConnect

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MQ-8B Fire Scout Photo: Northrop Grumman

Appropriate Technology:

Smaller, Lighter and Faster Connectors and Cables for Advanced Unmanned Vehicles

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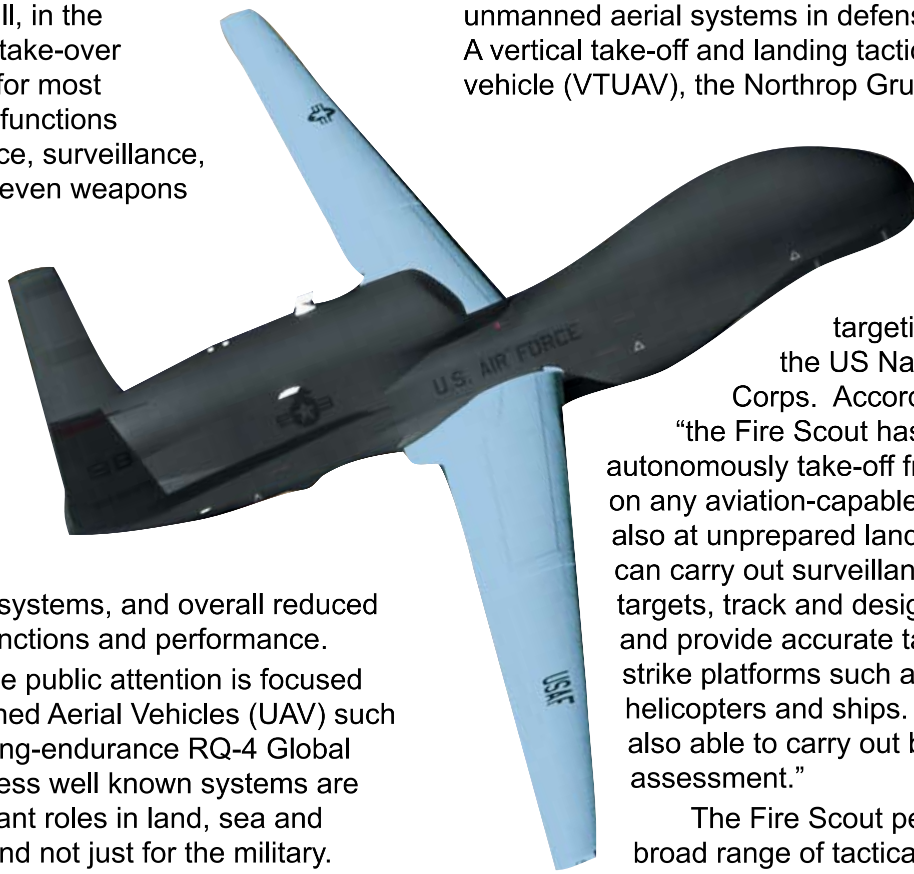
The F-35 Joint Strike Fighter is a multi-role fighter jet optimized for the air-to-ground role with secondary air-to-air capabilities. It is the most advanced manned fighter jet ever designed. Most likely, it will also be the last.

When evaluating the long-term, total cost of ownership, as well as critical safety and performance issues such as decreased human risk in security and defense roles, it is clear that unmanned systems will, in the not-too-distant future, take-over primary responsibility for most traditional air defense functions such as reconnaissance, surveillance, target acquisition and even weapons deployment. Unmanned vehicles in military applications offer advanced maneuverability in rough terrain, the ability to remain aloft for extended periods, better fuel efficiencies compared to manned systems, and overall reduced costs for equivalent functions and performance.



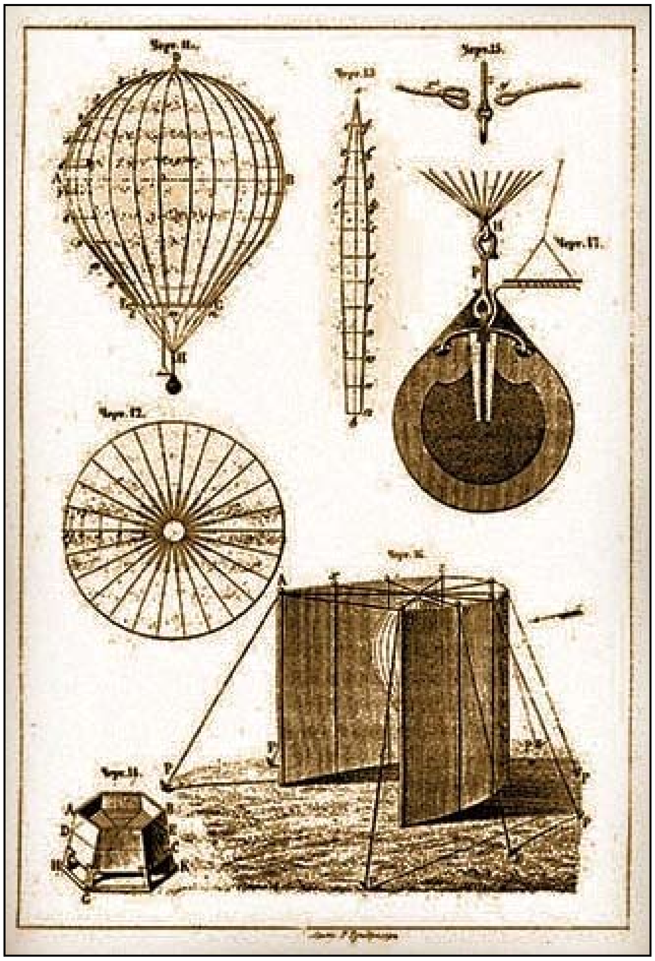
While considerable public attention is focused on successful Unmanned Aerial Vehicles (UAV) such as the high-altitude, long-endurance RQ-4 Global Hawk (shown), other less well known systems are playing equally important roles in land, sea and space applications—and not just for the military. Civilian uses for unmanned planes, subs and ground vehicles include atmospheric research and weather forecasting, fire watch and targeted forest fire fighting, crop monitoring, bomb disposal, commercial fishing, wildlife census taking in remote areas, urban and rural security, and search and rescue missions.

Tucson, Arizona drone-maker Advanced Ceramics Research, for example, produces a UAV system recently used by the Scripps Institute and NASA to perform an air pollution study in the Indian Ocean. Three ACR Manta drones successfully completed the research which had previously failed using manned fixed-wing aircraft.

The MQ-8B Fire Scout pictured on the cover is a showcase example for the expanded role of unmanned aerial systems in defense applications. A vertical take-off and landing tactical unmanned air vehicle (VTUAV), the Northrop Grumman-Ryan Aeronautical Fire Scout provides situational awareness and precision targeting support to the US Navy and Marine Corps. According to its makers, "the Fire Scout has the ability to autonomously take-off from and land on any aviation-capable warship and also at unprepared landing zones. It can carry out surveillance, find tactical targets, track and designate targets and provide accurate targeting data to strike platforms such as (other) aircraft, helicopters and ships. The UAV is also able to carry out battle damage assessment."

The Fire Scout performs such a broad range of tactical functions using its payload package of electronic reconnaissance, surveillance and target acquisition (RSTA) and target designation devices. The basic payload for the Navy includes both electro-optical and infrared sensors for real-time video imagery collection, as well as a laser range finder. On the new US Navy Littoral Combat Ship (LCS), the Fire Scout payload will include a FLIR Systems BRITE Star thermal imaging laser designator system. A Ku-band datalink system will provide narrow band uplink for vehicle and payload control and a wide band downlink for digital streaming of video and data from the payload. Ground control elements include an automatic recovery system. Other payload packages may include the Northrop Grumman COBRA mine detection system, radar, four-channel Joint Tactical Radio System (JTRS) and Signals Intelligence (SIGINT) package.

Glenair is proud to be in a position to supply a wide range of high-performance interconnect products for the Fire Scout, Predator, the Manta and other mission-critical military and commercial unmanned aerial vehicles. While UAV's share many of the same performance requirements of manned aircraft, they place additional demands on the connectors, backshells, cables and wire protection devices that make up the platform's interconnect cabling. Not surprisingly, weight reduction, size reduction, vibration and shock resistance, EMC, corrosion protection, and high-speed/bandwidth data handling are critical design requirements for interconnect cabling in unmanned vehicles. This requirement set extends from the vehicle itself to include the electronic hardware used in ground control/support systems as well as the vehicle's payload of electronic devices.



The origin of the species: Perley's Aerial Bomber (1863) was the first armed unmanned aerial vehicle. The hot air balloon used a timer to trigger its aerial bombardment.

This issue of *QwikConnect* provides an overview of key UV interconnect performance requirements as well as a summary of the Glenair interconnect technologies that are most applicable for use in advanced, unmanned air, sea, space and land vehicles.

Arms and The (Un)Man: The Roots Of Unmanned Vehicles In Tactical Military and Industrial Applications

The term "Unmanned Vehicles" includes all transport modes—air, ground, sea, and space. While Unmanned Aerial Vehicles are an active component in most military arsenals—and presently account for about 80% of defense-related military air traffic—the use of unmanned systems in other areas is still in its infancy. But as the history section below demonstrates, unmanned vehicle activity in all transport modes has been ongoing for decades, and key elements of unmanned technology have been in use for over a century. The breadth of specialized unmanned vehicles in use today is truly staggering, and includes everything from armed aircraft to underwater vehicles, bomb-disposal robots, and remote-controlled transportation systems. In fact, the field has become so diverse that users can now deploy one unmanned vehicle to launch, control, refuel and/or land another unmanned vehicle.

As noted, there are performance advantages to unmanned vehicles compared to traditional manned aircraft—including the ability to execute missions in high threat areas without endangering personnel, greater range (independent reach), greater persistence (ability to loiter over the target area), improved stealth (ability to survive in contested airspace) as well as cost-savings due to the elimination of pilot support systems. And thanks to their reduced size, unmanned vehicles are potentially less costly to manufacture and deploy.

The propulsion sub-systems of modern unmanned aerial vehicles had their origins in traditional aircraft and rocket technologies dating back to the earliest drones and radio-controlled planes of the 1930's. In this respect many UAV's are little more than conventional aircraft modified for operation by remote-control. But it is interesting to note another source of innovation and design that has contributed to smaller variants of UAV's. Because when it comes to truly miniaturized

The most advanced small UAV deployed with the U.S. Armed Forces, the AeroVironment Raven can be operated manually or programmed for autonomous operation.

unmanned systems, today's radio controlled model aircraft hobbyists have been extremely instrumental in the development of new technologies that have found their way into micro-and mini-sized UAV designs. These MUAV's, as they are known, are typically launched by hand or bungee and are the most common unmanned system type in use today.

But the ability of model aircraft technology to meet the performance requirements of high-reliability military and commercial applications is ultimately limited. This is particularly the case when sensitive electronic devices, such as electro-optical and infrared surveillance equipment are added to the vehicle's payload. At this point the vehicle morphs from a hobbyist's toy to a system that must pass more rigorous electrical, mechanical and environmental performance requirements. It is also at this point that wiring and cabling must withstand military-grade performance benchmarks for EMI, vibration and shock, temperature cycling, fluid resistance, contact fretting corrosion, and other durability and reliability requirements.

Interconnect Performance Requirements for Unmanned Vehicles

UV designers, when evaluating long-term, total cost of ownership, as well as the demands of the application environment are compelled to specify high-performance interconnect technologies such as MIL-DTL-38999, MIL-C-26482 or other military-grade connectors. These high-performance connectors offer UV designers such tangible benefits as:

- Improved longevity of service
- Reduced installation and maintenance costs
- Reduced testing and qualification costs
- Improved reliability and safety

But since UAV range and persistence are such critical factors; and since truly "man-portable" vehicles are so important in tactical settings, especially for "over-the-hill" reconnaissance operations, unmanned system designers are also compelled to minimize interconnect weight and size to free-up "real estate" for vehicle payload technologies, communications, flight controls and propulsion systems. Large or small, UAV's are inherently size and weight sensitive, which makes the specification of interconnect technologies a critical element in the overall design process.

Ground- or sea-based vehicle systems face many of the same requirements for improved longevity of service and reliability, but also encounter unique environmental challenges and connector packaging issues such as rapid-advance coupling and the need for field cleanability and chemical resistance. Again, like their aerial cousins, land and sea systems can realize significant benefits from reductions in size and weight.

The following list summarizes some of the more important interconnect performance benchmarks that must be met in military-grade unmanned vehicles:

Mechanical/Materials Packaging

- 300 g's Weapon Shock
- 20 to 30 g's Vibration
- Thermal Shock per EIA-364-32
- Operating Temperature Range: -55°C to +150°C
- Humidity (Condensation) Resistance
- Keyed
- High-Performance Contacts
- 22-28 Gage Signal Wire Support
- Up to 12 Gage Wire Support for Power/ Battery Systems
- Power, Signal, Coax Layouts

Electrical

- 500 Volts DC
- Minimum 3 AMP Current (Continuous Rating) Up to 23 AMP for Power Contacts
- Low Shell-to-Shell Resistance
- Shielded/Grounded
- Compatibility with Balanced Impedance/High Speed Signals
- Up to 65 dB at 1 MHZ EMI Shielding Effectiveness

Environmental

(Field and Man-Portable Systems)

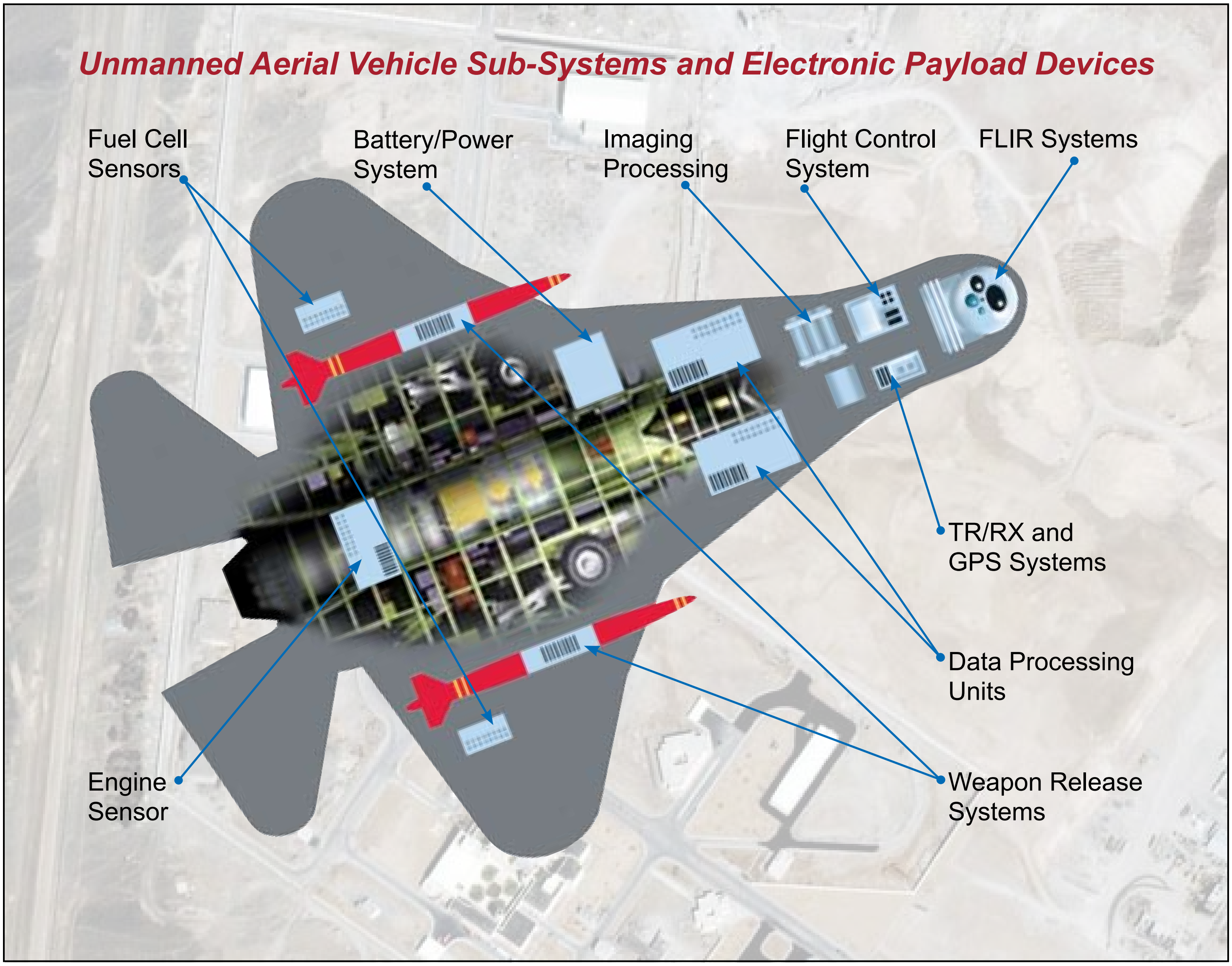
- MIL-STD-810F
- Durability: In Excess of 1000 Mating Cycles
- Field Cleanable
- Chemical Resistance
- Immersion: One Meter for One Hour

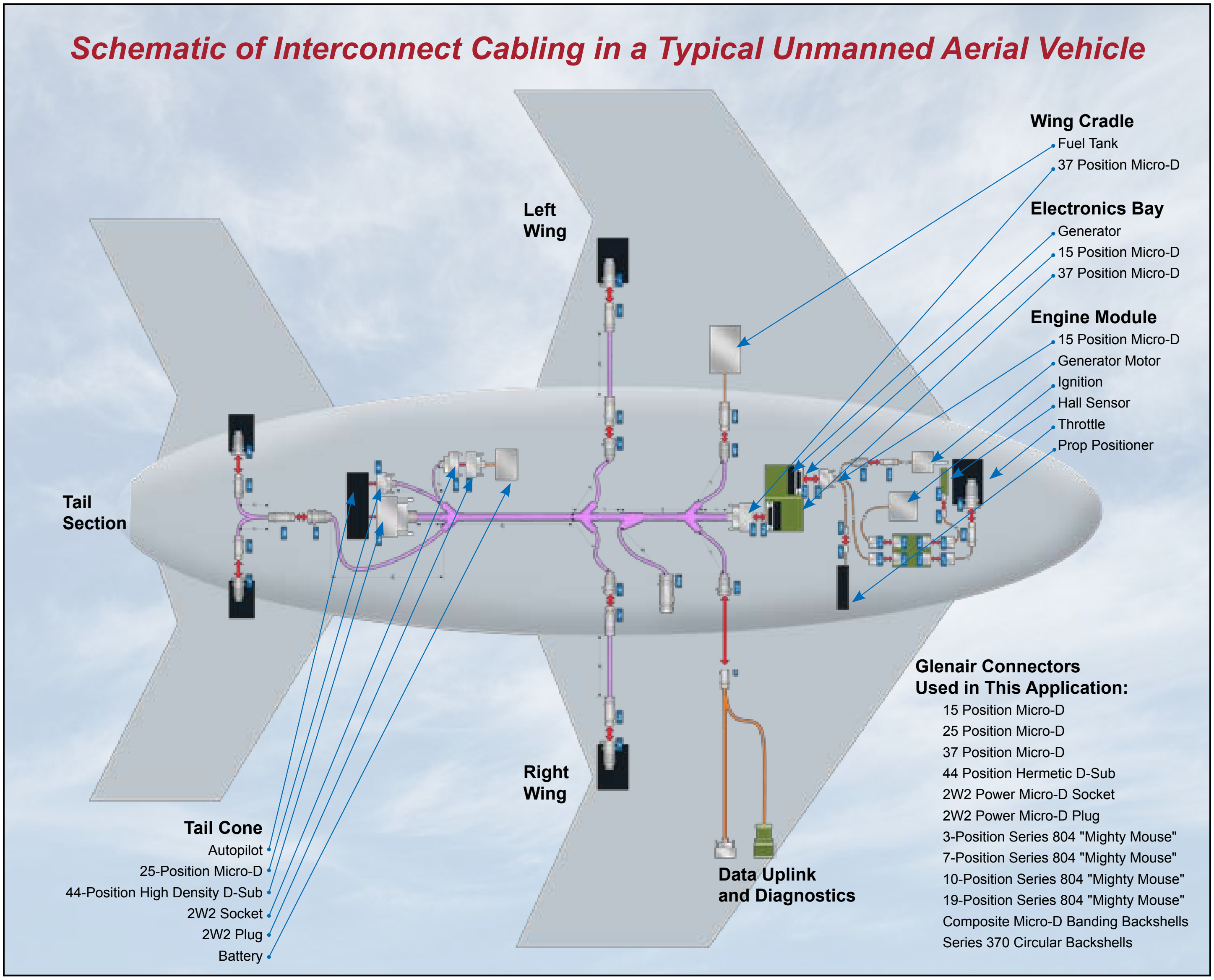
The core technology in the military-grade connectors produced by Glenair—the technology that enables the products to meet the requirements listed above—is the contact system. Superior base materials, superior plating, and superior fabrication processes are used in the contacts throughout Glenair's high-rel connector product line. Our Micro-D connectors, for example, utilize thick, gold plated beryllium copper TwistPin contacts that provide superior performance in such areas as mating durability, electrical performance, resistance to fretting corrosion and intermittence due to vibration and shock. For years we have taken calls from radio-controlled plane enthusiasts looking to get their hands on small quantities of loose TwistPin contacts for in-line incorporation into model plane wiring systems. The reasons are all too clear: the real-estate available for connectors in a micro-sized plane is limited, and yet performance demands for mating retention, corrosion resistance and vibration and shock are as intense as would be found in any aircraft. Our Series 80 "Mighty Mouse" connectors, Series 89 Nanominiature connectors, and our tactical fiber optic interconnect products all utilize superior contact materials and designs. Incorporated into precisely engineered connector housings, these contact systems insure reliable performance in harsh mechanical, electrical and environmental applications.

Ground-based platforms have their own unique set of performance requirements including MIL-STD-810F, the harsh environmental standard for interconnect systems.

The electronic sub-systems of a typical military-grade UAV served by interconnect cabling include: engine controls and sensors, landing/docking systems, flight controls, fuel cell sensors, data processing and navigation, and payload technologies such as high definition infrared camera systems, high speed image processing, special secured data communication electronics, targeting and fire control (weapons) systems, mine detection, sonar, radar or radios. These electronic sub-systems are typically equipped with military standard receptacle connectors for easy incorporation into the vehicle. Various configurations of high-performance rectangular and cylindrical connectors are specified, such as the MIL-DTL-38999 Series III, MIL-DTL-83513 (Micro-D) and other mil-qualified connector families. One of the best opportunities for the interconnect system engineer to improve key performance attributes and/or reduce the size and weight of wiring systems, is to influence connector specifications on payload "black-boxes" and other electronic equipment on the vehicle. Appropriate connector choices on the box will allow the engineer to specify a reduced size and weight cable harness to interconnect the vehicle's many sub-systems—again contributing to both the performance and size/weight requirements of the vehicle.

The illustration below depicts those areas in the vehicle's principal sub-systems using interconnect hardware. These are all areas where the incorporation of reduced size and weight connectors, and/or interconnect cable harness assemblies meeting higher performance standards, could contribute to the vehicle's reliability, safety and longevity of service.





The illustration above depicts a simplified interconnect harness providing power, signal and data handling for an unmanned aerial vehicle with a representative assortment of electronic payload equipment. As in conventional aircraft, the cable harness is principally designed with modular equipment easily installed and replaced throughout the vehicle. In this UAV, a premium was placed on reduced size and weight as the vehicle was targeted to weigh less than 300 pounds and loiter over target areas for extended periods. The interconnect system design also called for long-term durability, resistance to corrosion from condensation—particularly in mating contacts—and resistance to engine-induced vibration as well as (potentially) weapons shock. In terms of mechanical performance, all connectors were required to withstand damage from exposure to fuels or solvents, be hardened (shielded) against EMI, and incorporate polarization keying to prevent mismating. Media support included standard signal, power, coaxial contacts as well as high speed (100BaseT) balanced impedance cabling.

Now it is both good news and bad news that many traditional Mil-Spec circular and rectangular connectors simply don't match the needs of today's unmanned vehicle designers. Size and weight issues alone often prevent designers from specifying

History Of Unmanned Systems
Highlights From Over A Century Of Innovation

UAV—Perley's Aerial Bomber—In 1863, Charles Perley of New York patented an unmanned aerial bomber comprised of a hot air balloon carrying a basket of explosives (Picture on page 3). A timer tripped the hinged basket and the explosives would ignite as they fell to the earth.

1883 UAV—Surveillance Kites—Englishman Douglas Archibald used a kite to take aerial photographs in 1883. Fifteen years later, American Corporal William Eddy used Archibald's design to take hundreds of surveillance photographs during the Spanish-American war.

1898 UUV—Tesla's Telautomatons—Nikola Tesla invented and tested the first unmanned underwater vehicle. His radio-controlled submersible boat with a long whip antenna dazzled crowds at a Madison Square Gardens indoor pool demonstration. He offered the technology to the US Navy, but there was no interest.

1910s UCAV—Sperry Aerial Torpedo—Dr. Peter Cooper and Elmer Sperry invented an automatic gyroscopic stabilizer which they used to convert a US Navy Curtiss N-9 trainer into the first radio-controlled unmanned combat air vehicle.

1930s UAV—Queen Bee—designed as a training target for the Royal Navy, the Queen Bee was the first returnable and reusable UAV. Launched from land or sea, the "Queen Bee" is said to have led to the use of the term "drone" for pilotless aircraft.

UAV—Radioplanes—Reginald Denny, formerly a Hollywood actor, started Radioplane Company in 1939 by hiring engineers and radio experts from nearby Lockheed. He developed the large, remote-controlled airplanes used to train a generation of anti-aircraft gunners.

1940s UCAV—V-1—Adolph Hitler commissioned a flying bomb early in World War II intended for non-military targets. The Fieseler Fi-103, better known as the Vertgeltungswaffe-1 launched from a catapult, and could travel 150 miles before dropping its load.

UAV—PB4Y-1 and BQ-7—the deadly effectiveness of the V-1 led the US Navy's Special Air Unit One to develop bombers to attack V-1 launch sites. The planes took off with a two-man crew that flew to 2,000 feet. The crew bailed out and the plane was controlled by remote television guidance to destroy V-1 launch sites. These planes mark the first time a UAV was used against another UAV.

ROV—The Poodle—the first known ROV was developed by a pioneer in underwater photography named Dimitri Rebikoff.

AUV—SPURV—researchers in the Applied Physics Laboratory at the University of Washington developed the Self Propelled Underwater Research Vehicle (SPURV) primarily for data gathering in the Arctic.

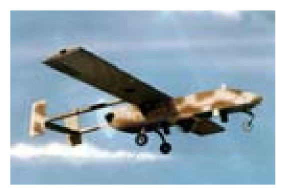
1960s—UAV Ryan Firebee—The US Air Force's earliest stealth reconnaissance programs included the Firebee. Launched and controlled from a DC-130, the Firebee parachuted to a safe landing zone for helicopter retrieval. Extremely reliable, the Firebee saw significant action in the Vietnam War.

UAV—DSN-1—Gyrodyne Company won the contract to develop a DASH (Drone Anti-Submarine Helicopter). The DSN-1 could fly off a frigate or destroyer carrying torpedoes or depth charges for attacks on enemy submarines.

ROV—CURV—the US Navy developed an ROV called CURV (Cable Controlled Underwater Recovery Vehicle) that recovered an atomic bomb lost off the coast of Spain in 1966 and saved the pilots of a sunken Irish submersible in 1973.

1970s—UAV Ryan SPA 147—modifying a Firebee, Ryan developed a new UAV designed for COMMINT acquisition at high altitude, above the range of enemy missiles. The Special Purpose Aircraft (SPA) 147 could fly for eight hours, eavesdrop on enemy communications and take photographs from 60,000 feet.

1980s UAV—Scout—built by Israel Aircraft Industries, Scout was deployed in a tactical environment. Its fiberglass frame, small size and low radar signature made it almost impossible to shoot down. A turret-mounted 360 degree camera provided real-time video.



UGV—Autonomous Land Vehicle (ALV)—Martin Marietta partnered with DARPA to make an eight-wheeled vehicle, the ALV, with video cameras and laser sensors to provide real-time data to the remote operator.

UGV—TeleOperated Dune Buggy—Advanced Technology Company worked with the Navy to develop a remotely operated dune buggy able to traverse complex terrain at relatively high speeds.

UGV—Ground/Air TeleRobotic Systems—GATERS was a HMMWV operable remotely from another HMMWV using non-line-of-sight communications at distances up to 30 km. Headset stereo visual displays, binaural audio and isomorphic driving controls enabled the operator to maneuver GATERS at relatively high speeds, fire a 50 caliber machine gun remotely and designate targets for Hellfire missiles.

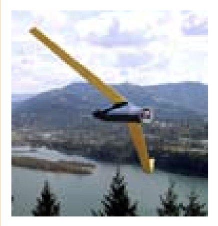
UGV—Mars Rover Sojourner—a six-wheeled vehicle weighing only 23 pounds, Sojourner could move about 500 meters from the lander at a maximum speed of one centimeter per second. From July to September 1997, Sojourner sent 550 images, chemical analyses of rocks and soil, and extensive wind and weather data from Mars.

Noteworthy Modern Day Systems

UAV—Pathfinder—AeroVironment's pioneering solar-electric unmanned aircraft, Pathfinder, is only the fourth AV innovation to be acquired for the permanent collection of the Smithsonian Institution.

UAV—Predator—General Atomics' Predator is well established in the US Air Force. With a 450 mile range, Predator can provide up to 16 hours of surveillance using high definition color television, infrared cameras, and synthetic aperture radar. The plane is controlled from the ground using line-of-sight or satellite link.

UAV—Global Hawk—Teledyne Ryan's Global Hawk is a large UAV with a 116 foot wingspan. It can take off from a US base, fly autonomously to a country of interest, collect and transmit surveillance data at a height of 65,000, and return to its base without refueling.



UAV—ScanEagle—a tailless, lightweight (40 pounds) UAV made by Insitu and the Boeing Company, ScanEagle is quite portable. It can achieve 68 knots for 15 hours. Launched by catapult and recovered by a Skyhook snag, ScanEagle can be carried on small patrol cutters.

UAV—Fire Scout—meeting the Navy's requirement for a VTOL UAV, Northrop designed Fire Scout, a pilotless helicopter weighing only 500 pounds with a payload of up to 700 pounds. Accommodating a wide variety of data gathering and reconnaissance applications, the Fire Scout can also carry armaments.

MAV—Wasp

AeroVironment's micro aerial vehicle (MAV) is a small, portable, and rugged unmanned aerial platform for front-line reconnaissance and surveillance.

TUGV—Tactical Unmanned Ground Vehicle—a joint venture of the US Army and Marine Corps, TUGV was designed for helicopter or HMMWV transport. Built by Polaris on a six-wheeled all-terrain base, TUGV employs stereo imaging, night-vision, chemical weapons detection, GPS data and acoustical detection for surveillance and patrol.

UCAV—The Boeing X-45C is an autonomous UCAV that cruises at Mach 0.85 carrying a 4,500 pound payload. It can fly 40,000 feet with a mission radius of 1,200 nautical miles and is air-to-air refuelable. Incorporating stealth technology, the X-45C is controlled via satellite communications.

AUV—Hugin 3000—Kongsberg Simrad of Norway developed an aluminum/oxygen fueled AUV that operates at four knots for 40 hours conducting deep sea geophysical mapping. Another model, the Hugin 1000, conducts mine countermeasure and environmental assessment operations.

standard high reliability military connectors—such as the popular MIL-DTL-38999 Series III—in unmanned vehicle systems. But other factors, such as the lack of effective EMI shielding or environmental sealing are additional barriers preventing the use of many conventional mil-spec connectors in mission-critical unmanned platforms. Many connectors, such the ubiquitous MIL-DTL-24308 D-Subminiature, lack virtually every attribute required for specification in today's high-performance UAV's, such as reliable resistance to vibration and shock, chemical resistance or effective EMI shielding/grounding. The good news is that Glenair manufactures a broad range of connector designs specifically geared to satisfy the high-performance requirements of a broad range of unmanned systems.

The Glenair Series 80 "Mighty Mouse" Connector

The Series 80 "Mighty Mouse" is a smaller, lighter alternative to MIL-DTL-38999 connectors yet with the same robust electrical, mechanical and environmental performance, and a familiar rear-release crimp contact system. With a wide range of styles and features, and up to 71% weight savings and 52% size reduction over an equivalent density D38999 connector, the Series 80 "Mighty Mouse" is ideally suited for use in smaller, lighter weight platforms. As mentioned above, the contact system Glenair used in the "Mighty Mouse" is in large measure responsible for the connector's outstanding performance and reduced size and weight.

Standard catalog Series 80 "Mighty Mouse" connectors use size #23 contacts with 0.076 inch contact spacing (size #12 and #16 power contacts are also supported in selected insert arrangements). The contacts are installed into a beryllium copper retention clip utilizing familiar crimp-and-poke technology. This contact system is what enables the Series 80 "Mighty Mouse" to match the performance of D38999, with approximately twice the density and half the weight. No other miniaturized connector offers equivalent performance.

Northrop Grumman was one of the earliest adopters of the Series 80 "Mighty Mouse" for use in the company's Fire Scout unmanned helicopter. Subsequently, Northrop specified "Mighty Mouse" for several other unmanned vehicles (please consult your Glenair Sales Group for additional Northrop Grumman references). General Atomics has also used the Series 80 "Mighty Mouse" to meet the rigorous performance requirements of its signature Predator drone. Other unmanned vehicles using the Series 80 "Mighty Mouse" include Shadow from AAI, ScanEagle from Insitu and Watchkeeper from Thales.

The Series 80 "Mighty Mouse" Connector is a mature product line with a broad range of insert arrangements from 3 to 85 contacts, shielding accessory backshells, and coupling styles. Glenair offers selected "Mighty Mouse" products with EMI/EMP filtering and/or hermetic capabilities. Special 3500 PSI submersible versions are also available. The table on the opposite page may be used as an aid in basic product selection.

For turnkey high speed serial data solutions, unmanned vehicle designers are also turning to "Mighty Mouse" ASAP Cordsets for 100BASE-T, Gigabit Ethernet, IEE 1394 and USB 2.0 applications. General Atomics has specified "Mighty Mouse" cables for high-speed Ethernet and Firewire video and audio data on the Predator. These cordsets combine aerospace-grade data cables with "Mighty Mouse" harsh environment connectors for maximum performance and minimum size.

High-Performance Series 80 "Mighty Mouse" #23 gage crimp contacts are made from beryllium copper alloy and gold-plated per ASTM B488 Type 3, Code C.

SERIES 80 "MIGHTY MOUSE" SELECTION GUIDE	Series 800	Series 801	Series 803	Series 804	Series 805
					
Description	UNF Threads	Double-Start ACME	¼ Turn Bayonet	Push-Pull	Triple-Start ACME
Notes	A general purpose connector for Ethernet switches, tactical equipment and instrumentation.	More rugged keys and threads compared to Series 800. Faster mating, slightly larger than Series 800.	Quick-mating, light duty, general purpose. Not rated for immersion. 50 milliohms shell-to-shell resistance.	Breakaway connector for headsets and tactical equipment. Gold-plated spring for long mating life and superior EMI shielding.	"Clicker" ratchet mechanism and ground spring for military airframes and avionics boxes. Fast-mating, D38999 equivalent.
Coupling	Threaded Coupling with 4 ½ Turns to Full Mate	Threaded Coupling with 1 ½ Turns to Full Mate	Push-to-Mate, ¼ Turn to Lock	Quick-Disconnect with Canted Spring	One Full Turn for Full Mate
Proven Performance Applications	Commercial air frame sensors; UAV telemetry; Tactical computers; field radios;	Military air frame; Dismounted soldier; Tactical ground weaponry; Avionic (FLIR) system	Soldier system radios; Autosport diagnostics; Airborne surveillance	Helmet breakaway connector; QDC battery; Missile applications; Weapon interconnect	Autosport; Military air frame; Joint Strike Fighter; UCAV

Unmanned Systems Glossary of Acronyms

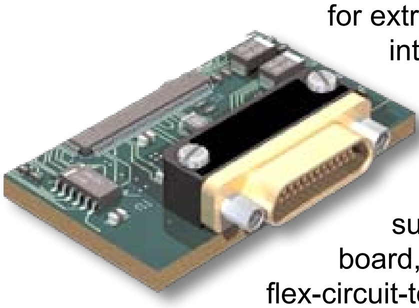
ACAS	Autonomous collision avoidance system
AI	Artificial intelligence—sophisticated programming of unmanned systems, particularly UGVs, intended to replicate human thinking
ALV	Autonomous land vehicle—a UGV pre-programmed for proscribed actions
ASH	Autonomous search and hydrographic vehicle—a pre-programmed unmanned surface vehicle used for reconnaissance
AUV	Autonomous underwater vehicle—pre-programmed underwater robots used for mapping, reconnaissance, and mine detection
CARD	Computer aided remote driving—using stereo pictures from a UGV, a human operator remotely designates a path for the UGV to travel
CDL	Common data link—data communications system in use on many D of D applications, to enhance cross-functional compatibility
DASH	Drone anti-submarine helicopter—flying off a frigate or destroyer carrying torpedoes or depth charges to destroy enemy submarines
DSA	Detecting, seeing and avoiding—a form of radar deployed on unmanned systems
FCS	Future Combat System—the US Army's family of manned and unmanned systems connected by a common network
HALE	High-altitude long-endurance—UAVs designed for sustained\ high-altitude service
HALSOL	High-altitude solar—solar powered UAV intended to stay aloft indefinitely
MAV	Micro (or Miniature) aerial vehicle—micro- or miniature-drone UAV with a largest dimension in the range of 5-6 inches.

NO-CON	No contrail—chemical intervention to eliminate visible contrail on target drones
NOTAR	No-tail rotor—propulsion system for helicopter UAVs that does not include a tail rotor
ROV	Remotely operated underwater vehicle—tethered underwater robots operated by a human aboard the surface vessel
RPSV	Remotely piloted surface vehicle—an unmanned surface vehicle controlled by a remote human operator
SAM	Semi-autonomous mobility—a human planner designs a route for a UGV using topographical data from a satellite
SEAD	Suppression of enemy defenses—use of UAVs to destroy enemy positions
STOVL	Short take-off and vertical landing—a means by which UAVs can operate from aircraft carriers
SWARM	Shallow water autonomous reconnaissance module—intended to proceed ahead of fleet for reconnaissance and threat identification.
TALD	Tactical air launched decoys—deployed to confuse air defenses
UAV	Unmanned aerial vehicle—all varieties of unmanned aircraft including airplanes, helicopters, dirigibles, balloons, flying wings, etc.
UCAV	Uninhabited combat air vehicle
UGV	Unmanned ground vehicles
USV	Unmanned surface vehicles—vehicles traversing the sea surface. Also (and less commonly): Unmanned Space Vehicles
VATOL	Vertical altitude take-off and landing—use of jet-powered and rocket-assisted lift to launch a UAV alongside the ship or off the stern
VLS	Vertical launch systems—a means to deploy an unmanned underwater vehicle from a ship or submarine
VSTT	Variable speed training target—a target drone UAV capable of variable speed to simulate evasive actions

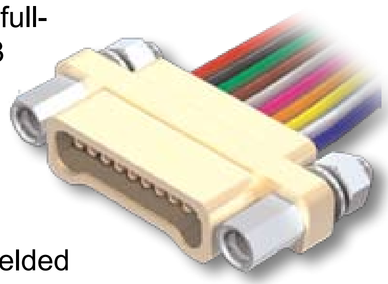
Military Standard MIL-DTL-83513 Micro-D TwistPin Connectors

Glenair's 0.050” contact spacing MIL-DTL-83513 Micro-D TwistPin Connectors offer uncompromised performance in a lightweight rectangular package. The connectors are equipped with a unique TwistPin contact system more rugged than a stamped pin, and providing a superior wire attachment for lower contact resistance. The TwistPin's wire attachment sleeve also allows a gas-tight crimp, ensuring superior tensile strength and lower circuit resistance than stamped-and-formed sleeves.

Glenair’s Micro-D TwistPin connector allows for extremely small interconnect wiring systems with no compromise in performance. The products are ideally suited for I/O wire-to-board, board-to-board or flex-circuit-to-board applications and are available in pre-wired pigtails, solder cups and PCB mount versions.



In addition to our full-range MIL-DTL-83513 series, Glenair offers comparable commercial designs with rapid turnaround on custom products including shielded and back-to-back Micro-D cable assemblies as well as flex circuit board assemblies. Extremely small and light weight, Glenair Micro-Ds have a legacy of top performance in adverse conditions. Glenair is qualified on virtually every MIL-DTL-83513 slash sheet and stocks thousands of part numbers in our Same Day inventory, ready for immediate shipment.



Glenair Micro-D’s are already on board many UAV programs including Predator, Shadow, Watchkeeper, and Fire Scout. Recently Insitu specified a Glenair custom-designed Micro-D for a blind-mate wing attachment on their second generation ScanEagle. Insitu is also using Glenair Micro-Ds on the propulsion system and remote controller of this advanced UAV. Under the seas, Micro-D assemblies are in a developmental miniature unmanned submarine operating mine detection sonar.

New Qualified MIL-DTL-32139 and Series 89 Nanominiature Connectors

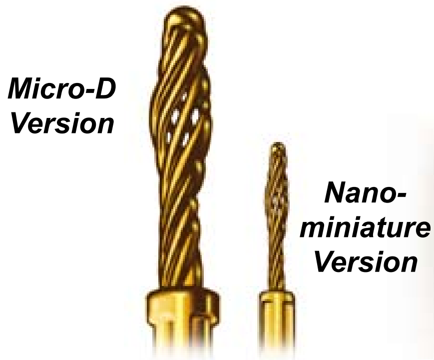
Glenair’s 0.025 inch contact spacing Series 89 Nanominiature connector is the latest evolution in rectangular shaped connectors for board-level I/O applications. Featuring solid gold TwistPin contacts and aluminum, titanium or stainless steel shells, the Nanominiature is the smallest, yet remarkably robust, connector we make. Glenair is one of the first interconnect manufacturers to qualify to the new MIL-DTL-32139 Nanominiature Mil-Spec for these precision-machined connectors that deliver both ultra high density and maximum weight and space savings. These high reliability ultra miniature interconnects are ideal for critical applications where size and weight restrictions preclude the use of larger Micro-D connectors. Ideal for unmanned vehicles of all types, contact spacing of 0.025 inches combined with a rugged contact system allow Nano connectors to be used in the most demanding unmanned vehicle environments.

The Glenair Nano contact system consists of a TwistPin (a miniaturized version of the Glenair Micro-D TwistPin) and a tubular socket providing excellent durability and superior resistance to shock and vibration. Accommodating #30 or #32 AWG wire, Nano TwistPin contacts handle 1 AMP current rating and 70 VAC RMS operating voltage.

The TwistPin contact system offers excellent durability and superior resistance to shock and vibration. The pin bundle consists of seven strands of gold alloy wire, providing multiple contact points with the socket. The contacts are unplated—possible because the contact material is 70% gold, alloyed with other metals to yield a superior spring temper material.

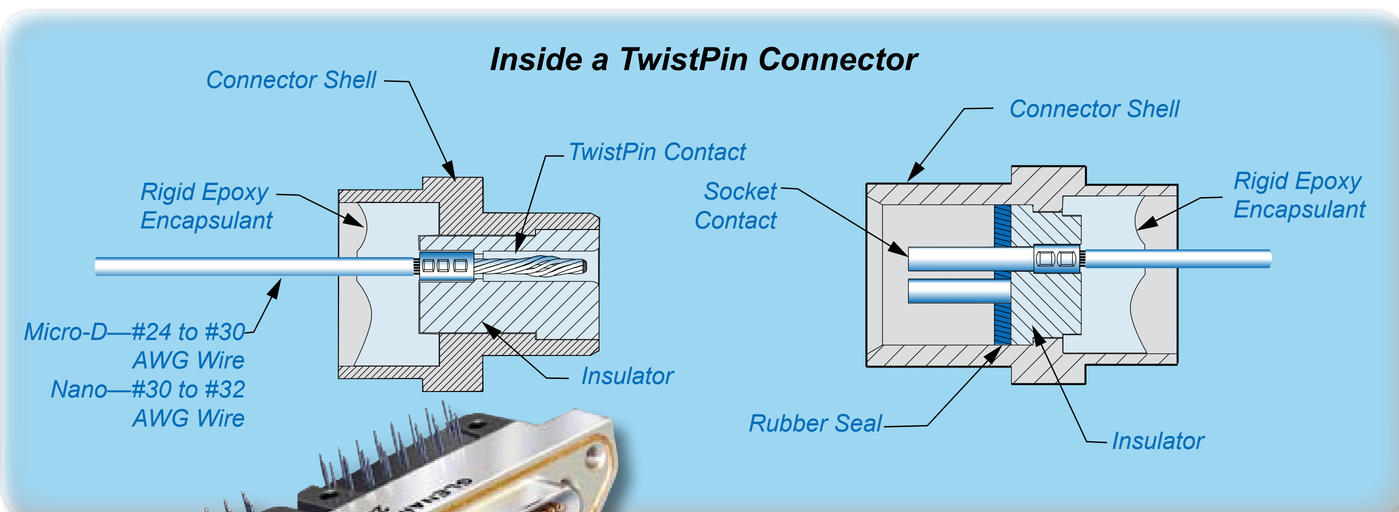
Available in single- and double-row packaging, with contact densities from 9 to 51 pins, plug and receptacle, Glenair Nanominiature connectors can be specified in insulated or uninsulated pigtail assemblies, back-to-back cables, right angle PCB mounts, vertical mounts, and surface mounts.

The Glenair TwistPin Contact System



At-a-Glance

If reliability and performance were the only design considerations of a Micro or Nano contact system, everyone would opt for a TwistPin contact and a machined socket and crimp sleeve. But cost and ease of manufacture are significant issues as well, which is why stamped and formed contacts are allowed in both the micro and nano specifications. But make no mistake, the Glenair TwistPin Contact System provides a *superior* wire attachment for lower contact resistance under extreme conditions of vibration, shock and high heat. An additional benefit of the TwistPin contact is the ease of designing custom connectors and packaging, as the contacts can be readily integrated into a wide range of connector package envelopes, including both rectangular and cylindrical designs.



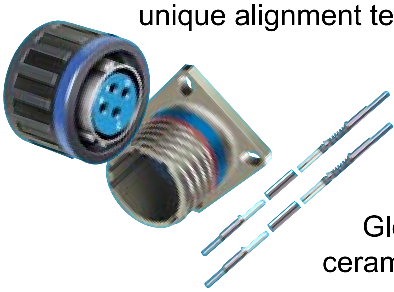
Close-up of eight-indent crimp wire termination.

Glenair Fiber Optic Connectors and Contacts

Glenair makes a wide range of fiber optic connectors and contacts (termini) for high-reliability applications. These products are ideally suited for use on both manned and unmanned vehicles due to their light weight, EMI immunity and high bandwidth. Fiber optic media has seen increasing use in unmanned systems from tactical mobile ground systems used for bomb disposal to naval UAV's used for targeting and surveillance. In certain cases, fiber media has been introduced after EMI problems have surfaced with traditional copper media. In one such instance, a ship-based UAV's rudder controls experienced repeated failure due to EMI when passing in front of a massive phased array antenna on a battleship. The plane's interconnect engineer solved the problem by replacing the copper-based media with a fiber optic interconnect link made by Glenair. More commonly, fiber is specified at the onset of design to address a bandwidth or high-speed data requirement. For example, an unmanned towed submarine uses Glenair fiber optic connectors and termini on the mast for an above- and below-surface periscope imaging system with extremely high data transfer and bandwidth requirements.

Glenair fiber optic products are specified as combined connector-contact systems. Each connector family, in other words, uses its own precisely engineered contact with different attributes such as density, single and multimode media support, APC polishing and so on. Here then are three of the optical interconnect systems made by Glenair that are particularly applicable to the needs of unmanned vehicles:

- **Our MIL-DTL-38999 Style Connectors** use qualified MIL-PRF-29504 termini which employ unique alignment techniques to maximize optical performance and provide reliable, repeatable interconnection of optical fibers. Glenair's unique precision ceramic ferrules, with concentricity and diametric tolerances controlled within a micron (.00004 of an inch) meet the needs of high bandwidth and low allowable insertion loss applications.



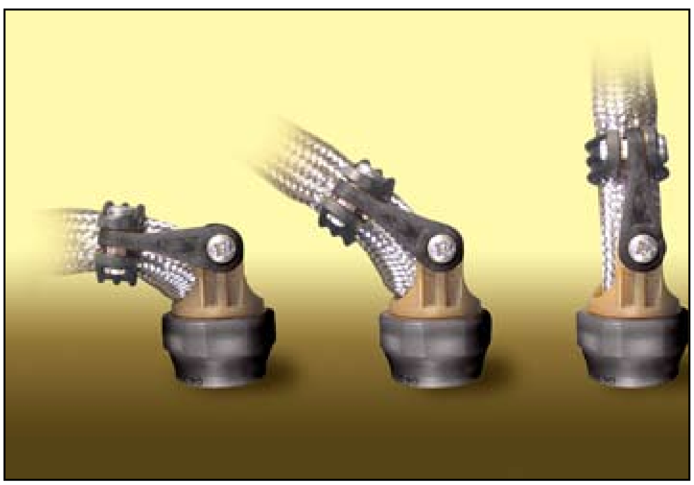
- **The Glenair High Density (GHD) Fiber Optic Connection System** is ideal for unmanned vehicle applications requiring reduced size and weight as well as outstanding optical and environmental performance. Dense cavity spacing is achieved with an innovative front-release terminus design that accommodates M85045/16 cable. The 18 gage genderless contact system offers insertion loss values less than .5dB (typical loss for Glenair termini is .3 dB). The GHD contact is also keyed for singlemode APC polish applications.

- **The Glenair Custom Front Release Fiber Optic Connection System** uses a unique 16 gage termini that allows rapid integration of optical media in a broad range of cylindrical and rectangular connector packages and systems. By placing the retention and environmental sealing components directly on the termini, Glenair is able to fabricate unique, custom fiber optic connector shell packages without costly tooling and engineering. This is particularly useful in applications where the addition of a single fiber line in a hybrid electrical connector is required.

Glenair is the only fiber optic connector and termini manufacturer to also offer a complete line of specialized fiber optic backshells. We also operate our own in-house fiber cable extrusion line, which is ideal for prototype projects and other applications which do not meet large cable house minimum length requirements. Our patented fiber optic test probes round out our fiber optic offerings

Composite Thermoplastic Interconnect Solutions

The choice of alternative materials in interconnect systems—such as composite thermoplastic—can reap significant benefits in weight reduction, stealth, corrosion protection and resistance to vibration and shock. Glenair offers a wide array of composite thermoplastic connectors, backshell accessories, convoluted tubing systems and junction boxes for advanced corrosion protection and weight reduction of 40% over aluminum. The products afford inherent shock and vibration dampening, reduced magnetic and acoustic signatures for stealth, dimensional stability, and platabilty for EMI/RFI protection. Currently on unmanned vehicle programs including Predator, Watchkeeper, Shadow and more, Glenair composite components are ideally suited for applications with advanced weight-reduction requirements. Here are three such composite technologies from Glenair which may be of particular interest to unmanned vehicle designers:



- **Patented Composite Swing-Arm Strain Relief Backshell:** Three backshells in one—straight, 90˚ and 45˚. The product meets stringent AS85049 mechanical and electrical standards, is simple to install, and reduces stock keeping overhead.

- **Composite EMI/RFI Junction Boxes:** Ideally suited for harsh environments and weight reduction efforts "on the bird" or on the controller. Our junction boxes meet shock and vibration requirements of MIL-S-901D and MIL-STD-167SHIPS, EMI/RFI/HIRF and indirect lightning strike performance specifications.

- **Composite Metalized EMI Braiding Solutions** offer 50% weight savings over standard metal braid with equal or better EMI shielding.

Conclusion

Electrical, mechanical and environmental interconnect system performance requirements for unmanned vehicles used in military and commercial applications are reasonably well understood. The requirement to specify interconnect systems that contribute to the vehicle's longevity of service, reliability, safety and cost can be addressed by choosing products that both optimize performance and accommodate desired reductions in size and weight.

Glenair is uniquely positioned in the interconnect industry as the only manufacturer that supplies virtually every component part in today's most high-reliability cable assemblies. We make the connectors, the contacts, the backshells, the cables, the dustcaps, the EMI braiding, and even the junction boxes. In fiber optic systems we make the precision contacts (termini), the connectors, the cable, the backshells and all the termination and test equipment. Finally, we run a qualified cable assembly shop where we can put all the components together, per customer specifications, into integrated cable, harness, conduit and box assemblies. It is not an overstatement to say that no one else in our industry has such a broad range of specialized interconnect solutions and expertise as Glenair.

The opportunity to design-in interconnect systems that truly contribute to the overall performance of an unmanned vehicle is well within the grasp of every interconnect system designer. At Glenair, we make interconnect systems that are smaller, lighter and faster and yet still meet the most critical performance benchmarks of today's most advanced unmanned vehicles. For more information, visit us at www.glenair.com or contact your local Glenair Sales Group.

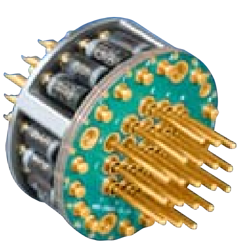
Appropriate Technology

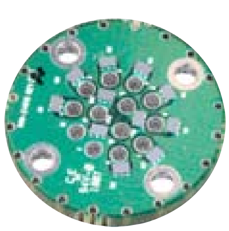
Appropriate technology means different things to different people. To the professionals out on our shop floor it means using the most efficient equipment and tooling for each phase of production. But to our customers who are designing and building today's most advanced unmanned vehicles, appropriate technology means component products and sub-systems that exactly meet the requirements of the vehicle and its mission. When it comes to connectors and cable harness assemblies for unmanned vehicles, we believe that no other supplier in our business has the expertise to design-in such "appropriate technology." From our lightweight composite products to our ultraminiature connectors and precision contact systems, we can offer our customers ideas and solutions that are virtually unavailable elsewhere in the industry.

Since it is not addressed in this issue of *QwikConnect*, I wanted to draw everyone's attention to another type of appropriate interconnect technology for unmanned vehicles that has become increasingly important to our customers—EMI/EMP filters: Filter connectors use internal capacitors and/or inductors and diodes to “strip off” unwanted noise or transient voltages from the desirable signals traveling into and out of a piece of electronic equipment. This is an important role for a connector to play, because solving EMI problems at the board level in a complex electronic device can be whale of a problem.

In just the last several years, Glenair has gone from being little more than an afterthought in our customers’ minds when it comes to filter connectors, to a first-choice supplier of these critical interconnect components. Here are the reasons why: First of all we have hired some of the top people in this field. I’m not going to name names (in case I forget somebody) but we really have put together a fantastic team of EMI/EMP filter experts in both the factory and in our field sales team. Second, we have taken aggressive steps to build up our factory capacity to the point where we can turn out these products as fast or faster than anyone else in the business. Third, we have done the necessary in-house design work to be able to offer filtering technology in every connector series that we produce. And finally, we have put together some easy-to-use sales tools, like our *EMI/EMP Filter Connector* catalog that takes much of the mystery and confusion out of nailing down the dozen or so variables in the design process. For a taste of what I am referring to here, take a look at the “Filter Connector Designer’s Application Checklist” in our new catalog.

And for an illustration of the caliber of work taking place in our filter connector division, take a look at these two photographs: The EMP diode package on the left is what the customer *was* using. The low-profile solution on the right performs the equivalent function at just a fraction of the weight and size—and it was designed and produced right here at Glenair. Now that’s what I call “appropriate technology.”





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Glenair has been the leading manufacturer and supplier of commercial and Mil-Spec connector accessories since 1956. Building on that foundation, we now offer full-spectrum product lines designed to meet every interconnect requirement. From ruggedized military connectors to tactical fiber optic connectors and cables, from EMI conduit systems to Micro-D harness assemblies, from Navy approved composite enclosures to a complete range of connector assembly tools—Glenair does it all. And throughout the years, we’ve made outstanding customer service our approach to earning customer trust, and to maintaining our position as the industry’s best-value interconnect supplier. *QwikConnect* is published occasionally by Glenair, Inc. Printed in U.S.A.

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